Title

Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873-76. Physics and chemistry - Vol. 1

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Publication Date

1911-12-28

THE
VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY—VOL. I.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF
CAPTAIN GEORGE S. NARES, R.N., F.R.S.
AND
CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF
THE LATE
Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.
REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH
DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD
AND NOW OF
JOHN MURRAY, F.R.S.E.
ONE OF THE NATURALISTS OF THE EXPEDITION

PHYSICS AND CHEMISTRY—VOL. I.

Published by Order of Her Majesty's Government

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE
AND SOLD BY
LONDON:—LONGMANS & CO.; JOHN MURRAY; MACMILLAN & CO.; SIMPKIN, MARSHALL & CO.
TRÜBNER & CO.; E. STANFORD; J. D. POTTER; AND KEGAN PAUL, TRENCH, & CO.
EDINBURGH:—ADAM & CHARLES BLACK AND DOUGLAS & FOULIS.
DUBLIN:—A. THOM & CO. AND HODGES, FIGGIS, & CO.
1884

Price Twenty-one Shillings.

CONTENTS.

EDITORIAL NOTES.

THE physical and chemical investigations conducted by Mr. J. Y. Buchanan, during the three and a half years' cruise of H.M.S. Challenger, are among the most important and valuable of the Expedition.

Mr. Buchanan collected daily, with much care, samples of the surface water, and determined the specific gravity. At all Stations, a slip water bottle was attached to the sounding line, and the specific gravity of the specimen of bottom water thus collected was also ascertained. At every Station, where practicable, waters were collected from intermediate depths at 25, 50, 100, 200, 300, 400, and 800 fathoms from the surface, with a stop-cock water bottle attached to a separate sounding line, under Mr. Buchanan's personal supervision. The specific gravity of these waters was also determined.

The routine chemical work of the Laboratory consisted in boiling out the gases from, and in determining the carbonic acid in, as many samples as possible.

A very large number of samples of sea-water were collected from the surface, bottom, and intermediate depths, and preserved in glass stoppered bottles. These were either sent home along with other collections from various ports touched at during the Expedition, or brought home by the ship.

It is difficult for any one, except those who actually witnessed the daily work at sea, to form an adequate idea of the labour, skill, and continuous effort required to carry on these observations in all sorts of weather, and to form, and bring home successfully, collections and observations like those which have resulted from Mr. Buchanan's exertions.

Shortly after the return to England, Mr. Buchanan analysed a number of the samples of gas which had been boiled out from the waters on board ship.

As Mr. Buchanan was subsequently unable to proceed with the chemical work connected with the Expedition, the remainder of the gas samples (along with the results of those analysed), the water samples, and Mr. Buchanan's official journals, were entrusted by the late Sir C. Wyville Thomson to Professor W. Dittmar, F.R.S., with a request that he would undertake certain analyses of the gas samples and the waters. Professor Dittmar forwarded reports on his analyses at various times to the late Editor during the years 1878–1881.

In the year 1882, Professor Dittmar undertook, at my request, to complete the gas and water analyses, and to prepare a Report on the whole of his investigations into the Composition of Ocean-Water, embracing the work done on board ship by Mr. Buchanan. The result is the valuable memoir which forms Part I. of the present volume. It will be found that Professor Dittmar has not contented himself with giving mere analyses, but has discussed their significance with respect to the Problems of Oceanography.

Part II. of this volume, which is accompanied by a map and numerous diagrams, has been prepared by Mr. Buchanan, and gives the results of his determinations of the specific gravity of surface, intermediate, and bottom waters of the ocean.

Part III. of this volume contains all the observations on the temperature of ocean-water taken by the officers of the Expedition, except those of the surface, taken every two hours, which will be found in the Meteorological Observations published in Volume II. Narrative.

John Murray.

Challenger Office, 32 Queen Street,
Edinburgh, *8th April* 1884.

THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on Researches into the Composition of Ocean-Water collected by H.M.S. Challenger during the years 1873–76. By William Dittmar, F.R.SS. L. and E., Professor of Chemistry, Anderson's College, Glasgow.

I. THE PRINCIPAL SALINE COMPONENTS.

Sea-water has long been known to consist in the main of a solution of the chlorides and sulphates of sodium, magnesium, potassium, and calcium. A quantitative analysis which correctly reports these few acids and bases, gives almost as close an approximation to the proportion of total solids as it is possible to obtain. And yet, from the fact of the ocean being what it is, it follows almost of necessity that there must be numerous minor components. Perhaps no element is entirely absent from sea-water; but according to Forchhammer only the following (in addition to the predominating components already named) have been proved to be present:—

Bromine: easily detected in the mother-liquor obtained in the preparation of sea-salt by crystallisation.

Iodine: this element is present only in very minute traces; its presence until lately was only inferred, from its relatively abundant occurrence in the ashes of sea-weeds.

Fluorine: detected directly; also found in the boiler crusts of transatlantic steamers.

Phosphorus: in phosphate.

Nitrogen: in ammonia, and in the organic matter necessarily diffused throughout the ocean.

Carbon: in carbonates and free carbonic acid, which, as we shall see, are by no means subordinate components; also as part of the organic matter.

Silicon: in silicates.

Boron: directly detectable; found also in the ashes of *Zostera maritima* and *Fucus vesiculosus.*

Silver: found by Malaguti in the copper bottoms of ocean-going ships. Forchhammer found 1–3,000,000th in a coral called *Pocillopora alcicornis.*

Lead: more abundant than silver; the coral just named gave to Forchhammer eight parts of lead to one of silver.

Copper: found in the ash of *Fucus vesiculosus*, and of other sea-weeds. The coral *Pocillopora* contains 1–500,000th, the coral *Heteropora* 1–350,000th, of the metal.

Zinc: proved to be present only indirectly by the analysis of the ashes of sea-plants. The ash of *Zostera maritima* contains ·035 per cent. of ZnO.

Cobalt and Nickel: found in the ash of sea-plants.

Iron: easily detected directly.

Manganese: readily detected in the residue left on re-dissolving sea-water solids in water. 500 parts of dry *Zostera maritima* gave, to Forchhammer, 81·4 of an ash which contained about 4 per cent. of manganese.

Aluminium: in alumina, which can be detected by the ordinary methods.

Barium and Strontium can be detected directly, and besides have been found in the ashes of marine plants and in oceanic boiler-crusts.

Arsenic: detected by Daubré.

Lithium: found by Bizio in the water of the Adriatic, by spectrum analysis.

Cæsium, Rubidium, and *Gold:* discovered by Sonstadt. C. Schmidt succeeded in determining the *rubidium* even quantitatively.

According to Forchhammer, who analysed a large number of samples of water from a great many different localities, *ocean-water* contains, on an average, in 1000 parts by weight, 34·404 parts of salts, including 0·07 to 0·1 part of insoluble "residue" left on treating the total solids, obtained by evaporation, with pure water. This value, 0·07 to 0·1 per 1000, gives a fair idea of the *sum total* of all the *minor* components. The principal components, according to the same authority, stand to one another on the average in the ratios expressed by the following numbers :—

Chlorine.	Sulphuric Acid.	Lime.	Magnesia.	Potash.
100	11·88	2·93	11·03	1·93 *

According to Forchhammer, these ratios are, in passing from one part of the ocean to another, subject to only very slight variations, if we omit (as was done in the calculation of the averages given) the waters of the Mediterranean, the Black Sea, the Red Sea, the Caribbean Sea, the German Ocean, the Baltic, and coast waters generally. It must be

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* From analyses of North Atlantic waters only.

remarked that the above numerical results refer to *surface waters* exclusively; but the proposition concerning the ratios might have been extended *a priori*, and without fear of going far wrong, to deep sea waters, even if it had not been proved by my own analyses.

Forchhammer's results naturally guided me, when I had to arrange my programme for examination of the 77 specimens of water collected by the Challenger, which were handed to me for "complete analysis."

As the individual samples never amounted to *more* than about 2 litres (in many cases only to half that quantity), anything like a determination of the minor components was simply out of the question. I at once decided upon confining myself to determining, with high precision, the chlorine, sulphuric acid, soda, potash, lime, and magnesia, and thus furnishing, if nothing better, at least a useful extension of Forchhammer's great work.

My original programme included also the determination of the ammonia and organic nitrogen; but, after having lost a considerable amount of time over attempts in this direction, I became convinced that these determinations would run away with an undue proportion of my precious material. Perhaps also they would ultimately have proved of little value, because, of what originally was organic nitrogen, it could not be expected that the whole, or even the greater part, had survived as such, after the long time which had elapsed between the collecting of the samples and their analysis.

The waters came to me in three lots, and the mode of procedure adopted was, passing from component to component, to determine one of these in the whole series of samples; then similarly the second, &c. Each determination, for a given sample, was made at least twice, often three or four times. The value ultimately adopted, however, was not in all cases the mean of the individual results: when I found, for instance, that two analyses would not agree sufficiently, a third and, as a rule, a fourth were made (which generally led to this, that three agreed while one differed from the rest), and then the one widely deviating number was allowed no influence in the calculation of the mean. I do not consider it necessary in this Report to give my individual determinations. I content myself with recording the finally adopted value, with as good estimates as I am able to make of the presumable errors. It would obviously be absurd, from two to four determinations, to calculate the *probable* error in the usual way.

No analytical method is free from inherent (*i.e.*, other than purely observational) errors; hence, after having once fixed upon a certain *modus operandi*, I made it a point subsequently to adhere rigorously to it, even at the expense of a little extra precision, which might have been gained by a modification suggested during the progress of the investigation. Only in one case (that of the determination of the potash) did I allow myself to break this rule, having succeeded in improving so essentially upon the original process, that I should have considered it wrong to adhere to it. Hence all my results (on the basis of the methods to be presently described) are susceptible of subsequent experimental rectification.

Determination of the Chlorine.

"Chlorine," in this section of the memoir, means total halogen calculated as chlorine.[*] The determinations might have been made by means of the old-established gravimetric process, or by the "titrimetric"[†] process which was founded, many years ago, by Gay-Lussac upon the same reaction. This latter method would naturally suggest itself to every chemist as being *the* process for the case in hand, if it were not for that beautiful new method of silver-titration which was introduced, some years ago, by Volhard, and which, as regards elegance and ease of execution, is superior even to Gay-Lussac's. The process, as is known, consists essentially in this, that after precipitation of the halogen by *excess* of standard nitrate of silver, the silver still dissolved is "titrated" by means of a standard sulphocyanate-solution in the presence of iron-alum, the appearance of a permanent red colour (due to $Fe(NCS)_3$) marking the end of the reaction. Volhard himself executes this titration *without* removing the precipitate of chloride. I found it impossible to obtain perfectly sharp results in this manner, and therefore adopted it only for preliminary determinations, the final titrations being executed in the following manner:—10 c.c. of sea-water were measured off into a tared phial of about 200 c.c. and *weighed*; and after addition of some pure water, there was added a slight measured excess of standard silver solution, and the weight of the silver solution ascertained and marked down. Enough water was then added to bring the total volume up to very nearly *twice* that of the standard silver solution used, the ingredients carefully mixed, then violently shaken together, and the phial put aside into a dark cupboard. After the lapse of half a day or a night, the precipitate had settled so completely that the supernatant liquor could be decanted off into a beaker without filtration, and so completely that a correction for the part adhering to the chloride was necessary only in the few cases where, by mistake, a somewhat large excess of standard silver-solution had been added. The residual dissolved silver was determined *volumetrically*, by titration with centesimal solutions of silver and sulphocyanate (*i.e.*, solutions containing 1·08 grms. of silver, and the equivalent weight of sulphocyanate, per 1000 c.c. respectively), care being taken in all cases to determine the end-point repeatedly by what we came into the habit of calling "zig-zag titration," and to take the mean of the last 3-4 end-point determinations (reduced individually to the case of centesimal silver added = 0) as a basis for the calculation.

The Standardisation of the Solutions was effected as follows:—[‡]$\frac{1}{10}[KCl] = 7{\cdot}459$ grms. of pure chloride of potassium (prepared from purified chlorate by expelling the oxygen by heating, dissolving the residue in water, adding hydrochloric acid, evaporating to dryness in a platinum basin, and gently igniting until the weight remained constant) were

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[*] For the relation of such "chlorine" to true chlorine, see the chapters on "Bromine" and on "Alkalinity."

[†] I venture upon coining this word as a substitute for the customary "volumetric," which I could not well have employed, as I estimated my standard solutions by weight and not by volume. (*Gollier.*—Analyses à solutions titrées.)

[‡] Whenever a formula is enclosed in square brackets it means the weight of the respective element, radical or substance, expressed by the symbols, when "O" is taken as representing 16 parts of oxygen.

dissolved in water to "1 litre,"[*] and the solution weighed exactly. Supposing it amounted to 1006·04 grms., this weight was put down as the *exact* deci-equivalent of the solution, it being of course remembered at the same time that the approximate deci-equivalent volume was = 1000 c.c.

The Solution of Nitrate of Silver was generally prepared on a large scale (40 to 50 litres at a time), by dissolving a known weight of pure crystallised nitrate, containing an ascertained proportion of water, in very dilute nitric acid, the proportion being chosen so that every litre of solution contained as exactly as possible 17 grms. of nitrate and 20 c.c. of nitric acid of 1·4 sp. gr. To ascertain the exact *titre*, equal volumes (50 c.c.[†] each at first; 100 c.c.[†] for the final tests) of the silver and of the chloride of potassium solutions were measured out, mixed, and *weighed* at the same time; the mixture shaken, allowed to settle, and the excess of silver titrated by means of centesimal solutions of silver and sulphocyanate of ammonium as above explained. When the chlorine happened to predominate, this was easily set right by neutralising the sulphocyanate added by its exact equivalent of silver, pouring the liquor back on the chloride in the precipitation phial, adding a sufficiency of measured silver for the chlorine and beginning *de novo*. We always took care at first to keep the silver solution a little above its intended standard, so that the correction could be effected by adding the calculated amount of water to the stock in the carboy. When the solution was as nearly as possible volumetrically correct, the exact *titre* was again determined three or four times, the *weight*-equivalent calculated, and this number used subsequently for the calculation of the exact proportion of chlorine in the sea-water analysed. To give an example, I may state that for a supply of solution which served for about half of all the chlorine determinations made,[‡] the equivalent was 1024·24 grms. (= very nearly 1000 c.c.), so that the number (χ)[§] of grms. of chlorine per kilo. of sea-water analysed followed from the computation of—

$$\chi = \frac{S \times 3{\cdot}546 \times 1000}{1024{\cdot}24 \times W}$$

where S means the weight of (corrected) silver-solution found equivalent to W grms. of sea-water. In no case was such a solution actually used before the correctness of its *titre* was confirmed by the analysis of exactly weighed samples of pure (*dry*) chloride of potassium or sodium.

The Deci-normal Solution of Sulphocyanate was prepared from pure ammonium salt, and adjusted by means of the standard silver. After some experience we found it con-

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[*] Meaning the capacity of the (fairly correct) litre-flask used.

[†] Measured in the *same* pipette.

[‡] A very large number of samples of water were analysed for chlorine only apart from those "completely" analysed.

[§] I may here state, once for all, that this symbol (χ) is used consistently throughout my memoir to signify "grms. of halogen, calculated as chlorine, in 1000 grms. of sea-water."

venient to keep a *normal* solution of this salt in stock, and when deci-normal was required, to prepare it by diluting the *correct weight* of this strong solution with water to say 2 litres, the *titre* of the dilute solution being, of course, confirmed by direct comparison with the standard silver solution.

The Centesimal Solutions were made synthetically from the deci-normal ones, and tested against each other volumetrically. We found it expedient to add some iron alum to the sulphocyanate, to give it a distinctive colour. It will be understood that although our solutions were all deci- or centi-normal in the volumetric sense, in the *final* analyses nothing depended on the exactitude of burette or pipette measurement, except the determination of the small excess of silver present in the mixture of *weighed* sea-water and *weighed* standard silver solution.

In the *preliminary* analyses the sea-water (5 c.c. in each case) and the standard solutions were measured by volume, the latter in Mohr's burettes. As already stated, I found it impossible to obtain *sharp* results by titrating the excess of silver with sulphocyanate in the presence of the chloride of silver precipitate. For this it is easy to account theoretically. Supposing we add a *slight* excess of nitrate of silver to a given solution of chloride, and then (in the presence of iron alum) exactly neutralise the excess of silver by sulphocyanate of ammonium, another drop of this solution will produce ferric sulphocyanate, but the colour cannot be seen distinctly before the precipitate has to some extent settled, and before it has done so the ferric sulphocyanate will have been decomposed by the large mass of chloride of silver present $(Fe(NCS)_3 + 3AgCl = 3AgNCS + FeCl_3)$; in fact part of the $(NCS)NH_4$ added will act directly upon the AgCl instead of on the $AgNO_3$. And so it will go on until an appreciable excess of NCS has been added, so that the colour survives the settling process. If I am right thus far the remedy would appear to be easy. Add a considerable excess of nitrate of silver from the first, so that, before the end-point of the reaction comes on, there is enough of (NCS)Ag in the precipitate to effectually combat the reaction above formulated; in this fashion: $3AgNCS + FeCl_3 = 3AgCl + Fe(NCS)_3$. This condition (according to a series of incidental observations made) seems to be fulfilled when, for about 25 c.c. of decimal silver-solution *needed*, 4–5 extra c.c. of reagent are added to be titrated by the sulphocyanate solution. As the preliminary chlorine titrations were effected only for our own guidance, I did not find it worth while to inquire more minutely into the matter by a series of systematic experiments. Having carried out a large number of chlorine titrations, both by the original Volhard process and by my own modification of the same, I, of course, came into possession of extensive statistics of the errors which the former gave in our hands; but, useful as these experiences were to us, their reproduction in this place could serve no useful purpose.

A large number of exact chlorine determinations had been made and booked for reporting, when some incidental observations made in the laboratory shook my faith in Volhard's method in a most uncomfortable manner. In endeavouring by its means to determine the halogen in certain organic bromine compounds (by combustion with lime or tri-sodic phosphate [*]), we obtained very unsatisfactory results, showing that in the presence of large quantities of pyro-phosphoric acid, or even of nitrate of lime, the titration by sulphocyanate solution could not be relied on. About the same time my friend Professor Crum Brown informed me that the well-known colour of ferric sulphocyanate was destroyed by large quantities of magnesia salts. I therefore instituted a series of experiments in order to see to what extent our determinations of chlorine in sea-water must be assumed to have been vitiated by the presence in the water of magnesia and lime salts. The following two standard solutions were prepared:—

1. 15·65 grms. of pure chloride of sodium were dissolved in water and diluted to ("250 c.c."=) 261·21 grms. One grm. of solution contained 59·91 mgrms. of chloride of sodium.

2. 10·55 grms. of crystallised sulphate of magnesium and potassium ($MgK_2S_2O_8 6H_2O$) were dissolved in water, and 0·58 grm. of pure carbonate of lime dissolved in dilute nitric acid, the two solutions mixed and diluted to 1 litre.

One-half c.c. of solution 1 and two c.c. of solution 2 form a fair equivalent, in respect of contents in chlorine, lime, and magnesia, to 1 c.c. of sea-water.

310·4 mgrms. of sodium chloride (in the shape of solution 1) were titrated by Volhard's method. The resulting mixture was now mixed with 40 c.c. of solution 2, *i.e.*, with about twice the quantity of lime and magnesia which, in sea-water, is associated with 310 mgrms. of chloride of sodium, a little extra silver added, and the point of saturation again determined by the method of repetition.

Sodium chloride found in solution 1 alone, .	310·0
After addition of solution 2, ...	309·88

In the following series of experiments the impurities were added to the original salt-solution before addition of the nitrate of silver. The same salt-solution and the same silver-solution (both approximately deci-normal) were used in the four analyses.

Analysis	(1)	(2)	(3)	(4)
50 c.c. of Salt, weighing N = .	50·274 grms.	50·260 grms.	50·265 grms.	50·263 grms. = N.
Lime as nitrate = . . .	0 "	0 "	28 mgrms.	28 mgrms.
Magnesia as sulphate = . .	0 "	0 "	100 "	100 "
Excess of deci-normal silver-solution found by titration = . .	0·373 "	0·413 "	0·442 grms.	0·435 grms.
Corrected silver-solution in grms. = S =	51·405 "	51·387 "	51·399 "	51·387 " = S
S − N = ...	1·131 "	1·127 "	1·134 "	1·124 "

As a matter of arithmetic these values S−N may be assumed as holding for the

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[*] How we came to use the latter reagent is of no consequence here; it will perhaps be explained in a special memoir.

mean of the values of N which is = 50·265 grms. The mean value for S−N is 1·129. For the deviations from the mean we have—

(1)	(2)	(3)	(4)
+0·002	−0·002	+0·005	−0·005

i.e., at most $\frac{5}{50000}$ = 0·0001 of the most probable value.

This shows that my apprehensions, as far as my sea-water analyses were concerned, had no foundation. At a subsequent date I resumed the question from a more general stand-point, and found that there are a number of theoretically unobjectionable salts (sulphate of magnesia, alkaline phosphate (even ortho-phosphate), nitrate of lime, alkaline nitrate), which, when present in large quantities in a chloride solution obscure the final reaction in Volhard's titration-process to such an extent as to render it useless. But even in these cases, if the proportion of the impurities does not exceed certain limits, their effect can be compensated by the addition of a very large proportion of iron alum. The details, which would be out of place here, will be published in a separate memoir.

Determination of the Sulphuric Acid.

The following method was rigorously adhered to:—

20 c.c. of the sea-water were *weighed*, mixed with 5 c.c. of a chloride of barium solution, containing about $\frac{1}{4}$ [Ba] mgrms. per c.c., and 2 c.c. of 20 per cent. hydrochloric acid; the mixture was heated on a water bath, and then allowed to stand over night. The precipitate was collected on a Swedish filter, washed first with very dilute hot hydrochloric acid, then with hot water, ignited in a platinum crucible, and weighed. Each series of such determinations was controlled by a "*blank*" with 20 c.c. of pure water instead of sea-water, and the same quantities of reagents as were used for the latter, and the filter-ash + minute trace of $BaSO_4$ subtracted from each of the precipitates as a correction. I deliberately refrained from any purification of the sulphate of baryta, being afraid that the unavoidable losses involved in any such process would be greater than the impurities in the crude precipitate.

A considerable number of determinations had been thus made, when a doubt arose in my mind as to the correctness of my judgment in regard to the point just touched upon, and I therefore made the following synthetical experiments:—A kind of artificial sea-water was prepared by dissolving 1·02 grms. of pure lime (CaO) and 3·3 grms. of pure magnesia (MgO)[*] in 20 c.c. of normal hydrochloric acid (1 c.c. = [HCl] = 36·5 mgrms.), adding the aqueous solution of 42 grms. of pure chloride of sodium, and diluting to 1425 c.c. to leave space for the 75 c.c. of standard sulphuric acid to be added in the trials.

The standard sulphuric acid used had been prepared shortly before (for other

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[*] Regarding the preparation of pure magnesia, see below, p. 16.

purposes), and by a series of very careful titrations had been found to saturate 53 grms. of pure carbonate of soda (Na_2CO_3) per 1028·9 grms.

4·6 c.c. of such acid were *weighed*, diluted to 80 c.c. with water, and precipitated by addition of 20 c.c. of the chloride of barium solution and 5 c.c. of 20 per cent. hydrochloric acid, the *modus operandi* being in strict accordance with the one followed in the analysis of the Challenger samples. The results were as follows:—

	I.	II.	III.
Weight of acid, ...	4·7663	4·7465	4·7445 grms.
Weight of barium sulphate corrected for filter-ash, .	0·5437	0·5420	0·5409 "
Weight of sulphur tri-oxide per 5 grms. of standard acid,	0·19582	0·19600	0·19569 "
Mean, ...	0·19583		
By titration with sodium carbonate,	0·19438		

The difference, 1·5 mgrms. = 0·0075 of the quantity to be determined, is very small, and, besides, lies in the right direction, because the acid must be presumed to have contained at least traces of alkaline sulphates.

In the following trials 4·6 c.c. of standard acid in each case were *weighed*, diluted to 80 c.c. with artificial sea-water, and the precipitation of the sulphuric acid effected in exactly the same way as before.

Three blank experiments with 80 c.c. of "sea-water," gave only 1·2, 1·2, and 1·8 mgrms. for the amount of barium sulphate + ash; I adopted the value 1·2 mgrms. Eleven trials with known weights, each equal to about 5 grms. of acid, diffused throughout 80 c.c. of "sea-water" gave for the amount of

Sulphur tri-oxide per 5 grms. of standard acid (allowing for blank)

0·19600, 0·19583, 0·19569, 0·19586, 0·19695, 0·19624, 0·19662, 0·19689, 0·19629, 0·19538, 0·19612.

Mean, ...	0·19617
By analysis of the pure acid, ...	0·19583
Excess, ...	0·00034

The individual sulphates of baryta in the Challenger analyses amounted to about 135 mgrms. each; the correction, therefore, would amount to about −0·2 mgrm., *i.e.*, to little, if at all, more than the possible error in the operation of weighing. I accordingly allowed the weights of sulphate of baryta, obtained as above explained, to stand *un*corrected for foreign salts carried down.

Determination of the Lime and Magnesia.

40 c.c. of sea-water were measured off and weighed. They were mixed with 0·5 c.c. of 20 per cent. hydrochloric acid, and boiled to expel the carbonic acid. After cooling there were added—first, 5 c.c. of 10 per cent. ammonia, then 15 c.c. of an oxalate of

ammonia solution, of which 1 c.c. corresponded to 14 mgrms. of lime. The mixture was allowed to stand *cold* over night; the oxalate of lime was then filtered off, washed, ignited, and weighed as lime. The filtrate and wash-waters were mixed with 15 c.c. of 10 per cent. ammonia, and 10 c.c. of phosphate of ammonia (1 c.c. corresponding to 20 mgrms. of MgO), and allowed to stand (*cold*) over night. The precipitate was filtered off, washed with dilute ammonia, ignited, and weighed as pyrophosphate.

In the first series of analyses (21 samples) this method was applied exactly according to the above description. I was quite aware that oxalate of lime, precipitated under the circumstances, of necessity carries down some of the magnesia, but thought I had better not aim at a higher precision at the *certain* expense of constancy in the results. When subsequently the process was looked into synthetically, it turned out that I was not far wrong in estimating the loss of magnesia involved in it; but the experiments brought to light another error, affecting the lime only, for which I had not been prepared. The ignited "CaO" contained a considerable admixture of carbonate of soda, showing that the oxalate of lime must have carried down a corresponding proportion of *soda* as oxalate. In the second series of analyses (30 samples), the crude lime precipitates were carefully collected, mixed, and analysed as follows:—

The mixed lime precipitates were reignited to bring them back to a constant weight before analysis. The hydrochloric solution of a known weight was boiled to expel carbonic acid, ammonia in excess added, and the excess boiled off again to bring down a trace of alumina, which was filtered off.

The lime was then precipitated with excess of oxalate of ammonia, ignited and weighed as lime. This lime was redissolved and reprecipitated as oxalate, the latter converted into lime and weighed.

Results.

1. Crude precipitate taken, . . .	0·4062 grms.	
2. Lime, CaO, first precipitation, . .	0·3768 ,,	= 92·76 per cent. of (1)
3. ,, second ,, . . .	0·3746 ,,	= 92·21 per cent. of (1)

The filtrate from (2) was evaporated to dryness, the ammonia salts burned off, the residue redissolved, and the magnesia separated out as ammonio-phosphate. The soda was determined in an aliquot part of the same filtrate.

Found in 100 *parts of Crude Lime, including the Filter-ashes.*

Pure lime, CaO, ...	92·21
Magnesia, ...	2·34
Carbonate of soda, Na_2CO_3, ...	5·12
Alumina, silica, &c., and error, ...	0·33
	100·00

Taking L as meaning the weight of "CaO + filter-ash," and M as the weight of the magnesia calculated from the ash-free pyrophosphate obtained in a given analysis, the corrected values $L'=0{\cdot}9221L$ and $M'=M+0{\cdot}0234L$ should come nearer the truth than L and M. These corrections accordingly were applied to the second series of analyses. When the third series of (26) samples came to hand, I might have applied the same formulæ; but as I had some doubts about the perfect soundness of the work upon which they were based, I preferred to analyse the collected precipitates again, including this time the pyrophosphates of magnesia. As a result I found in

The Crude Lime Precipitate, including Filter-ash.

	I.	II.	III.
Lime, CaO,	91·58	91·21	91·23
Silica, Alumina, Ferric oxide, SiO_2, Al_2O_3, Fe_2O_3,	1·35	1·72	2·02
Magnesia, MgO,	2·18	2·11	2·34
Potassium carbonate, K_2CO_3,	0·65	0·53	0·28
Sodium carbonate, Na_2CO_3,	5·26	5·96	5·92
	101·02	101·53	101·79

The excess over 100 per cent. is *partly* due to the fact that the carbonic acid in the alkaline carbonates was only *calculated* from the potash and soda, as determined by the platinum process. The "lime" in each of the three analyses was redissolved in hydrochloric acid, reprecipitated as oxalate, reduced to lime, and weighed in this purified condition. Calculating from this latter weight, the percentages come down to

	I.	II.	III.
Pure lime,	90·97	90·92	90·95

With regard to the pyrophosphate of magnesia, I could not see my way towards an actual method of analysis sufficiently simple and precise to promise results worthy of serving as a basis for a correction formula. I therefore satisfied myself with merely dissolving a known weight of (mixed and re-ignited) substance in pure concentrated vitriol, maintaining a temperature somewhat below boiling for three or four hours, diluting, filtering off a minute precipitate, and reprecipitating with ammonia and a little phosphate of ammonia. The ignited precipitate was weighed as presumably purified pyrophosphate.

Of crude pyrophosphate 2·5106 grms. (including the filter-ash) were taken, and the sulphuric-acid solution made up to 251·45 grms. with water. Of this mixture aliquot parts were analysed with the following result:—

Solution taken,	51·729	51·735	51·734	51·731	grms
Magnesium pyrophosphate obtained,	0·5145	0·5133	0·5143	0·5133	,,
Per cent. of "pure" magnesium pyrophosphate,	99·69	99·36	99·56	99·37	
Mean,	99·49				

From the above analyses we see that the amounts of crude lime are liable to the correction

$$(\text{Crude lime})\times 0{\cdot}91=\text{pure lime}.$$

The crude pyrophosphate, as it gave only 99·49 (say 99·5) per cent. of "pure" substance, should be diminished by 0·5 per cent., and then be increased by the magnesia contained in the lime. Now the quantities of lime averaged about 34 mgrms.; those of pyrophosphate about 310 mgrms.; hence the correction should be $= -1{\cdot}55 + \frac{34 \times {\cdot}022}{0{\cdot}36} = +0{\cdot}53$ mgrm. I felt very diffident about the validity of this slight correction, and at last decided upon omitting it. In the tabular statement of analytical results included in this publication, the amounts of lime and magnesia are all corrected (or recorrected) according to this statement; *i.e.*, the magnesia only for the filter-ash, the crude lime by multiplication by 0·91.

Determination of the Potash.

This gave me a great deal of trouble. The customary method, as applied to sea-water, would be, after (or perhaps without) elimination of the sulphuric acid, magnesia, and lime, to convert *all* the bases into chloroplatinates by evaporation with a large excess of chloride of platinum, and from the residue (which must contain the Na_2PtCl_6 in the hydrated form) to lixiviate out what is *not* chloroplatinate of potassium, either by means of aqueous alcohol (Fresenius), or by means of small instalments of chloride of platinum solution (containing 5 per cent. of metal), followed by alcohol (Tatlock). I prefer Tatlock's form of the process, as it is in a high degree independent of the presence of salts of lime and magnesia, and of sulphates, and consequently directly applicable to sea-water. That this process gives good results with anything that fairly falls within the heading of even impure "potash salts," is well enough proved, but I felt very diffident as to its giving a sufficiently close approximation in the case of sea-water, where the potash forms such a small proportion of the whole. My suspicions were confirmed by the following two test analyses, in which known weights of pure chloroplatinate of potassium, after being dissolved in a solution containing about the same amount of chloride of sodium as the potassium of the former is associated with in sea-water, were recovered by Tatlock's method:—

	(1)	(2)	
Chloroplatinate of potassium taken, . .	123	115	mgrms.
Chloride of sodium taken, ...	1350	1270	"
Metallic platinum in the precipitant used, . .	2500	2300	"
Chloroplatinate of potassium recovered, . .	108·2	102·2	"
Loss, ...	12	11	per cent.

A similar result was obtained on the application of the method to an artificial sea-water prepared synthetically from pure materials. Ten cubic centimetres of the "sea-water" containing, by synthesis, 9·40 mgrms. of potash (K_2O), gave 41·8 mgrms. of chloroplatinate corresponding to 8·06 mgrms. of potash (K_2O). Loss = 14 per cent. These three test-analyses were made before any analysis of sea-water was attempted. Let me at once add another experiment, made at a far later date, with specially purified chloride of platinum. A known weight of chloride of potassium equivalent to 52·02 mgrms. of metallic platinum was dissolved in 50 cubic centimetres of potash-free artificial sea-water, prepared from absolutely potash-free materials, and evaporated down with a quantity of pure chloride of platinum, containing 3·2 grms. of metal, to the consistence of a paste, from which the foreign chloroplatinates were washed away successively by a little water (forming a strong $PtCl_4$ solution with the excess of reagent), 5 per cent. solution of platinum chloride, and lastly alcohol,—according to Tatlock's directions. The chloroplatinate of potassium obtained (dried at 105° C.), amounted to 107·9 mgrms.$=$43·62 mgrms. of metal. This chloroplatinate, not presenting a perfectly normal appearance, was purified by redissolving it in hot water, adding 1 cubic centimetre of chloride of platinum solution, containing 10 per cent. of metal, re-evaporating and again applying Tatlock's washing process. The purified product weighed 101·7 mgrms.$=$41·18 mgrms. of metal. The filtrate from the *original* chloroplatinate was evaporated to dryness, reduced in hydrogen, the salts extracted with water, made into sulphates and worked up by Finkener's process. (*See* below.) Platinum obtained from the $PtCl_6K_2$=8·9 mgrms. Calculating the potash in terms of metallic platinum, we have :—

(1) In purified precipitate, ...	41·18	mgrms.
(2) Lost in purification, an unknown weight x, sure to be less than	2·44	„
(3) From $PtCl_6K_2$ in filtrate from the crude chloroplatinate, .	8·90	„
Accounted for .	52·52	„ $(+x-2·44)$
Due, . .	52·02	„

Even the unpurified precipitate (1) represents only 83·85 per cent. of the potash to be determined.

Seeing that the customary process even in its most exact form, would not work, I thought I should give a trial to that ingenious modification of the platinum process which was invented some years ago by Finkener,* the more so as this process, far more readily than the old one, lends itself to the laying down of a hard and fast sequence of operations, which, although it may fail to ensure perfect precision, was certain (I thought) to give at least constant results, susceptible in the worst case of subsequent correction. For this purpose I brought the process into the following form :—Measure off 50 c.c. of sea-water, and after having determined its weight, evaporate with sulphuric acid (*vide infra* under "Soda,") and ignite the residue to convert all the bases into normal sulphates. Dissolve these in 10 to 20 c.c. of water, filter, add excess of chloride of platinum, *i.e.*, more than $1\frac{1}{2}$ $[PtCl_4]$ per 1 $[K_2SO_4]$, evaporate to a very small volume, allow to cool, and add, first 10 volumes of absolute alcohol, and then 5 volumes of ether. After some hours' standing wash

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* *Poggendorff, Annalen*, vol. cxxi. p. 637, *et seq.*; also Handbuch der analytischen Chemie von H. Rose, 6th ed. by R. Finkener, vol. II. p. 929.

the precipitate (a mixture of chloroplatinate of potassium and sulphates) with ether-alcohol (1 volume of alcohol + ½ volume of ether),—decanting through a filter,—then dry the precipitate and reduce it in the porcelain basin in which it has been produced, by placing a funnel over it, passing hydrogen in by the stem, and heating to about 300°C. From the residue extract what is not metallic platinum (1) by water, and (2) by hydrochloric acid; collect the metal on a filter, ignite and weigh. The weight multiplied by 0·4747 gives the weight of the potash (K_2O) contained in the water. The method, when applied to the synthetically prepared sea-water above referred to, gave the following results:—

	Water taken. Grms.	Platinum obtained. Mgrms.	Potash found per 1000 parts.
(1)	21·28	38·6	0·861
(2)	53·27	94·7	0·844
Demanded by synthesis,	.	. . .	0·879

These results, although not what I could have wished them to be, contrasted favourably with those previously obtained by the ordinary method, and encouraged me to enter upon a systematic series of test analyses, chiefly with the view of obtaining a higher degree of precision by a greater familiarity with the *modus operandi*. Known weights of the pure sulphates of potash and soda were weighed out, dissolved in water and wrought according to the modified form of Finkener's method. The results are given in the following table, in which the unit of weight is the milligramme:—

	Taken of		Obtained.		
	Potassium sulphate.	Sodium sulphate.	Met. platinum.	corresponding to	Potassium sulphate.
(1)	*Nil.*	500	2·4		2·1
(2)	562·0	*Nil.*	636·5		562·2
(3)	406·8	1000	449·2		397·0
(4)	521·0	500	589·6		520·7
(5)	418·5	1000	471·4		416·4
(6)	399·2	1000	450·5		397·9

After these experiments, I felt sure that the method when applied to sea-waters, with strict adherence to the method once laid down, would at anyrate give fairly constant results, susceptible of subsequent correction, and sure to be closer approximations to the truth than could have been obtained by any other known process. The method, accordingly, was applied to the first series of waters as above explained. The results, however, though better than those quoted above as first trials (with synthetical sea-water), were not as constant as they would necessarily have been if they had been affected by only accidental errors. Therefore, when the second series of waters came to hand, I caused Mr. W. G. Johnston, one of my assistants, to try experimentally whether the substitution, for the adopted proportion of platinic chloride ($PtCl_4$), of another proportion, or the use of chloroplatinate of sodium or lithium, would ensure greater constancy in the results. The results of these trials are given in the following table, for the interpretation of which it is only necessary to say that, in all cases, the solution analysed included 3·25 grms. of pure Na_2SO_4 and 0·639 grm. of pure $MgSO_4$, *i.e.*, the quantities of these salts contained in the sulphates from about 100 c.c. of sea-water. For experiments 1 to 5 the ordinary "pure" preparations were used, as kept in stock for analytical work generally; for the rest of the experiments the sulphates were specially prepared, so as to ensure the absence from them of every trace of potash: the soda salt from recrystallised bicarbonate and pure sulphuric acid; the magnesia salt as follows:—The double salt $Mg(NH_4)_2(CO_3)_2 + 4H_2O$ was prepared from "pure" sulphate of magnesia by precipitation with a large excess of neutral carbonate of ammonia, the precipitate washed thoroughly with the reagent, until sure to be free from mother-liquor, and then ignited so as to reduce it to magnesia. Weighed quantities of this

No.	The Precipitant contained 10 per cent. of Metal, as—			Obtained Mgrms. of		Used Mgrms. of K_2O.
	$PtCl_4$ or $PtCl_6H_2$	$PtCl_6Na_2$	$PtCl_6Li_2$	Pt –	K_2O.	
1	...	2 c.c.	...	3·8	1·8	0·0
2	...	2 c.c.	...	2·45	1·16	0
3	...	2 c.c.	...	99·05	47·01	45·37
4	...	2 c.c.	...	96·55	45·81	46·08
5	Lost.		...	...	...	...
6	2 c.c.	...	...	3·6	1·71	0·0
7	2 c.c.	...	...	3·2	1·49	0·0
8	1·1 c.c.	...	...	Lost.		...
9	1·1 c.c.	....	...	96·1	45·5	46·3
10	1·5 c.c.	...	...	96·8	45·93	46·77
11	1·5 c.c.	...	...	97·1	46·08	46·77
12	2·0 c.c.	...	...	96·4	44·75	45·7
13	2·0 c.c.	...	...	94·3	45·75	46·57
14	3·0 c.c.	...	...	96·1	45·6	46·2
15	3·0 c.c.	...	...	97·6	46·33	46·56
16	...	...	2 c.c.	3·3	1·56	0·0
17	...	...	2 c.c.	4·5	2·13	0·0
18	...	...	2 c.c.	99·1	46·94	46·16

magnesia were dissolved in the calculated volume of standard sulphuric acid. In experiments 8 to 15 a mixture of chloride of platinum solution with standard hydrochloric acid, adjusted so as to represent a solution of chloroplatinic acid ($PtCl_6H_2$) was used instead of simple platinic chloride ($PtCl_4$).

A glance at this table shows that although pure unmixed sulphate of soda always gave a little platinum equivalent to 1–2 mgrms. of potash, the tests made with 45 to 47 mgrms. of added potash gave in general low results, showing that to some extent the method owes even its moderate degree of precision to an accidental compensation of errors. Obviously we had not succeeded in effecting any material improvement; but I thought it could only do good to take 100 c.c. instead of 50 c.c. of sea-water for each analysis, and as a matter of principle it was better to use $PtCl_6H_2$ than $PtCl_4$. These modifications I accordingly adopted, fixing upon 200 mgrms. of platinum (as $PtCl_6H_2$ solution) as the proportion of reagent to be employed.

On receipt of the third (and last) instalment of waters, we renewed our attempts to improve upon our process of potash determination, and this time succeeded at once in discovering a source of error which had so far escaped our notice. It consists in this, that the reduced platinum obtained from the mixture of sulphates and chloroplatinate of potassium by hydrogen, under circumstances which I did not succeed in defining, is slightly soluble in dilute hydrochloric acid. The remedy is easy. The hydrochloric acid which has been used for washing, must be treated with sulphuretted hydrogen, and the precipitate (after some hours' standing) be collected and ignited along with the bulk of the platinum. This modification was, of course, at once adopted. At first I thought it was probably not platinum itself, but some impurity in the reagent which dissolved in the hydrochloric acid; but this proved a mistake. Absolutely pure chloride of platinum, prepared from commercially pure metal by Schneider's method (which removes even the foreign platinum metals), yielded a metal which behaved to hydrochloric acid in the same capricious manner as the metal from the ordinary "pure" reagent had done. The solvent action of the acid on the reduced platinum is checked in a marked degree, though not always prevented, by the addition to the acid of strong sulphuretted hydrogen water. By means of the sulphuretted acid we often obtained filtrates absolutely free from platinum.

Before applying the modified process to the samples of water, it was examined by means of test analyses.

Perfectly potash-free chloride of sodium was made from recrystallised bicarbonate by means of pure hydrochloric acid, the solution being evaporated until about one-half of the salt had crystallised out of the hot liquor. The crystalline deposit was washed with small instalments of hot water until it was sure to be free from the mother-liquor, and ignited gently in platinum.

Pure magnesia was prepared from the double salt $Mg(NH_4)_2(CO_3)_2 4H_2O$ (derived from "pure" sulphate), ignited and effectually freed from a trace of sulphuric acid, still present in it, by repeated digestion in hot neutral carbonate of ammonia and re-ignition. From these materials and pure carbonate of lime a kind of sea-water free from potash was prepared, and 100 c.c. of it taken for each trial. Two blank experiments gave 0·8 and 1·0 mgrm. of platinum. In the analyses of mixtures of artificial sea-water with weighed chloride of potassium the following results were obtained :—

	I.	II.	III.	IV.	V.
Mgrms. of platinum due,	12·2	26·3	49·6	97·6	103·0
Mgrms. of platinum found,	14·0	28·4	51·1	96·7	102·1

One hundred mgrms. is about the weight of platinum due from 100 c.c. of natural sea-water. Hence the platinum obtained, according to IV. and V., should be liable to a positive correction of about 0·9 mgrm. = to about 0·5 mgrm. of potash. But considering the *general* evidence of these (and preceding) trials, I thought I had better simply accept the results of the analyses as probably correct to within ±1 per cent. of their value. For the reduction of platinum to potash the same atomic weights Pt=198, K=39, were used as in all the previous analyses, although, according to a research lately published by Seubert, the atomic weight of platinum is more nearly equal to 195·0, whence $\frac{K_2O}{Pt}=0{\cdot}48353$. Recalculating trials IV. and V. with this new factor we have—

	IV.	V.
Platinum due, . . .	96·1	101·4
Platinum found, . . .	96·7	102·1
Error, ...	+0·6	+0·7
Instead of, . . .	−0·9	−0·9

I thought I had better adhere to the old factor, and did so.

Determination of the Soda.

To this item in my analysis I paid special attention, because I hoped by the exact determination of *all* the salt radicals in my sea-waters to be able to settle finally the important question whether carbonate of lime really exists as such in sea-water. This question has, I believe, been looked at from an erroneous standpoint by some of the chemists interested in it. There have been attempts, for instance, to separate out carbonate of lime directly from sea-water by boiling or by evaporation to dryness and re-solution. Neither method could give an absolutely decisive result, because the carbonate of lime, supposing it to be obtained, especially in the latter process, might have been formed in consequence of the decomposition of the chloride of magnesium, and elimination of the liberated hydrochloric acid with the steam. The base thus liberated should certainly consist partly of lime, and this lime might have combined with the free carbonic acid of the water or of the atmosphere. The question, I thought, and still think, is answered in the affirmative, as soon as it is proved that, in sea-water, the number of equivalents of base present is greater than the number of equivalents of sulphuric and muriatic acids taken together. Supposing the existence of an excess of base to be proved, that excess must consist of *carbonates*, and these must include carbonate of lime. A more direct solution of the problem is simply impossible in the present state of science.

One thing I felt convinced of from the first, namely, that the routine method adopted in mineral salt analysis, *i.e.*, the elimination of the lime and magnesia, and subsequent joint determination of soda and potash as sulphates or muriates, would never give sufficiently precise results. But I thought I might attain my object by an exact determination of the "*total salts*" (meaning the sum total of SO_3, Cl_2, Na_2O, K_2O, CaO, MgO, minus Oxygen-equivalent of the chlorine), and caused Mr. Johnston to try a number of methods which I had worked out for the purpose. Unfortunately the total salts in sea-water cannot be determined by mere evaporation to dryness and weighing of the dried residue, on account of the instability of the chloride of magnesium in the presence of water at high temperatures. To prevent this dissociation—or as one might call it "loss of anhydrous muriatic acid" ($Cl_2H_2 - H_2O = Cl_2 - O$)—we tried successively, with synthetically prepared solutions, the addition of weighed quantities of normal chromate of potash, tri-sodic phosphate, and oxide of mercury; but we never succeeded in obtaining sufficiently constant results. As a last resource, and for obtaining at least an apology for the total salts, we attempted a determination of the *total bases* as sulphates, and, without any effort, obtained surprisingly constant results. The *modus operandi* adopted was as follows:—

A known *weight* of sea-water * was mixed with rather less than the calculated volume of a strong standard solution of sulphuric acid, and next evaporated to dryness, first on a water-bath, then on an air-bath, in a platinum basin provided with a perforated lid; the perforation being more than shielded by a circular platinum plate welded on to the under side of the lid, as shown by the figure (fig. 1). After the last trace of acid had been expelled at a dull red heat, over a naked flame and with the help of an auxiliary flame playing on a piece of platinum foil laid on the perforated lid, the residue was weighed. A *little* more vitriol was then added, and the process repeated until the appearance of heavy sulphuric acid vapours, and subsequently the constancy of the weight after repeated exposure to dull redness, proved

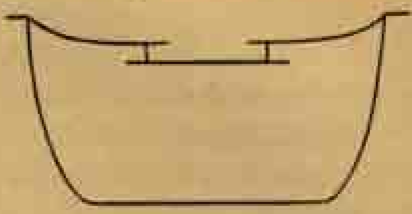

Fig. 1.—Section of Platinum Basin.

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* At first we used to measure out 10 c.c. for each analysis; but in the last series increased it to 20 c.c. I do not think that the change added much to the precision.

the reaction to be accomplished. During the first dozen or so of determinations, the perfect neutrality of the residue was ascertained by solution in water and application of litmus paper; but we soon became convinced that the balance alone afforded a sufficient test. Special experiments with pure substances having shown that sulphate of magnesia, when diffused throughout a large mass of sulphate of soda, remains unaltered at temperatures at which the salt by itself would lose acid, we began to allow a somewhat higher temperature in the ignitions, and thus saved a good deal of time.

Before the process was applied to the Challenger specimens, it was tested by means of synthetically prepared artificial "sea-water." In this water (which was far more concentrated than any natural sea-water) the "*total sulphates*," as calculated from the synthesis, happened to come to *exactly* 10 per cent. of the weight of the water.

	(1)	(2)	(3) *
Water taken, in grms, . .	3·276	10·614	3·259
"Total Sulphates" found, in grms, .	0·3271	1·0633	0·3256

In the sulphates from (1) and (2) the sulphuric acid was determined by precipitation with chloride of barium.

	(1)	(2)
Barium sulphate obtained, . . .	0·5476	1·8058
Sulphur trioxide found, . . .	0·1880	0·6199
Sulphur trioxide demanded by synthesis,	0·1914	0·6200

Supposing the corresponding determination to have been made for an otherwise analysed sea-water, the quantity of sulphur trioxide found divided by 80 should give the number of equivalents of base present, and its excess over the sum of the numbers of molecules of sulphur trioxide and chlorine should furnish in a very direct way a value for the "alkalinity" of the water. Unfortunately the baryta process is accompanied by too many sources of error and uncertainty to be safely available for this purpose. For a time I hoped to be able to give it a higher degree of precision, by precipitating a *large* weight of specially prepared total sulphates with a small excess of standard chloride of barium, and determining the *small* weight of baryta in the filtrate gravimetrically; but a number of test experiments, made with mixtures synthetically prepared from known weights of pure sulphate of soda and pure magnesia, did *not* exhibit the extra high degree of precision for which I had hoped. I therefore returned to the original idea of basing the calculation of the soda on the weight of the total sulphates themselves. To give an example, I extract from my preliminary investigations the calculation of "Water 924."† The quantity of lime was left uncorrected.

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* Chlorine was sought for in the sulphates but not found.

† Laboratory number 45.

Found in 1000 *Grms. of Water.*

Lime,	0·655 = 1·591 of $CaSO_4$	= 0·01170 × [CaO]	grms.
Magnesia,	2·156 = 6·468 $MgSO_4$	= 0·05390 × [MgO]	"
Potash,	0·458 = 0·848 K_2SO_4	= 0·00487 × [K_2O]	"
	Total 8·907		
Total sulphates,	41·634		
Sodium sulphate (Na_2SO_4),	32·728*		
Soda,	14·269 =	0·23050 × [Na_2O]	"
		Total 0·30097 × [$R''O$] = b × [$R''O$]	
Sulphuric acid,	2·228	0·0279 × [SO_3]	
Chlorine,	19·201	0·2707 × [Cl_2]	
		Total 0·2986 × X'' = a × [SO_4 *or* Cl_2]	

Alkalinity = $b - a$ = 0·0024, corresponding to 0·0024 × [$CaCO_3$] grms. = 0·24 grm. of carbonate of lime, we should say, if we had a right to assume that all the excess of base found is carbonate of lime, which, of course, we have not.

The oxygen equivalent of the chlorine found is $\frac{[O]}{[Cl_2]} \times 19{\cdot}201 = 4{\cdot}326$; deducting this from the sum of acids and bases, we have, for the "*total salts*" 34·661 grms. (per kilo. of sea-water). Atomic weights used: Cl = 35·46, Na = 23, K = 39,† Ca = 40, Mg = 24, S = 32 (standard: O = 16).

My first set of (21) sea-water analyses, which were reported in August 1879, all gave a positive value for the "alkalinity" $b - a$. Taking 0·00001 = 1, and excluding *one* exceptionally high result (= 0·00611), I found for $b - a$,

Maximum value, . 453 }
Minimum value, . 103 } mean of the 20 values = 259.

±[259 − ($b - a$)] =	0 to 40,	41 to 80,	81 to 120,	121 to 194,
occurred	8,	3,	2,	7 times.

I took care at the time not to draw any far-reaching conclusions from these results. I even deemed it quite possible that the *positive* values found for all the values $b - a$ might be owing to some constant error in one or other of my analytical methods; and I therefore tried hard to obtain direct evidence of the existence of carbonates (*i.e.*, bases, other than sulphates or chlorides) in the waters. These experiments fill a good many pages in my Laboratory Journal; but as, subsequently, the problem was solved in an unexpectedly simple manner by the chemists of the Norwegian North Atlantic Expedition (whose method I found perfectly valid), I satisfy myself with briefly indicating the principles of my methods.

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* The calculations originally were carried to four decimal-places.

† The round number 39·00 was *here* used instead of Stas's number 39·13, which was adopted in weighing out KCl as a standard for the chlorine (*vide supra*).

1. Elimination of free and loosely combined carbonic acid by distillation with chloride of barium in a current of pure air; subsequent redistillation after addition of a little hydrochloric acid, and determination of the carbonic acid thus liberated by Pettenkofer's method. Results, *partly* * owing to my having to work on a very small scale, highly indefinite.

2. Distillation of 100 c.c. of the sea-water, after addition of a small weighed quantity of perfectly neutral sulphate of ammonia, in an evacuated apparatus constructed on the principle of the cryophorus. Determination of ammonia in distillate, correction by blank experiments executed with an artificial sea-water made of *absolutely neutral* salts, checked by experiments with the same sea-water, rendered alkaline by addition of a measured volume of standard lime-water, subsequently neutralised by carbonic acid gas. Results not very constant, but clearly showing that sea-water, *cæteris paribus*, eliminates more ammonia than the corresponding neutral-salt mixture does.

I shall recur to this subject in the chapter on "The Carbonic Acid in Sea-Water."

After this digression let me now go back to the analyses proper. The serious constant error inherent in the method adopted for the determination of the lime, which was referred to on p. 10, was detected only after the first series of 21 analyses had been reported on. But as I had always rigorously adhered to the mode of operating once laid down, I was able to correct the consequent inaccuracies by subsequent calculation. Taking l_0 and n_0 as signifying the true weights of lime and soda per kilogram of water analysed, and l and n as the corresponding incorrect values originally reported, it is clear from what was said on p. 11, that $l_0=0{\cdot}91\ l$ very nearly, and from the method used for the determination of the soda (pp. 17 to 19), it follows that the correct value of sulphate of soda = the reported + 0·09 times the reported sulphate of lime. Now $\frac{[Na_2O]}{[Na_2SO_4]}=0{\cdot}4366$ and $\frac{[CaSO_4]}{[CaO]}=2{\cdot}4286$. Hence

$$n_0=n+l_0\times\left(\frac{0{\cdot}09\times0{\cdot}4366\times2{\cdot}4286}{0{\cdot}91}\right).$$

or

$$n_0=n+0{\cdot}10487\ l_0\,.$$

or

$$1=\frac{n}{n_0}+0{\cdot}10487\frac{l_0}{n_0}.$$

But $\frac{l_0}{n_0}$ according to the sum total of my correct analyses is practically constant, and equal to very nearly 0·04102; hence, without appreciable error

$$n_0=1{\cdot}0043\times n.$$

The amounts of magnesia and potash are independent of the determinations of lime;

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* Compare chapter on carbonic acid.

hence, if A is the uncorrected and A_0 the corrected "*alkalinity*" (see pp. 19 and 20), we have

$$A_0 = \text{const.} + \frac{n_0}{62} + \frac{l_0}{56},$$

$$A = \text{const.} + \frac{n_0(1-0{\cdot}0043)}{62} + \frac{100}{91}\,\frac{l_0}{56};$$

whence

$$A_0 - A = \frac{0{\cdot}0043}{62}n_0 - \frac{9}{91\times 56}l_0,$$

and as

$$n_0 = 24{\cdot}38 l_0,$$

$$A_0 - A = -l_0 \times 0{\cdot}000\,075,$$

or, as l_0 is about ·58 grm. per kilo.

$$A_0 = A - 0{\cdot}000044.$$

The minimum A in the first series was $=0{\cdot}00163$; hence the corresponding A_0 is 0·00099, *i.e.*, still very much greater than nothing.

With regard to the *total solids* (S and S_0 respectively), we easily see that

$$S_0 - S = -\frac{9}{91}l_0 + 0{\cdot}0043 n_0,$$

or, in terms of l_0,

$$S_0 - S = 0{\cdot}00593 l_0 = 0{\cdot}0034.$$

Now S comes to about 34·4, hence this result could be allowed to remain uncorrected. I originally calculated my results in two ways: firstly, in reference to one kilogram of sea-water; and secondly, referred to 100 grms. of "*total salts*," meaning the sum total of the values of [SO_3, Cl_2-O, Na_2O, K_2O, CaO, MgO]. In this memoir I content myself with giving the latter values.

From what has been said it is clear that all I had to do to correct the 21 analyses of the first set was to multiply all the quantities of lime by 0·91, and of soda by 1·0043, which for these practically came to the adding on of a constant correction. The results of all the 77 analyses are united in the following table (pp. 23 and 24), whose headings require no explanation, except the statements that the numbers in the last column are the laboratory numbers attached to the respective specimens by me for readier identification, and that D means the depth of the sea at the place where the sample of water was taken, while δ designates the depth (in most cases less) from which the sample came. The symbol B under δ means that the water was obtained from the bottom. Why the quantities of sulphuric acid, and only they, besides being given in terms of total salts = 100, were also reduced to chlorine = 1, is explained on page 29.

TABLE I.

Showing the quantities of the Principal Saline Components present in a series of Challenger Samples.

Challenger Number.	Date.	Station.	Latitude.	Longitude.	D.	δ.	Per 100 grs. of total Salts.							Alkalinity per kilo units of V place.	Sulphuric Acid per 1 grm. of Chlorine.	Laboratory Number.
							Sea Water.	Chlorine.	SO_3.	CaO.	MgO.	K_2O.	Na_2O.			
4	1873. Feb. 17	2	25°52' N	19°14' W	1945	B	2855·3	55·438	6·465	1·728	6·253	1·340	41·290	172	·11663	203
10	„ 21	5	24°20' N	24°28' W	2740	B	2695·7	55·370	6·419	1·703	6·217	1·340	41·428	252	·11592	206
19	„ 26	9	23°23' N	35°10' W	3150	B	2798·0	55·437	6·405	1·696	6·251	1·329	41·390	231	·11554	213
21	„ 28	10	23°10' N	38°42' W	2720	B	2707·4	55·514	6·460	1·727	6·197	1·337	41·290	89	·11637	214
22	„ 28	10	23°10' N	38°42' W	2720	0	2682·1	55·376	6·415	1·730	6·185	1·338	41·464	290	·11580	215
30	Mar. 3	12	21°57' N	43°29' W	2025	B	2924·2	55·440	6·422	1·717	6·151	1·327	41·452	180	·11584	220
31	„ 3	12	21°57' N	43°29' W	2025	0	2696·6	55·191	6·474	1·711	6·115	1·425	41·585	347	·11730	221
32	„ 3	12	21°57' N	43°29' W	2025	400	2832·2	55·411	6·395	1·702	6·200	1·334	41·461	270	·11541	222
226	Aug. 23	104	2°25' N	20° 1' W	2500	B	2852·0	55·404	6·421	1·723	6·226	1·309	41·405	226	·11613	243
240	Sept. 1	113	Off Fernando Noronha		1010	B	2859·2	55·365	6·428	1·736	6·219	1·327	41·417	206	·11610	245
253	Oct. 6	121	29°22' S	28° 9' W	2275	1000	2871·1	55·419	6·434	1·751	6·213	1·335	41·332	207	·11615	251
272	„ 23	137	35°59' S	1°34' E	2550	B	2883·4	55·407	6·420	1·744	6·225	1·346	41·362	235	·11587	258
—	Dec. 19	143	36°48' S	19°24' E	1900	0	2800·3	55·579	6·368	1·585	6·227	1·325	41·457	122	·11457	93
—	„ 19	143	36°48' S	19°24' E	1900	50	2825·5	55·514	6·405	1·630	6·213	1·370	41·384	134	·11538	94
—	„ 19	143	36°48' S	19°24' E	1900	100	2840·3	55·518	6·419	1·653	6·209	1·324	41·404	126	·11562	95
—	„ 19	143	36°48' S	19°24' E	1900	200	2878·2	55·492	6·408	1·661	6·226	1·318	41·417	167	·11548	96
—	„ 19	143	36°48' S	19°24' E	1900	300	2896·9	55·544	6·411	1·637	6·173	1·289	41·477	102	·11542	97
—	„ 19	143	36°48' S	19°24' E	1900	400	2892·7	55·510	6·430	1·603	6·207	1·322	41·388	118	·11583	98
—	„ 19	143	36°48' S	19°24' E	1900	B	2864·6	55·487	6·371	1·613	6·193	1·295	41·559	108	·11482	99
—	„ 20	...	—	...	...	0	2806·6	55·496	6·389	1·622	6·203	1·310	41·492	176	·11513	100
—	„ 24	144	45°57' S	34°39' E	...	...	...	...	...	...	...	...	...	...	...	...
233	„ 29	146	46°46' S	45°31' E	1375	B	2868·9	55·506	6·411	1·628	6·187	1·342	41·450	131	·11550	101
259	„ 30	147	46°16' S	48°27' E	1600	B	2904·8	55·415	6·378	1·670	6·193	1·380	41·466	242	·11509	102
279	1874. Feb. 11	152	60°52' S	80°20' E	1260	B	2874·6	55·402	6·414	1·685	6·206	1·308	41·440	184	·11585	103
281	„ 12	—	—	—	...	0	2955·7	55·445	6·396	1·682	6·165	1·301	41·521	200	·11536	104
284	„ 14	153	65°42' S	79°49' E	1675	0	3027·5	55·467	6·364	1·689	6·176	1·356	41·461	201	·11473	105
285	„ 14	153	65°42' S	79°49' E	1675	B	2573·2	55·387	6·396	1·690	6·212	1·276	41·536	280	·11548	106
286	„ 16	...	...	...	...	0	3028·9	55·365	6·400	1·648	6·222	1·324	41·532	278	·11560	107
288	„ 17	...	...	...	...	0	2968·3	55·302	6·433	1·650	6·202	1·306	41·583	300	·11632	108
290	„ 19	154	64°37' S	85°49' E	1800	0	2988·5	55·297	6·399	1·676	6·174	1·354	41·574	320	·11572	109
291	„ 19	154	64°37' S	85°49' E	1800	50	2907·4	55·365	6·402	1·685	6·184	1·346	41·509	168	·11563	110
292	„ 19	154	64°37' S	85°49' E	1800	140	2893·1	55·455	6·402	1·675	6·222	1·353	41·497	199	·11545	111
300	„ 15	154	64°37' S	85°49' E	1800	300	2850·1	55·385	6·399	1·690	6·157	1·287	41·567	258	·11554	112

Challenger Number.	Date.	Station.	Latitude.	Longitude.	D.	δ.	Per 100 grms. of total Salts.							Alkalinity per kilo. units of 4th place.	Sulphuric Acid per 1 grm. of Chlorine.	Laboratory Number.
							Sea Water.	Chlorine.	SO_3.	CaO.	MgO.	K_2O.	Na_2O.			
394	1874: Feb. 19	154	64°37' S	85°49' E	1800	400	2805·1	55·628	6·418	1·670	6·202	1·285	41·347	29	·11537	113
397	,, 21	...	...	...	...	50	2880·0	55·307	6·390	1·667	6·172	1·305	41·638	327	·11554	114
...	,, 23	155	64°18' S	94°47' E	1300	—	...	...	—	—	...	...	—	—	...	...
421	Mar. 7	158	50° 1' S	123° 4' E	1800	400	2922·2	55·378	6·414	1·633	5·207	1·309	41·551	253	·11582	115
—	,, 7	158	50° 1' S	123° 4' E	1800	B	2900·4	55·348	6·412	1·688	6·216	1·273	41·568	297	·11585	116
...	,, 13	160	42°42' S	134°10' E	2600	50	2868·7	55·343	6·422	1·627	6·210	1·368	41·613	272	·11604	117
435	,, 13	160	42°42' S	134°10' E	2600	100	2873·0	55·304	6·417	1·624	6·222	1·331	41·570	326	·11603	118
436	,, 13	160	42°42' S	134°10' E	2600	200	2886·6	55·390	6·408	1·637	6·229	1·223	41·623	322	·11561	119
437	,, 13	160	42°42' S	134°10' E	2600	300	2888·0	55·352	6·421	1·658	6·219	1·372	41·464	265	·11600	120
441	Mar. 14	...	...	...	—	0	2837·4	55·335	6·405	1·666	6·180	1·373	41·520	292	·11575	121
...	April 1	161	(Off entrance to Port Philip D = 33.)					...	...	...	...	...	...	...	...	...
470	June 19	165 A	36°41' S	158°29' E	2600	400	2827·7	55·425	6·412	1·683	6·227	1·332	41·426	10	·11606	270
...	July 17	171 A	25°5' S	172°56' W	2900	...	...	...	...	...	...	...	...	...	...	...
515	,, 23	...	...	...	—	0	2780·4	55·502	6·394	1·650	6·218	1·366	41·363	162	·11520	287
576	Sept. 11	180	9°36' S	137°50' E	23 to 29	B	2952·0	55·548	6·444	1·697	6·244	1·370	41·229	72	·11601	311
629 B	Oct. 22	199	5°44' N	123°34' E	2600	B	2876·6	55·468	6·401	1·621	6·188	1·343	41·341	244	·11553	332
656	1875. Jan. 8	206	17°54' N	117°14' E	2100	B	2879·2	55·451	6·429	1·716	6·221	1·290	41·323	183	·11594	339
691	Feb. 12	215	4°19' N	130°15' E	2500	B	2880·5	55·445	6·418	1·662	6·228	1·340	41·415	193	·11576	340
754	Mar. 16	222	...	...	...	100	2833·4	55·424	6·431	1·672	6·212	1·244	41·521	218	·11603	122
755	,, 16	222	2°15' N	146°16' E	2450	200	2842·8	55·458	6·439	1·672	6·206	1·308	41·429	164	·11611	341
791	,, 23	225	11°24' N	143°16' E	4575	B	2880·6	55·394	6·429	1·708	6·265	1·341	41·353	235	·11624	342
865	June 18	238	35°18' N	144° 8' E	1950	B	2902·3	55·340	6·466	1·730	6·257	1·323	41·363	260	·11673	52
871	,, 19	239	35°18' N	147° 9' E	3625	B	2903·6	(54·962)	6·457	1·688	6·281	1·329	41·656	(607)	·11748	53
874	,, 21	240	35°20' N	153°39' E	2900	25	2920·2	55·348	6·427	1·738	6·302	1·329	41·343	299	·11612	54
875	,, 21	240	35°20' N	153°39' E	2900	50	2914·0	55·377	6·394	1·761	6·242	1·338	41·380	235	·11528	55
877	,, 21	240	35°20' N	153°39' E	2900	200	2943·0	55·644	6·414	1·808	6·202	1·330	41·215	107	·11548	56
878	,, 21	240	35°20' N	153°39' E	2900	300	2928·6	55·194	6·445	1·711	6·216	1·327	41·559	397	·11673	57
905/906	,, 28	244	35°22' N	169°53' E	2900	400/600	2938·7	55·417	6·427	1·689	6·290	1·334	41·356	224	·11598	58
910	,, 29	...	...	...	—	0	2885·5	55·508	6·436	1·698	6·187	1·383	41·297	97	·11596	59
912	,, 30	245	36°23' N	174°31' E	2775	B	2912·9	55·463	6·419	1·725	6·270	1·343	41·287	192	·11574	60
920	July 2	246	36°10' N	178° 0' E	2050	400	2930·0	55·544	6·403	1·696	6·242	1·298	41·246	129	·11528	42
921	,, 2	246	36°10' N	178° 0' E	2050	1000	2921·0	55·306	6·402	1·707	6·209	1·370	41·480	323	·11576	43
922	,, 2	246	36°10' N	178° 0' E	2050	B	2901·8	55·335	6·449	1·700	6·239	1·353	41·465	446	·11654	44
924	,, 3	247	35°49' N	179°57' W	2530	B	2885·1	55·706	6·428	1·720	6·222	1·322	41·404	232	·11604	45
947	,, 9	250	37°49' N	166°47' W	3050	2500	2926·9	55·406	6·387	1·652	6·249	1·370	41·438	257	·11528	46
948	,, 9	250	37°49' N	166°47' W	3050	B	2890·6	55·190	6·405	1·729	6·246	1·347	41·530	449	·11605	47
952	,, 10	251	37°37' N	163°26' W	2950	B—100	2923·7	55·395	6·437	1·716	6·242	1·342	41·356	225	·11620	48
953	,, 10	251	37°37' N	163°26' W	2950	B	2939·2	55·505	6·221	1·733	6·203	1·290	41·293	138	·11270	49

Challenger Number.	Date.		Station.	Latitude.	Longitude.	D.	δ.	Per 100 grms. of total Salts.							Alkalinity per kilo. units of γ place.	Sulphuric Acid per 1 grm. of Chlorine.	Laboratory Number.
								Sea Water.	Chlorine.	SO_3.	CaO.	MgO.	K_2O.	Na_2O.			
	1874.																
861	July	12	222	37°52′ N	160°17′ W	2740	850	2911·3	55·431	6·372	1·725	6·227	1·316	41·429	260	·11496	50
862	,,	12	222	37°52′ N	160°17′ W	2740	B—100	2940·0	55·450	6·371	1·811	6·209	1·291	41·261	218	·11490	51
1153	,,	16	...	...	...	...	200	2873·8	55·519	6·388	1·684	6·194	1·316	41·446	140	·11506	62
...	,,	17	254	35°13′ N	154°43′ W	3025	...	...	...	...	...	...	...	...	...	...	...
...	,,	27	260	21°11′ N	157°25′ W	310	...	...	...	...	...	...	...	...	...	...	...
967	,,	28	...	...	...	...	B	2895·5	55·281	6·369	1·689	6·207	1·343	41·603	320	·11521	61 & 61A
1190	Sept.	2	269	5°54′ N	147° 2′ W	2550	25	2862·1	55·412	6·437	1·706	6·231	1·331	41·367	221	·11617	343
1196	,,	2	269	5°54′ N	147° 2′ W	2550	B	2900·6	55·549	6·434	1·717	6·216	1·355	41·261	78	·11582	344
1135	,,	16	276	13°28′ S	149°30′ W	2350	B	2861·7	55·437	6·428	1·726	6·242	1·319	41·358	207	·11595	345
1221	Oct.	14	285	32°36′ S	137°43′ W	2375	B	2858·3	55·440	6·471	1·721	6·200	1·278	41·401	157	·11672	346
1259	,,	25	290	39°16′ S	124° 7′ W	2300	B	2897·1	55·478	6·429	1·701	6·209	1·336	41·366	151	·11588	347
1300	Nov		295	38° 7′ S	94° 4′ W	1500	B	2873·5	55·424	6·434	1·713	6·187	1·323	41·409	189	·11609	348
Mean,									55·414	6·415	1·692	6·214	1·333	41·433	225	·11576	
Mean, excluding Number 871 (Chall. No.).									55·420	...	...	...	...	...	220	...	

DISCUSSION OF THE PRECEDING TABLE.

In going over the 77 reports embodied in this table, we see that although the concentration of the waters is very different, the percentage composition of the dissolved material is almost the same in all cases; the mean values being as follows:—

(In 100 parts of Total Salts.)

Chlorine,*	55·420
Deduct basic oxygen equivalent to this chlorine,	− 12·503
Muriatic acid, $Cl_2 - O$	42·917
Sulphuric acid, SO_3	6·415
Lime,	1·692
Magnesia,	6·214
Potash,	1·333
Soda,	41·433
	100·004

= 100,004

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* Excluding the abnormally low value in Challenger number 871.

To compare these results with Forchhammer's, we must adopt his mode of stating them, that is with reference to 100 parts of chlorine. We then obtain:—

	Dittmar.	Forchhammer.
Chlorine,	100	100
Oxygen equivalent of the chlorine,	(22·561)	...
Sulphuric acid,	11·576	11·88
Lime,	3·053	2·93
Magnesia,	11·212	11·03
Potash,	2·405	1·93
Soda,	74·760	not determined.
"Total salts,"*	180·445	181·1

It is perhaps as well to state that both with Forchhammer and myself "chlorine" means "total halogen calculated as chlorine;" the only difference being that he weighed the halogen as haloid of silver, and from the weight calculated the "chlorine" as if the precipitate had been pure chloride—using, as it seems from his paper, the ordinary numbers Ag = 108, Cl = 35·5, whereas I determined the total halogen by titration with silver-solution, using Stas's values, and multiplied the number of equivalents of halogen thus correctly ascertained by Stas's Cl = 35·46. I may also state on this occasion that I subsequently found reason to correct my values for the lime and the soda and for the chlorine *qua* real chlorine. My final numbers will be found at the end of the chapter on *Alkalinity.*

Leaving aside the potash, for whose determination Forchhammer used an unsatisfactory method, his results and mine show a fair degree of agreement, although Forchhammer's numbers all refer to surface waters, while the majority of my 77 samples came from more or less considerable depths.

When we compare the percentages of the several components with the respective means, we frequently meet with differences which lie decidedly beyond the probable limits of the analytical errors; hence, the variations must be owing partly to natural causes. Unfortunately, whatever these causes may be, they must in their effect on the numbers be presumed to be, to a certain extent, of the nature of observational errors, and, to this extent they are in our reports inseparably entangled with the analytical errors. But there may be a tangible surplus, and I thought I should not leave this part of my subject without having at least made an attempt to represent the several numerical items of my analyses as functions of either the geographical position or of the depth from which the respective waters were taken. Being more hopeful in the former direction, I began by classifying my analyses according to certain districts of the ocean, and averaging the percentages of chlorine, sulphuric acid, &c., for each group; but I did not arrive at satisfactory

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* This, in my column, means total acids and bases here reported; in Forchhammer's the same *plus* his "Silica, &c." (see page 2).

results. Whether I took the waters from all depths, or those from considerable depths by themselves, or those from small depths by themselves, I failed to see any distinct relation between any of the percentages and geographical position. In order now to trace the influence of *depth*, I divided my 77 waters into three categories, irrespective of geographical position, according to the depths (δ) from which they had been taken, namely, into

I. "*Surface waters*," from a depth of less than 100 fathoms.
II. "*Medium waters*," from depths varying from 100 to 1000 fathoms.
III. "*Deep-sea waters*," from depths greater than 1000 fathoms.

From these divisions I drew up a number of tables (one for each component except the soda, which was omitted as hopeless), which again classified the three categories of waters according to the magnitude of the numerical value found for the respective component. As an example, I give the table drawn up of the quantities of lime, in which the bracketed numbers refer to bottom waters.

Columns II., III., IV., V. state how many waters of the respective classes gave a value for the percentage of lime in the total salts lying within ±0·005, of the number stated in column I.

The Quantities of Lime.

Approximate percentage of lime in the total salts.	Depth in Fathoms.			
	6–99.	100–1000.	1000 or more.	All Depths.
I.	II.	III.	IV.	V.
1·585	1	...	...	1
1·615	...	...	(1)	...
1·625	1	2	(1)	4
1·635	...	4	...	4
1·645	2	...	...	2
1·655	...	2	1	3
1·665	1	6	(3)	10
1·675	2	4	...	6
1·685	2	1 + (1)	(3)	7
1·695	1	2 + (1)	(2)	6
1·705	...	2	2 + (2)	6
1·715	1	1	1 + (5)	8
1·725	1	1	1 + (7)	10
1·735	...	1	(2)	3
1·745	...	...	(1)	(1)
1·755	...	...	1	1
1·765	...	1	...	1
1·805	...	1	...	1
1·815	...	...	1	1
1·825	...	...	(1)	1

None of the tables showed any marked contrast between deep-sea waters on the one hand and surface-waters or medium-depth waters on the other; but this did not exclude the possibility of the data containing some hidden evidence of a relation between richness in one or other component and depth, which I thought might perhaps be brought to view by discussing each table in the light of the law of frequency of errors. Only, as the number of surface-waters analysed was too small to accommodate themselves to this law, I treated them in common with those from "medium-depths" as "shallow waters," and then rearranged each table into three diagrams, one for the whole set of 77 waters analysed, another for the 34 deep sea-waters, a third for the "shallow" waters. In each of these the values in the first column of the table were laid down as abscissæ, and the corresponding numbers in the other columns as ordinates, in a system of rectangular coordinates, the idea being that each series of points would suggest the probability-curve characteristic of the respective set of cases. I had no special anticipations regarding the degree of definiteness in the expected suggestions, but I hoped that at least the maxima of the curves would be indicated clearly, and certainly more truthfully than by mere mechanical calculating. Even in this, however, I was disappointed: the curves had to be drawn in too arbitrary a fashion to be relied upon as offering objective evidence. I accordingly omit the more or less indefinite indications which they furnished, and pass on to give the results which I obtained subsequently by the ordinary arithmetical method.

In the following paragraphs x_0 always stands for the arithmetical mean of the set of numerical values, x, considered; n, for the number of the latter; r, for the probable "error" of the single x as calculated by the formula $r=0{\cdot}6745\sqrt{\frac{\Sigma(x_0-x)^2}{n-1}}$, while r_0 signifies the probable error of the mean x_0, as calculated by the formula $r_0=\frac{r}{\sqrt{n}}$.

The Quantities of Chlorine.

Among the 77 values given in our table, the one for number 871 differs so much more largely from the mean than any of the rest, that, after some hesitation, I decided upon excluding it.

For the remaining 76 *values* we have $x_0=55{\cdot}420$; $r=\pm0{\cdot}06$; $r_0=\pm0{\cdot}0069$.

My individual chlorine *determinations* as such, I feel sure, are not infected by a greater probable error than about ± 0·03; but the quantities of chlorine in the 77 reports, being influenced by all the rest of the analytical determinations conjointly, could not be expected to be uncertain by less than ± 0·06; and if it were not for a number of exceptionally high values for x_0-x registered, I should say the results on the whole are in accordance with the assumption that, as a matter of natural law, the percentage of chlorine in their salts is the same throughout the whole set of waters analysed. At any rate the irregularities are of the *nature* of accidental errors; none of them can be fairly attributed to the influence of depth or geographical position. This impression is confirmed by the following table, in which the first column enumerates a series of multiples of the "probable error" r of the individual result, while the second column states in how many cases the difference $x_0 - x$ was less than the respective value $\nu \times r$. The third column states what this number should be, according to the law of the frequency of error:—

Error under $\nu \times r$. ν =	Number of Cases.	
	Counted.	Calculated.
0·2	9	8·1
0·4	18	16·2
0·6	28	23·9
0·8	35	31·2
1·0	39	38
1·2	42	44
1·4	49	49·8
1·6	57	54·6
1·8	59	58·9
2·0	63	62·6
2·4	70	68·0
3·0	72	72·7
Error > 3 r.	4	3·3
Total, ...	76	

The Quantities of Sulphuric Acid.

Next to those of chlorine, these rest upon the most precise determinations; but to do justice to their precision, I thought I ought to recalculate them in terms of unit-weight of chlorine. I accordingly did so. The results are entered in the last column of the general table, pp. 23–24. In discussing these numbers I did not exclude the suspected case (Number 871), because I had not then made up my mind to reject it. As the SO_3-quotient for it has no abnormal value, I did not consider it necessary to recalculate r and r_0 for the 76 cases, which only, strictly speaking, come into consideration. Found for—

	x_0.	r.	r_0.
All the 77 cases analysed, ...	0·115 76	Not calculated.	
The 34 deep-sea waters, . . .	0·115 86	0·000 44	0·000 08
The 43 shallow waters, . . .	0·115 69	0·000 34	0·000 05
Value of x_0 for the deep-sea *minus* that for the shallow waters,	+ 0·000 17		

Each of the 77 percentages of sulphuric acid reported in the general table is based upon at least two well agreeing determinations, the mean of which was adopted as the most probable result. In each case the mean deviation of the individual result from the mean may be taken as a guess at the probable error, and the mean of the 77 mean deviations should be a fair approximation to the probable error of the individual percentage x of sulphuric acid reported. I have calculated this general mean, and found it equal to $\pm 0{\cdot}00026$ per $x = 0{\cdot}1158$. Adding on 0·00006 for the influence of the uncertainty in the chlorine determination, we have for the presumable analytical error the value $\Delta x = \pm 0{\cdot}00032$, which is not much below either of the calculated r's, and is nearly double the difference between the x_0 of the "shallow" and the x_0 of the deep-sea waters. Hence, although I find in my list of values for $x - x_0$ not a few which I could not well admit to fall within the probable limits of analytical errors, there is no chance of tracing a relation between this x and depth. But supposing the irregularities to be of the nature of accidental errors, they should be amenable to the law of frequency of error, and it should be possible to calculate the probability of the actual difference of 0·00017 between the x_0 for the deep-sea and the x_0 for the shallow waters, being brought about by mere accident and not by the existence of a law prescribing to the one x_0 a higher value. Or to formulate the question in more definite terms. Supposing out of our 77 values for x we take 34 cases *at random;* we take their mean x_{34} and compare it with the mean x_{43} of the rest. What is the probability that the difference $x_{34} - x_{43}$ amounts to 0·00017? The treatises on the method of the least squares, as far as my knowledge goes, do not give a formula that would enable one to calculate the precise numerical value of this probability. As a makeshift I adopted for this and the subsequent analogous cases the following mode of reasoning. According to the law of "frequency of error," the probability of an error being greater than four times the probable error is 0·007, $5r$ corresponding to ·0007. Hence, we may say, the unknown errors of our two means x_0 are sure to fall short, in the case of the 34 deep-sea waters, of 5 times their r_0, which is 0·0004; in the case of the 43 shallow waters, of $5 \times$ their r_0, *i.e.*, of 0·00025. Supposing them to be of opposite signs, the possible *accidental* difference $x_{34} - x_{43}$ may amount to 0·00065, which is considerably more than the actual difference 0·00017.

The Quantities of Magnesia.

(Taken in terms of 100 parts of total Salts.)

	x_0	r	r_0
For all the 77 cases analysed, . .	6·2145	not calculated.	
For the 34 deep-sea waters, . .	6·222	0·019	0·0032
For the 43 shallow waters, . .	6·209	0·022	0·0033
Value of x_0 for deep-sea *minus* that for shallow waters, . . .	+0·013		

But 5 times the sum of the two values of r_0 comes to 0·0325; even *this* difference might be accidental.

The Quantities of Potash.

(Taken in terms of 100 parts of total Salts.)

	x_0	r	r_0
For all the 77 cases analysed, . .	1·333	not calculated.	
For the 34 deep-sea waters, . .	1·336	0·019	0·0034
For the 43 shallow waters, . .	1·330	0·023	0·0035

Here the sum of the two values of r_0 by itself comes to rather more than the difference between the value of x_0 for deep-sea and for shallow waters.

The Quantities of Lime.

(Taken in terms of 100 parts of total Salts.)

	x_0	r	r_0
For all the 77 cases analysed, . .	1·692	0·029	0·0033
For the 34 deep-sea waters, . .	1·710	0·028	0·0048
For the 43 shallow waters, . .	1·679	0·027	0·0042
Value of x_0 for deep-sea *minus* that for shallow waters	×0·031		

According to my calculation the mean of the mean errors in the analyses which served to fix the 77 values is ±0·0147 (referred to $x=1·7$). The two *means* for the shallow and deep-sea waters respectively should not be wrong by more than this, the probability is that it is less; and supposing even the errors in the two values of x_0 to be $=\pm 0·015$, we must assume them to have different signs to account for the fact that the value of x_0 for the deep-sea waters is greater by 0·031 than that for the shallow.

A consideration of the two values of r_0 leads to a similar result. The probability is 9993 to 7 that the actual errors of the two means are less than 0·024 and 0·021 respectively. It is true the two values taken together come to 0·045, or more than the difference, 0·031, to be explained. But there is no occasion for putting such a strain on our assumptions. According to the law of frequency of error the probability is 957 to 43 that the errors in the two mean values x_0 are less than three times the respective values of r_0. And adopting $3(r_0+r_0)=0·027$ as being the maximum possible difference between the two values of x_0, it still takes 0·004 unit to come to the actual difference. It really appears as if the deep-sea waters did contain more lime than the shallow, on account of their coming from greater depths. And this result need not surprise us, because the lime in the upper strata of the sea is constantly being used up by living organisms, to be replaced by lime dissolved at the bottom of the sea, from the mass of dead calcareous shells which lie there. But is the result really established by my analyses? I felt very diffident in trying to answer this question, because, unfortunately, the percentages of lime in my analyses are the least certain of all the several numbers; and I consequently decided upon having the result put to a test.

To answer a similar question to the one here discussed with reference to the *bromine*,* we had prepared three mixtures of Challenger waters, labelled respectively "I.," consisting of 64 waters, from depths ranging from 0 to 50 fathoms; "II.," consisting of 70 waters, from depths ranging from 300 to 1000 fathoms; and "III.," consisting of 70 waters, from depths greater than 1500 fathoms.

It naturally suggested itself to me to test the result concerning the quantities of lime, by determining this component in these three mixtures with the highest degree of precision, to calculate the results for 100 parts of chlorine and compare the numbers.

Appendix on the Lime.

The supplementary analyses referred to were all carried out according to the following method, which, after having once been fixed upon, was rigorously adhered to in all cases.

Reagents used.—A 20 per cent. hydrochloric acid—50 c.c. left 0·8 mgrm. of fixed residue. Ammonia of 10 per cent.—50 c.c. left 0·6 mgrm. of a fixed residue, consisting of alumina and a trace of lime. Oxalate of ammonia, 1 c.c. corresponded to 11·2 mgrms. of CaO. 3 grms. of the crystals used for preparing the solution left on ignition 4 mgrms. of fixed alkali-salts.

Filters.—The oxalate of lime precipitates were all collected on Swedish filters of 5 cm. radius, previously purified by exhaustion with hot 10 per cent. hydrochloric acid, and washing with hot water. 10 such filters left 6·5 mgrms. of ash; whence the amount of ash per filter = 0·65; the value 0·7 mgrm was adopted.

Method.—About 500 grms. of the sea-water are weighed exactly, mixed with 15 c.c. of hydrochloric acid, and boiled for fifteen minutes to expel the carbonic acid. The liquid is allowed to cool, supersaturated by addition of 100 c.c. of ammonia, mixed with 180 c.c. of oxalate of ammonia, and allowed to stand cold over two nights. The precipitated oxalate is then filtered off, ignited over the gas blowpipe, and weighed as *crude lime*.

This "crude lime" is then transferred to a beaker, slaked, and dissolved in 5 c.c. of hydrochloric acid. The solution is mixed with 7 c.c. of ammonia, the excess of ammonia boiled off, and the precipitate, which contains the silica, alumina, and ferric oxide of the "crude" lime, filtered off and washed. This precipitate is redissolved in 2 c.c. of hydrochloric acid, and reproduced by adding 4 c.c. of ammonia, and expelling the excess of ammonia by boiling. It is collected on a filter, ignited, and weighed as "*sesquioxides*."

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* See chapter on Bromine, p. 89, *et seq.*

From the united filtrates the lime is thrown down by addition of 20 c.c. of ammonia and 40 c.c. of oxalate of ammonia, and the mixture, which amounts in all to about 300 c.c., allowed to stand cold over night. In the morning it is heated over a water-bath, the oxalate of lime collected on a filter, ignited repeatedly (finally over the blowpipe), and the weight determined; in the final weighings by first putting the approximately correct amount of weights on the balance, then placing the crucible, as it comes out of the desiccator, on the other pan, and lastly, without loss of time, determining the existing small overweight by the method of vibration. This operation of re-igniting and re-weighing was continued until a series of at least six consecutive weighings gave practically the same result. We found it impossible to establish absolute constancy of weight; but the sum total of the results gives me the conviction that the mean values ultimately adopted are right to within about ± 0·1, or at most ± 0·2 mgrm.*

The ignitions were effected in platinum crucibles of 20 c.c. capacity. The empty crucible, as it came out of the desiccator, required about one minute's rest in the balance-case to assume a constant weight, which was then put down as "the tare." This tare, according to 10 experiments (5 with each of two crucibles), exceeds the actual weight, as it is when the lime is on the balance, by 0·4 mgrm. Maximum observed = 0·6; minimum = 0·2 mgrm.

This method was applied to the three mixtures of Challenger waters referred to, and also to a surface-water which had been collected for me at Port Louis, King's Cross, Arran, for the bromine investigation. The analyses were executed in four sets, each of which included the four different waters, so that each set, in reference to the question in hand, could be discussed by itself and independently of the other three. The object of this was to eliminate, if necessary, the influence of any involuntary change in the *modus operandi* that might have taken place in passing from one set of analyses to another.

The filtrates from the crude oxalates, and from the pure oxalates, of lime; also the "sesquioxides" and the "pure lime precipitates" obtained in the several analyses were collected, and, at the end, examined as follows:—

The sesquioxides, from 16 analyses, were ground up, re-ignited and weighed. Weight found = 16·6 mgrms., which yielded on analysis:—

	Mgrms.
Residue left on dissolving in hot hydrochloric acid, ...	6·9
Purified sesquioxides, ...	7·2
Lime, ...	1·7
Magnesia, ...	0·4

---

* The following is the worst specimen of inconstancy observed:—Crucible + CaO = 19·84 + [3·0, 2·4, 2·7, 2·6, 2·3, 2·7, 2·8, 2·4, 2·4, 2·1, 2·6, 2·7 mgrms.]

Hence: lime in the "sesquioxide" = 0·1 mgrm. for each analysis.

The filtrates from the crude oxalates of lime (from 16 analyses) were mixed and allowed to stand for about six weeks, when a large crystalline crust was found to have separated out, consisting chiefly of oxalate of magnesia. This crust was freed from the mother-liquor, and washed, by decantation, ignited, dissolved in a little more than the calculated weight of standardised sulphuric acid, and enough alcohol added to the solution to produce an incipient precipitate. After a day's standing, a magma of sulphate of magnesia had formed, which was dissolved by cautious addition of successive instalments of water. *No* sulphate of lime remained undissolved.

The united filtrates from the pure lime precipitates (14 analyses), when allowed to stand for about six weeks, deposited a small precipitate, which was analysed and found to include 1·1 mgrms. of sesquioxides and 4·4 mgrms. of lime. This amounts to 0·3 mgrm. of lime for each analysis.

The pure lime precipitates were well mixed in an agate mortar, and in four portions (weighed after re-ignition) the true quantity of lime was determined by the same method as had served to produce the pure lime precipitate from the crude. Results in mgrms.:—

	Substance taken.*	Real lime obtained.	Impurity per grm. of substance.
(1.)	358·4	357·5	2·5
(2.)	309·3	308·8	1·6
(3.)	1178·0	1176·9	0·93
(4.)	1183·9	1182·7	1·17
	Mean of (3) and (4),		1·05

This small value (1·05 mgrms.) may almost be accounted for by the solubility of the oxalate of lime; I thought the corresponding correction had better be neglected.

From the above we see that, in each analysis, the weight of "*pure lime*" as determined by the balance was liable to the following corrections in mgrms.:—

(1.)	On account of the filter-ash,	−0·7
(2.)	On account of the CaO retained by the "sesquioxide,"	+0·1
(3.)	On account of the loss of CaO involved in the purification of the crude lime,	+0·3
(4.)	For impurities in the "pure lime,"	*nil.*
(5.)	Tare-error,	+0·4
	Total,	+0·1

This minute correction was applied to the weight of pure lime obtained in each analysis, the result being thus made somewhat more accurate without appreciable increase of labour.

In the following tabular statement of the results, the numbers all mean "grms. per

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* Corrected for filter-ash.

kilogramme of sea-water analysed." χ stands for the "chlorine," meaning total halogen calculated as chlorine; L for the crude lime, corrected only for the filter-ash; L_0 for the pure lime, fully corrected; r_0 for the probable error of a mean value.

Mixed Water I.; *from depths of* 50 *fathoms or less.*

Series of Analyses.	$\chi = 19{\cdot}644$.		$L_0 \div L$.	$(L_0 \div \chi)100$.
	L.	L_0.		
(1)	0·6676	0·5918	0·8864	3·0126
(2) *	0·6740	0·5930	0·8798	3·0187
(3)	0·6732	0·5928	0·8806	3·0177
(4)	0·6768	0·5934	0·8768	3·0208
Mean, . .		0·59275	...	3·0175
r_0 = .		...	...	±0·0012

Mixed Water II.; *from depths between* 300 *and* 1000 *fathoms.*

Series of Analyses.	$\chi = 19{\cdot}332$.		$L_0 \div L$.	$(L_0 \div \chi)100$.
	L.	L_0.		
(1)	0·6654	0·5850	0·8792	3·0261
(2) *	0·7688	0·5858	0·7620	3·0302
(3)	0·6656	0·5862	0·8808	3·0323
(4)	0·6710	0·5860	0·8733	3·0312
Mean, . .		0·58575	...	3·02995
r_0 = .		...	...	±0·0014

---

* In the second series the crude oxalates stood for *four* days before being filtered.

Mixed Water III. ; *from depths greater than* 1500 *fathoms.*

Series of Analyses.	$\chi=19·528$.		$L_{\phi}\div L$.	$(L_{\phi}\div\chi)100$.
	L.	L_{ϕ}		
(1)	0·6706	0·5912	0·8816	3·0274
(2)*	0·6712	0·5920	0·8820	3·0315
(3)	0·6728	0·5922	0·8802	3·0326
(4)	0·6798	0·5920	0·8708	3·0315
	Mean, . .	0·59185	...	3·03075
	$r_0=$.	...	...	±0·0011

Surface-Water from Arran.

Series of Analyses.	$\chi=17·247$.		$L_{\phi}\div L$.	$(L_{\phi}\div\chi)100$.
	L.	L_{ϕ}		
(1)	0·5838	0·5210	0·8924	3·0209
(2)*	0·5978	0·5238	0·8762	3·0371
(3)	0·5908	0·5218	0·8832	3·0254
(4)	0·5942	0·5216	0·8778	3·0243
Supplementary	0·5892	0·5228	0·8873	3·0313
	Mean, ...	0·52220	...	3·0278
	$r_0=$.	...	...	±0·0029

In discussing these results the Arran water may shortly be disposed of by saying that its analyses confirm, as far as could have been expected, the general evidence afforded by those of the three Challenger water mixtures. The principal point in this evidence is that the value $L_{\phi}\div\chi$ (of the lime per unit-weight of chlorine) is more highly constant and amounts to less than appeared in the 77 complete analyses previously discussed. (See page 31.) These latter gave, as a general mean, for the weight of lime per 100 of

* In the second series the crude oxalates stood for *four* days before being filtered.

total salts, the value 1·692; and 0·029 as the probable deviation (r) of the individual result from this mean. Referring from chlorine $=55{\cdot}42$ to chlorine $=100$, we have—

$$\text{Mean, } 100\frac{L_0}{\chi}=3{\cdot}053$$
$$r=\pm 0{\cdot}0523.$$

The corresponding values brought out by the 12 analyses of the three mixtures are—

$$\text{Mean, } 100\frac{L_0}{\chi}=3{\cdot}0261$$
$$r=\pm 0{\cdot}0046.$$

The method used for the 77 previous determinations must have been infected with an inherent source of inconstancy not observed at the time. Exact analyses of two different mixtures of crude lime precipitates obtained in these had, by accident, given very nearly the same value of about 0·91 for $L_0 \div L$. Our new analyses give us the individual values of L_0 and L for 16 cases, and show that the quotient $L_0 \div L$, even under apparently constant conditions, is subject to considerable variation. And this casts a doubt upon the important conclusion which I (somewhat diffidently) drew from those analyses in regard to the relation of $L_0 \div \chi$ to the depth from which the water is taken. Let us examine the new analyses with respect to this point. Taking s, m, d as symbols for lime per hundred of chlorine in water-mixture I., II., and III. respectively, we have—

(A) *If we take the three mean values as our basis.*

$$m-s=0{\cdot}0124=4{\cdot}8\times(0{\cdot}0012+0{\cdot}0014).$$
$$d-s=0{\cdot}0132=5{\cdot}8\times(0{\cdot}0012+0{\cdot}0011).$$

The differences $m-s$ and $d-s$, as we see, have positive values, and to explain them as accidental we must assume that, supposing even in both cases the two actual errors had opposite signs, their sum was in the case of m, 4·8 times; in the case of d, 5·8 times the probable error r_0 of the mean. But the corresponding probabilities are no more than about 0·0007—*i.e.*, even disregarding the fact that the original assumption as to the signs of the errors has only the probability $\frac{1}{2}$ on its side, the probability is 9993 to 7 that the lime per unit of chlorine was greater in the deep-sea and medium waters (II. and III.) than in the surface waters (I.), for some definite and ascertainable reason.

This is exactly the interpretation we got from the 77 complete analyses; except that we then considerably over-estimated the difference.

(B) *If we consider each series of analyses by itself, we have*—

	For $m-s$.	$d-s$.
I. Series,	$-0·0135$	0·0148
II. Series,	$-0·0115$	0·0128
III. Series,	$-0·0146$	0·0149
IV. Series,	$-0·0104$	0·0107

Now, the probable error r in the individual value of 100 $(L_0 + \chi)$, as we saw, is $\pm 0·0046$, whence $2 \times r = 0·0092$. Our smallest difference is the $m-s$ in series IV., which amounts to $0·0104 = 1·13 \times 0·0092$; and the probability that even this difference owes its existence to accidental errors is 0·45, or rather considerably less, because we started with the improbability that the two r's are of opposite signs.

I have to thank Mr. John M‘Arthur for the scrupulous care with which he executed all the analyses quoted in this appendix.

II.—ON THE SALINITY OF OCEAN-WATER.

Although the composition of the material dissolved in ocean-water is substantially the same everywhere, the quantity in a given volume is subject to considerable variation; and it is one of the great problems of oceanography to define this ratio numerically as a function of longitude and latitude, of depth and time.

For the determination of the salinity of a given sample of sea-water, the following methods readily suggest themselves:—

1. *The determination of the specific gravity* at some chosen standard temperature. This constant, of course, bears a fixed relation to the salinity, which relation can be ascertained, once for all, by standard experiments; but even as it stands, it obviously "measures" the salinity in the sense in which the reading of a thermometer "measures" the temperature. The specific gravity of a water can easily be determined, both with promptitude and precision, by means of a delicate hydrometer—a method which is specially adapted for being carried out on board ship. Mr. Buchanan adopted it, and during the voyage applied it to a large number of samples.

2. *The determination in a given weight or volume of the water of the weight of chlorine* present, which latter, on multiplication by a certain constant factor, yields the total solids. According to my 77 complete analyses, as recalculated in the chapter on *Alkalinity*, this factor should be $=1·8058$. According to p. 28 in the discussion of the results of the complete analyses, the probable uncertainty of this factor, as applying to any one sample, taken at random, should be about $\pm\frac{0·06}{55·42}$ of its value, or $=\pm 0·002$. This method, to a chemist working in a laboratory on *terra firma*, would naturally suggest itself as the best, and I accordingly applied it to the samples of water collected by the Challenger.

3. *The direct determination of the total salts* in a known quantity of the water. This at first sight would appear to be the best method of all; but unfortunately sea-water cannot be evaporated to dryness, and the residue dehydrated by ignition, without sending off some of the chlorine of the chloride of magnesium as hydrochloric acid. On p. 18 of Chapter I., I have already referred to a number of abortive attempts of my own for preventing this decomposition, or rendering it innocuous in the determination of the total salts, which datum I was very much in need of at the time, as enabling me to calculate the percentage of soda in my analyses of the salt of sea-water. The Norwegian chemists,* who required the datum for the reduction of their chlorine determinations and specific gravities, employed the following process, and found it to give good results:—

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* Den Norske Nordhavs-Expedition, 1876–1878; Chemi, af Tornøe, p. 56.

"From 30 to 40 c.c. of sea-water was introduced into a thick porcelain crucible of known weight, furnished with a tight-fitting cover, and evaporated in a water-bath. So soon as the salt was sufficiently dry, the crucible, with the cover on, was heated for about five minutes over one of Bunsen's gas burners, then cooled and weighed with its contents. The free magnesia liberated was now determined in the manner described,"—meaning by titration with very dilute standard solutions of hydrochloric acid and caustic alkali, using aurine as an indicator.

The method came to me far too late to help me in my work, but being curious to see how it answers, I tested it by a few trials with analysed waters.

Water Sample 629 B., Oct. 22, 1874; lat. 5° 44′ N., long. 123° 34′ E. (Laboratory number 332.)

1.3483
.0858
1.4341

Water used = 40·984 grms.

Ignited residue, 1·3483 grms.

Decinormal hydrochloric acid required for MgO = 31·2 c.c. = 3·12 × ½ [Mg] mgrms.[*]

Hence $(Cl_2 - O) = 31{\cdot}2 \times 2{\cdot}75$ mgrms. = 0·0858 grm. and corrected residue = 1·4341 or 34·992 grms. per kilo. The full analysis had led to the value 34·797 for the total salts, exclusive of carbonic acid.[†] The "chlorine," per kilo. was 19·274. Hence real total salts = same × 1·8058 = 34·804; deducting 0·152 for the carbonic acid per 100 of total salts, we have 34·751.

The Norwegian factor, 1·809 (which excludes the CO_2), leads to the number 34·866.

Water Sample 1259, Oct. 25, 1875; lat. 39° 16′ S., long. 124° 7′ W. (Laboratory number 347.)

Water used, 40·996.

Residue after	5	minutes'	ignition,	1·3970.
Do.	10	"	do.,	1·3680.
Do.	15	"	do.,	1·3530.

Last residue required, 26·1 c.c. of decinormal hydrochloric acid = 71·8 mgrms. of $(Cl_2 - O)$.

Hence corrected residue = 34·755 per kilogramme.

By full analysis,[†] = 34·582.

From the "chlorine," which was = 19·149, we have (exclusive of CO_2)—

By my factor, . . .	34·526
By the Norwegian factor, . .	34·640

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[*] The correction which, strictly speaking, is necessary for the original alkalinity, amounts to only 0·07 c.c., and may, therefore, be neglected.

[†] Corrected for the bromine and a slight over-determination in the soda.

Summary.

(Total amount of Salts per kilogramme of water, carbon dioxide being deducted.

Method adopted.	No. 332.	No. 347.
I. By full analysis,	34·797	34·582
II. By determination of chlorine and my factor, × deducting CO_2,	34·751	34·526
III. By the Norwegian method,	34·992	34·755
IV. By determination of chlorine and Norwegian factor,	34·866	34·640
Difference between III. and I.	+0·195	+0·173
" " II. " I.	−0·046	−0·056
" " IV. " III.	−0·126	−0·115
" " IV. " I.	+0·069	+0·058

Taking the result obtained by the first method as our standard, it appears that the Norwegian method slightly over-estimates the total salts, and that, starting from the chlorine, my factor gives a deficit in the total salts of about 0·051, the Norwegian factor an excess of about 0·063, or less than the Norwegian method of determining the solids by about 0·120. But in my opinion method II. is the most exact, and consequently my two full analyses slightly overstate the total salts, while the Norwegian method gives somewhat high results, and their factor, as applied to *my chlorine determinations*, is too high. But the Norwegians used a method of chlorine-determination of their own—which I think very well adapted for its special purpose—and I have no doubt that their determinations of total solids, as deduced from their own amounts of chlorine, and for the purpose of comparison, are more exact than would appear from the above table. I now proceed to state the results of my chlorine-determinations in the following Table I.:—

Column I. gives the number assigned to the sample by Mr. Buchanan.

Columns II.–V. are explained in the heading of the table.

Column VI.—The depth "D" of the ocean at the place, given in Column IV., where the sample was collected.

Column VII.—The mean "χ" of, in general, two determinations of the chlorine, in grammes per kilogramme, by means of my refinement on Volhard's method, as described in Chap. I., p. 4.

Column VIII.—The mean deviation "$\Delta\chi$" of the mean χ from the individual results; hence, in most cases, half the difference of the two analyses made. A blank in this column indicates that the respective χ was transcribed from the report on a complete analysis, and that its precision consequently must be presumed to be rather *above* the average.

Column IX.—This column, as is seen, is headed "B.; $\chi'-\chi$." The symbol χ' stands for the amount of chlorine per kilogramme, as calculated from Mr. Buchanan's determination of the specific gravity by means of the formula ${}_4S_t-{}_4W_t=a+bt+ct^2$, which is explained on p. 58 as summing up a series of standard determinations of my own. A printed list of Mr. Buchanan's specific gravities was placed in my hands by the Editor of the Challenger Reports. This list, in addition to the values ${}_4S_t$ found directly at $t°$ C., gave also the specific gravities at 15°·56 C., reduced, as I am informed by Mr. Buchanan, from the former by means of Hubbard's Tables of the thermic expansion of "sea-water." In my original draft for this memoir I gave the values χ' as deduced from these latter values by my formula. But when I subsequently came to criticise Hubbard's results in the light of my own experiments, and of those of Thorpe and Rücker and of Ekman, I found that Hubbard's Table is infected with inaccuracies,* which I saw I had no right to charge against Mr. Buchanan's determinations. I accordingly re-calculated all my values of χ' from Buchanan's *directly* determined specific gravities by means of my formula, and it is these re-calculated values, or rather their excesses over the value χ, which are now before the reader.

Column X. gives the "Laboratory Number" by which the sample was known in my laboratory.

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* *Vide infra.*

TABLE I.

GIVING THE PERMILLEAGES CHLORINE (χ) FOUND IN A SERIES OF CHALLENGER WATERS.

I. *The Surface Water of the North Atlantic.*

I.	II.	III.	IV.		V.	VI.	VII.	VIII.	IX.	X.
Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which the Sample was obtained. δ	D.	χ	$\Delta\chi$	B. $\chi^1-\chi$	Laboratory Number.
			Latitude.	Longitude.						
			N. ° ′	W. ° ′						
	1873.									
2	Feb. 15	1	27 24	16 55	Surface.	1890	20·343	4·5	+ ·012	201
5	„ 17	2	25 52	19 22	„	1945	20·461	10	− ·035	204
6	„ 18	3	25 45	20 14	„	1525	20·401	0	− ·121	264
9	„ 21	...	24 22	24 11	„	2740	20·544	0·5	− ·016	205
14	„ 24	...	23 15	30 56	„	2750	20·640	0	− ·042	209
17	„ 25	8	23 12	32 56	„	2800	20·638	15	+ ·036	211
18	„ 26	9	23 23	35 11	„	3150	20·694	5·5	+ ·015	212
22	„ 28	10	23 10	38 42	„	2720	20·658	11	+ ·028	215
31	Mar. 3	12	21 57	43 29	„	2025	20·452	9	+ ·137	221
100	May 6	46	40 17	66 48	„	1350	18·202	17·5	− ·170	265
201	Aug. 13	97	10 25	20 30	„	2575	19·577	3·5	− ·075	235
	1876.									
1687	May 1	...	21 33	31 15	„	2575	20·640	1	− ·037	489
1700	„ 5	...	30 20	36 6	„	2575	20·571	2	− ·118	498

II. *The Bottom Water of the North Atlantic.*

I.	II.	III.	IV.		V.	VI.	VII.	VIII.	IX.	X.
	1873.									
1	Feb. 15	1	27 24	16 55	Bottom.	1890	20·267	5·5	+ ·512	200
4	„ 17	2	25 52	19 22	„	1945	19·413	9	+ ·027	203
10	„ 21	5	24 20	24 28	„	2740	20·541	3·5	− ·083	206
15	„ 24	7	23 23	31 31	„	2750	19·458		+ ·033	210
19	„ 26	9	23 23	35 11	„	3150	19·814	0·5	− ·016	213
21	„ 28	10	23 10	38 42	„	2720	20·505	0·5	+ ·025	214
23	Mar. 1	11	22 45	40 37	„	2575	19·471	1·5	+ ·111	216
30	„ 3	12	21 57	43 29	„	2025	19·630	2	+ ·081	220
38	„ 6	14	20 49	48 45	„	1950	19·401	22	+ ·140	223
50	„ 10	18	19 41	55 13	„	2650	19·359	6	+ ·182	224
53	Mar. 11	19	19 15	57 47	„	3000	19·351	20	+ ·179	225
66	„ 26	25	19 41	65 7	„	3875	19·614	1·5	+ ·023	226
...	April 22	35a	29 5	65 1	„	2450	19·682	4	...	259
...	„ 25	38	31 24	65 0	„	2600	19·462	33	...	260
...	„ 27	39	31 49	64 55	„	2850	19·470	9	...	261
95	„ 30	42	35 58	70 35	„	2425	19·998	9	− ·092	262
122	June 16	60	34 28	58 56	„	2575	20·243	20	− ·073	228
126	„ 18	62	35 7	52 32	„	2875	20·177	1	+ ·030	229

II. *The Bottom Water of the North Atlantic*—continued.

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Position.		V. Depth in Fathoms from which the Sample was obtained. δ	VI. D.	VII. x	VIII. Δx	IX. B. x^1-x	X. Laboratory Number.
			Latitude.	Longitude.						
			S. ° ′	W. ° ′						
130	1873. June 19	63	35 29	50 53	Bottom.	2750	19·605	4	−·083	233
133	„ 21	65	36 33	47 58	„	2700	19·408	0·5	+·001	234
...	July 26	92	...	...	„	1975	20·430	2·5	...	263
205	Aug. 13	97	10 25	20 30	„	2575	19·437	1·5	+·021	237
223	„ 21	102	3 8	14 49	„	2450	19·428	12·5	−·035	242
226	„ 23	104	2 25	20 1	„	2500	19·427	16·5	+·011	243
237	„ 30	111	0 9	30 18	„	2275	19·468	2·5	−·025	244
1697	1876. May 3	353	26 21	33 37	„	2965	20·339	6	−·143	497
1710	„ 6	354	32 41	36 6	„	1675	19·949	5	−·100	506

III. *Water from Intermediate Depths in the North Atlantic.*

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Latitude.	IV. Longitude.	V. Depth δ	VI. D.	VII. x	VIII. Δx	IX. B. x^1-x	X. Laboratory Number.
24	1873. Mar. 1	11	22 45	40 37	2100	2575	19·429	7·5	+·012	217
27	„ 1				850	2575	19·471	1·5	+·099	218
29	„ 3	12	21 57	43 29	980	2025	19·506	1	−·002	219
32	„ 3				400	2025	19·564	18	+·094	222
127	June 18	62	35 7	52 32	500	2875	19·580	7	−·103	230
128	„ 18				250	2875	20·091	4	−·044	231
129	„ 18				150	2875	20·245	9	−·046	232
202	Aug. 13	97	10 25	20 30	50	2575	19·711	6	−·061	236
218	„ 21	102	3 8	14 49	50	2450	19·876	4·5	−·020	238
219	„ 21				100	2450	19·824	0	−·086	239
220	„ 21				200	2450	19·628	1·5	−·059	240
221	„ 21				300	2450	19·544	9·5	−·048	241
1649	1876. April 9	348	3 10	14 51	25	2450	19·645	0	−·231	481
1650	„ 9				50	2450	19·669	6	−·046	482
1651	„ 9				100	2450	19·594	18	+·014	483
1652	„ 9				200	2450	19·363	1	−·013	484
1670	„ 12	351	9 9	16 41	100	...	19·612	6	−·058	485
1671	„ 12				200	...	19·477	2	−·003	486
1676	„ 13	352	10 55	17 46	100	2500	19·573	6	−·018	487
1678	„ 13				300	2500	19·486	5	−·063	488
1690	May 3	353	26 21	33 37	25	2965	20·627	3	−·097	490
1691	„ 3				50	2963	20·630	0	−·228	491
1693	„ 3				200	2965	20·105	5	−·091	493
1694	„ 3				300	2965	20·158	3	−·084	494
1695	„ 3				400	2965	19·702	1	−·030	495
1698	„ 3				500	2965	19·787	6	+·194	495

III. *Water from Intermediate Depths in the North Atlantic*—continued.

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained. δ	VI. D.	VII. χ	VIII. $\Delta\chi$	IX. B. $\chi^1-\chi$	X. Laboratory Number.
			N. ° '	W. ° '						
	1876.									
1702	May 6	354	32 41	36 6	25	1675	20·257	16	−·090	499
1703	" 6				50	1675	20·245	6	−·152	500
1705	" 6				200	1675	20·219	1	−·068	501
1706	" 6				300	1675	20·023	3	−·110	502
1707	" 6				400	1675	19·944	3	−·141	503
1708	" 6				600	1675	19·758	11	−·151	504
1709	" 6				1200	1675	20·128	0	+·201	505

IV. *The Surface Water of the South Atlantic.*

	1873.		S.	W.						
265	Oct. 1	...	22 15	35 37	Surface.	...	20·511	11·5	−·022	250
	1876.									
1462	Feb. 11	318	42 32	56 29	"	2040	18·876	7	...	424
1473	" 11				25	2040			−·015	
1471	" 12	...	41 39	54 48	Surface.	2040	18·964	1	+·131	423
1573	Mar. 20	...	23 27	13 51	"	...	20·210	0	+·007	450
1581	" 22	...	19 55	13 56	"	...	20·470	4	+·034	451

V. *The Bottom Water of the South Atlantic.*

	1873.									
240	Sept. 1	112	3 33	32 16	Bottom.	2200	19·363	1·5	+·114	245
294	Oct. 11	133	35 41	20 55	"	1900	19·382	13	−·056	252
305	" 20	136	36 43	7 13	"	2100	19·300	5	+·056	253
			S.	E.	"					
312	Oct. 23	137	35 59	1 34	"	2550	19·350	9	−·039	258
	1876.		S.	W.						
1443	Jan. 20	313	52 20	67 39	55	55	18·268	2	−·005	420
1472	Feb. 12	319	41 54	54 48	Bottom.	2425	19·043	4	+·030	425
1481	" 14	320	37 17	53 52	"	600	19·088	4	−·097	426
1494	" 28	323	35 39	50 47	"	1900	19·747	17	−·037	429
1496	" 29	324	36 9	48 22	"	2800	19·401	0	+·038	430
1507	Mar. 2	325	36 44	46 16	"	2650	19·244	3	+·053	434
1518	" 7	329	37 31	36 7	"	2675	19·242	6	+·006	436
1520	" 8	330	37 45	33 0	"	2440	19·859	10	−·376	437
1529	" 9	331	37 47	30 20	"	1715	19·322	2	−·008	439
1533	" 10	332	37 29	27 31	"	2200	19·753	6	−·474	442
1557	" 16	335	32 24	13 5	"	1425	19·346	6	−·030	443
1589	" 23	339	17 26	13 52	"	1415	19·225	5	−·030	456

V. *The Bottom Water of the South Atlantic*—continued.

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Position.		V. Depth in Fathoms from which the Sample was obtained. δ.	VI. D.	VII. χ	VIII. Δχ	IX. B. $\chi'-\chi$	X. Laboratory Number.
			Latitude.	Longitude.						
	1875.		S. ° ′	W. ° ′						
1598	Mar. 24	340	14 33	13 42	Bottom.	1500	19·367	3	+·048	457
1607	,, 25	341	12 16	13 44	,,	1475	19·410	10	+·028	460
1616	,, 26	342	9 43	13 51	,,	1445	19·439	8	−·007	466
1628	April 4	345	5 45	14 25	,,	2010	19·439	3	−·015	469
1646	,, 7	347	0 15	14 25	,,	2250	19·418	4	−·066	480

VI. *Water from Intermediate Depths in the South Atlantic.*

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Latitude.	IV. Longitude.	V. Depth δ.	VI. D.	VII. χ	VIII. Δχ	IX. B. $\chi'-\chi$	X. Laboratory Number.
	1873.									
265	Sept. 30	129	20 13	35 19	300	2150	19·149	2	−·014	249
283	Oct. 6	131	29 35	28 9	1000	2275	19·302	7	−·027	251
			S.	E.						
308	,, 23	137	35 59	1 34	100	2550	19·522	12	−·068	254
309	,, 23				200	2550	19·422	7	−·040	255
310	,, 23				300	2550	19·229	7	−·032	256
311	,, 23				400	2550	19·108	0·5	−·004	257
	1876.		S.	W.						
1463	Feb. 11	318	42 32	56 29	25	2040	18·949	2	−·061	421
1464	,, 11				50				−·151	
1465	,, 11				100	2040	18·984	0	−·207	422
1467	,, 11				300				−·231	
1487	,, 28	323	35 39	50 47	25	1900	20·073	13	−·144	427
1488	,, 28				50				−·046	
1489	,, 28				100	1900	19·978	0	−·119	428
1501	Mar. 2	325	36 44	46 16	50	2650	20·109	10	−·044	431
1506	,, 2				800	2650	19·044	3	−·092	432
1517	,, 7	329	37 31	36 7	2000	2675	19·267	8	+·037	435
1525	,, 9	331	37 47	30 20	300	1715	19·433	6	−·092	438
1531	,, 10	332	37 29	27 31	800	2200	19·129	1	−·053	440
1532	,, 10				1400	2200	19·271	0	+·086	441
1563	,, 18	336	27 54	13 13	200	1890	19·412	3	−·014	444
1564	,, 18				300	1890	19·289	7	+·058	445
1566	,, 18				800	1890	19·298	3	+·017	446
1569	,, 19	337	24 38	13 36	25	1240	20·180	8	+·015	447
1570	,, 19				50	1240	19·846	4	−·010	448
1571	,, 19				100	1240	19·804	0	−·035	449
1583	,, 23	339	17 26	13 52	25	1415	20·381	4	−·127	452
1584	,, 23				50	1415	20·150	0	−·029	453
1586	,, 23				200	1415	19·367	2	−·068	454
1587	,, 23				300	1415	19·185	6	−·055	455
1605	,, 25	341	12 16	13 44	400	1475	19·041	0	+·093	458
1606	,, 25				800		19·153	8	+·003	459

VI. *Water from Intermediate Depths in the South Atlantic*—continued.

I.	II.	III.	IV.		V.	VI.	VII.	VIII.	IX.	X.
Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which the Sample was obtained. δ	D.	χ	$\Delta\chi$	R. $\chi' - \chi$	Laboratory Number.
			Latitude.	Longitude.						
	1876.		S. ° ′	W. ° ′						
1609	Mar. 26	342	9 43	13 51	25	1445	20·240	1	− ·041	461
1610	" 26				50		20·174	2	− ·124	462
1611	" 26				100		19·543	0	− ·120	463
1612	" 26				200		19·680	6	− ·162	464
1613	" 26				300		19·567	1	− ·122	465
1626	April 4	345	5 45	14 25	400	2010	19·176	4	+ ·011	467
1627	" 4				1525		19·312	16	− ·051	468
1631	" 6	346	2 42	14 41	25	2350	19·608	5	− ·163	470
1632	" 6				50		19·625	0	− ·119	471
1634	" 6				200		19·505	2	− ·059	472
1635	" 6				300		19·267	8	− ·058	473
1636	" 6				400		19·128	5	− ·021	474
1637	" 6				800		19·422	5	− ·035	475
1638	" 6				1875		19·430	0	− ·066	476
1641	" 7	347	0 15	14 25	25	2250	19·960	3	− ·082	477
1642	" 7				50		20·035	0	+ ·035	478
1643	" 7				100		19·580	5	− ·089	479

VII. *Surface Water of the Southern Part of the Indian Ocean.*

	1873.		S.	E.						
327	Dec. 19	143	36 48	19 24	Surface.	1900	19·848	...	− ·024	93
335	" 20	...	38 37	20 27	"	...	19·773	...	+ ·020	100
	1874.									
381	Feb. 12	...	63 0	80 0	"	...	18·759	...	− ·121	104
384	" 14	153	65 42	79 49	"	1675	18·321	...	− ·201	105
386	" 16	...	66 29	78 18	"	...	18·279	...	− ·008	107
388	" 17	...	64 57	79 30	"	...	18·631	...	− ·522	108
390	" 19	...	65 0	86 3	"	...	18·503	...	− ·084	109
441	Mar. 14	...	40 53	137 43	"	...	19·502	...	− ·061	121

VIII. *Bottom Water of the Southern Part of the Indian Ocean.*

	1873.									
333	Dec. 19	143	36 48	19 24	Bottom.	1900	19·370	...	+ ·103	99
353	" 29	146	46 46	45 31	"	1375	19·361	...	− ·266	101
359	" 30	147	46 16	48 27	"	1600	19·077	...	− ·021	102
	1874.									
378	Feb. 11	152	60 52	80 20	"	1260	19·294	...	− ·161	103
383	" 14	153	65 42	79 49	"	1675	19·277	...	− ·099	106
423	Mar. 7	158	50 1	123 4	"	1800	19·083	...	− ·000	116

IX. *Water at Intermediate Depths in the Southern Part of the Indian Ocean.*

I.	II.	III.	IV.		V.	VI.	VII.	VIII.	IX.	X.
Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which the Sample was obtained. δ	D.	χ	$\Delta\chi$	B. $\chi^1-\chi$	Laboratory Number.
			Latitude.	Longitude.						
			S.	E.						
	1873.									
328	Dec. 19	143	36 48	19 24	50	1900	19·648	...	− ·028	94
329	" 19				100	1900	19·548	...	− ·008	95
330	" 19				200	1900	19·280	...	+ ·096	96
331	" 19				300	1900	19·174	...	+ ·045	97
332	" 19				400	1900	19·190	...	+ ·078	98
	1874.									
391	Feb. 19	154	64 37	85 40	50	1800	19·043	...	− ·099	110
392	" 19				140		19·102	...	− ·066	111
393	" 19				300		19·197	...	− ·086	112
394	" 19				400		19·215	...	− ·075	113
397	" 21	156	62 26	95 44	50	...	19·078	...	...	114
421	Mar. 7	158	50 1	123 4	200	1800	18·951	...	+ ·097	115
434	" 13	160	42 42	134 10	50	2600	19·292	...	− ·050	117
435	" 13				100		19·243	...	− ·073	118
436	" 13				200		19·168	...	+ ·058	119
437	" 13				300		19·164	...	− ·031	120

X. *The Surface Water of the South Pacific.*

	1874.									
488	July 10	...	37 13	179 45	Surface.	...	19·861	1	− ·186	273
497	" 13	...	31 23	177 48	"	...	19·844	5	− ·031	277
504	" 15	...	28 25	177 39	"	...	20·008	27	+ ·024	282
505	" 16	...	26 48	175 0	"	...	19·728	8	− ·018	283
	1875.									
1127	Sept. 8	272	3 48	152 56	"	2600	19·885	2	− ·111	373
			S.	W.						
1271	Oct. 28	...	38 56	116 8	"	...	19·119	3	− ·213	400

XI. *The Bottom Water of the South Pacific.*

	1874.		S.	E.						
485	July 8	168	40 28	177 43	Bottom.	1100	19·057	24	+ ·245	272
492	" 10	169	37 34	179 22	"	700	19·451	5	− ·073	276
			S.	W.						
511	" 17	171*a*	25 5	172 56	"	2900	19·525	...	+ ·080	285
			S.	E.						
524	Aug. 12	175	19 2	177 10	"	1350	19·491	7	+ ·162	289
546	" 21	179	15 58	160 48	"	2325	19·470	4	− ·085	297
558	" 25	181	13 50	151 49	"	2440	19·360	14	+ ·001	304
561	" 27	182	13 6	148 37	"	2275	19·264	0	+ ·047	305
567	" 28	183	12 42	146 46	"	1700	19·324	10	+ ·065	310

XI. *The Bottom Water of the South Pacific*—continued.

I. Number of Sample.	II. Date.		III. Distinguishing Number of Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained. 3	VI. D.	VII. χ	VIII. Δχ	IX. B. χ¹—χ	X. Laboratory Number.
	1875.			S. ° ′	W. ° ′						
1157	Sept.	17	277	15 51	149 41	Bottom.	2325	19·286	0·5	−·001	387
1165	”	18	278	17 12	149 43	”	1525	19·308	7	−·141	388
1221	Oct.	14	285	32 36	137 43	”	2375	19·395	6	−·156	346
1259	”	25	290	39 16	124 7	”	2300	19·149	7	−·116	347
1270	”	27	291	39 13	118 49	”	2250	19·230	3	−·168	399
1274	”	29	292	38 43	112 31	”	1600	19·248	4	−·122	401
1286	Nov.	1	293	39 4	105 5	”	2025	19·315	3	−·090	402
1300	”	5	295	38 7	94 4	”	1500	19·288	12	−·140	348
1313	”	9	296	38 6	88 2	”	1825	19·216	3	−·199	406
1388	Dec.	28	302	42 43	82 11	”	1450	19·338	6	−·196	413
1397	”	30	303	45 31	78 9	”	1325	19·264	11	−·115	414

XII. *Water from Intermediate Depths in the South Pacific.*

I.	II.		III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII.	IX.	X.
	1874.			S.	E.						
467	June	19	165*a*	36 41	158 29	100	2600	19·637	5	−·172	268
469	”	19				300		19·278	19	−·066	269
470	”	19				400		19·601	8	+·010	270
491	July	10	169	37 34	179 22	200	700	19·309	19	−·081	275
				S.	W.						
500	”	14	170*a*	29 45	178 11	100	630	19·706	7	−·035	278
501	”	14				200		19·482	7	+·019	279
502	”	14				300		19·281	22	−·042	280
503	”	14				400		19·195	12	+·034	281
510	”	17	171*a*	25 5	172 56	400	2900	19·144	25	+·105	284
				S.	E.						
523	Aug.	12	175	19 2	177 10	200	1350	19·758	2	−·004	288
536	”	19	178	16 47	165 20	50	2650	19·495	19	+·095	291
537	”	19				100		19·808	4	+·136	292
538	”	19				200		19·560	12	+·091	293
544	”	21	179	15 58	160 48	300	2325	19·535	8	−·004	295
545	”	21				400		19·335	13	+·027	296
552	”	24	180	14 7	153 43	100	2450	19·785	26	+·182	298
553	”	24				200		19·379	6	+·074	299
554	”	24				300		19·448	19	+·005	300
555	”	24				400		19·524	8	+·098	301
563	”	28	183	13 42	146 46	100	1700	19·809	2	−·090	306
564	”	28				200		19·410	3	−·022	307
565	”	28				300		19·152	16	+·127	308
566	”	28				400		19·365	1	+·038	309
	1875.			S.	W.						
1128	Sept.	8	272	3 48	152 56	25	2600	19·693	6	−·131	374
1129	”	8				50		19·698	5	−·136	375
1130	”	8				100		19·655	7	−·117	376
1132	”	8				300		19·485	26	−·166	377

XII. *Water from Intermediate Depths in the South Pacific*—continued.

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained. δ	VI. D.	VII. x	VIII. Δx	IX. B. x²—x	X. Laboratory Number.
	1875.		S. ° ′	W. ° ′						
1133	Sept. 8	272	3 84	152 56	400	2600	19·298	11	−·186	378
1134	„ 8				800		19·278	3	−·166	379
1148	„ 16	276	13 28	149 30	25	2350	20·136	3	−·220	380
1149	„ 16				50		20·146	4	−·164	381
1150	„ 16				100		20·172	13	−·109	382
1151	„ 16				200		19·319	...	−·081	62
1152	„ 16				300		19·265	4	−·182	383
1153	„ 16				400		19·243	0	−·166	384
1154	„ 16				800		19·388	6	−·193	385
1156	„ 17	227	15 51	149 41	1850	2325	19·300	4	−·023	386
1169	Oct. 4	280	18 40	149 52	50	1940	20·158	6	−·204	389
1170	„ 4				100		20·111	1	−·069	390
1171	„ 4				200		19·592	2	−·080	391
1172	„ 4				300		19·211	1	−·126	392
1173	„ 4				400		19·137	5	−·095	393
1174	„ 4				1550		19·263	9	−·082	394
1264	„ 27	291	39 13	118 49	100	2250	19·096	1	−·136	395
1265	„ 27				200		19·126	3	−·307	396
1266	„ 27				300		19·143	4	−·183	397
1267	„ 27				400		19·073	1	−·134	398
1293	Nov. 3	294	39 22	98 46	300	2270	19·195	1	−·194	403
1295	„ 3				800		19·226	3	−·136	404
1299	„ 5	295	38 7	94 4	1000	1500	19·379	0	−·226	405
1346	Dec. 14	299	33 31	74 43	100	2160	19·101	7	−·123	407
1347	„ 14				200		19·240	14	−·201	408
1349	„ 14				400		19·133	1	−·125	409
1353	„ 16	...	32 50	77 6	10	...	19·066	2	−·198	410
1356	„ 17	300	33 42	78 18	50	1375	18·802	1	−·019	411
1357	„ 17				100		18·987	2	−·143	412

XIII. *Surface Water of the North Pacific.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII.	IX.	X.
	1875.		N.	E.						
682	Feb. 10	214	4 33	127 6	Surface.	500	19·137	12	−·067	354
817	Mar. 31	...	21 17	140 40	„	...	19·369	16	+·163	363
910	June 29	...	35 55	171 54	„	...	19·217	...	−·043	59

XIV. *Bottom Water of the North Pacific.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII.	IX.	X.
	1875.									
681	Feb. 10	214	4 33	127 6	Bottom.	500	19·280	5	−·130	353
691	„ 12	215	4 19	130 15	„	2500	19·248	6	−·030	340
758	Mar. 16	222	2 15	146 16	„	2450	19·308	0·5	−·176	358
791	„ 23	225	11 24	143 16	„	4575	19·170	2	+·106	342
865	June 18	238	35 18	144 8	„	3950	19·068	...	+·053	52
871	„ 19	239	35 18	147 9	„	3625	18·929 †	...	...	53
907	„ 28	244	35 22	169 53	„	2900	19·092	...	+·119	61

XIV. *Bottom Water of the North Pacific*—continued.

I.	II.	III.	IV.		V.	VI.	VII.	VIII.	IX.	X.
Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which the Sample was obtained. δ	D.	x	Δx	B. x^1-x	Laboratory Number.
	1875.		N. ° ′	E. ° ′						
912	June 30	245	36 23	174 31	Bottom.	2775	19·040	...	+·037	60
922	July 2	246	36 10	178 0	"	2050	19·135	...	+·085	44
			N.	W.						
924	" 3	247	35 49	179 57	"	2530	19·201	...	−·007	45
948	" 9	250	37 49	166 47	"	3050	19·054	...	+·137	47
953	" 10	251	37 37	163 26	"	2950	19·242	...	−·024	49
1116	Sept. 4	270	2 34	149 9	"	2925	19·269	11	−·002	372

XV. *Intermediate Waters of the North Pacific.*

	1875.		N.	E.						
753	Mar. 16	222	2 15	146 16	70	2450	19·603	5	−·155	355
754	" 16				100		19·561	...	−·092	122
755	" 16				200		19·508	8	−·201	341
756	" 16				300		19·289	8	−·159	356
757	" 16				380		19·247	4	−·103	357
806	" 27	227	17 29	141 21	300	2475	19·014	11	−·054	360
813	" 29	228	19 24	141 13	200	2450	19·181	7	−·001	361
814	" 29				300		19·033	4	−·029	362
821	Apr. 1	229	22 1	140 27	100	2500	19·512	14	−·230	364
823	" 1				200		19·283	13	−·184	365
824	" 1				400		19·036	12	−·135	366
874	June 21	240	35 20	153 39	25	2900	18·953	...	+·167	54
875	" 21				50		19·004	...	+·014	55
877	" 21				200		18·873	...	−·153	56
878	" 21				300		18·847	...	−·004	57
905	" 28	244	35 22	169 53	400	2900	18·858	...	−·013	58
906	" 28				600				−·013	
920	July 2	246	36 10	178 0	400	2050	18·957	...	−·068	42
921	" 2				1000		18·928	...	−·010	43
			N.	W.						
947	" 9	250	37 49	166 47	2800	3050	18·229	...	+·050	46
952	" 10	251	37 37	163 26	2850	2950	19·247	...	+·067	48
962	" 12	252	37 52	160 17	850	2740	19·040	...	−·010	50
963	" 12				2640		18·861	...	+·030	51
1094	Aug. 30	268	7 35	149 49	300	2900	19·204	6	−·114	367
1100	Sept. 2	269	5 54	147 2	25	2550	19·360	15	−·098	343

XVI. *Surface Water.—Miscellaneous Observations.*

	1874.		S.	E.						
584	Sept. 23	191	5 41	134 4½	Surface.	800	18·561	13	+·099	313
589	" 28	...	5 26	130 22	"	...	19·177	7	+·008	315
625	Oct. 22	...	6 3	123 20	"	...	19·179	1	−·102	331
			N.	E.						
645	Nov. 3	...	13 31	121 17	"	...	18·647	4	+·043	335

XVI. *Surface Water—Miscellaneous Observations*—continued.

I. Number of Sample.	II. Date.	III. Distinguishing Number of Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained. δ	VI. D.	VII. x	VIII. Δx	IX. B. x'−x	X. Laboratory Number.
			N. ° ′	E. ° ′						
668	1875. Jan. 26	...	9 10	124 25	Surface.	...	18·939	5	−·103	350
650	1874. Nov. 14	...	18 15	118 0	"	...	18·863	5	+·012	336
651	" 15	...	20 20	115 30	"	...	18·856	1	−·082	337
652	" 16	...	21 50	114 12	"	...	18·147	0·5	−·011	338
			S.	W.						
1424	1876. Jan. 8	...	50 17	74 46	"	...	16·761	0	−·087	417

XVII. *Bottom Water.—Miscellaneous Observations.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII.	IX.	X.
			S.	E.						
586	1874. Sept. 24	191*a*	5 26	133 19	580	580	19·155	15	+·133	314
596	" 28	193	5 24	130 37½	2800	2800	19·108	27	+·024	322
605	Oct. 13	196	0 48½	126 58½	825	825	19·265	1	+·048	323
			N.	E.						
606	" 14	197	0 41	126 37	1200	1200	19·197	23	...	324
621	" 20	198	2 55	124 53	2150	2150	19·217	9	+·105	330
675	1875. Feb. 8	213	5 47	124 1	2050	2050	19·270	4	−·084	351
643	1874. Nov. 2	204*a*	12 43	122 9	100	100	19·225	9	−·023	334
665	1875. Jan. 16	207	12 21	122 15	700	700	19·180	8	−·065	349
656	" 8	206	17 54	117 14	2100	2100	19·259	0·5	−·069	339
			S.	W.						
1405	1876. Jan. 2	306*a*	48 27	74 30	345	345	18·947	8	−·139	415
1427	" 8	309*a*	50 56	74 14	140	140	18·461	3	−·135	416
1431	" 10	310	51 27½	74 3	400	400	18·447	7	−·090	418
1438	" 11	311	52 45½	73 46	245	245	18·470	0	−·091	419

XVIII. *Intermediate Water.—Miscellaneous Observations.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII.	IX.	X.
			S.	E.						
590	1874. Sept. 28	193	5 24	130 37¼	50	2800	19·039	4	+·121	316
591	" 28				100		19·235	22	+·065	317
592	" 28				200		19·185	4	+·154	318
593	" 28				300		19·219	3	+·089	319
594	" 28				400		19·274	6	+·032	320
595	" 28				600		19·110	8	+·060	321
			N.	E.						
616	Oct. 20	198	2 55	124 53	50	2150	19·269	3	−·006	325
617	" 20				100		19·293	8	+·029	326
618	" 20				200		19·214	0·5	−·018	327
619	" 20				400		19·169	1	−·033	328
620	" 20				800		19·352	26	+·105	329

The salinity of a sea-water could not possibly be more succinctly defined than by the statement of the percentage or permilleage of chlorine; hence our chlorine-determinations could well be allowed to stand as they are. But they are not sufficiently numerous to have any value, except as a small addition to, and as affording to some extent a check upon, Mr. Buchanan's extensive hydrometer-work. Hence it is not so much the values of χ as the values $\chi'-\chi$ in Column IX. which give the practically useful result of my analytical determinations. The constants which I needed for calculating the values χ', corresponding to Mr. Buchanan's specific gravities, were ready to hand in the memoir* published by the chemists of the Norwegian North Atlantic Expedition; and judging by the general character of their work, I had no doubt in my mind about the substantial correctness of their results. But I thought I had better at least check these numbers by a series of experiments of my own; and when I had once entered upon this work, I somehow allowed it to expand into a more general research into the matter, which I will now proceed to give *in extenso*, hoping that it may prove of some utility to physical oceanographers.

The Specific Gravity of Ocean-Water, a Function of Salinity, Temperature, and Pressure.

The pressure, as an independent variable, of course comes into consideration only in reference to an ocean-water as it is *in situ*; and, for oceanographic purposes, it might, perhaps, be assumed to be measured with sufficient exactness by the depth of the superincumbent layer of water. But this datum, in many of our Challenger samples, assumes rather high values, and its influence on the specific gravity then is greater than one might be inclined at first sight to think. According to Grassi (Ann. d. Chim. et de Phys., sér. 3, vol. xxxi. p. 437), sea-water of 1026·4 sp. gr. at 17°·5 C. when subjected to pressure, contracts by 43·6 millionths of its original volume per atmosphere of over-pressure. Now taking x as designating the number of fathoms (1 fath. = 72 in.), exerting a pressure equal to that of 30 inches of mercury, we have $30\times13{\cdot}596=72\times1{\cdot}026\times x$, whence $x=5{\cdot}521$. Hence a sea-water of 1·026 sp. gr. under the pressure of δ fathoms of water of the same density undergoes compression to the extent of $\frac{\delta\times43{\cdot}6}{5{\cdot}521}=7{\cdot}9\times\delta$ millionths of its volume; its density consequently rises from 1·026 to $1{\cdot}026\left(1+\overset{\text{vi}}{7{\cdot}9\delta}\right)$; when $\delta=1000$ fathoms, for instance, we have an increase $\Delta S=0{\cdot}0079$; *i.e.*, the actual density *in situ* would be $=1{\cdot}034$ instead of 1·026 at the ordinary pressure. And a good number of the Challenger samples were procured from depths of 3000 fathoms and more. It is very desirable that Grassi's research should be extended to waters of different strengths, and to different temperatures.

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* Den Norske Nordhavs-Expedition, 1876–78; Chemi, p. 47, &c.

I had not the necessary apparatus in my laboratory to attempt to do this, and besides had been informed that the problem was likely to be taken in hand by Professor Tait. A notice in the Royal Society of Edinburgh's Proceedings for 1882–83, p. 45, indicates that he has done so, and I hope that his results may enable him to give the right formula for the reduction of Mr. Buchanan's specific gravities of deep sea-waters to their actual pressures *in situ*.* I confined myself to determining the influence on the specific gravity of concentration and temperature. For this purpose I carried out the following series of experiments :—

I. *Series.*—A number of the more saline of Challenger waters were mixed together, so as to produce several litres of a sea-water containing about 20·5 grms. of chlorine per kilo. ("$\chi=20·5$"). The specific gravity of this water was determined at 12 different temperatures, ranging from $-3°·4$ to $+29°·45$ C., by means of a glass plunger, which, by a previous series of experiments (ranging from 6°·6 to 30°·6) had been ascertained to displace the volume of 190·7144 grms. $+5·8\times t$ mgrms. of water of 4°, at $t°$ C. In the experiments the plunger was suspended from the bottom of one of the pans of an Oertling 16 inch balance, by means of a fine platinum wire, while the water or sea-water operated upon was contained in a large cylinder standing within a large water-bath (of 30–40 litres capacity), which served to maintain a constant temperature. At temperatures differing from that of the room, the temperature of the bath was kept uniform by constant agitation with a perforated horizontal plate fixed to a vertical rod, while the plunger itself served for mixing together the water to be tested. A small bulb thermometer, divided into tenths of a degree, was constantly kept immersed in the latter. As soon as a constant temperature was established, this temperature was maintained for a time, and the apparent weight of the immersed plunger determined two or three times in succession so as to make sure in this manner of perfect equilibrium of temperature. Previous to the last weighing, the cylinder with the plunger was lifted out of the bath for an instant, to make sure of the absence of air-bells, or to remove any that might show themselves, which, however, happened only a few times at the higher temperatures. The χ of the water had been previously determined by a duplicate analysis (by our refinement on Volhard's method), and was again determined after the specific gravity experiments, when it turned out that, by the unavoidable evaporation at the higher temperatures, its χ had increased by about 0·05 unit. The value adopted for the calculations was $\chi=20·523$. The specific gravities† ${}_tS_t$, or rather the excesses of ${}_tS_t$ over the minimum value, were laid down as ordinates, the corresponding temperatures as abscissæ in a system of rectangular coordinates, and united by the nearest curve, three ordinates of which served for the calculation of an interpolation-formula—

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* In a recently published fasciculus (No. 114) of the *Proc. Roy. Soc. Edin.*, Professor Tait has given for sea-water at 12° C. the following value of the true compressibility per ton weight per square inch (about 150 atmospheres) 0·00686 (1−0·034 *p*). Here *p* represents the number of ton's weight per square inch to which the water was at first exposed :—*i.e.*, it represents (very nearly) the depth in miles under the surface.

† ${}_tS_t$ means—specific gravity at $t°$ referred to water of 4° as $=1000$.

$S_t = S_0 - at + bt^2$, which was found to do sufficient justice to the experiments (the "errors" ranged from $-0\cdot05$ to $+0\cdot06$).*

II. *Series.*—This series was quite similar to the first, except that a more dilute water ($\chi = 18\cdot023$) was operated upon—in 20 experiments—the temperatures for which ranged from $+0^{\circ}\cdot8$ to $29^{\circ}\cdot8$. Here also a formula of the second degree was found to sum up the results satisfactorily.

As the excess of the specific gravity over 1000 must be presumed to be at least approximately proportional to χ, I tried to sum up the two series in one formula—

$$ {}_4S_t - 1000 = \chi(a_0 - \beta t \pm \gamma t^2), $$

but did not succeed in establishing a sufficient general agreement between calculation and experiment.

III. *Series.*—The object of this series was to determine the exact relation between ${}_4S$ and χ for a wider range of concentration at a constant "ordinary" temperature. Starting with a sea-water of $\chi = 20\cdot345$, I mixed three separate portions of it with known proportions by weight of pure water, so as to produce in all four waters of convenient strengths. Each of the four waters was analysed, the results were calculated as so many determinations of the χ of the original water, and the mean, $20\cdot345$, adopted as the value of χ for it. From this value (and the data of the syntheses) the χ's of the other three waters were calculated and found—

	Original Water.	Mixture A.	Mixture B.	Mixture C.
$\chi=$	$(20\cdot345)$	$19\cdot290$	$18\cdot322$	$17\cdot322$

The specific gravity of the original water was ascertained by means of the plunger and I found that—

$$ {}_4S_{19\cdot2} = 1026\cdot396. $$

I then proceeded to determine the differences between the specific gravity of this water and those of the mixtures A, B, and C, by means of a method of my own invention.† A cylindrical specific gravity bottle, of about 30 c.c. capacity, whose glass stopper was perforated by a capillary aperture, was filled with "original" water, and from the one pan of a balance, by means of a thin platinum wire, suspended within a mass of water of the same kind, kept at a constant temperature (about 19° C.), its tare taken and noted down as W_0. The bottle was then emptied out, rinsed and charged with, say, water A, up to near the edge, and the "original" water in the cylinder used as a bath

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* In the final calculations (see Table II.) I adopted for each of certain groups of experiments such an intermediate value between the initial and the final χ as seemed to me most probable. The arbitrary element thus introduced is of no significance.

† See *Chem. News*, vol. xliv. p. 51.

for bringing the water A to very near its own temperature. The stopper was now inserted, the overflowing liquid quickly wiped off, the bottle suspended within the mass of "original" water, and its weight as soon as it had become constant noted down (as W_A). I thus obtained the data for solving the equation—

$$W_0 - W_A = V(S_0 - S_A),$$

whence

$$(S)_0 - (S)_A = \frac{W_0 - W_A}{V},$$

where V stands for the capacity of the bottle in grms. of water at 4° (at the temperature $t°$). Small variations of temperature, of course, were unavoidable; these, however, were easily allowed for by calculation. The results thus corrected were as follows:—

Name.	χ.	${}_4S_{19\cdot7}$.
The Original Water,	20·345	1026·29
A,	19·290	1024·83
B,	18·322	1023·50
C,	17·322	1022·125

The first value had been obtained by weighing a bottle full of pure water within the "original." The plunger experiment (made at 19°·3), when corrected to 19°·7, gave 1026·295, which is practically the same number. The "original" water, after having been used as a medium as described, was again analysed, and found to contain 20·346 grms. of chlorine per kilo., showing that the slight diffusion into it of less concentrated and even of pure water had not sensibly affected its strength. From the four values for χ and ${}_4S_{19\cdot7}$, I deduced the following relation:—

$${}_4S_{19\cdot7} = 998\cdot32 + 1\cdot3745\chi,$$

and was struck by the fact that the constant term came to exactly the specific gravity of *pure* water at 19°·7. Acting upon this hint, I calculated the *whole* of my experiments on the basis of the assumption that for a given temperature t the excess of the specific gravity of a sea-water over that of pure water (W_t) is proportional to χ, *i.e.*, that

$$\frac{{}_4S_t - {}_4W_t}{\chi} = D,$$

and that $D = a + bt + ct^2$.

To make the best of my numbers, I adopted the method of the least squares; but saved myself some trouble, without, I am sure, losing in precision, by uniting certain sets of individual experiments made with the same water at nearly the same temperature into one determination for the nearest integer temperature, which my provisional interpolation formulæ enabled me to do. Thus, for instance, four determinations of series II. at

$$t = 7°\cdot2 \qquad 7°\cdot3 \qquad 7°\cdot7 \qquad 7°\cdot8$$

were reduced to 8°, and gave

$${}_4S_8 - 1000 = 25\cdot447 \qquad 25\cdot451 \qquad 25\cdot452 \qquad 25\cdot457$$

and from the mean of these the specific gravity at 8° C. was taken to be 1025·452. I thus formed 13 groups from series I. and II., which, with the four experiments of series III., gave 17 couples of values. These, after having been duly "weighted," were used for forming the equations. The results are summarised in the following Table II.

TABLE II.

Experiments to determine the dependence of Specific Gravity on Salinity and Temperature; i.e., the function $S=f(t, \chi)$.

I. Group.	II. t.	III. χ.	IV. D_c (calculated).	V. D (found).	VI. $D-D_c$.	VII. S_c (calculated).	VIII. S (found).	IX. $S-S_c$.	X. W_t.
I.	30	20·480	1·35062	1·3498	−·0008	1023·438	1023·421	−·017	995·765
II.	25	20·522	1·36071	1·3629	+·0022	1025·044	1025·090	+·046	997·120
III.	20	20·554	1·37407	1·3747	+·0006	1026·502	1026·515	+·013	998·259
IV.	15	20·524	1·39065	1·3904	−·0002	1027·702	1027·696	−·006	999·160
V.	7	20·493	1·42396	1·4231	−·0009	1029·115	1029·096	−·019	999·933
VI.	0	20·493	1·45993	1·4593	−·0006	1029·790	1029·777	−·013	999·871
VII.	29	17·984	1·35238	1·3513	−·0011	1020·372	1020·353	−·019	996·031
VIII.	22	18·003	1·36833	1·3701	+·0018	1022·460	1022·493	+·033	997·826
IX.	16	18·013	1·38708	1·3872	+·0001	1023·988	1023·990	+·002	999·002
X.	13	18·023	1·39821	1·3978	−·0004	1024·631	1024·623	−·008	999·430
XI.	8	18·023	1·41935	1·4185	−·0008	1025·467	1025·452	−·015	999·880
XII.	6	18·023	1·42871	1·4287	0	1025·719	1025·719	·000	999·970
XIII.	0	18·023	1·45993	1·4619	+·0020	1026·184	1026·218	+·034	999·871
(34)	19·7	20·345	1·37496	1·3748	−·0002	1026·294	1026·290	−·004	998·320
(35)	19·7	19·290	1·37496	1·3744	−·0006	1024·843	1024·832	−·011	998·320
(36)	19·7	18·322	1·37496	1·3745	−·0005	1023·512	1023·503	−·009	998·320
(37)	19·7	17·322	1·37496	1·3743	−·0007	1022·137	1022·125	−·012	998·320
				r =	±·00070		r =	±·0135	

Column I. names the group of experiments, or [under (34), (35), (36), (37)] the one experiment utilised.

Column II. gives the temperature.

Column III., the value χ adopted.

Column IV., the value D calculated as D_c.

Column V., the value D found as D.

Column VI., $D - D_c$.

Column VII., the sp. gr. ${}_tS_t$ calculated as S_c.

Column VIII., the sp. gr. ${}_tS_t$ found, as S (plain).

Column IX., $S - S_c$.

Column X., the adopted sp. gr. of pure water at $t°$, water of $4° = 1000$, as W_t.

The numbers in Column X. are taken from the table appended by Prof. Thorpe to his Manual of Quantitative Analysis, as being "compiled from the experiments by Kopp, Pierre, Despretz, Hagen, Matthiesen, Weidner, Kremers, and Rosetti." A comparison of these numbers with the corresponding entries in a table given in Naumann's edition of the first volume of Gmelin's chemistry, shows that up to 30° the values are Rosetti's. The values r at the foot of the two difference columns were calculated by the well-known "probable error" formula—

$$r = \pm 0{\cdot}6745 \sqrt{\frac{\Sigma\Delta^2}{n-1}}.$$

The calculation of the values D and S was effected according to the formula :—

$$\frac{{}_tS_t - {}_tW_t}{\chi} = D = a + bt + ct^2.$$

$a = \ \ 1{\cdot}459\,93$ . . log. $a = 0{\cdot}164\,3304$

$b = -0{\cdot}005\,5922$ . . log. $b = \bar{3}{\cdot}747\,5827$

$c = +{\cdot}000\,06494$ . . log. $c = \bar{5}{\cdot}812\,5190$

The excellent work of the Norwegian chemists enabled me to check my results in two directions.

They determined the relation between χ and ${}_{15{\cdot}56}S_{15{\cdot}56}$ from the data in Columns II. and I. of the following table, from which I calculated the ratios $\frac{{}_{15{\cdot}56}S_{15{\cdot}56} - 1000}{\chi}$ given in Column III. :—

I.	II.	III.
1026·70	19·47	1·3713
1017·39	12·71	1·3682
1025·73	18·68	1·3774
1026·76	19·56	1·3681
1024·88	18·09	1·3753
1026·69	19·47	1·3708
1026·55	19·38	1·3699
Mean, ...		1·3716

Now, according to my experiments (by formula)—

$${}_4S_{17.5} - {}_4W_{17.5} = \chi D_{17.5} = 1.38196\chi\ ;$$

whence

$$\frac{{}_4S_{17.5}}{{}_4W_{17.5}} - 1 = \frac{1.38196\chi}{{}_4W_{17.5}}$$

or

$$\frac{{}_{17.5}S_{17.5} - 1000}{\chi} = 1.38369 .$$

The Norwegians' result is 1.3716,

or, writing ΔS for ${}_{17.5}S_{17.5} - 1000$.

According to my experiments, $\chi = (\Delta S) \div 1.3837$

According to the Norwegians' experiments, $\chi = (\Delta S) \div 1.3716$.

i.e., taking my result as the standard, the Norwegians overrate their chlorines by about $\frac{12}{1383} = 0.0087$ of their true values. But this is *not* doing justice to the *relative* correctness of their results; they used different methods from mine, both for the determination of the chlorine and of the specific gravity,* and their formula may be more correct than mine for the reduction of *their* χ's and S's to one another.

The primary and principal object of my investigation was to formulate the mathematical relation between χ on the one hand and a given couple of values of t and ${}_4S$ on the other. And from the values for r given at the foot of Table II., it would appear that my equation

$$\chi = \frac{{}_4S_t - {}_4W_t}{a + bt + ct^2}$$

with the calculated values substituted for a, b, c, does this with a very fair degree of precision. But part of this precision probably is bought, so to say, at the expense of some of the exactitude which my experiments, Series I. and II., might claim as determining the relative volumes, at different temperatures, of the respective two kinds of sea-water. This we must keep in view when we now proceed to utilise the equation, as formulating, in reference to a sea-water of given salinity (*i.e.*, for χ=constant), the relations between volume and temperature.

Of the several researches on the thermic expansion of sea-water, I have utilised the following for checking my results in the sense referred to:—

(1) *Hubbard's;* or rather a table giving the volumes of "Ocean-Water" at 0°, 1°, 2° . . . 30° Cent., in terms of the volume at 15°·56 C. or 60° F., which Mr. Buchanan has calculated from a table in Hubbard's original memoir, which gives the volumes

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* This they determined by means of hydrometers.

corresponding to the series of integer temperatures Fahrenheit. I am indebted to Mr. Buchanan for having placed a manuscript copy of his (and Hubbard's original) table at my disposal. From Buchanan's table I calculated the volumes at t°, in terms of the volume at 0° C. as unity. Hubbard's results are of importance, because, forming as they do part of "Maury's Sailing Directions," they are sure to have been hitherto, and to be perhaps in the future, used largely by seafaring scientific men. Mr. Buchanan, in fact, used them for the reduction of his specific gravities during the cruise, because at that time there were no other tables published which he saw reason to prefer. It is perhaps as well for me here to state at once that Hubbard, as one of the results of his work, asserts that in ocean-water (not in sea-water generally) the variations in salinity are too small to appreciably affect the law of thermic expansion.

(2) *Ekman's.*—I never had the original memoir at hand; what I utilised are his tables on the relative volumes of sea-waters as reprinted in the Norwegians' memoir,* page 53. Ekman operated on four waters, the specific gravities of which were as follows:—

Water	A	B	C	D
${}_{18}S_{18}=$	1016·03	1019·82	1023·06	1026·95

Only the water D falls fairly within the area of my experiments. Ekman's temperatures range from − 5° C. to + 25° C.

(3) *Thorpe and Rücker's.*—I very much regret that up to the time when the first proofs of this memoir passed through the press, I knew this most excellent research only by a somewhat meagre abstract in the Royal Society's Proceedings, and, misled by some remarks in the Norwegians' memoir, came to form an incorrect estimate of its importance. Since then, however, I have, through the courtesy of the authors, come into possession of a copy of their full memoir as presented to the Royal Society in November 1875, and printed in this Society's Transactions, vol. clxvi. part 2, p. 405. I hardly need say that what I give in the sequel on the authority of these two experimenters is taken direct from the memoir quoted. Thorpe and Rücker determined the relative volumes at a series of temperatures ranging from about 0° to 30° or 40° C. of four sea-waters, the specific gravities of which were found to be as follows:—

Water	A	B	C	D
${}_0S_0=$	1033·015	1028·66	1024·915	1020·755

B is a surface-water from the North Atlantic; from it the other three were prepared—A by evaporation, C and D by dilution with certain proportions of distilled water. The expansion of each of these four waters was determined twice by means of two different

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* Quoted in footnote, page 53.

dilatometers, the temperature in all cases being defined by means of special thermometers, *à haute précision.* It is this latter circumstance more especially which induces me to think that whatever may be the degree of precision with which I succeeded in formulating the relation $\chi = f(S, t)$, they came nearer the truth than I did in determining the relation for a given kind of sea-water between temperature and volume. I very much regret that Thorpe and Rücker did not supplement their masterly research by the determination of the salinities (the χ's) of their waters, so that I could have utilised it for checking the constants in my formula, and thereby my reductions of Buchanan's "specific gravities at the temperature of observation" to terms of χ. I hope that Messrs. Thorpe and Rücker have preserved samples of their sea-waters, and will one day carry out the supplementary chemical work which I suggest. Meanwhile their results afford to me an excellent means for criticising what my formula contains of the $S = f(t)$ element.

In the following Table III., Columns II., III., and IV. give the relative volumes, at the temperatures named in Column I., of a sea-water whose $\chi = 19{\cdot}39$, which I calculate to be the value appertaining to Ekman's water "D," according to the authorities named in the columns' headings. Column V. gives the volumes assigned by Thorpe and Rücker to their water "B." In Column VI. follow Hubbard's relative volumes of "average ocean-water." The two last columns refer to the salinity ($\chi = 17{\cdot}09$) of Thorpe and Rücker's water "C." Column VII. gives their values; Column VIII. the corresponding values demanded by my formula. The numbers under "Ekman" are transcribed from his table in the Norwegian memoir; those under "Hubbard" are the entries in Buchanan's Centigrade edition of Hubbard's table, divided by the there given relative volume at 0° C. The numbers given as "Thorpe and Rücker's" are extracted from Table XIV. of their memoir. This table gives the relative volumes of their waters A, B, C, and D at 0°, 2° . . . 12°, 15°, 18° . . . 36°. From this table I deduced what I needed of volume-values for 5°, 20°, and 25° by interpolation by first and second differences. This sufficed for my Columns V. and VII. The numbers in Column IV. were obtained by what I may call horizontal interpolation between corresponding values for B and C, based on the assumption that taking V as a general symbol for the volumes (of A, B, &c.) at a given temperature, and S_0 as designating their result for the specific gravity at 0° C., $\frac{\Delta(V)}{\Delta(S_0)}$ is a constant. I had no difficulty in satisfying myself that this assumption does hold for their results with a sufficient degree of approximation.

I may here state, in passing, that according to a series of calculations which I made (but had no time to check, and simply put aside), this proposition, or rather the almost identical assertion that (at $t°$) $\frac{\Delta(V)}{\Delta(\chi)}$ is a constant, does not hold for Ekman's results with *his* waters A, B, C, D. This may be owing either to the fact that the relation as a matter of physical law ceases to hold at salinities as low as those of his water A, or to the fact that his more dilute waters were not prepared synthetically from *one* strong ocean-water, but were all natural sea-waters, that is, ocean-water diluted naturally with river-water of variable composition.

TABLE III.

Giving the Relative Volumes of Sea-Water according to various Observers.

I.°	II.	III.	IV.	V.	VI.	VII.	VIII.
	$\chi = 19\cdot39$ $_4S_0 = 1028\cdot27$			Th. & R.'s "B." $_4S_0 = 1028\cdot66$.	Hubbard. $\chi = ?$		
t° Cent.	Ekman "D."	Dittmar.	Thorpe & Rücker.	Thorpe & Rücker.		Thorpe & R.'s "C."	Dittmar.
0	1·000 00	1·000 00	1·000 00	1·000 00	1·000 00	1·000 00	1·000 00
5	0·42	0·38	0·43	0·44	0·35	0·36	0·33
10	1·10	1·05	1·14	1·15	0·98	1·01	0·95
15	2·04	2·00	2·07	2·09	1·92	1·91	1·85
20	3·20	3·20	3·25	3·27	3·17	3·07	3·01
25	4·56	4·57	4·64	4·66	4·62	4·44	4·36
30	Not determined.	6·09	6·20	6·23	6·26	5·97	5·86

The deductions from this Table III. need hardly be expressed in words. I satisfy myself with pointing out that, on its showing, Hubbard's assumption that the variations in salinity which occur in ocean-water do not sensibly affect the law of thermic expansion, cannot be admitted to hold good with a sufficient degree of approximation.

Ekman's Water D, in salinity, stands about mid-way between the least and the most saline of Challenger waters; it besides falls fairly within the area of the experiments of all the four observers referred to. I have, therefore, selected it in calculating the following Table IV., which gives the values *y* which have to be added to, or subtracted from, the specific gravity at 15°·56 C. = 60° F. (Mr. Buchanan's standard temperature), to find the specific gravity at 0°, 5° . . . . 30° C. According to my calculation, after Ekman's statements, we have $\chi = 19\cdot39$, $_4S_{15\cdot56} = 1025\cdot96$, and (taking the expansion from Ekman's table) $_4S_0 = 1028\cdot17$.

The columns headed T – D, E – D, H – D, T – E, show, in a very obvious sense, by how much the two observers referred to by their initials differ from each other in their value for *y* at the given temperature.

TABLE IV.

Referring to a Sea-Water of the Salinity of Ekman's "D."

General Equation: ${}_tS = {}_tS_{15\cdot56} \pm y$.

t°	Values of ± y according to				Difference between Observers.			
	Dittmar.	Thorpe and Rücker.	Ekman.	Hubbard.	T − D.	E − D.	H − D.	T − E.
0	2·18	2·24	2·21	2·11	+ ·06	+ ·03	− ·07	+ ·03
5	1·79	1·81	1·78	1·75	+ ·02	− ·01	− ·04	+ ·03
10	1·10	1·08	1·08	1·10	− ·02	− ·02	0	0
15·56	0	0	0	0	0	0	0	0
20	1·10	1·08	1·07	1·14	− ·02	− ·03	+ ·04	+ ·01
25	2·49	2·50	2·46	2·62	+ ·01	− ·03	+ ·13	+ ·04
30	4·04	4·10	Not determined.	4·29	+ ·06	?	+ ·25	?

This table, again, needs not be commented upon. To show more fully what the $\Delta(y)$'s given as T−D, &c., mean, let us translate them into differences of temperature. From a table given below (as Table V.) we see that, for

$$t = \quad 0^\circ \quad 5^\circ \quad 10^\circ \quad 20^\circ \quad 25^\circ \quad 30^\circ$$
$$\frac{\Delta(t)}{\Delta(S)} = -20^\circ \quad 9^\circ{\cdot}1 \quad 5^\circ{\cdot}9 \quad 3^\circ{\cdot}7 \quad 3^\circ{\cdot}3 \quad 3^\circ{\cdot}1$$

whence we easily compute the temperature-equivalents for the divergencies in specific gravity given as T−D, &c. The result is as follows:—

TABLE IV. (A).

t.	T−D	E−D	H−D	T−E
0°	−1°·2	−0°·6	+1°·4	−0°·6
5	−0·18	+0·09	+0·36	−0·27
10	+0·12	+0·12	0	0
20	−0·07	−0·11	+0·15	+0·04
25	+0·03	−0·10	+0·43	+1·13
30	+0·18	...	+0·75	...

The large values under H − D suggest that Hubbard's thermometer registered too low. What he called 25°·0 really was 25°·43—virtually, at least. Leaving the Hubbard column on one side, the other discrepancies might be called moderate (the more so as they really represent the conjoint effect of two discrepancies—$\Delta(\mathrm{S})$ and $\Delta(t)$—as one discrepancy charged against the thermometer), if it were not for the uncomfortably large values entered in the line for $t=0°$. It will not do to charge the temperature error against the (virtual) observation at 15°·56. It would then, as a temperature error, appear small, but the pleasant smallness of all the other $\Delta(y)$'s besides those at 0° would vanish.

Assuming the truth to lie mid-way between Thorpe and Rücker on the one side, and myself on the other, the y for the reduction of a specific gravity from 15°·56 to 0°, or *vice versa*, according to either authority would be uncertain by ±0·°03 (pure water of 4° = 1000). Table IV. is constructed on the model of a far more extensive table, which I calculated long ago for the reduction of specific gravities from 15°·56 to $t°$ and *vice versa*. That table, which gave the values y under the successive headings of $\chi = 17, 18 \ldots 21$, was used at the Challenger Office for the final reduction of Buchanan's specific gravities; but I have cancelled it as part of this memoir, because I found that Thorpe and Rücker's plan is more convenient for purposes of computation. Their reduction table is founded upon a proposition which they extracted from their general interpolation formula, but which stands out more visibly in my own equation for $\mathrm{S} = f(\chi, t)$. Assuming S_t and $\mathfrak{S}_t$ to be the specific gravities of two different sea-waters at $t°$, and S_0 and $\mathfrak{S}_0$ to be the corresponding values for 0°, then

$$\frac{\mathrm{S}_t - \mathfrak{S}_t}{\mathrm{S}_0 - \mathfrak{S}_0} = f(t)$$

where $f(t)$ is a function of temperature, which, according to my formula is simply

$$f(t) = \frac{\mathrm{D}_t}{\mathrm{D}_0} = \frac{a + bt + ct^2}{a}$$

(compare page 58). Hence, by analogy for any other temperature τ (instead of t)

$$\frac{\mathrm{S}_\tau - \mathfrak{S}_\tau}{\mathrm{S}_0 - \mathfrak{S}_0} = f(\tau)$$

Hence,

$$\frac{\mathrm{S}_t - \mathfrak{S}_t}{\mathrm{S}_\tau - \mathfrak{S}_\tau} = \frac{f(t)}{f(\tau)} = \text{“}\phi(t)\text{”}$$

as we will call it. According to my equation obviously

$$\phi(t) = \frac{\mathrm{D}_t}{\mathrm{D}_\tau}.$$

Let us take $\tau = 15°{\cdot}56$, and we have a convenient formula for the reduction of specific gravities to or from 15°·56, provided we have a table giving the specific gravities of a standard water for the requisite series of temperatures.

Thorpe and Rücker take as their standard the sea-water for which ${}_0S_0=1020$, and give the values ${}_0S_t$ of this water for all integer temperatures from 0° to 36° in their Table XV. Column II.; their values $f(t)$ are entered in Column IV. of their table. For Challenger purposes it is more convenient to take as a standard the sea-water whose ${}_4S_{15\cdot56}=1026$, which lies about mid-way between the occurring extremes, and it is better, in lieu of $f(t)$, to give $\phi(t)$ ready calculated. The following Table V. is constructed on this plan.

TABLE V.—*Giving the Specific Gravities* ${}_4\Xi_t$ *of "Standard Sea-Water" at* $t°$.

${}_4\Xi_{15\cdot56}=1026\cdot30$.

I.	II.	III.	IV.	V.
t°.	Specific Gravity.		Log. of $\phi(t)$.	
	Dittmar.	Excess in Th. and R.	Dittmar.	Excess in Th. and R. in units of the fourth place.
0°	1028·18	+·07	0·0217	+ 1
1	28·13	+·05	·0201	− 5
2	28·07	+·03	·0185	−10
3	27·99	+·03	·0169	−12
4	27·90	+·03	·0154	−14
5	27·79	+·03	·0138	−12
6	27·68	+·02	·0124	−15
7	27·55	+·01	·0109	−14
8	27·41	+·01	·0095	−14
9	27·26	·00	·0081	−13
10	27·10	·00	·0068	−13
11	26·92	·00	·0055	− 9
12	26·74	·00	·0042	−10
13	26·54	·00	·0030	− 7
14	26·34	·00	·0018	− 4
15	26·13	·00	·0006	− 2
16	25·90	·00	$\bar{1}$·9995	0
17	25·67	·00	·9984	+ 2
18	25·42	+·02	·9974	+ 3
19	25·16	+·03	·9964	+ 4
20	24·90	+·03	·9954	+ 9
21	24·63	+·03	·9945	+ 9
22	24·36	+·04	·9936	+14
23	24·08	+·03	·9928	+12
24	23·80	+·02	·9919	+16
25	23·51	+·01	·9912	+15
26	23·21	+·01	·9904	+17
27	22·90	·00	·9898	+15
28	22·59	−·01	·9891	+12
29	22·27	−·02	·9885	+ 9
30	21·95	−·04	·9879	+ 2
31	21·63	−·06	·9874	− 9

Column II. gives the specific gravities ${}_t\mathfrak{S}_t$ of "Standard Water" at the temperatures t named in Column I., calculated by my equation. Column III. states the correction to be "added" to the value Column II. to obtain Thorpe and Rücker's value. Column IV. gives logarithms of $\phi(t)$ calculated from my constants (*i.e.*, the logarithms of the ratios $\left.\frac{D_t}{D_{15\cdot56}}\right)$. Column V. gives the correction to be applied to my logarithm $\phi(t)$ for obtaining Thorpe and Rücker's. Their specific gravities and values $\phi(t)$ I calculated from their Table XV.*

This table shows fully what discrepancies we must be prepared for if a series of specific gravities is being reduced to or from 15°·56, at one time by means of my constants, and at another by Thorpe and Rücker's. In regard to $\phi(t)$ we agree very satisfactorily. The greatest difference is 0·0017, corresponding to 17 ÷ 4300 of the value of the computed correction, and consequently to in general less than about 0·008 units in the S, which is meant to be calculated to only two decimals, or to ±0·005. Our agreement in regard to the specific gravities of "Standard Water" is less perfect; the differences for from 0° to 2° especially going rather beyond what can be tolerated as an effect of observational errors. Fresh experiments must show which of us has come nearest the truth. Meanwhile the means of our results (*i.e.*, the entry for ${}_t\mathfrak{S}_t$ in Column II. *plus* half the entry in Column III.) would presumably reduce the maximum uncertainty to something like ±0·03.

I propose now to pass to an important point in connection with my experiments, which I have hitherto kept in the background in order not to break the continuity of my exposition.

Reduction of the Specific Gravities to the Vacuum.

When I started my specific gravity work, I did not expect to reach such a degree of precision as would justify the application of the vacuum-correction to every individual weighing; a summarily calculated correction for the final results, I felt sure in my mind, would fully meet the requirements of the case. But, in order to be able to found this calculation upon something better than mere assumption, I made periodic observations of the temperature and pressure of the air in the laboratory. The data which I thus collected enable me now to determine limit-values for the corrections to which my values for the specific gravities, as given in the above tables, are liable. Supposing the plunger to have been weighed (1) in air, (2) in pure water of t°, (3) in sea-water of t°, and the results to have been as follows, uncorrected :—

	Weight.	Loss of Weight as against (1).
(1) In air, . . .	(W)	0
(2) In pure water, . .	W_0	L_0
(3) In the sea-water, . .	W_1	L_1

---

* For the information of any person who may repeat my calculations, I will state that all the specific gravities and values of $\phi(t)$ were originally computed to 3 decimals and 5 decimals respectively.

Then the uncorrected specific gravity of the sea-water S, taken with reference to water of 4° = 1, is calculated as follows:—

$$L_0 \times \frac{\mathfrak{W}_4}{\mathfrak{W}_t} = {}_4L_0,^{*}$$

meaning the weight of water of 4°, equal in volume to the displacement of the plunger at t°, and

$$S = \frac{L_1}{{}_4L_0}.$$

In ascertaining the error in S, as arising from the neglecting of the weight of the displaced air, L_0 itself may be substituted for ${}_4L_0$, i.e., we may assume ${}_tS$ to be wanted instead of ${}_4S$.

In my experiments ${}_4L_0$ was always taken from a table founded upon a special series of experiments made at a previous time, when the weight, δ, of 1 c.c. of air varied from 1·187 to 1·220 mgrms. Mean, $\delta_0 = 1·203$.

In series I., with the strong sea-water, the experiments formed three groups, the values of δ being 1·217, 1·213, and 1·217 respectively. Mean, $\delta_1 = 1·216$. Now the values W_0 and W_1 in themselves are not liable to any vacuum correction, as water is incompressible; $L_0 = (W) - W_0$; $L_1 = (W) - W_1$; hence the corrected sp. gr. S_0 is

$$S_0 = \frac{(W) - W_1 + \delta_1 L_0}{(W) - W_0 + \delta_0 L_0},$$

or dividing by $(W) - W_0 = L_0$, above and below,

$$S_0 = \frac{\frac{L_1}{L_0} + \delta_1}{1 + \delta_0} = \frac{S + \delta_1}{1 + \delta_0},$$

or with sufficient approximation—

$$S_0 = S + \delta_1 - S\delta_0.$$

The correction (arithmetically) becomes a maximum, when δ_0 is at its maximum and δ_1 at its minimum. Taking, then, 1000 δ_1 = 1·216 grm. and 1000 δ_0 = 1·220 grm., we have[†]

$$S_0 = S - 0·000037,$$

or, for ${}_4W = 1000$; $S_0 = S - 0·037$.

With the mean values for δ_0 and δ we obtain

$$1000\ S_0 - 1000\ S = -0·020.$$

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[*] $\mathfrak{W}_t$ means the sp. gr. of pure water at t°.

[†] Taking S = 1·0270.

Passing to Series II. (S for ordinary temperature about 1·024), we have δ_0 as before; $\delta_1 = \frac{1}{1000}$ (1·188, 1·190, 1·179; mean, 1·186 grm.), whence for the case of greatest error

$$1000\ S_0 = 1000\ S - 0·06.$$

With the mean δ's we have

$$1000\ S_0 = 1000\ S - 0·046.$$

In the third series the one plunger experiment I made is liable to a correction of −0·02. The determinations made by my difference method are obviously almost independent of the air-correction.

To Sum up.—When we wish to reduce our numbers for S to the vacuum, *subtract* 0·033, and the result will be right apart from a residual uncertainty of about ±0·013, or at most ±0·03. My numbers for the relative volumes of sea-waters at different temperatures are, as is easily seen, relatively independent of this correction, but no doubt their precision would have been a little higher if they had been deduced directly from the special interpolation formulæ for series I. and II.

When I planned my experiments, I overlooked a very obvious modification of the *modus operandi*, which would have rendered the vacuum-correction almost insignificant. If, before each series of sea-water weighings, we determine the loss of the plunger L_τ for water of some convenient temperature τ, we have for the corrected value S_0 for ${}_tS_t$,

$$S_0 = \frac{\frac{L_t}{L_\tau} + \delta}{(1+\delta)(1+k\Delta t)}$$

where the second factor in the denominator allows for the expansion of the glass by the temperature-change $\Delta t = t - \tau$. The value k could easily be determined once for ever. We will therefore keep the factor in mind and say—

$$S_0 = S - (S-1)\delta,$$

where the plain S stands for the uncorrected sp. gr., and δ, as we see, multiplies a quantity of the order 0·025 about; hence, instead of determining δ we may adopt for it some predetermined value, such as 0·0012, which would make 0·025δ = −0·000 03, and *this* value might be adopted even for all the S's that practically come into consideration, without going wrong by more than about 0·000 003 at the very outside.

I will now proceed to give a few tables intended to facilitate reduction of specific gravities of sea-water from one temperature to another, and for translating specific gravities into salinities (χ) and *vice versa*.

Table VI. gives the correction which we must apply to a specific gravity when we wish to pass from pure water of $t°$ to pure water of $T°$ as our standard. If ${}_tS = 1000 + x$;

TABLE VI.

To find $_{T}S$ from $_{t}S$ add the correction; to find $_{t}S$ from $_{T}S$ do the same after reversing the signs.

Given $_{t}S$ $t=$	Wanted $_{T}S$ $T=$	Correction to be added.
0°	4°	$-(0{\cdot}132 \pm 0{\cdot}000\,65)$
0°	15°	$+0{\cdot}711+0{\cdot}000\,711\,x$ or $+0{\cdot}729 \pm 0{\cdot}0036$
0°	15°·56	$+0{\cdot}798+0{\cdot}000\,798\,x$ or $+0{\cdot}818 \pm 0{\cdot}0040$
0°	17°·5	$+1{\cdot}123+0{\cdot}001\,123\,x$ or $+1{\cdot}151 \pm 0{\cdot}0056$
4°	15°	$+0{\cdot}840+0{\cdot}000\,840\,x$ or $+0{\cdot}861 \pm 0{\cdot}0042$
4°	15°·56	$+0{\cdot}927+0{\cdot}000\,927\,x$ or $0{\cdot}950 \pm 0{\cdot}0046$
4°	17°·5	$+1{\cdot}252+0{\cdot}001\,252\,x$ or $1{\cdot}283 \pm 0{\cdot}0063$
15°	15°·56	$+0{\cdot}0892 \pm 0{\cdot}0004$
15°	17°·5	$+0{\cdot}412+0{\cdot}000\,412\,x$ or $+0{\cdot}422 \pm 0{\cdot}0021$
15°·56	17°·5	$+0{\cdot}325+0{\cdot}000\,325\,x$ or $+0{\cdot}333 \pm 0{\cdot}0016$

then ${}_tS$ will have a different value $1000+y$. To find y, operate as shown in Column IV. of the table. The formulæ terminating with ±0·00 . . . are calculated for $S=1025$, and the uncertainty is given on the assumption that the formula be applied to $S=1020$ to $S=1030$ as extreme cases.

The Table VII. which now follows is intended for the reduction of the specific gravity ${}_tS_t$ of a sea-water from 15°·56 to any temperature $t°$ between 0° and 31°, and *vice versa*. The table is an extension of Table V., hence there is no need of its being explained in general terms; but for the convenience of any person who may wish to use it, I will give two examples. The specific gravity ${}_tS$ of a sea-water is 1027·34 at 15°·56; how much is it at 18°·3? Answer: At 15°·56 the water is heavier than *standard water* by 1·34, hence at 18°·3 it is heavier than the latter by $1·34\times\phi(18·3)$ = by table to $1·34\times0·9937=1·332$; but standard water, by table, at 18°·3 has the specific gravity 1025·34, hence the result is $1025·34+1·33=1026·67$. *Second Example.*—Given the specific gravity at 18°·3 as 1026·67; find the specific gravity at 15°·56. Answer: At 18°·3 the specific gravity of the given water is $1026·67-1025·34=1·33$ heavier than standard; hence the corresponding difference at 15°·56 is $1·33\frac{1}{\phi(18·3)}$ = by table to $1·33\times1·0063=1·34$; hence result sought $=1026·0+1·34=1027.34$. This is the result according to Dittmar; if Thorpe and Rücker's function be preferred, add (in the sense of algebra) the correction given in Column V. to the specific gravity of *standard water* at $t°$ which enters the calculation. This correction of course is *nil* for $t=15°·56$.

TABLE VII.

To find Specific Gravity ${}_tS_t$ at $t°$ from given Specific Gravity at 15°·56.

I. $t°$.	II. Specific Gravity ${}_t\mathfrak{S}_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for ${}_t\mathfrak{S}_t$ to find Th. and R.'s result.
0	1028·18	1·0514	·9511	+ ·069
0·1	·18	1·0509	·9515	·067
·2	·17	1·0505	·9519	·065
·3	·17	1·0500	·9524	·063
·4	·16	1·0496	·9528	·061
·5	·16	1·0491	·9532	·059
·6	·15	1·0486	·9536	·056
·7	·15	1·0482	·9540	·054
·8	·14	1·0477	·9545	·052
·9	·14	1·0473	·9549	·050

I. $t°$.	II. Specific Gravity ${}_t\mathfrak{S}_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for ${}_t\mathfrak{S}_t$ to find Th. and R.'s result.
1·0	1028·13	1·0468	·9553	+ ·048
·1	·13	1·0463	·9557	·046
·2	·12	1·0459	·9561	·045
·3	·11	1·0454	·9566	·043
·4	·11	1·0450	·9570	·042
·5	·10	1·0445	·9574	·040
·6	·09	1·0440	·9578	·038
·7	·09	1·0436	·9582	·036
·8	·08	1·0431	·9587	·034
·9	·07	1·0427	·9591	·033
2·0	·07	1·0422	·9595	·031
·1	·06	1·0418	·9599	·031
·2	·05	1·0414	·9602	·031
·3	·04	1·0410	·9606	·030
·4	·04	1·0406	·9610	·030
·5	·03	1·0402	·9614	·029
·6	·02	1·0398	·9617	·029
·7	·01	1·0394	·9621	·029
·8	·00	1·0390	·9625	·028
·9	·00	1·0386	·9628	·028
3·0	1027·99	1·0382	·9632	·028
·1	·98	1·0378	·9636	·028
·2	·97	1·0374	·9638	·028
·3	·96	1·0370	·9642	·027
·4	·95	1·0366	·9646	·027
·5	·94	1·0362	·9651	·027
·6	·93	1·0359	·9654	·027
·7	·92	1·0355	·9658	·027
·8	·92	1·0351	·9662	·026
·9	·91	1·0347	·9665	·026
4·0	·90	1·9343	·9669	·026
·1	·89	1·0340	·9672	·026
·2	·88	1·0336	·9675	·026
·3	·87	1·0333	·9678	·027
·4	·85	1·0329	·9681	·027
·5	·84	1·0326	·9685	·027
·6	·83	1·0323	·9688	·027
·7	·82	1·0329	·9691	·027
·8	·81	1·0316	·9694	·028
·9	·80	1·0312	·9697	·028
5·0	·79	1·0309	·9700	·028
·1	·78	1·0305	·9704	·027
·2	·77	1·0304	·9707	·026
·3	·76	1·0298	·9711	·026
·4	·74	1·0294	·9715	·025
·5	·73	1·0290	·9719	·024
·6	·72	1·0286	·9723	·023
·7	·71	1·0282	·9727	·022
·8	·70	1·0279	·9731	·022
·9	·69	1·0275	·9734	·021

I. t.	II. Specific Gravity ${}_4\mathfrak{S}_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for ${}_4\mathfrak{S}_t$ to find Th. and R.'s result.
6·0	1027·68	1·0271	·9737	+ ·020
·1	·66	1·0268	·9740	·019
·2	·65	1·0264	·9743	·019
·3	·64	1·0261	·9746	·018
·4	·62	1·0258	·9749	·018
·5	·61	1·0255	·9753	·017
·6	·60	1·0251	·9756	·016
·7	·59	1·0248	·9759	·016
·8	·57	1·0245	·9762	·015
·9	·56	1·0241	·9765	·015
7·0	·55	1·0238	·9768	·014
·1	·53	1·0235	·9771	·013
·2	·52	1·0231	·9774	·012
·3	·51	1·0228	·9777	·012
·4	·49	1·0225	·9780	·011
·5	·48	1·0222	·9784	·010
·6	·46	1·0219	·9787	·009
·7	·45	1·0215	·9790	·008
·8	·44	1·0212	·9793	·008
·9	·42	1·0208	·9796	·007
8·0	·41	1·0205	·9799	·006
·1	·39	1·0202	·9802	·005
·2	·38	1·0199	·9805	·005
·3	·36	1·0195	·9808	·004
·4	·35	1·0192	·9811	·004
·5	·34	1·0189	·9815	·003
·6	·32	1·0186	·9818	·003
·7	·31	1·0183	·9821	·002
·8	·29	1·0179	·9824	·002
·9	·28	1·0176	·9827	·001
9·0	·26	1·0173	·9830	·001
·1	·24	1·0170	·9833	·000
·2	·23	1·0167	·9836	·000
·3	·21	1·0164	·9839	− ·001
·4	·20	1·0161	·9842	·001
·5	·18	1·0158	·9845	·001
·6	·16	1·0154	·9848	·002
·7	·15	1·0151	·9851	·002
·8	·13	1·0148	·9854	·002
·9	·11	1·0145	·9857	·002
10·0	1027·10	1·0142	·9860	·002
·1	·08	1·0139	·9862	·001
·2	·06	1·0137	·9865	·001
·3	·05	1·0134	·9867	·000
·4	·03	1·0132	·9870	+ ·001
·5	·01	1·0129	·9872	·002
·6	1026·99	1·0126	·9875	·002
·7	·98	1·0124	·9877	·003
·8	·96	1·0121	·9880	·004
·9	·94	1·0119	·9882	·004

I. t.	II. Specific Gravity $_4\mathfrak{S}_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for $_4\mathfrak{S}_t$ to find Th. and R.'s result.
11·0	1026·92	1·0116	·9885	·005
·1	·91	1·0113	·9888	·004
·2	·89	1·0110	·9891	·003
·3	·87	1·0107	·9894	·002
·4	·85	1·0104	·9897	·001
·5	·83	1·0104	·9900	·000
·6	·81	1·0998	·9903	·000
·7	·80	1·0995	·9906	– ·001
·8	·78	1·0992	·9909	·002
·9	·76	1·0089	·9912	·003
12·0	·74	1·0086	·9915	·004
·1	·72	1·0083	·9917	·003
·2	·70	1·0081	·9920	·002
·3	·68	1·0078	·9922	·001
·4	·66	1·0076	·9925	·000
·5	·64	1·0073	·9927	·000
·6	·62	1·0071	·9930	+ ·001
·7	·60	1·0068	·9932	·002
·8	·58	1·0066	·9935	·003
·9	·56	1·0063	·9937	·004
13·0	·54	1·0061	·9940	·005
·1	·52	1·0059	·9942	·005
·2	·50	1·0056	·9945	·005
·3	·48	1·0054	·9947	·005
·4	·46	1·0051	·9950	·005
·5	·44	1·0049	·9952	·005
·6	·42	1·0047	·9954	·005
·7	·40	1·0044	·9957	·005
·8	·38	1·0042	·9959	·005
·9	·36	1·0039	·9962	·005
14·0	·34	1·0037	·9964	·005
·1	·32	1·0035	·9966	·004
·2	·30	1·0032	·9969	·004
·3	·27	1·0030	·9971	·003
·4	·25	1·0027	·9974	·003
·5	·23	1·0025	·9976	·002
·6	·21	1·0023	·9978	·001
·7	·19	1·0020	·9980	·001
·8	·17	1·0018	·9982	·000
·9	·15	1·0015	·9985	·000
15·0	·13	1·0013	·9987	– ·001
·1	·10	1·0011	·9989	·001
·2	·08	1·0008	·9992	·001
·3	·06	1·0006	·9994	– ·000
·4	·04	1·0003	·9997	·000
·5	·01	1·0001	·9999	·000
·6	1025·99	·9999	1·0001	·000
·7	·97	·9996	1·0004	·000
·8	·94	·9994	1·0006	+ ·001
·9	·92	·9991	1·0009	·001

I. C.	II. Specific Gravity ${}_4\Xi_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for ${}_4\Xi_t$ to find Th. and R.'s result.
16·0	1025·90	·9989	1·0011	·001
·1	·88	·9987	1·0013	·001
·2	·85	·9984	1·0016	·001
·3	·83	·9982	1·0018	·001
·4	·81	·9980	1·0021	·001
·5	·79	·9978	1·0023	·001
·6	·76	·9975	1·0025	·001
·7	·74	·9973	1·0027	·001
·8	72	·9971	1·0029	·001
·9	·69	·9968	1·0032	·001
17·0	·67	·9966	1·0034	·001
·1	·65	·9964	1·0036	·003
·2	·62	·9962	1·0038	·004
·3	·60	·9959	1·0041	·006
·4	·57	·9957	1·0043	·007
·5	·55	·9955	1·0045	·009
·6	·52	·9953	1·0047	·010
·7	·50	·9951	1·0049	·012
·8	·47	·9948	1·0052	·014
·9	·44	·9946	1·0054	·015
18·0	·42	·9944	1·0056	·017
·1	·39	·9942	1·0058	·018
·2	·37	·9940	1·0061	·019
·3	·34	·9937	1·0063	·020
.4	·32	·9935	1·0066	·021
·5	·29	·9933	1·0068	·021
·6	·27	·9931	1·0070	·022
·7	·24	·9929	1·0072	·023
·8	·21	·9926	1·0074	·024
·9	·19	·9924	1·0077	·025
19·0	·16	·9922	1·0079	·026
·1	·14	·9920	1·0081	·026
·2	·11	·9919	1·0082	·026
·3	·09	·9917	1·0084	·027
·4	·06	·9915	1·0086	·027
·5	·03	·9914	1·0088	·027
·6	·01	·9912	1·0089	·027
·7	1024·98	·9910	1·0091	·027
·8	·96	·9908	1·0092	·028
·9	·93	·9907	1·0094	·028
20·0	·90	·9905	1·0096	·028
·1	·88	·9903	1·0098	·028
·2	·85	·9902	1·0100	·029
·3	·82	·9899	1·0102	·029
·4	·80	·9897	1·0104	·029
·5	·77	·9894	1·0107	·030
·6	·74	·9892	1·0109	+ ·030
·7	·72	·9890	1·0112	·030
·8	·69	·9888	1·0113	·031
·9	·66	·9886	1·0115	·031

I. $t°$.	II. Specific Gravity ${}_{s}\mathfrak{S}_{t}$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for ${}_{s}\mathfrak{S}_{t}$ to find Th. and R.'s result.
21·0	1024·63	·9884	1·0117	·031
·1	·61	·9882	1·0119	·032
·2	·58	·9881	1·0120	·032
·3	·55	·9879	1·0121	·033
·4	·52	·9878	1·0123	·034
·5	·50	·9876	1·0124	·035
·6	·47	·9875	1·0126	·035
·7	·44	·9874	1·0127	·036
·8	·41	·9872	1·0129	·037
·9	·39	·9871	1·0130	·038
22·0	·36	·9869	1·0132	·038
·1	·32	·9867	1·0134	·037
·2	·29	·9865	1·0136	·036
·3	·27	·9863	1·0138	·035
·4	·25	·9861	1·0140	·034
·5	·22	·9859	1·0143	·034
·6	·19	·9857	1·0145	·033
·7	·16	·9855	1·0147	·032
·8	·14	·9853	1·0149	·031
·9	·11	·9851	1·0151	·030
23·0	·08	·9849	1·0153	·029
·1	·05	·9847	1·0155	·028
·2	·02	·9846	1·0156	·028
·3	·00	·9844	1·0158	·027
·4	1023·97	·9843	1·0159	·027
·5	·94	·9841	1·0160	·027
·6	·91	·9840	1·0162	·026
·7	·88	·9838	1·0163	·026
·8	·86	·9837	1·0165	·025
·9	·83	·9835	1·0166	·025
24·0	·80	·9834	1·0168	·024
·1	·77	·9832	1·0170	·023
·2	·74	·9830	1·0172	·021
·3	·71	·9828	1·0174	·020
·4	·68	·9826	1·0176	·018
·5	·65	·9825	1·0178	·017
·6	·62	·9823	1·0180	·016
·7	·59	·9821	1·0182	·014
·8	·56	·9819	1·0184	·013
·9	·53	·9817	1·0186	·011
25·0	·51	·9815	1·0188	·010
·1	·48	·9814	1·0189	·010
·2	·45	·9812	1·0191	·010
·3	·42	·9811	1·0192	·010
·4	·39	·9810	1·0194	·010
·5	·36	·9809	1·0195	·011
·6	·33	·9807	1·0196	·011
·7	·30	·9806	1·0198	·011
·8	·27	·9805	1·0199	·011
·9	·24	·9803	1·0201	+ ·011

I. $t°$.	II. Specific Gravity $_t\mathfrak{S}_t$ of Standard Water, Dittmar.	III. $\phi(t)$.	IV. $\frac{1}{\phi(t)}$.	V. Correction for $_t\mathfrak{S}_t$ to find Th. and R.'s result.
26·0	1023·21	·9802	1·0202	·011
·1	·18	·9800	1·0204	·010
·2	·15	·9798	1·0206	·009
·3	·12	·9797	1·0208	·007
·4	·08	·9795	1·0210	·006
·5	·05	·9793	1·0212	·005
·6	·02	·9791	1·0213	·004
·7	1022·99	·9789	1·0215	·003
·8	·96	·9788	1·0217	·002
·9	·93	·9786	1·0219	·000
27·0	·90	·9784	1·0221	−·001
·1	·87	·9782	1·0223	·002
·2	·84	·9780	1·0225	·002
·3	·81	·9779	1·0227	·003
·4	·78	·9777	1·0229	·003
·5	·75	·9775	1·0231	·004
·6	·71	·9773	1·0232	·004
·7	·68	·9771	1·0234	·005
·8	·65	·9770	1·0236	·005
·9	·62	·9768	1·0238	·006
28·0	·59	·9766	1·0240	·006
·1	·56	·9764	1·0242	·007
·2	·53	·9762	1·0244	·008
·3	·50	·9761	1·0245	·009
·4	·46	·9759	1·0247	·010
·5	·43	·9757	1·0249	·012
·6	·40	·9755	1·0251	·013
·7	·37	·9754	1·0253	·014
·8	·34	·9752	1·0254	·015
·9	·31	·9750	1·0256	·016
29·0	·27	·9749	1·0258	·017
·1	·24	·9746	1·0260	·019
·2	·21	·9744	1·0263	·022
·3	·18	·9742	1·0265	·024
·4	·15	·9740	1·0268	·027
·5	·11	·9737	1·0270	·029
·6	·08	·9735	1·0272	·031
·7	·05	·9733	1·0275	·034
·8	·02	·9731	1·0277	·036
·9	1021·99	·9728	1·0280	·039
30·0	·95	·9726	1·0282	·041
·1	·92	·9724	1·0284	·043
·2	·89	·9722	1·0286	·045
·3	·86	·9720	1·0289	·047
·4	·82	·9718	1·0291	·049
·5	·79	·9716	1·0293	·052
·6	·76	·9713	1·0295	·054
·7	·73	·9711	1·0297	·056
·8	·70	·9709	1·0300	·058
·9	·66	·9707	1·0302	·060
31·0	·63	·9705	1·0304	·062

I now proceed to give a table (VIII.) for reducing a given specific gravity to chlorine (grams per kilogramme); *i.e.*, to find χ from ${}_tS_t$. In using this table it must be understood that the values ${}_tS_t$ are those corresponding to my experimental conditions, and *not* reduced to the vacuum. Hence, if the given specific gravity is corrected for the displaced air, begin by *adding* 0·033. Supposing the value ${}_tS_t$ given is 1025·43 and $t = 18°\cdot3$: begin by *cancelling* the vacuum-correction, *i.e.*, substituting 1025·463 for the given S; then find that value χ under 1025 which corresponds to $t = 18°\cdot3$ (by interpolation between 18° and 19°); *i.e.*, compute 19·087 + 0·3 × 0·186 = 19·087 + 0·056 = 19·143. This is the χ for ${}_tS_{18\cdot3} = 1025$; the χ for 1025·463 is greater by 0·463 × *k* where *k* means the value $\frac{\Delta(\chi)}{\Delta(S)}$ for $t = 18°\cdot3$.

According to the last column but one, we have *k* = 0·7245; diff. for 1° = 0·0017; hence *k* for 18°·3 = 0·7245 + 0·3 × 0·0017 = 0·725. But 0·725 × 0·463 = 0·336; hence the χ sought is 19·143 + 0·336 = 19·479 or rather 19·48, because the third decimal is purely accidental.

To find the specific gravity ${}_tS$ at $t°$ for a given χ is, of course easy when the *t* is an integer, and the given χ happens to stand somewhere in a line with that *t*. But as a rule this of course is not the case. Supposing we want the ${}_tS$ at 20°·7 for χ = 18·60. The two χ's, under S = 1023 opposite *t* = 20° and 21° respectively come near to, and are less than, our number. By interpolation, we find that $S_{20\cdot7} = 1023$ for χ = 18·006 + 0·7 × 0·193 = 18·141. The given χ is by 0·459 greater, hence the S sought is greater than 1023 by $\frac{1}{k}$ × 0·459. Now *k*, by interpolation is 0·7289, hence ΔS = 0·459 ÷ 0·729 = 0·630, and ${}_tS_{20\cdot7}$ (meaning what I may call *my* specific gravity) is 1023·63. To reduce it to the vacuum deduct 0·03. But this is a troublesome calculation; I shall therefore append a special table for finding $S_{15\cdot56}$ for a given χ by mere inspection. From it any S_t can be obtained by Table VII.

TABLE VIII.

To find χ *from a given* ${}_tS_t$.

t.	1020.	Differences.	1021.	Differences.	1022.	Differences.	1023.	Differences.	1024.	Differences.	1025.	Differences.	1026.	Differences.
0	...	...	...	...	...	...	...	...	...	...	17·212	...	17·897	...
1	...	...	...	...	...	...	...	...	...	...	17·240	28	17·927	31
2	...	...	...	...	...	...	...	...	...	...	17·274	34	17·965	37
3	...	...	...	...	...	...	...	...	...	...	17·322	48	18·015	50
4	...	...	...	...	...	...	...	...	...	...	17·378	56	18·074	59
5	...	...	...	...	...	...	...	...	...	...	17·445	67	18·143	69
6	...	...	...	...	...	...	...	...	...	...	17·519	74	18·219	76
7	...	...	...	...	...	...	...	...	...	...	17·604	85	18·306	87
8	...	...	...	...	...	...	...	...	...	...	17·694	90	18·398	92
9	...	...	...	...	...	...	...	...	...	...	17·794	100	18·501	103
10	...	...	...	...	...	...	...	...	17·195	...	17·904	110	18·613	112
11	...	...	...	...	...	...	...	...	17·312	117	18·023	119	18·734	121
12	...	...	...	...	...	...	...	...	17·438	126	18·151	128	18·864	130
13	...	...	...	...	...	...	...	...	17·572	134	18·288	137	19·003	139
14	...	...	...	...	...	...	...	...	17·715	143	18·432	144	19·149	146
15	...	...	...	...	...	...	...	...	17·862	147	18·581	149	19·300	151
16	...	...	...	...	...	...	...	...	18·022	160	18·743	162	19·464	164
17	...	...	...	...	...	...	...	...	18·183	161	18·906	163	19·629	165
18	...	...	...	...	...	...	...	...	18·362	179	19·087	181	19·811	182
19	...	...	...	...	...	...	...	...	18·546	184	19·273	186	19·999	188
20	...	...	...	...	17·278	...	18·006	...	18·734	188	19·461	188	20·189	190
21	...	...	...	...	17·470	192	18·199	193	18·928	194	19·657	196	20·387	198
22	...	...	...	...	17·667	197	18·398	199	19·129	201	19·859	202	20·590	203
23	...	...	...	...	17·866	199	18·598	200	19·330	201	20·063	204	20·795	205
24	...	...	...	...	18·071	205	18·805	207	19·539	209	20·272	209	21·006	211
25	...	...	...	...	18·284	213	19·019	214	19·754	215	20·489	217	...	...
26	...	...	...	...	18·502	218	19·238	219	19·974	220	20·710	221	...	...
27	...	...	17·988	...	18·726	224	19·463	225	20·200	226	20·938	228	...	...
28	...	...	18·216	228	18·954	228	19·693	230	20·431	231	21·170	232	...	...
29	17·709	231	18·448	232	19·188	234	19·927	234	20·666	235	...	...	...	...
30	17·944	235	18·684	236	19·424	236	20·165	238	20·905	239	...	...	...	...
31	18·184	240	18·925	241	19·667	243	20·408	243	21·149	244	...	...	...	...
15·56	15·070	...	15·790	...	16·510	...	17·231	...	17·951	...	18·671	...	19·391	...

TABLE VIII.—*continued.*

To find χ from a given S.

t.	1027.	Differences.	1028.	Differences.	1029.	Differences.	1030.	Differences.	1031.	Differences.	k $\Delta\chi$ for $\Delta S = 1$.	Differences.
0	18·582	...	19·267	...	19·952	...	20·637	...	21·322	...	·6849	...
1	18·614	34	19·302	36	19·989	39	20·677	40	21·365	43	·6876	27
2	18·655	39	19·345	42	20·035	44	20·725	48	...	...	·6901	25
3	18·708	53	19·400	55	20·093	58	20·785	60	...	...	·6926	25
4	18·769	61	19·464	64	20·159	66	20·854	69	...	...	·6952	26
5	18·840	71	19·538	74	20·235	76	20·933	79	...	...	·6975	23
6	18·919	79	19·619	81	20·319	84	21·018	85	...	...	·6999	24
7	19·008	89	19·711	92	20·413	94	...	...	...	...	·7023	24
8	19·103	95	19·807	96	20·512	99	...	...	...	...	·7045	22
9	19·208	105	19·915	108	20·622	110	...	...	...	...	·7068	23
10	19·322	114	20·031	116	20·740	118	...	...	...	...	·7090	22
11	19·445	123	20·156	125	20·867	127	...	...	...	...	·7111	21
12	19·578	133	20·291	135	21·004	137	...	...	...	...	·7132	21
13	19·718	140	20·433	142	...	...	...	...	...	...	·7152	20
14	19·866	148	20·584	151	...	...	...	...	...	...	·7172	20
15	20·020	154	20·739	155	...	...	...	...	...	...	·7191	19
16	20·185	165	20·906	167	...	...	...	...	...	...	·7209	18
17	20·351	166	21·074	168	...	...	...	...	...	...	·7227	18
18	20·536	185	...	...	...	...	...	...	...	...	·7245	18
19	20·725	189	...	...	...	...	...	...	...	...	·7262	17
20	20·917	192	...	...	...	...	...	...	...	...	·7278	16
21	21·116	199	...	...	...	...	...	...	...	...	·7293	15
22	...	...	...	...	...	...	...	...	...	...	·7308	15
23	...	...	...	...	...	...	...	...	...	...	·7322	14
24	...	...	...	...	...	...	...	...	...	...	·7336	14
25	...	...	...	...	...	...	...	...	...	...	·7349	13
26	...	...	...	...	...	...	...	...	...	...	·7361	12
27	...	...	...	...	...	...	...	...	...	...	·7373	12
28	...	...	...	...	...	...	...	...	...	...	·7384	11
29	...	...	...	...	...	...	...	...	...	...	·7394	10
30	...	...	...	...	...	...	...	...	...	...	·7404	10
31	...	...	...	...	...	...	...	...	...	...	·7413	9
15·56	20·111	...	20·831	...	...	...	...	...	...	...	·7201	...

The following two Tables, IX. and X., require no explanation, but I have again to state that in them, as in Table VIII., the specific gravities must be understood *not* to be

TABLE IX.

S at 15°·56	x.	S at 15°·56	x.	S at 15°·56	x.
1022·0	16·510	1024·2	18·093	1026·4	19·678
·1	·582	·3	·163	·5	·750
·2	·654	·4	·237	·6	·822
·3	·726	·5	·309	·7	·894
·4	·798	·6	·381	·8	·966
·5	·870	·7	·453	·9	20·038
·6	·942	·8	·525	1027·0	·110
·7	17·014	·9	·597	·1	·182
·8	·086	1025·0	·669	·2	·254
·9	·158	·1	·741	·3	·326
1023·0	·230	·2	·813	·4	·398
·1	·302	·3	·885	·5	·470
·2	·374	·4	·957	·6	·542
·3	·446	·5	19·029	·7	·614
·4	·518	·6	·102	·8	·686
·5	·590	·7	·174	·9	·758
·6	·662	·8	·246	1028·0	·830
·7	·734	·9	·318	·1	·902
·8	·806	1026·0	·390	·2	·974
·9	·878	·1	·462	·3	21·046
1024·0	·950	·2	·534		
·1	18·022	·3	·606		
·2	·093	·4	·678		

ΔS.	Δx.
·01	·0072
·02	·0144
·03	·0216
·04	·0288
·05	·0360
·06	·0432
·07	·0504
·08	·0576
·09	·0648
·10	·0720

corrected for the displaced air. Hence, before using Table IX. to find the χ corresponding to a given reduced specific gravity, one begins by adding 0·033. And any S extracted from Table X. must be *diminished* by 0·033 to be reduced to the vacuum.

TABLE X.

χ	$_4S$ at 15°·56.	χ	$_4S$ at 15°·56.
17·0	1022·681	19·0	1025·458
·1	22·820	·1	25·597
·2	22·959	·2	25·736
·3	23·098	·3	25·875
·4	23·237	·4	26·014
·5	23·376	·5	26·153
·6	23·514	·6	26·292
·7	23·653	·7	26·431
·8	23·792	·8	26·570
·9	23·931	·9	26·709
18·0	24·070	20·0	26·847
·1	24·209	·1	26·986
·2	24·348	·2	27·125
·3	24·486	·3	27·264
·4	24·625	·4	27·403
·5	24·764	·5	27·542
·6	24·903	·6	27·681
·7	25·042	·7	27·819
·8	25·181	·8	27·958
·9	25·320	·9	28·097
19·0	25·458	21·0	28·236

Differences.	
Δχ	ΔS.
·01	·014
·02	·028
·03	·042
·04	·056
·05	·070
·06	·083
·07	·097
·08	·111
·09	·125
·10	·139

TABLE XA.

To find the Chlorine per litre [χ] from the Chlorine per kilo. χ.

χ	[χ]	Diff.	χ	[χ]	Diff.
17·0	17·386	...	19·5	20·010	·526
17·5	17·909	·523	20·0	20·536	·526
18·0	18·433	·524	20·5	21·064	·528
18·5	18·958	·525	21·0	21·593	·529
19·0	19·484	·526			

Multiples of Mean Diff.			
Δχ	[Δχ]	Δχ	[Δχ]
·1	·105	·6	·631
·2	·210	·7	·736
·3	·316	·8	·842
·4	·421	·9	·947
·5	·526		

The Hydrometer Error.

Mr. Buchanan, like most of his predecessors, determined his specific gravities by means of very delicate hydrometers; hence it is worth while to consider whether such hydrometer-results can confidently be assumed to be the same as would have been obtained by a plunger and a chemical balance,—the method which I used in determining the dependence of χ on S at t°.

At first sight it would appear that a result obtained with a properly standardised hydrometer could be wrong only on account of the capillarity, *i.e.*, the error arising from the fact, that the instrument, when used, in addition to its own weight, carries also the weight of a small hillock of liquid drawn up around its stem. As it happened that I had occasion, some years ago, to inquire into this matter from a more general standpoint, it gave me little trouble to apply my experience to the special case of Buchanan's instrument. I speak in the singular, because I examined only *one* of his set of four hydrometers, which, with his journal before me, I had no difficulty in identifying as being the one which he used. Buchanan's hydrometer has a cylindrical body of about 160 c.c. displacement, and a narrow stem (periphery =10·1 mm.), provided with a millimetre scale. There is besides a little table which can be fixed to the top of the stem, and loaded with weights. The weight of the instrument is so adjusted that, when in sea-water, it must be loaded with the table, and a greater or less weight on the table, to bring the surface of the liquid within the range of the millimetre scale. Supposing the hydrometer has to be charged so as to weigh W_0 grms. to sink it in pure water down to a certain mark, while, *cæteris paribus*, a weight W_1 is needed in the case of sea-water, then the specific gravity S is

$$S=\frac{W}{W_0},$$

not allowing for the capillarity. To compensate the capillarity error, we must imagine, in each of the two experiments, the weight μ of the hillock to go, say to the top of the instrument, and the hillock itself to vanish. The reading will remain the same, but the correct specific gravity will be $=S_0$, and

$$S_0=\frac{W_1+\mu_1}{W_0+\mu_0}.$$

Whence $$S_0-S=\frac{\mu_1-S\mu_0}{W_0} \quad \text{very nearly.}$$

To determine the quantities μ_1 and μ_0, I took a piece of wide, thin glass tubing, open at both ends, made a diamond-mark round the middle, and provided it with a platinum wire suspender fused on at each end, so that it could be suspended from a balance, and made to plunge into the liquid exactly up to the diamond mark. A heavy plunger, suspended from below within the liquid, kept the instrument steady, and ensured to it a vertical position. To determine the double weight of the hillock drawn up by this apparatus from water, I determined (1), the loss l' in weight which it suffered when plunged into water up to the mark; (2), the loss l'' which it suffered when suspended the other way; and (3), the loss L it suffered when totally immersed. Obviously the water displaced in (1) and (2) is $l'+m$ and $l''+m$, and $l'+l''+2m=\mathrm{L}$;

or,

$$m=\frac{\mathrm{L}-(l'+l')}{2}.$$

Now, $m=an$ where n is the sum of the two peripheries, which in my instrument was $=140$ mm., whence

$$a=\frac{m}{140}.$$

Operating in this manner, I found the value of the constant a (the units being the gramme and millimetre)

For pure water $a_0=0{\cdot}00456$.
For sea-water $a_1=0{\cdot}00402$.

Whence $\mu_0=0{\cdot}046$ and $\mu_1=0{\cdot}0406$, and for the capillarity correction of Buchanan's hydrometer (calling it $\mathrm{S}_0-\mathrm{S}$)

$$\mathrm{S}_0-\mathrm{S}=\frac{0{\cdot}0406-1{\cdot}028\times0{\cdot}046}{160},$$

or

$$\mathrm{S}_0-\mathrm{S}=\frac{-0{\cdot}0067}{160}=-0{\cdot}000\,042,$$

or $\mathrm{S}_0=\mathrm{S}-0{\cdot}042$ for water equal to 1000. The specific gravities, as found by the hydrometer, should be too high by 0·042, water = 1000. When I actually used Mr. Buchanan's hydrometer to determine the specific gravity of a sea-water which had already been ascertained exactly by means of the plunger, I obtained a number which differed from the plunger-result by considerably more than 0·04, and the difference lay in the opposite direction. To settle this matter I carried out the following two series of experiments.

1st Series. A number of spirals of copper wire of known weights were prepared, and so adjusted that when one of them was attached to the top of the instrument, and the latter floated in water of 16° C. to 18° C., it sank down to somewhere between 40 and 60 mm. of the scale.

The hydrometer then was floated in a *large* mass of pure water, of about the temperature named (the temperature of the surrounding air being about the same), the several over-weights, w_1 w_2, &c., were attached successively, and in each case the hydrometer and the thermometer were read. This was repeated sixty-five times, the weights being made to vary from reading to reading, so that each turned up about three to five times at different temperatures. The readings then were all reduced to a medium temperature of 16°·7, and classified according to the over-weights w corresponding to them.

As the several temperatures differed from 16°·7 by at most 1° C., the coefficient of expansion of water was taken as having the constant value $\epsilon = 0{\cdot}000\,169$; the coefficient of expansion of glass was taken to be $k = 0{\cdot}000\,025$.

Supposing the hydrometer to read h mm. in water of $16^\circ{\cdot}7 + \Delta t$, and the temperature to fall to 16°·7, then, on account of the contraction of the water, the hydrometer rises by h_1, and, on account of the contraction of the glass, sinks by h_2 mm., the conjoint effect being a rise of

$$\Delta h = \frac{(\Delta t)\mathrm{W}(\epsilon - k)}{0{\cdot}0081}\ \mathrm{mm.},$$

and as the scale is numbered from above downwards, a positive fall of temperature Δt corresponds to a positive Δh in the reading, and a negative to a negative. Substituting numerical values, we have

$$\Delta h = \Delta t \times 2{\cdot}86\ \mathrm{mm.}$$

The 65 pairs of values for h and w were subjected to graphic rectilinear interpolation, and the constants w_{60} and a of the equation $w = w_{60} + a\,(60 - h)$ taken from the line drawn.

2nd Series. In a second series a certain sea-water of exactly known specific gravity was used, the table belonging to the instrument, and a variable amount of gram-weights serving to establish the w's. The number of readings this time was 62, and the temperatures lay within a degree of 17°, which latter was adopted as the standard temperature. The co-efficient of expansion of the sea-water operated upon was taken from my own tables as deduced from the formula, page 58. The graphic interpolation led to a formula—

$$w_1 = (w_{60})_1 + a_1 \times (60 - h)\,.$$

As the specific gravity of the sea-water at 17° was about 1·028, the value a_1 ought to have been $= 1{\cdot}028 \times a$. Unfortunately I had great latitude in drawing my two lines, and so it came that this relation did not hold at all exactly. I therefore took the mean of a and of $\frac{a_1}{1{\cdot}028}$ as applying to pure, and the multiple of this mean by 1·028 as applying to the sea-water, slightly altering the constant terms w_{60} on both sides, so as to keep the lines fairly within their respective dots on the diagram. I thus obtained for the total weight of the (charged) instrument standing at h mm. in sea-water what forms the numerator, and for the corresponding weight for pure water what forms the denominator in the following formula:—

$${}_{17}\mathrm{S}_{17} = \frac{165{\cdot}077 + (60 - h) \times 0{\cdot}00868}{160{\cdot}579 + (60 - h) \times 0{\cdot}00845}\,.$$

As

$$0{\cdot}00868 = \mathrm{S} \times 0{\cdot}00845 = \frac{165{\cdot}077}{160{\cdot}579} \times 0{\cdot}00845,$$

only the constant terms need be retained in the computation, which leads to the value—

$${}_{15\cdot7}S_{17}=1028\cdot01,$$

whence, by a series of corrections,

$${}_{4}S_{15\cdot56}=1027\cdot202 \text{ by hydrometer.}$$

By analysis $\chi=20\cdot345$, whence by tables (if we deduct 0·04 from the tabular value for the vacuum correction),

$${}_{4}S_{15\cdot56}=1027\cdot287,$$

or hydrometer result $+0\cdot085$; but this latter result is liable to a correction of $-0\cdot042$ for the capillarity (see p. 83), which brings it down to 1027·160, whence error in corrected hydrometer reading $=-0\cdot127$.

By a specially made plunger experiment (plunger displacement specially determined, weighings reduced to the vacuum from actually observed air-density) I found

$${}_{4}S_{19\cdot15}=1026\cdot43.$$

The hydrometer result, when reduced to 19°·15, is

$${}_{4}S_{19\cdot15}=1026\cdot315$$

(capillarity *not* allowed for), hence error in *uncorrected* hydrometer reading $=-0\cdot12$; in corrected $=-0\cdot16$. We see the capillarity correction alters the result in the wrong direction, and consequently had better be omitted. The number 0·00845, which in my final equation figures as the water-value of 1° of the hydrometer, is the result of a compromise between those two series. The water series by itself gave 0·00805, which coincides with what I obtained before by a more direct determination, in observations stretching over a wider range of the scale. By, so to speak, forcing this value (*i.e.*, $0\cdot00805 \times 1\cdot028$) on the sea-water curve, slightly altering the constants, and calculating on this basis, I find—

$${}_{4}S_{19\cdot15}=1026\cdot349,$$

which is only 0·08 less than the plunger result. Adopting this method, the hydrometer value is too low: if we neglect the capillarity correction by 0·08; if we take in the capillarity correction, by 0·12.

There is no need of our searching for the cause of this error; it is fully explained by the inherent uncertainty in the hydrometer's position of apparent equilibrium. On comparing the several readings obtained in series I. for identical over-weights and reduced to the same temperature, I often found them to differ from the mean by as much as

±2 mm., *i.e.*, 2° of the hydrometer, and occasionally even by more. On classifying the errors of series I., as deduced from the original line—

$$w = (w_{\infty})_t + (60 - h) \times 0{\cdot}00805,$$

according to their magnitudes I counted—

± Error under.	Number of Cases.
0·5	11
1·0	27
1·5	38
2·0	53
2·5	59
3·2	65

The entry 32 (=nearest integer to 32·5) in Column II. if interpolated would correspond to some value between 1·0 and 1·5 for the error, hence the probable error may be set down as ±1·3 degrees of the hydrometer scale; the probability of the error being less than ±2·0 is seen directly from the table to be about $\frac{53}{65} = 0{\cdot}81$. I think it is a fair assumption that the "*h*" put down by Mr. Buchanan in his volume table for a given *w* at *t*° as a result of his standard experiments, is uncertain by at least ±0·5 mm. Adding ±1·5 as the probable uncertainty of the reading for a given sample of sea-water in the subsequent practical applications of the instrument, we arrive at $\pm 2{\cdot}0 \times 0{\cdot}008 \div 160$ as an estimate of the probable relative error in the individual specific gravity reported, which comes to ±0·1 for a specific gravity referred to water=1000. The corresponding uncertainty in χ (number of grams of chlorine per kilogram of sea-water) is ±0·072.

This then is about the degree of precision which we may *presume* Mr. Buchanan to have reached in his numerous specific gravity determinations. But my determinations of the chlorine in waters examined by him, enable us, to some extent, to actually measure the precision of his work.

Column IX. of Table I. gives the differences $\chi^1 - \chi$ between the chlorines χ^1 calculated from Mr. Buchanan's specific gravities ${}_4S$, and the values χ which I found in my analyses. I have arranged their values $\chi^1 - \chi$ according to their magnitude, which, in the first instance, led to the detection of the following exceptionally high numbers, which may be put aside as being probably owing to blunders in the specific gravity determination, or to mistakes in regard to the identity of the waters which I analysed—

$\chi - \chi_0$ . .	−0·376	−0·474	−0·522	−0·307	+0·245	+0·512
No. of the water, .	1520	1533	388	1265	485	1

In looking down the ninth column of our Table I., we are struck by the predominance of negative values, which suggests that there must be a relatively constant element in the difference between χ^1 and χ; as expressed in the equation $\chi^1 - \chi = \text{constant} \pm$ observational error.

To find a value for this *quasi* constant, I took the mean of all my 315 values of $\chi^1-\chi$, which came to $-0·037$. This I subtracted from (*i.e.*, I added $+0·037$ to) all the entries, and arranged the remainders as follows, according to their magnitudes.

TABLE XI.

Classification of the Observational Errors in Buchanan's Values χ^1.

Numerical value of error in units of the third place.	Δ.	Number of errors in interval.			Total number of errors less than ± Δ.
		Positive.	Negative.	Total.	
0 to 19	20	32	18	50	50
20 to 39	40	32	24	56	106
40 to 59	60	19	28	47	153
60 to 79	80	22	17	39	192
80 to 99	100	12	22	34	226
100 to 119	120	7	12	19	245
120 to 139	140	12	12	24	269
140 to 159	160	9	7	16	285
160 to 179	180	7	7	14	299
180 to 199	200	2	6	8	307
200 to 219	220	5	0	5	312
220 to 239	240	2	1	3	315
		161	154	315	315

By direct counting of the individual errors in the original table, which gave them all as an ascending series, the "probable error" lies between ±0·061 and ±0·062. And again, by direct counting, there are 249 cases (out of the 315) where the error is less than ±0·123; hence the probability of an error taken at random being less than twice the probable is, *by counting*, $=\frac{249}{315}=0·79$. Theory demands 0·82.

The numbers χ^1 were calculated from Buchanan's results for ${}_4S_t$ by means of Table III.; but in so-doing the vacuum correction which Buchanan's specific gravities contain, I added on +0·04 instead of +0·033, which I now think comes nearer the truth. To $\Delta S = -0{\cdot}007$ corresponds $\Delta \chi = -0{\cdot}005$; hence if I had used 0·033, the constant part in $\chi^1 - \chi$ would have become $= -0{\cdot}042$. The correction is insignificant; but we will adopt it and formulate the net result of our inquiry by saying (in reference to the 315 cases considered) that

$$\chi^1 - \chi = -0{\cdot}042 \pm \delta$$

where δ is a variable quantity of which the chances are even that it is less or greater than 0·06, and about 8 against 2 that it is less than 0·12. It would not be fair to charge the whole of either term against Mr. Buchanan as representing an error in his specific gravity determination. My analytical values χ must be charged with a probable error of (say) $\pm \frac{1}{2000}$th of their value, *i.e.*, of about ±0·01, and part of the constant term may be owing to my having unwittingly changed my unit for χ when (a considerable time after the Challenger water analyses had been made) I analysed my standard waters for the specific gravity research. I feel sure in my mind that this latter error could not amount to more than ±0·02 at the outside. Assuming it to be negative, the error in the numbers χ^1 would be reduced to $\Delta(\chi^1) = -0{\cdot}02 \pm 0{\cdot}05$ as an estimate of its "probable" value. Only the variable term affects the oceanographic applications; translated into a difference of specific gravity it amounts to about ±0·07, which is a little less than the value which resulted from my hydrometer experiments.

The oceanographic significance of his specific gravities will be discussed by Mr. Buchanan himself.

I am indebted to Mr. Thomas Barbour for the valuable assistance he has given me in carrying out the specific gravity research, and in the tedious calculations involved in it and in the construction of the tables.

III.—THE BROMINE IN OCEAN WATER.

The *chlorine* in the 77 sea-water analyses, tabulated on pages 23 to 25, includes the bromine and iodine, in the sense that [Br] parts of the former or [I] parts of the latter are put down as [Cl] parts of chlorine. Now the proportion of iodine* in sea-water is so very minute, that its effect on the chlorine determinations may well be neglected; but with the bromine the case is different, for, according to all authorities, it forms quite an appreciable fraction of the total halogen. In regard, however, to the numerical ratio of the bromine to the chlorine, the several analysts differ widely from one another. Justus Roth, in his Allgemeine und chemische Geologie, vol. i. pp. 505 *et seq.*, quotes a number of sea-water analyses by the authorities to be named, whose results for the bromine, when reduced to 100 parts of total salts, are as follows:—

C. Schmidt,	1877,	0·136 and 0·144
Von Bibra,	1851,	1·01 „ 0·89
Thorpe and Morton,	1870,	0·181

J. Hunter, in 13 analyses of waters collected S.S.W. of Ireland (1869), finds values oscillating about 1·0. The results, as we see, vary from 0·136 to about *seven* times this value.

Considering these immense divergences, I thought it would be well to try and determine the bromine in at least a selection of Challenger waters, the more so as, just on account of the smallness of its proportion, I had a chance of proving that this value is different for different ocean waters.

A few preliminary determinations sufficed to show that von Bibra's and Hunter's results are far too high, while Thorpe and Morton's or Schmidt's come at least near the truth. Hence an exact determination of the bromine could not be attempted with less than a whole litre of sea-water, meaning 2 litres for a duplicate analysis, which is very considerably more than I could have spared of any one of my samples. I had not, moreover, the time for a very extensive series of analyses, and therefore at once decided upon preparing mixtures of waters representative of certain regions of the ocean (or certain depths in a given region), and analysing these mixtures.

For the quantitative determination of the bromine contained in a small quantity of bromide diffused throughout a large mass of chloride only one method is known. We must separate out the bromine by fractional precipitation with nitrate of silver, and in the precipitate—which in the case of sea-water always consists mostly of chloride—determine the bromine by heating the mixed precipitate in chlorine gas, and ascertaining the loss of weight resulting from this operation. In it every [AgBr] parts of bromide of

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* See the memoir by J. Köttstorfer, *Zeitschrift für Analytische Chemie*, 1878, p. 305; also *Jahresbericht für Chemie*, 1878, p. 1043. He finds one milligram of iodine in fifty litres of the water of the Adriatic. In a few experiments with Challenger samples I found similar values.

silver become [AgCl] parts of chloride. Hence every [Br − Cl] grms. of loss of weight indicate [Br] grms. of bromine. According to Stas's determinations, Br = 79·95; Cl = 35·46; Ag = 107·93. Hence Br − Cl = 44·49; and

$$\frac{\mathrm{AgBr}}{\mathrm{Br}-\mathrm{Cl}} = 4{\cdot}2230\;;\quad \frac{\mathrm{Br}}{\mathrm{Br}-\mathrm{Cl}} = 1{\cdot}7970\,.$$

To be able to work this method to the best advantage, I began by ascertaining the minimum weight of nitrate of silver which is sure to precipitate the maximum weight of bromine presumably present in a litre of sea-water. And here, unfortunately, I fell into an error which rendered a whole string of subsequent analyses almost useless. Two test analyses of synthetically prepared mixtures agreed fairly well, and had apparently brought out the fact that 100 c.c. of deci-normal silver solution, *i.e.*, about $\frac{1}{55}$th of the volume required for the total halogen, brings down the whole of the bromine from one litre of sea-water. This exact proportion of precipitant accordingly was used in the duplicate analyses of 14 sea-water mixtures, before it was discovered by additional synthetical trials, that the proportion named falls considerably short of what is really necessary. The results of the 14 bromine-determinations thus became, of course, valueless in an absolute sense; but as all the work had been done in a strictly uniform fashion, the results still remained available to some extent for seeing whether or not the proportion of bromine in sea-water salts is subject to considerable variation; and it is only on this account that I refer to the accident in this memoir. In all the 14 samples of water, the "chlorine" had been determined by my modification of Volhard's process, and the numbers for the bromine had been reduced finally to 100 parts of "chlorine." The 14 results when thus reduced, varied from 0·280 to 0·316; mean of them all = 0·292; probable error of the individual determination = ±0·007. Hence it would appear that the ratio of bromine to total halogen in sea-water *is* subject to considerable variation; but even this result I could not accept as final, the less so as the particular *modus operandi* which had been adopted, when critically looked into, was found to be infected with irregular errors which deprived the few exceptionally high results of a considerable portion of their value as evidence.

Unfortunately the work, through sheer want of material, could not be repeated, or even resumed on similar lines; there were, however, still a sufficient variety and number of Challenger water samples in my possession to enable me to prepare mixtures fairly representative of *surface*, *medium-depth*, and *great depth* respectively, and I accordingly decided upon preparing such mixtures and analysing them. But I had first to make quite sure of my analytical method.

Having found out that it is not possible to eliminate the whole of the bromine from a litre of sea-water, without producing an inconveniently large haloid of silver precipitate, I endeavoured to concentrate the bromine before converting it into the silver-salt, by distillation of the water with chlorine, and collecting the liberated bromine (and the excess of re-agent) in pure caustic potash. To test this method, a large number of trials were made with synthetically prepared sea-waters, containing known weights of pure bromide of potassium; but the results were unsatisfactory. Even when six equivalents of chlorine were used to expel one equivalent of bromine, the residue still contained a remnant of undecomposed bromide, whose bromine, it is true, was found capable of being eliminated by one or two repetitions of the process; but the method then becomes rather troublesome, besides being uncertain as to its exhaustiveness. In addition to this, the determination of the bromine in the distillate proved not so easy as I had expected. The reduction of the bromate is, of course, easily effected by means of sulphurous acid; but the haloid of silver precipitate obtained from the reduced liquor is often contaminated with a dark-coloured (sulphur?) compound, which has to be removed by hot nitric acid; a risky operation under the circumstances.

Several attempts to separate the bromides from the bulk of the other salts by means of alcohol gave still more discouraging results. I therefore at last came back to the original method, which, as the result of a number of trials, assumed ultimately the following form:—

A decinormal solution of nitrate of silver is prepared by dissolving 17 grms. of the anhydrous salt in 20 c.c. of nitric acid of 1·4 specific gravity, and enough water to produce 1 litre of solution. This solution serves for the precipitation of the bromine, and its *titre* must be sufficiently exact to enable one to maintain in all the analyses a *constant ratio* between silver added and silver-equivalent of the total halogen present; so that, assuming the method to be infected with some latent inherent error, the results retain at least their comparative value. For the same reason an exact determination of the "chlorine" always precedes that of the scarcer halogen. The *modus operandi* is as follows:—

One kilogram of the sea-water is weighed out, and mixed with a volume of the silver-solution, equivalent to exactly $1/n$th of the total halogen present, the mixture shaken and put aside in a dark place. What the right value for n is will be explained by and by. After the precipitate has settled down, which generally takes about twelve hours,* the supernatant liquor is syphoned off, the precipitate washed by decantation, and the washings are added to the decantate. The precipitate is then transferred to a basin, and dried over a water-bath, in the absence of light. The dry residue is then collected in a porcelain boat, which has previously been tared within, and along with a piece of combustion-tubing, which is about 1½ to 2 inches longer than the boat itself. Within this tube the dehydration of the haloid is effected by fusion in a current of dry air, and the chlorination by repeated heating in a current of dry chlorine until the weight is constant. As the latter operation is generally accompanied by a slight effervescence (which would otherwise lead to a loss of from 1–3 mgrms. of chloride),

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* In a *neutral* mixture the precipitate remains suspended for days as an intractable milk.

the boat and contents are always weighed along with the tube. No cork-joints are used in any of the operations; the connection of the tube with the air-gasometer or the chlorine apparatus is effected by means of a closely (though not hermetically) fitting glass tube, slipped into the end of the operation-tube, which works perfectly well, as the gas has to overcome no pressure. The combustion-tube is never heated directly in the gas flames, but separated from them by an interposed magnesia bath, as recommended by Stas. The small particles of haloid of silver which unavoidably pass into the decantate are collected on a filter, ignited within the filter, chlorinated by evaporation with nitric and hydrochloric acids, weighed as chloride, and the weight is allowed for in the calculation of the total bromine. This weight was always so small, that even supposing it had contained its full complement of bromide, instead of being mere chloride as assumed in the calculation, the error would have been inappreciable.

I now pass to the test experiments which were made for determining the value *a* referred to, and settling certain other questions. Pure bromide of potassium solution was made by shaking bromine with solution of the commercial pure salt, and then distilling the mixture. The distilled bromine was converted into zinc salt, the latter decomposed by its exact equivalent of pure carbonate of potassium, and the carbonate of zinc filtered off. The solution after having been conveniently diluted, was analysed by the gravimetric form of Volhard's method, with the following result:—

Found in one gram of solution

I.	II.	Mean.
13·099	13·081	13·09 mgrms. of bromine.

This solution served for the synthesis of solutions containing known weights of bromine as bromide. Part of it was utilised for preparing pure bromide of silver. 0·1971 of the pure silver salt (weighed after fusion) when chlorinated in a boat within a hard glass tube (as explained above) gave ·1499 grm. of chloride—loss of weight =47·0 mgrms.=84·46 mgrms. of bromine. Calculated from the weight of the bromide it is 83·79, whence the error = +0·67 mgrm. In order now to see whether chloride of silver when chlorinated retains its weight, 100 c.c. of decinormal silver solution were precipitated with hydrochloric acid, the precipitated chloride, in one case (*a*), filtered off, washed, dried, and what could conveniently be detached from the filter-paper, chlorinated. In another case (*b*), the precipitate was collected by decantation. Loss of weight in chlorination (of about 1420 mgrms.)—

	(*a*)	(*b*)
	0·3 mgrm.	0
Corresponding to	0·54 ,,	0 of Bromine.

In each of the following experiments a known weight of bromine (in the shape of our standard solution, *vide supra*) was mixed with enough of pure chloride of sodium to produce very nearly 10 mgrm. equivalents of haloid, the solution precipitated by 100 c.c. of decinormal silver, *plus* a few drops extra to be sure of an excess of silver, the precipitate collected, washed, and chlorinated to determine the bromine. The *modus operandi* was exactly that explained in the introduction as being the one finally adopted for the water-samples, except in the case of No. 4, when the haloid-precipitate, instead of being worked by decantation, was all collected on a filter and the chlorination effected in a bulb-tube instead of in a boat within a tube.

No. of Experiment.	Bromine Taken.	Bromine Found.	Error.
	mgrms.	mgrms.	mgrms.
4	63·63	63·68	+0·05
6	63·54	62·50	−1·04
15	63·92	63·78	−0·14
16	63·88	62·72	−1·16
17	63·86	62·52	−1·34
18	63·86	63·40	−0·46
Mean error, ...			−0·68

The weighing error corresponding to this mean = +0·37 mgrm., which I suspect is owing to the fact that chloride of silver, when fused in chlorine, retains a slight excess of halogen, which is not expelled by a current of air of short duration such as we used to apply at the end. The mere inconstancy in the weight of the apparatus, according to my judgment, cannot have been more than ±0·2 mgrm. at the most, and besides it would not always have affected the result in the same direction. Admitting that the method is subject to an inherent negative error, this error (excluding No. 4) would amount to about $\frac{1}{80}$ths of the bromine to be determined. But the experiments are too few to admit of such an interpretation.

ATTEMPTS TO DETERMINE THE MINIMUM OF SILVER REQUIRED FOR PRECIPITATING THE BROMINE FROM 1 LITRE OF SEA-WATER.

(1.) *Preliminary Trials with Natural Sea-Water.*

In each of the following trials 1 litre of some sea-water (or sea-water mixture) was mixed with 100 c.c. of the decinormal silver, the precipitate separated by filtration or decantation and chlorinated. In general the mother-liquor was again worked up with

50 c.c. of silver, and in one case the second mother-liquor was again precipitated with 50 c.c of the reagent. The results are given in the following table. Column I. gives a reference mark; Column II. the symbol assigned to the water; Column III. the bromine found in the first precipitate; Column IV. that in the second; Column V. that in the third; Column VI. the total bromine in milligrams per kilogram of water analysed:—

No.	Water.	Bromine, milligrams, in				
		I. Prec.	II. Prec.	III. Prec.	Total.	
7	A	49·34	11·21	...	60·55	Filtration.
8	A	54·41	...	...	...	Do.
9	B	53·95	9·62	...	63·57	Do.
10	B	55·41	...	...	...	Do.
19	A^1	55·58	7·66	...	63·24	Decantation.
20	A^1	55·81	...	...	...	Do.
21	B^1	56·91	7·71	1·58	66·19	Do.
22	B^1	56·63	...	...	...	Do.

Assuming No. 21 to have given the whole of the bromine, it would follow that 100 c.c. of silver added to 1 litre of sea-water bring down 85·8 per cent. of the total bromine; hence the results of the first (rejected) series of bromine determinations in Challenger waters are liable to correction by multiplication with $\frac{100}{85 \cdot 8} = 1 \cdot 165$. Applying this factor to the mean weight of bromine found in those fourteen determinations per 100 of chlorine, we have $0 \cdot 292 \times 1 \cdot 165 = 0 \cdot 339$, which, as will be seen, comes pretty near the final result.

(2.) *Synthetical Trials.*

In all these trials 30 grms. of pure chloride of sodium were dissolved in water, mixed with a small known weight of the standard bromide of potassium solution, made up to one litre, and the mixture subjected to successive precipitation with known volumes of decinormal silver solution. Each precipitate was chlorinated, or, if presumably very poor in bromine, tested for bromine qualitatively. No filters were used in these or in any of the subsequent analyses.

(No. 23.) Bromine taken, 63·83 mgrms. The weight of bromine in the successive silver precipitates was b_1, b_2, b_3, &c., as shown in the following table :—

I. Precip.,	100 c.c.	of silver solution,	$b_1 =$	53·96
II. ,,	50 c.c.	,,	$b_2 =$	5·98
III. ,,	50 c.c.	,,	$b_3 =$	2·16
IV. ,,	25 c.c.	,,	$b_4 =$	0·36
V. ,,	25 c.c.	,,	$b_5 =$	— 0·18

Total bromine, excluding number V., = 62·46
Error = − 1·37

(No. 24.) Bromine taken, 64·02 mgrms.

I. Precip.,	100 c.c.	of silver solution,	$b_1 =$	53·80
II. ,,	50 c.c.	,,	$b_2 =$	7·34
III. ,,	50 c.c.	,,	$b_3 =$	1·80
IV. ,,	failed ;	taking	$b_4 =$	0·36 (?)

We have for total bromine, 63·3
Error = − 0·7

(No. 25.) Bromine taken, 63·85 mgrms.

I. Precip., 100 c.c. of silver solution, $b_1 = 53·81$
(Not continued.)

Seeing that a complete precipitation could not be effected by less than some 250 c.c. of decinormal silver, which means an inconveniently large silver precipitate, I tried to improve upon the method by effecting a fractional precipitation in a *neutral* solution, and adding nitric acid only after some standing to render the precipitate amenable to decantation. What I hoped for was that the milkiness of the haloid precipitate produced in the absence of acid would favour the exchange of precipitated chlorine for dissolved bromine, so that the latter could be got down by means of less silver. The result (Nos. 26 and 27) was not as expected.

(No. 26.) Bromine taken, 61·2 mgrms.

I. Precip., 100 c.c. of silver solution, $b_1 = 51·57$

(No. 27.) Bromine taken, 61·24 mgrms.

I. Precip., 150 c.c. of silver solution, $b_1 = 53·41$

In the second case the result for b_1, on account of an accident in the chlorination, is not quite safe ; but the decantate was proved, by qualitative testing, to contain abundance of dissolved bromide. In the following experiments acid silver solution was employed as usual :—

(No. 28.) Bromine taken, 61·21 mgrms.

I. Precip., 200 c.c. of silver solution, $b_1 = 56·95$
Loss = 4·26

(No. 29.) Bromine taken, 61·31 mgrms.

I. Precip., 250 c.c. of silver solution, $b_1 = 56·77$
Loss = 4·54

The decantate was precipitated with silver (the volume used was forgotten to be noted down); the precipitate was decomposed by means of zinc, water, and a few drops of sulphuric acid; and the liquid tested with chlorine water and chloroform, and the bromine estimated colorimetrically. The quantity found was about 4 mgrms.

These last two trials were very disappointing. They seemed to prove that although, as shown by experiments Nos. 23 and 24, about [illegible]ths of the bromine can be brought down by means of about 250 c.c. of the silver solution, even this is possible only at the expense of a tedious succession of fractional precipitations, each of which occupies a whole day. The following series of experiments was made with a view of seeing what can be attained by *two* successive precipitations with *large* proportions of silver solution. In each case the bromine to be determined was diffused throughout a litre of liquid containing 30 grms. of pure chloride of sodium:—

(No. 45.) Bromine taken, 61·31 mgrms.

I. Precip., 200 c.c. of silver solution, $b_1 = 56·77$
II. " 300 c.c. " $b_2 = 1·26$
Total bromine found = B = 58·03.

The second precipitate in this case was decomposed by zinc and very dilute sulphuric acid, the solution precipitated with 50 c.c. of silver, and this small precipitate chlorinated.

(No. 46.) Bromine taken, 61·22 mgrms.

I. Precip., 200 c.c. of silver solution, $b_1 = 59·66$
II. " 300 c.c. " $b_2 = 1·08$
(2nd precipitate manipulated as in 45.)
B = 60·74

(No. 47.) Bromine taken, 61·21 mgrms.

I. Precip., 200 c.c. of silver solution, lost
II. " 200 c.c. " $b_2 = 2·88$
(2nd precipitate chlorinated as it was.)

(No. 48.) Bromine taken, 61·32 mgrms.

I. Precip., 200 c.c. of Ag., ... b_1 lost
II. „ 200 c.c. „ ; precipitate reduced and solution reprecipitated by 50 c.c. of Ag., $b_2=3·42$

(No. 49.) Bromine taken, 61·51 mgrms.

I. Precip., 200 c.c. of Ag., ... $b_1=56·96$
II. „ 200 c.c. „ precipitate chlorinated directly, $b_2=3·60$
III. „ 100 c.c. „ . . . . . $b_3=(-0·18)$

(No. 50.) Bromine taken, 61·37 mgrms.

I. Precip., 200 c.c. of silver, $b_1=56·89$
II. „ 200 c.c. „ $b_2=4·14$
III. „ 100 c.c. „ $b_3=(-0·18)$

(No. 51.) Bromine taken, 61·47 mgrms.

I. Precip., 200 c.c. of Ag., ... $b_1=56·79$
II. „ 300 c.c. „ ; precipitate reduced, and Br reprecipitated by 50 c.c. of silver, $b_2=4·03$

(No. 52.) Bromine taken, 61·38 mgrms.

I. Precip., 200 c.c. of Ag., ... $b_1=56·61$
II. „ 300 c.c. „ ; precipitate reduced, Br reprecipitated by 50 c.c. of silver, $b_2=2·57$

In the following summary the results of experiments Nos. 45 to 52 are referred to 100 mgrms. of bromine taken:—

Obtained per 100 *Milligrammes of Bromine taken.*

No.	Precipitation with v c.c. of Silver Solution.				b_1+b_2 or B.	100 − B.
	First.		Second.			
	v_1.	b_1.	v_2.	b_2.		
45	200	92·6	300	2·07	94·7	5·3
46	200	97·5	300	1·77	99·2	0·8
47	200	...	200	4·71	...	...
48	200	...	200	5·58	...	...
49	200	92·6	200	5·85	98·5	1·5
50	200	92·7	200	6·75	99·4	0·6
51	200	92·4	300	6·57	99·0	1·0
52	200	92·2	300	4·19	96·4	3·6

In criticising these results we must not forget that in each case the small quantity of bromine sought to be determined was diffused throughout about 500 times its weight of a foreign salt, and that b_1 and b_2 are each dependent on the difference of two weighings of a bulky apparatus which, between each weighing, was heated for hours in chlorine gas. Under the circumstances, the tare could not be expected to be absolutely constant. Supposing the weight of the mixed haloid and the weight of the chloride to be wrong by $-0·5$ and $+0·5$ milligram respectively, this would account for an absolute error of $-1·8$ mgrms. in the calculated bromine=3 per cent. of the quantity to be determined. But in the case of Nos. 52 and 45 the loss of bromine amounted to 3·6 and 5·3 per cent.; and even if we rejected these two trials (which we have no right to do), the high value 97·5 for b_1 in No. 46 would confront us as an anomaly. The method is obviously subject to occasional irregularities. These, however, I hoped, could be eliminated by a more rigorous adherence to a fixed method than had prevailed in the synthetical trials, and by a sufficient multiplication of analyses in each case. Besides, I was unable to see my way to any essential improvement upon the method adopted, and therefore now proceeded to the actual analyses, according to the following method:—

Determine the "chlorine" in the water to be analysed. Then weigh out 1 kilogram and add to it 200 c.c. of the decinormal silver solution per 30 grms. of potential chloride of sodium present, *i.e.*, 3·90 per cent. of what would precipitate the whole of the halogen, collect the precipitate by decantation and chlorinate it. To the mother-liquor add the same volume of precipitant as served for the first precipitation, and treat the precipitate like the first, operating otherwise as explained in the instructions given on pp. 91 and 92. This method was applied to three mixtures of Challenger waters, namely:—

I. A mixture of 64 samples of "*Surface Water*," taken from depths varying from 0 to 50 fathoms, inclusive.

II. A mixture of 71 samples of "*Medium-Depth Water*," taken from depths varying from 300 to 1000 fathoms, both inclusive.

III. A mixture of 70 samples of "*Deep-Sea Water*," taken from depths of 1500 fathoms or more.

As in the series of Challenger samples shallow shore-waters do not occur at all, I procured a supply of water from off Port Louis, Isle of Arran, where there is abundance of sea-weeds (thinking that these vegetable growths might probably tell appreciably on the proportion of bromine present in the dissolved salts), and analysed it like the rest. The results are given in the following tables:—

I. *Surface Waters.*

Analysis.	Milligrammes of Bromine per kilogram of Sea-water.		
	I. Precip.	II. Precip.	Total.
No. 1, . . .	63·16	4·32	67·48*
" 2, . . .	62·93	4·68	67·61†
" 3, . . .	lost.	4·50	...
" 4, . . .	62·98	3·42	66·40
" 5, . . .	62·90	3·78	66·68
Means, . .	62·99	4·14	67·04
‡ r_0= . . .	±0·039	...	±0·20

Chlorine per kilogram found = 19·634 and 19·653 grms.; mean, 19·644; hence bromine per 100 parts of chlorine = 0·3394 ± 0·001.

II. *Medium-Depth Waters.*

Analysis.	Milligrammes of Bromine per kilogram of Sea-water.		
	I. Precip.	II. Precip.	Total.
No. 1, . . .	62·32	4·14	66·46
" 2, . . .	62·55	2·88	65·43
" 3, . .	62·37	3·24	65·61
" 4, . . .	62·03	3·24	65·27
Mean, . . .	62·32	3·38	65·69
r_0= . .	±0·073	...	±0·18

Chlorine per kilogram 19·332 and 19·331 grms.; hence bromine per 100 of chlorine = 0·3414 ± 0·000 93.

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* Third precipitate gained 0·1 mgrm. on chlorination.

† Third precipitate gained 0·3 mgrm. on chlorination.

‡ r_0 = probable error of mean = $0·6745\sqrt{\frac{\Sigma(x-x_0)^2}{n(n-1)}}$; $x-x_0$ being the deviation of the individual result from the mean.

III. *Deep-Sea Waters.*

Analysis.	Milligrammes of Bromine per kilogram of Sea-water.		
	I. Precip.	II. Precip.	Total.
No. 1, . . .	62·66	3·60	66·26*
„ 2, . . .	62·90	2·88	65·78*
„ 3, . . .	62·64	4·14	66·78
„ 4, . . .	62·50	3·96	66·46
Mean, . . .	62·67	3·645	66·32
$r_0 =$ . . .	± 0·056	...	±0·14

Chlorine per kilogram 19·518 and 19·538; mean, 19·528; hence bromine per 100 of chlorine 0·3398 ± 0·0007.

IV. *The Arran Water.*

Analysis.	Milligrammes of Bromine per kilogram of Sea-water.		
	I. Precip.	II. Precip.	Total.
No. 1 . . .	55·38	3·24	58·62
„ 2, . . .	55·31	3·78	59·09
„ 3, . . .	54·99	3·42	58·41
„ 4, . . .	55·38	3·24	58·62
Mean, . . .	55·26	3·42	58·69
$r_0 =$ . .	± 0·06	...	±0·10

Chlorine per kilogram 17·241 and 17·253; mean, 17·247; hence bromine per 100 of chlorine =0·3403 ± 0·000 58.

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* Third precipitate on chlorination gave loss of 0 and −0·1 mgrm. respectively.

Summary.

Bromine per 100 parts of chlorine in water from :—

I.	II.	III.	IV.
Surface.	Medium depth.	Deep-Sea.	Arran.
0·3394	0·3414	0·3398	0·3403
r_s=±0·0010	±0·0009	±0·0007	±0·0006

Deviation from the general mean, *i.e.*, from ·3402,

−0·0008 +0·0012 −0·0004 +0·0001

The deviations, as we see, lie within, or do not materially exceed, even the "probable" errors of the means as calculated from the law of frequency of error. This, after the irregularities observed in the test analyses (page 97), is so surprising a result that I find it necessary to state expressly that the above report includes *all* the analyses that were made.

The ratio of bromine to chlorine (or total salt), as far as can be seen from our analyses, is the same at all depths, the weight of bromine per 100 of chlorine being always =0·3402±0·0004.

I hasten to add that this small fraction 0·0004 does not include a constant *method error*, which, according to the test analyses tabulated on page 97, would appear to lie somewhere about −0·0034, so that perhaps we should come nearer the truth by adopting the value ±0·3436, or say ±0·344 a somewhat uncertain probable error.*

As the weights of the first precipitates were decidedly more constant than those of the second, it would perhaps be better, for a mere comparison, to take them as our guide.

Taking the four means and referring each to 100 of chlorine, we have,—

	I.	II.	III.	IV.
(1) Original numbers, . .	62·99	62·32	62·675	55·265
(2) Per 100 of Chlorine, . .	0·3207	0·3224	0·3210	0·3205
Mean of (I. II. III.). . .	. .	. ·3214		
Deviation from the mean, . .	−0·0007	+0·0010	−0·0004	−0·0009
Probable error in value (2), . .	±0·000 20	0·000 36	0·000 28	0·000 30

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* The results of C. Schmidt for a water "*a*" off the Norwegian coast, and a water "*b*" W.N.W. from Bergen, and that of Thorpe and Morton for the Irish Channel, when referred to 100 of chlorine, I calculate to be,

	Schmidt. *a*.	Schmidt. *b*.	Thorpe and Morton.
Bromine per 100 of chlorine,	0·2451	0·2000	0·3269

Thorpe and Morton came near my number; Hunter's and v. Bibra's analyses (see p. 89) are worthless.

Although the deviations are less than for the total quantities of bromine, the net result is the same. The ratio of the bromine to the chlorine in ocean water is, it appears, independent of the depth, unless the ratio is a function of geographical position *and* depth, and the influence of the former, in my mixtures, has happened to just compensate for that of the latter independent variable. But this is not probable, the less so, as the Arran water gives the same result as the mixtures of Challenger samples.

The constancy of the bromine ratio is important as tending to prove that the composition of ocean-water salts is the same everywhere; because if it is not, the percentage of bromine, being so very small and necessarily affected by the plant life on the surface, should be more liable to fluctuation than that of any of the major components. And yet, according to my 77 complete analyses, the percentage of the lime at all events is greater in deep-sea than it is in shallow water. Is this result safe and sound, and not perhaps after all brought about by analytical errors? This question naturally forced itself upon me, and caused me to utilise what was left of our mixtures of water for those supplementary determinations of the ratio of the lime to the chlorine which, although later in being done, are reported in an earlier part of this Memoir (see pp. 32 *et seq.*).

All the quantitative determinations recorded in this chapter (except the 14 abortive analyses referred to in the introduction) were made under my eyes by Mr. John M'Arthur, and I feel greatly indebted to him for the zeal and self-denial with which he, for a series of months, devoted himself to this tedious and troublesome work.

IV.—ON THE CARBONIC ACID IN OCEAN-WATER.

In the composition of sea-water the carbonic acid, on account of its intimate relations to life, forms an item of particular interest. Mr. Buchanan, accordingly, in the course of the expedition, took care to determine this component in a large number of freshly-drawn samples, by means of a method which he had worked out in the Edinburgh University laboratory before starting.

Oscar Jacobsen* had found that the operation of boiling in vacuo, which so readily sets free the absorbed oxygen and nitrogen, liberates in general only a small fraction of the carbonic acid present. Buchanan experimented on the absorptiometric relations of the gas to solutions of individual sea-water salts, and came to the conclusion that solutions of all sea-water salts retain carbonic acid in a state of more intimate combination than that of physical absorption, and that sulphate of magnesia (as sea-water sulphates generally) exhibits this property in a particularly high degree. O. Jacobsen, before Buchanan, had identified the chloride of magnesium as being the salt to which sea-water owes its affinity for carbonic acid, and had also ascertained that the bonds of this carbonic acid union—whatever be its cause—are severed by a distillation of the water to very near dryness. His method for the determination of the carbonic acid accordingly consisted in this:—he distilled a measured volume of the sea-water almost to dryness in a current of air free from carbonic acid, caught the distillate, and whatever carbonic acid passed away from it, in measured standard baryta-water, and titrated the excess of baryta by means of standard acid (Pettenkofer's method). The general result of his analyses was that undiluted North Sea water contains some 90 mgrms. of carbonic acid, CO_2, per litre. Buchanan adopted Jacobsen's method, with this modification, however, that he added to the water, immediately before distillation, 15 c.c. of saturated solution of chloride of barium (per 225 c.c. of sea-water), in order to destroy the sulphates, which, according to him, are the cause of the relative non-volatility of the carbonic acid. This method, when applied to a very large number of samples of ocean-water, gave an average of about 45 mgrms. of carbonic acid per litre of sea-water. The results varied from about 41 to 47. Buchanan was very much struck by this immense discrepancy between his and Jacobsen's results, and tried to explain it by the difference between the nature of North-Sea water on the one hand, and ocean-water on the other. "The water in which nearly all my observations were made was the deep, clear, ultramarine-blue water of the ocean. The North Sea water, on which Jacobsen experimented, is comparatively opaque and green.

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* Oscar Jacobsen, *Annalen der Chemie*, 1873, vol. clxvii. p. 1.

In the Antarctic Ocean, where such water was met with occasionally, though very sparingly, the carbonic acid was always present in marked excess. The green colour of shoal-water is generally attributed to the influence of solid matter, which may also tend to retain carbonic acid, as we know is the case with dissolved saline matter" (Buchanan, Chem. Soc. Journ. 1878, p. 464). At that time it was generally believed that sea-water contains no carbonates, or that at least the carbonic acid of these forms only an insignificant fraction of the whole carbonic acid.

Some years ago, when I first directed my attention to the subject as part of the general problem of sea-water analysis, I perceived this weak point in Buchanan's position, but I had no doubt in my mind about the soundness of the basis on which he had founded his analytical process—the immense gulf between his and Jacobsen's results had somehow escaped my attention, or perhaps slipped from my memory—and I thought the best thing I could do would be, to apply to a selection of Challenger waters the following extension of his method founded (as will readily be perceived) upon the assumption that the total carbonic acid in a given sample of sea-water consists of three parts, namely,—a part "a," which is simply absorbed; a part "b," which is combined with the sulphates, &c.; and a part "c" (which I presumed to be very small), which is present in general as *bi*carbonate. To find these quantities, apply Buchanan's method to a part of the sample as it is; this gives $a+b+\frac{1}{2}c$. Then apply the same method to another part which has previously been shaken with air to a sufficient extent to expel what is present of purely absorbed carbonic acid; this gives $b+\frac{1}{2}c$. To determine "c," dilute the residue obtained in either distillation with gas-free water, add some hydrochloric acid, and resume the distillation; this gives the remaining $\frac{1}{2}c$.

When we tried this method with a supply of sea-water, specially procured for the purpose, we had no difficulty in working it; but the results were utterly and absolutely useless, so inconstant and mutually conflicting in their evidence, as to defy all attempts at a rational interpretation. I now know—and shall by and by explain—the cause of these irregularities, but I did not know at the time, and accordingly deferred the consideration of the subject for a time, in order to direct my attention more exclusively to the exact determination of the saline components in a series of 21 waters, which had been entrusted to me as a first instalment for complete analysis. These analyses incidentally solved the greater part of the carbonic acid question. There is no need of my here recapitulating at length what was so fully reported on in a previous part of this memoir (p. 20, compare also pp. 23 to 25). All the 21 analyses brought out an excess of base over the sum of muriatic and sulphuric acid equivalents, which excess of course must be put down as so much carbonate. It is true the several values of the "alkalinity," as deduced from the individual analyses, did not agree with one another, and all my attempts at finding a more direct method for its precise determination failed. But the sum total of the results left no doubt in my mind that a considerable portion at least of the carbonic acid which Buchanan had liberated, from its combination with sulphates as he thought, was only eliminated from the bicarbonates, thus:—

$$R_2O.H_2O.2CO_2 + BaCl_2 = BaOCO_2 + 2RCl + H_2O + CO_2.$$

A subsequent critical examination of Buchanan's paper in the Royal Society's Proceedings* gave me the conviction that the alleged affinity between sulphates and carbonic acid is founded upon an incorrect interpretation of what are probably in themselves correct observations.

When at a later date I resumed the carbonic acid question, I conceived the idea of determining both this acid and the alkalinity by the following *gasometric* method:—Take two portions of the given water, and in one convert all the "free" base into bicarbonate by passing in carbonic acid, and then removing the excess by shaking with air. Then eliminate the carbonic acid from each by boiling it out in a Jacobsen flask, and determining it gasometrically in the boiled out gas, taking care to use hydrochloric acid instead of water for producing the vacuum in the bulb and gas-collecting tube. In order to try this method a Jacobsen's flask† of 800 c.c. capacity was charged with gas-free water and a known weight of carbonate of soda, equal to about 10 c.c. of carbonic acid, and the gas eliminated as just explained. This experiment was made five times, and in each case the carbonic acid gas found was *short* of the calculated volume by about one cubic-centimetre. Just as if, after all the boiling under reduced pressure, so much of the carbonic acid had been retained by the hot acid liquid. An attempt to prove its presence in the residual liquid by addition of baryta water gave no result, because enough of the substance of the glass had dissolved in the liquor to cause the formation of a precipitate not carbonate of baryta; and, besides, a direct synthetic trial showed that the detection of 2 mgrms. of carbonic acid in 800 c.c. of water is altogether beyond the range of the baryta test. I therefore tried to solve the question synthetically:—Two litres of ordinary (aerated) distilled water were boiled down in a narrow-necked flask to about one-half of the original volume, and a quantity of clear baryta water was then run in from a protected Mohr's burette, without interrupting the boiling, which was continued until only a few cubic-centimetres remained. The flask was now allowed to cool and suck in air free from carbonic acid. Finally the contents were acidified with hydrochloric acid, boiled in a current of air free from carbonic acid, and the out-going air allowed to bubble through clear baryta-water. There was a slight but distinct precipitate of carbonate of baryta produced, and a similar result was obtained in two or three repetitions of the experiment. It was not so much in consequence of this result, as on account of the pressure of other work, that the carbonic acid question was again put aside for a

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* *Proc. Roy. Soc.*, vol. xxii. pp. 192–196, and pp. 483–495; 1874.

† A drawing and description of the apparatus will be found in the chapter "On the Absorbed Air in Ocean Water."

while. Before I resumed it, I had, through the kindness of the Editor of the Challenger Reports, come into possession of a copy of Tornoe's excellent memoir on his and his collaborators' chemical work in connection with the Norwegian expedition.* In it I found a very simple method for the determination of the alkalinity, which so far had always eluded my grasp, and also a method for the total carbonic acid, which certainly seemed easier of application than the one I had marked out for myself. I at once decided upon testing these two methods before doing anything else. Neither of the two methods is new, but this, far from detracting from, rather adds to, Tornoe's merit.

Account of the Norwegian Methods.

The Alkalinity is determined simply by titration with dilute standard acid and alkali in the heat, using *aurine* as an indicator, which marks an alkaline reaction by a violet, an acid by a yellow, colour. Tornoe's numbers show, and a few experiments of my own confirmed his result, that it is possible by means of this method, even when applied to solutions containing magnesia salts (*e.g.*, sea-water), to obtain sufficiently constant results. I found, however, that on prolonged boiling of sea-water in glass, enough of the alkali of the glass is dissolved to render the point of saturation somewhat indistinct, and I was thus led to operate in Berlin basins, which proved sufficiently resistant.

But constant results are not necessarily correct results. I considered it quite possible that in the case of magnesia-salts, at least, the point of *aurine*-neutrality might be one thing, and the point of true chemical neutrality another. To settle this doubt I prepared perfectly neutral sulphate of magnesia by dissolving the ordinary pure salt in water, adding a little sulphuric acid, and precipitating part of the dissolved salt by addition of strong alcohol. The precipitate was washed with strong alcohol until the last washings were absolutely free from acid, and the salt then dried between blotting paper. 250 c.c. of an aqueous solution of such salt, fully equivalent in regard to its percentage of magnesia to the same volume of sea-water, when tested in the heat (in a porcelain basin) by alternate neutralisation (in the presence of aurine) with decinormal hydrochloric acid and decinormal potash, proved absolutely neutral, showing that the method is available for the determination of even small quantities of free magnesia or acid in magnesia salt.

To make sure of everything I made similar trials with solutions (equivalent to sea-water) of pure common salt, and incidentally made a singular observation which I consider worth recording. Ordinary pure chloride of sodium was further purified by solution in the least proportion of water and reprecipitation with hydrochloric acid.

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* Den Norske Nordhavs-Expedition, 1876-1878; Chemi, Christiania. Text in Norwegian and in English.

The precipitate was washed with strong hydrochloric acid, and then once or twice with water, and ultimately dried for hours at 200° C. Yet the salt, when tested with aurine, proved decidedly, though slightly, acid. The acid could not be completely washed away with alcohol, so that I almost believed that in the case of chloride of sodium the point of aurine-neutrality corresponded to some point like $NaCl + \delta NaOH$ where δ is a very small number, when I found that recrystallisation from a hot solution by evaporation, and a subsequent slight washing with hot water, deprived the salt of its acid reaction. This is an instructive example of the difficulty of preparing *perfectly* pure specimens of even such a common thing as common salt.

After the Tornoe method had thus been tested, I applied it to a large number of Challenger samples. In each case 250 c.c. of water were operated on, and the point of neutrality determined repeatedly by zig-zag titration with acid and alkali. At first we used decinormal liquids; but we soon found it more convenient to use solutions containing $\frac{1}{22}$ [HCl] grms. and $\frac{1}{22}$ [KOH] grms. respectively per litre, so that 1 c.c. of each corresponded to exactly 1 mgrm. of carbonic acid. The results are tabulated in the chapter on the "Alkalinity of Ocean Water."

The Method for the Determination of Carbonic Acid.—This method is an adaptation of one proposed years before by Borchert and by Classen. It consists in this:—250 c.c. of the sea-water are placed in a flask surmounted by an inverted Liebig's condenser, the upper end of which communicates with a set of absorption-apparatus charged with a known sufficient volume of standard baryta water. After addition of some sulphuric acid, a current of purified air is passed through the liquid in the flask, which is then heated to boiling and kept boiling for about 15 minutes, when, according to experience, the whole of the carbonic acid has been conveyed to the baryta. The baryta-liquors are united in a graduated cylinder, allowed to settle, an aliquot part of the liquor is decanted off clear, and titrated with standard oxalic acid. I do not describe the very practical absorption apparatus, because I ultimately discarded it, as will be seen in the sequel.

When I made trial of this method—with solutions in 250 c.c. of pure boiled-out water of known weights of pure ignited carbonate of soda, varying from 2 to 50 mgrms. —the result in the majority of (some 20) trials proved 1 to 2 mgrms. too high. I do not mean to insinuate that Tornøe's results are likely to be vitiated by similar positive errors; it is quite possible that my experiments may have been infected by some constant error in manipulation which Tornøe avoided. Whether or no I am unable to say, because, while engaged in the necessary blank experiments for elucidating this point, I happened to hit upon a most essential improvement in the apparatus, which I thought would, and when tested was actually found to, eliminate the worst of the errors of the method. My improvement consists in this, that the gas which comes out of the condenser is passed straight into an *evacuated* flask of about $1\frac{1}{2}$ litres capacity, previously charged with the baryta water in a manner precluding the premature formation of carbonate of baryta. Should a film of carbonate show in the flask, it is, of course, easy to empty it out (after having allowed it to suck in *pure* air), to rinse it with water free from carbonic acid, and charge and evacuate it once more. The air carrying with it the carbonic acid enters the flask through a glass stop-cock prolonged inside into a tube dipping into the baryta-water, so that the rate at which the gas flows in can be seen and regulated. In the rehearsals it sometimes occurred that the boiling liquid, through a momentary increase of pressure in the atmosphere of the flask was driven back through the air-inlet tube. This was easily prevented by the insertion of a mercury-valve between the flask and the air-gasometer. The air in the latter must, of course, be absolutely free from carbonic acid, or, if not, be freed from it on its way to the boiling-flask. According to my experience, it is far easier to fulfil the former than the latter condition, by charging the gasometer with dilute caustic soda, and vigorously shaking the air with the liquid contents. When all the carbonic acid is in the vacuum flask, the latter is allowed to fill itself with pure air, and to stand until all the carbonic acid diffused throughout it may be assumed to be absorbed. The glass stop-cock is then pulled out of its aperture in the india-rubber stopper, a few drops of turmeric solution are run in, the beak of the standard hydrochloric acid burette is inserted through the hole, and acid run into the liquid until it is almost but not quite neutralised. Should the point of neutrality be by chance overstepped, this is easily rectified by a few drops out of the baryta-burette. The hole is now closed, the flask moved about so as to cause any trace of stray carbonic acid to be absorbed by the still decidedly alkaline liquid; the contents are poured out into a graduated cylinder, or, more conveniently, a tared phial, and weighed; they are then allowed to settle in the absence of air, an aliquot part is decanted off clear, and neutrality established by zig-zag titration with acid and baryta, the point of incipient acidity being taken as the end-point. The method in this form, when applied to known weights of carbonate of soda as before, gave very satisfactory results. The apparatus employed is depicted in Pl. I.

After having thus come into possession of exact methods for the determination both of the carbonic acid and the alkalinity, I next applied these in the following *synthetical experiments*:—

I. *Experiments with Pure Solution of Bicarbonate of Soda.*

5·3 grms. of pure carbonate of soda, Na_2CO_3, were dissolved in water to 1 litre. 50 c.c. of this solution were diluted with water to about 100 c.c., fully saturated with carbonic acid gas, and then diluted to 2000 c.c. Of this solution successive volumes of 250 c.c. were measured off, and each shaken *n* times with 10 times its volume of air, the air being renewed after each shaking. In the resulting solution the total carbonic acid was determined by the above ("vacuum") method. To check the synthesis the alkalinity of the solution was determined analytically by Tornøe's method. Assuming the soda and the carbonic acid to be associated in the proportion of $Na_2O:2CO_2$, the resulting alkalinity corresponded to 109·7 mgrms. of carbonic acid per litre of liquid, instead of 110·0 mgrms., as demanded by the synthesis. Found, after n shakings with air, for

$n=$	2.	4.	6.	8.
Carbonic acid, mgrms. p. litre =	107·6	107·8	108·0	107·8

This shows that a solution of bicarbonate of soda in pure water is hardly, if at all, affected by contact with air at ordinary temperatures.

II. *Pure Solution of Bicarbonate of Magnesia.*

Commercial *magnesia alba* was washed with water to remove adhering alkali-salts, then made into a milk with water, and treated with carbonic acid gas until the most of the precipitate was dissolved. Solution filtered and titrated with aurine. 100 c.c. found to be equivalent to $98·8 \times \frac{1}{22} \times [HCl]$ milligrammes.

200 c.c. of this liquor were diluted with Loch Katrine water* to 2000 c.c. Neglecting the alkalinity of the Loch Katrine water, and assuming the existence in the solution of the ratio $MgO:2CO_2$, the solution should contain 197·6 mgrms. of carbonic acid per litre. A direct determination of the alkalinity of the finished solution gave 211·4 mgrms. This latter number was adopted. Successive measured volumes of this solution were shaken n times with 10 volumes of air, and the carbonic acid in the resulting liquor determined—

$n=$	2.	4.	6.	8.
x = Carbonic acid, mgrms. p. litre =	207·0	202·3	195·8	193·8
$211·4 - x$ =	4·4	9·1	15·6	17·6

That is to say, by eight shakings with air about $\frac{1}{6}$th of the loose carbonic acid of the bicarbonate of magnesia was eliminated

III. *Experiments with Artificial Sea-Water.*

56 grms. of pure chloride of sodium and 27·5 grms. of pure sulphate of magnesia ($MgSO_4.7H_2O$) were dissolved in distilled water and diluted to 1900 c.c. To this 100 c.c. of the bicarbonate of magnesia solution (the same as used for the above experiments) were added to produce 2 litres of a quasi sea-water of exaggerated alkalinity. As the salts had not been specially purified, their alkalinity was determined analytically. 7 grms. of the chloride of sodium plus 3·44 grms. of the sulphate of magnesia were found equivalent to $0·58 \times \frac{[HCl]}{22}$ mgrms. Hence the alkalinity of the "sea-water," by calculation, was thus composed per litre—

---

* We had run short of distilled water.

Part owing to the salts, 4 × 0·58 = 2·32 × $\frac{[HCl]}{22}$
" magnesia liquor = 49·4 × "
S = 51·72 × "
The alkalinity of the finished solution determined analytically, and found = 53·7 × "

Adopting this latter number, and assuming the "alkali" to be simply $RHCO_3$* free from H_2CO_3, we have for the carbonic acid per litre 107·5 mgrms. The solution was shaken n times with air, as usual, and the carbonic acid in the resulting liquor determined. Found for

n =	2.	4.	6.	8.
Carbonic acid mgrms. per litre	(lost)	98·9	97·7	95·9

107·5 − 95·9 = 11·6. Hence about $\frac{1}{10}$th of the whole, or $\frac{1}{5}$th of the loose, carbonic acid had been eliminated by eight shakings with air at the ordinary temperature.

Elimination of Carbonic Acid from Artificial Sea-Water by Chloride of Barium.

250 c.c. of distilled water were heated to boiling, coloured by aurine, and exactly neutralised by the requisite few drops of the standard hydrochloric acid. 7 grms. of a certain chloride of sodium and 3·44 grms. of a certain Epsom salt were now dissolved in the liquid, and the solution again titrated. 0·38 × $\frac{[HCl]}{22}$ mgrms. were required for neutralisation. From these two salts—

Solution I. was prepared, by dissolving 56 grms. of the chloride of sodium and 27·5 grms. of the Epsom salt in water, boiling, filtering, and diluting to 1 litre.

Solution II. A freshly made solution of bicarbonate of magnesia was diluted, so that, by intention, 1000 c.c. = 100 × $\frac{[HCl]}{22}$ mgrms. It was found by actual titration, that 1000 c.c. = 99·0 × $\frac{[HCl]}{22}$ mgrms. Equal volumes of these two solutions were mixed together, and the alkalinity of the mixture determined by titration.

$$\left.\begin{array}{l}\text{By calculation, } 1000 \text{ c.c.} = 51{\cdot}02 \times \\ \text{By analysis, } \quad 1000 \text{ c.c.} = 50{\cdot}20 \times\end{array}\right\} \frac{[HCl]}{22} \text{ mgrms.}$$

Adopting the latter number, and assuming both the magnesia and the carbonic acid to be present only as $RHCO_3$, we have for the carbonic acid, 100·4 mgrms. per litre. This liquor was shaken three times with air, to eliminate the free carbonic acid, and from successive measured volumes of the resulting liquid the carbonic acid eliminated (as far as possible), by boiling it in Classen's apparatus in a current of air, with either chloride of barium or hydrochloric acid, as shown in the following table:—

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* Where "R" stands for an equivalent of metal; *i.e.*, for Na, ½ Ca, &c.

Exp.	1.	2.	3.	4.	5.	6.
Water used, . .	250	250	200	200	200	200 c.c.
Quantity of hydrochloric acid added,* .	0	0	30	0	30	0
Solution of barium chloride added, .	50 c.c.†	60 c.c.	0	60 c.c.	0	60 c.c.

Milligrammes of Carbonic Acid obtained per litre of Water.

Carbonic acid per litre).	65·7	32·3	99·6	32·6	101·5	36·7.

Mean of (3) and (5) = 100·55, instead of 100·4 as calculated from the alkalinity.

In experiments (2), (4), and (6) (where the chloride of barium was in excess of the sulphuric acid), only 65, 65, 73 per cent. respectively, of even the loose carbonic acid was set free, while in experiment (1),† where the sulphates predominated slightly over the baryta-salt, the whole of the loose carbonic acid, and besides about $\frac{4}{10}$ths of the B_2CO_3 acid were eliminated. An explanation of *this* result is afforded by the experiments of Tornøe, who found that in boiling down plain sea-water to near dryness, the bulk of the carbonic acid (if not the whole of it) is evolved with formation of a precipitate of *magnesia* free from carbonic acid. In other words, sea-water, on *protracted* distillation at least, behaves as if its carbonic acid were present, substantially, partly as magnesium carbonate and partly as free carbonic acid ($MgCO_3 + xH_2CO_3$). In experiment (1) the influence of the baryta was practically eliminated, and the bicarbonate of magnesia suffered a considerable decomposition by the action of the water; in experiments (2), (4), and (6), the part of the bicarbonate present as $MgCO_3$ was, by the action of the chloride of barium, converted into barium carbonate, which, as we know, is proof against the action of even hot water; and only the part which is considered to be free carbonic acid had a chance of being liberated. But why was it not all liberated? As I could find no satisfactory answer to this question, I thought I had better make sure at least of the facts in the manner to be immediately described.

Final Series of Experiments.

About four litres of a mixture similar to the one used for the above experiments were prepared, and the alkalinity determined. This was found to be equivalent to, by *synthesis*,

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* Expressed in multiples of $\frac{[HCl]}{22}$ mgrms.

† 1 c.c. = $\frac{[Ba]}{4}$ mgrms.; ∴ 50 c.c. are short of the calculated minimum (through a slip in the planning of the experiment); 60 c.c. are an excess.

$58{\cdot}45 \times \frac{[\mathrm{HCl}]}{22}$; by direct analysis to $57{\cdot}16 \times \frac{[\mathrm{HCl}]}{22}$ (expressed in mgrms. per litre). Hence the amount of carbonic acid required to produce bicarbonate $= 2 \times 57{\cdot}16 = 114{\cdot}32$ mgrms. per litre. According to two direct determinations the carbonic acid amounted to only 110·5 and 111·2 mgrms. A portion of the liquor was therefore taken out, saturated with carbonic acid, and then reincorporated with the rest. The carbonic acid now was found to be 124·1 mgrms. per litre; showing the presence of free carbonic acid.

The whole of the mixture, therefore, was shaken three times, each time with 10 volumes of fresh air.

The carbonic acid in the resulting liquid was found to be 109·04 and 109·0 mgrms. per litre; less than before!

Three successive volumes of this water were boiled in my modification of Classen's apparatus with excess of solid chloride of barium, the eliminated carbonic acid collected in standard baryta, and titrated as usual.

Number of Experiment.	1.	2.	3.
Amount of water used, ...	250	250	200 c.c.
Hydrated barium chloride added, . .	4	4	3·5 grms.
Mgrms. of carbonic acid per litre of water,	44·0	39·0	53·0.

In the case of (1) and (2), the residues were mixed with excess of standard hydrochloric acid, the boiling resumed, and the additional liberated carbonic acid collected in a fresh supply of standard baryta.

Experiment	(1.)	(2.)
Amount of hydrochloric acid added,* . . .	20	50
Mgrms. of carbonic acid eliminated by acid, per litre of water,	24·0	23·2
Total carbonic acid extracted, mgrms. per litre, . .	68·0	62·2
Loose carbonic acid in mgrms. per litre of water, calculated,	51·8	51·8

Here, as before, the inconstancy of the results is very surprising; in (1) about 88 per cent., in (2) about 78 per cent., and in (3) a little more than 100 per cent. of the loose carbonic acid was recovered by chloride of barium.

In the case of No. 2 the residue obtained in the second boiling (with acid) was mixed with its own volume of 20 per cent. hydrochloric acid, and again treated as before. The baryta-water in the vacuum-flask remained perfectly clear, though strongly alkaline. By testing with nitrate of silver, only a mere trace of chlorine could be discovered in it, which shows that the inverted condenser, even under these very unfavourable conditions, is very efficient in condensing the volatilised hydrochloric acid. The 11·7 mgrms. of carbonic acid which must have been present in the liquor operated upon, resisted the action of even 10 per cent. hydrochloric acid. This, however, is no more than a con-

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* Expressed in multiples of $\frac{[\mathrm{HCl}]}{22}$ mgrms. The quantity required according to the alkalinity determination was 14·52.

firmation of what has been previously found by others. A mixed precipitate of carbonate and sulphate of baryta does not yield the whole—and may not yield any—of its carbonic acid on treatment with hydrochloric acid; the cause being no doubt that such a precipitate contains a double compound of sulphate and carbonate undecomposable by acids.

In the following experiment (No. 4) the carbonic acid was eliminated by chloride of barium as far as possible; the residue, after cooling, was taken out of the flask and distilled in vacuo to as near dryness as practicable, *no air* from without being admitted. The distillate ran into measured standard baryta, so that the carbonic acid in it was amenable to titrimetric determination.

Obtained, mgrms. per litre, of carbonic acid by barium chloride under inverted condenser, current of air as usual,	44·4
By distillation of residue in vacuo,	20·0
Total,	64·4

All the loose carbonic acid, and, besides, 12·6 mgrms. of the 57·2 mgrms. of the carbonic acid of the normal carbonates were recovered.

In the following two experiments the water was distilled with chloride of barium "in vacuo" without preliminaries:—

Experiments,	(5)	(6)
Water taken,	200 c.c.	200 c.c.
Hydrated barium chloride added,	3·5 grms.	3·5 grms.
Carbonic acid obtained, reduced to mgrms. per litre,	44·4	38·3
Loose carbonic acid (mgrms. per litre) calculated,	51·8	51·8

The results substantially confirm those of experiments (1) and (2) above. But none of these experiments do full justice to the method of Buchanan, who distils his mixture under *ordinary* pressure, and consequently at higher temperatures than can have prevailed in either No. 5 or No. 6. I therefore decided upon carrying out a few distillations in the following manner:—A measured volume of the water, after addition of an excess of solid chloride of barium, is distilled in a current of air under *ordinary pressure*, and the distillate received in a flask connected by air-tight joints, on the one hand with the exit-end of the Liebig's condenser, on the other with a large flask previously charged with a sufficiency of baryta-water, and evacuated. A glass stop-cock at the entrance of the vacuum flask serves to regulate the flow of gas into the latter. The distillation is carried on to as near dryness as possible. A part of the carbonic acid liberated goes straight into the vacuum flask, and is there absorbed by the baryta; the rest remains absorbed in the distillate. To recover it, the flask containing it is joined on to the bottom end of the inverted condenser in Classen's apparatus, the carbonic acid expelled by boiling in a current of air, and the air carrying with it the carbonic acid caught in the baryta-flask which has meanwhile been re-exhausted. The rest explains itself.

This method was applied to a fresh artificial sea-water, the analysis of which had given (in mgrms. per litre) for the alkalinity 53·37 and 53·72; mean, $53·54 \times \frac{[HCl]}{22}$ mgrms. The total carbonic acid had been found to be 110·0 mgrms. The alkalinity (on the assumption of $R_2O : 2CO_2$) demands 107·1 mgrms. Hence, the free carbonic acid amounted to 2·9 mgrms.

Three distillations, carried out as just explained, gave—

(7)	(8)	(9)
19·0	45·1	48·5

mgrms. of carbonic acid per litre of water, the loose carbonic acid according to calculation should have been 110·0 − 53·5 = 56·5. The very low result in experiment (7) may have been owing to an unobserved gross error in manipulation, although apparently the experiment went on quite rightly to the end. Of the other two even No. 9 gave only about $\frac{6}{7}$ of the loose carbonic acid; and it does not agree with No. 8.

The number 110·0 for the total carbonic acid was the result of a single analysis; hence, after experiment (9), I again determined the carbonic acid in the remainder of the water and found these values for it,—

103·65 and 105·35; mean, 104·5

mgrms. of carbonic acid per litre. This is a considerable falling off, even against the number 107·1 calculated from the alkalinity, which is to some extent accounted for by the fact that the water, since the execution of the original carbonic acid determination, had been standing in an only partially filled, though corked, vessel. But even supposing we adopt the lower one of the two last carbonic acid determinations, there remains 103·65 − 53·54 = 50·11 for the loose carbonic acid, as against the 48·5 found by Buchanan's process in No. 9.

There was a considerable quantity of the water left, which I utilised for studying the effect on it of repeated treatment with air. The liquid (containing 104·5 mgrms. per litre of total carbonic acid) was accordingly shaken thrice, each time with 5 times its volume of air, and the remaining carbonic acid determined. The quantities found were 100·0 and 98·6; mean, 99·3 mgrms. of carbonic acid. The residue was subjected again to treatment with air in the same manner: the carbonic acid now amounted to 94·8 and 93·9; the mean being 94·4. After another repetition of the operation, the quantity of carbonic acid was 90·1 and 91·3; mean, 90·7.

To sum up: after n treatments with 5 volumes of air, the carbonic acid per litre $=c$ was found to be as follows:—

For	$n=$ 0	3	6	9
	$c=$104·5	99·3	94·3	90·7 mgrms.

The ultimate loss of carbonic acid (which of course does not represent the greatest possible loss) was 104·5—90·6=13·9 mgrms., or about 27 per cent. of the loose carbonic acid originally present.

By way of appendix to the critical trials on Buchanan's method, I will insert here an experiment which I made, in order to see to what extent a sea-water can be deprived of its carbonic acid by mere boiling in a current of air and without evaporation. The water which I utilised was part of a supply of a surface-water which Messrs. Burns & Co. had had the kindness to collect for me near the Ailsa Craig, in the Irish Channel, and which I kept in stock for trial of methods. 250 c.c. of this water when treated in my apparatus with hydrochloric acid, as usual, gave 97·72 mgrms. of carbonic acid per litre.

The same water, when simply boiled in the same apparatus (in a current of air) *without* addition of acid, gave 82·16 mgrms. The residue left, on addition of acid, gave 18·56 mgrms. The sum of the two instalments of carbonic acid obtained, 82·16+18·56, comes up to 100·72 instead of 97·7, which is a fair approximation, because the corresponding difference of the absolute weights of carbonic acid determined is only 0·75 mgrm. About 84 per cent. of the total carbonic acid had been eliminated by mere boiling. (Compare Exp. (1) in table on page 111.)

The experiments reported on in this chapter, so far, do not exhibit the degree of regularity I should wish them to possess; but they are sufficient to prove,—1st, that distillation with chloride of barium extracts from sea-water only a fraction even of the loose carbonic acid (*i.e.*, of what is present over and above that existing in the form of normal carbonates), and this fraction, even under apparently similar conditions, has no constant value; and 2nd, that, supposing a sea-water which contains its carbonic acid as bicarbonate, associated or not with free carbonic acid, to be exposed to the air even at ordinary temperatures, such a water will soon lose, not only its free, but also part at least of the loose carbonic acid of the bicarbonate. Hence, I did not consider it expedient to determine the carbonic acid in any large number of the samples of sea-water which had been placed at my disposal.

Influence of Sulphates on the affinity of Water for Carbonic Acid.

Before tabulating the results of the few analyses that were made, I will report shortly on a few attempts to inquire, quite directly, into the alleged influence of sulphate of magnesia on the affinity of water for carbonic acid.

Experiment I.—28 grms. of specially purified Epsom salts were dissolved in water to 1 litre.

233·2 mgrms. of recently ignited pure carbonate of soda were dissolved in water and diluted to 100 c.c., in order to obtain a solution of which 1 c.c. should be equivalent to 0·968 mgrm. of carbonic acid.

250 c.c. of the magnesia-salt solution were mixed with $25 \times \frac{[HCl]}{22}$ mgrms. of hydrochloric acid and boiled under an inverted condenser in a current of air, until the latter, as it came out above, failed to cause the slightest turbidity in baryta-water. The liquid was then allowed to cool in the ensured absence of carbonic acid, 10 c.c. of the carbonate of soda solution run in, the boiling in a current of air resumed, and the carbonic acid thus liberated collected in the vacuum flask charged with baryta-water. Three such experiments were made; the carbonic acid found was

10·82	10·37	10·18 mgrms.

According to calculation, this should be 9·68. Thus it appears that under the circumstances a solution of sulphate of magnesia, containing about as much magnesia as sea-water (and consequently twice as much sulphuric acid), does *not* retain any carbonic acid.

This time the liquid operated upon, in addition to the sulphate of magnesia and chloride of sodium, contained about $15 \times \frac{[HCl]}{22}$ mgrms. of free hydrochloric acid, that is, about 25 mgrms. of hydrochloric acid. But this minute quantity of acid is not likely to have appreciably influenced the 7000 mgrms. of Epsom salt and the 250,000 mgrms. of water in their action on the carbonic acid.

I did not consider it necessary to specially prove this, or to extend the inquiry to the case of sulphate of lime solutions under similar conditions, but preferred to ascertain whether either solution, or perhaps even pure water, *at ordinary temperatures*, contains at least a small fraction of its absorbed carbonic acid in a state of combination more intimate than that of mere absorption. I took 300 c.c. each, of pure water, solution of Epsom salt and solution of gypsum respectively, and, in each case, after having saturated the respective liquid with carbonic acid, shook it repeatedly with several times its volume of air until, according to the laws of absorptiometric exchange, the gas remnant in the liquid ought to have been reduced to a small fraction of a milligram. The actual carbonic acid was then determined by manipulating the solution in my modification of Classen's apparatus like an acidified solution of a carbonate. The *sulphate of magnesia solution* was prepared from a salt purified as explained on page 106, and contained 13·5 grms. of $MgSO_4 7H_2O$ per litre. The sulphate of lime solution was prepared by neutralising a measured volume of normal sulphuric acid (1c.c. $= \frac{1}{2}[H_2SO_4]$ mgrms.) with the calculated proportion of pure precipitated carbonate of lime, diluting to a convenient volume and filtering. To determine the strength of the solution, a measured volume of it was precipitated by chloride of barium, and the sulphate of baryta weighed. It was found to correspond to 1·973 grms. of (anhydrous) sulphate of lime per litre.

The results of the carbonic acid determinations were as follows:—

Milligrams of Carbonic Acid per litre of Liquid.

	I.	II.	III.
Substance in solution,	*Nil.*	Magnesium sulphate	Calcium sulphate
Carbonic acid,	2·5	2·8	3·1

From these experiments it would appear that each of the three solutions contained a small quantity of its gas in a state of *quasi*-chemical combination, and that this quantity was the same in the three cases. But it is extremely difficult in such experiments to exclude every trace of adventitious carbonic acid, and the carbonic acid actually extracted from the 300 c.c. of liquid operated upon amounted to only 0·76 to 0·94 mgrm.; no more than the excess of carbonic acid which we obtained in the three experiments with sulphate of magnesia and carbonic acid added as carbonate of soda (page 116). Quantities not much, if at all, below those found in the present case I often obtained in blank trials with absolutely carbonic acid free materials. I suspect that these irrepressible traces of carbonic acid came out of the india-rubber stoppers used for making the gas-tight joints. In any case my conclusion from the present experiment is that the alleged affinity of carbonic acid for sulphate solutions (or pure water) has no existence.

The following table gives the total quantity of carbonic acid actually found in a selection of Challenger waters, contrasted with the carbonic acid calculated from the alkalinity on the assumption of the "alkali" being all bicarbonate unmixed with free carbonic acid. In each case 250 c.c. of water were taken for analysis, and the carbonic acid titrated with baryta-water and hydrochloric acid, 1 c.c. of each being equivalent to

1 mgrm. of carbonic acid. The error in such a titration, according to my estimate, is rather above ± 0·25 c.c., hence each of the numbers given for the actual carbonic acid per litre must be considered uncertain by at least ± 1 mgrm. on that account alone. I fear we must add another mgrm., and put down the limit of uncertainty in the carbonic acid per litre at ± 2 mgrms. Hence, practically, the evidence of the 13 analyses may be summed up by saying, that in all cases the "alkali" was substantially bicarbonate, unassociated in any case with free carbonic acid, but very appreciably contaminated with normal carbonates in the 8 cases out of the 13 which are marked with asterisks in the last column. The numbers of course apply only to the samples as analysed; when first collected they must be presumed, in general, to have been richer in carbonic acid. This would be more especially true of the five neutral samples.

In conclusion, I append in a tabular form the results of the carbonic acid determinations in freshly drawn sea-water, which Mr. Buchanan made on board H.M.S. Challenger

TABLE XII.

Showing the proportion of total Carbonic Acid found in a selection of Challenger Waters.

Laboratory Number.	Challenger No.	Collected.		Station.	Carbonic Acid mgrms. per litre.	
		On	At Depth of fathoms.		Calculated from Alkalinity.	Found.
439	1529	1876. March 9	Bottom.	331	107·3	105·6
379	1134	1875. Sept. 8	800	272	107·0	106·1
390	1170	Oct. 4	100	280	107·6	98·7 *
400	1271	" 27	0	291	105·7	102·6 *
406	1313	Nov. 9	Bottom.	296	108·3	101·0 *
414	1397	Dec. 30	Bottom.	303	115·4	111·6 *
417	1424	1876. Jan. 8	0	309	91·4	87·8 *
416	1427	" 8	140	300	100·2	101·5
423	1471	Feb. 11	0	318	103·8	97·8 } *
423	1471	" 11	0	318	104·0	99·1 }
424	{1472 1473}	" 11	25 & 50	318	105·2	98·1 } *
424	{1472 1473}	" 11	25 & 50	318	105·2	102·2 }
421	{1463 1464}	" 11	50 & 100	318	106·9	107·2 }
421	{1463 1464}	" 11	50 & 100	318	107·2	106·7 }
422	{1465 1467}	" 11	200 & 400	318	106·3	106·4 }
422	{1465 1467}	" 11	200 & 400	318	106·8	107·0 }
425	1481	" 14	Bottom.	320	109·0	†(?) 114·7 } *
425	1481	" 14	Bottom.	320	110·2	103·2 }
425	1481		Shaken twice with 10 vol. air.			100·6

* *Note.*—It must be remembered that the samples of water had been stored for some years in stoppered bottles. The analyses were made in the summer of 1881.

† Obvious blunder.

during the cruise, by means of his own (the chloride of barium) method. The entries in the table are simply transcribed from his journal. I am inclined to think that his results, being all obtained by a rigorously constant method, as comparative determinations of the loose carbonic acid, are more exact than would appear from the few test experiments made in my laboratory.

Table XIII.*

Carbonic Acid Determinations executed by Mr. Buchanan on board H.M.S. Challenger during the Cruise.

Number of Sample.	Date of Collection.	Depth f.	Mgrms. of CO_2 per Litre.	Remarks.
	1873			
21	Feb. 28	2720 B	40·0	
66	March 26	3875 B	57·0	
68	,, 27	0	46·0	
70	,, 28	2960 B	53·0	
72	,, 29	2850 B	52·0	
75	,, 31	0	48·0	
114	May 26	2650 B	64·0	The water was slightly turbid with calcium carbonate.
117	,, 27	1	45·0	When about half distilled over, the apparatus was stopped up and the water squirted out behind. The most of the carbonic acid had passed over, probably all.
119	June 14	0	41·5	
120	,, 14	2360 B	47·2	
122	,, 16	2575 B	50·0	
136	,, 23	0	52·9	
138	,, 24	2175 B	53·6	
146	,, 27	1675 B (?)	59·2	
149	,, 30	B (?)	44·6	
209	Aug. 16	0	43·2	
214	,, 18	0	38·2	
215	,, 19	0	45·5	
216	,, 20	0	43·0	
221	,, 21	300	53·6	
228	,, 25	0	42·6	
231	,, 26	50	53·3	
256	Sept. 27	0	33·0	
261	,, 30	100	36·0	Owing to a fault in the new water bottle, this was probably surface water.
265	Oct. 1	0	59·1	Sample well shaken up with air so as to saturate it at 22°·8 C.
267	,, 2	0	41·8	
275	,, 3	B	49·1	

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* With reference to this table see an explanatory note by Mr. J. Y. Buchanan appended to this Report.

Number of Sample.	Date of Collection.	Depth ₤.	Mgrms. of CO_2 per Litre.	Remarks.
	1873.			
276	Oct. 4	0	43·2	This water was shaken, as in No. 265, with air, so as to establish equilibrium.
283	" 6	1000	55·6	
353	Dec. 29	B	59·5	
354	" 30	0	54·2	
355	" 30	100	56·9	
360	" 31	0	51·3	
	1874.			
364	Jan. 3	0	47·4	
369	" 27	0	37·3	
371	Feb. 3	0	44·7	
372	" 4	0	52·3	
376	" 9	0	47·6	
378	" 11	1260 B	67·9	
380	" 12	0	64·4	
382	" 13	0	65·6	
383	" 14	1675 B	82·9	The gases were boiled out of water, and 225 c.c. of the remaining water barium chloride were treated as usual for carbonic acid; therefore the carbonic acid in gas tube must be added to this.
386	" 16	0	56·3	
387	" 17	0	51·7	
389	" 18	0	48·5	
395	" 19	B	57·6	
396	" 20	0	48·7	
397	" 21	50	70·6	
414	Mar. 3	1950 B	44·3	
415	" 4	0	51·6	
417	" 6	0	54·0	
419	" 7	50	68·3	
428	" 10	2150 B	52·6	
439	" 13	B	53·7	
461	June 17	50	53·3	
464	" 18	5	44·0	
466	" 19	5	51·1	
471	" 20	0	49·8	
477	" 23	B	53·8	
489	July 10	50	51·1	
497	" 13	0	59·4	This result is probably false, as a sudden frothing over occurred which would introduce magnesia into the distillate, and so increase the apparent amount of carbonic acid.
504	" 15	0	41·2	
512	" 18	0	36·1	
515	" 23	0	60·9	
529	Aug. 15	B	45·9	
532	" 17	0	96·0	Very large amount of carbonic acid. The determination was quite satisfactory.
539	" 20	0	31·7	
543	" 21	200	44·4	
556	" 24	B	43·4	
557	" 25	0	35·6	

Number of Sample.	Date of Collection.	Depth §.	Mgrms. of CO_2 per Litre.	Remarks.
	1874.			
567	Aug. 28	B	60·9	
569	,, 29	B	36·1	
572	Sept. 1	0	27·3	
575	,, 11	B	28·7	
581	,, 14	0	39·3	
594	,, 28	400	40·0	
602	Oct. 12	0	41·9	
620	,, 20	800	39·7	
629	,, 22	2600 B	52·4	
	1875.			
661 (a)	Jan. 16	0	37·2	
671	,, 28	B	24·3	
678	Feb. 8	50	29·8	
682	,, 10	0	25·1	
691	,, 12	2500 B	52·4	
760	Mar. 18	0	30·3	
771	,, 19	2325 B	61·0	
791	,, 23	4475 B	31·2	
797	,, 25	200	33·8	
817	,, 31	0	24·7	
823	April 1	300	34·0	
830	,, 5	50	32·8	
826	,, 3	0	20·7	
836	,, 7	0	32·0	
910	June 29	0	35·3	
912	,, 30	2800 B	35·3	
921	July 2	1000	50·7	
922	,, 2	2050 B	47·5	
924	,, 3	2550 B	38·2	
926	,, 4	0	26·7	
934	,, 5	2475	35·3	
933	,, 5	400	39·2	Preserved over night in a bottle with tubulated cork.
947	,, 9	2800	37·4	
949	,, 10	0	29·1	
949 (a)	,, 10	0	27·4	The portion of 949 from which oxygen and nitrogen had been extracted, allowed to cool in closed flask.
949 (b)	,, 10	0	27·3	Portion of 949 (a) exposed to the air outside port from 6.30 to 9.30 a.m. 11th July.
964	,, 12	2740 B	42·0	
974	,, 14	3090 B	30·1	
973	,, 14	2990	25·5	Preserved in bottle full up to stopper. Determination 15/7/75.
972	,, 14	800	23·8	Determined 16/7/75. Preserved with pressure stopper.
971	,, 14	400	39·7	Determined 16/7/75. Preserved in bottle full up to stopper.
987	,, 17	B	25·4	
984	,, 17	400	28·7	The water was kept in a bottle full up to the stopper, and the carbonic acid was determined on the 19th.
990	,, 20	0	19·3	

Number of Sample.	Date of Collection.		Depth ƒ.	Mgrms. of CO_2 per Litre.	Remarks.
	1875.				
1001	July	21	2875	29·9	
1003 (a)	„	22	0	6·5	Brine from boilers. Steaming at 17 lbs. pressure.
1096	Aug.	30	2900 (?) B	34·3	
1087	„	28	2700 B	40·5	
1097	„	31	0	28·9	
1096	Sept.	1	2900 (?) B	42·7	Bottom water of 30th August distilled to dryness with ·2 grm. cryst. potassium permanganate ($KMnO_4$). The water contains 8·4 mgrms. organic CO_2 = 2·3 mgrms. carbon.
1106	„	2	2550 B	32·8	
1181	Oct.	6	200	43·2	The almost dry residue was treated with ·2 grm. cryst. $KMnO_4$ dissolved in 100 c.c. water, and this sol. distilled to dryness and the carbonic acid evolved determined. 24·6 mgrms. CO_2 = 6·7 mgrms. carbon.
1205	„	11	200	35·8	The dry residue was treated exactly as that of 1181. 23·7 mgrms. CO_2 = 6·5 mgrms. carbon.
1209	„	11	1975	51·2	The residue treated with $KMnO_4$, 27·2 mgrms. CO_2 = 7·4 mgrms. C.
1208	„	11	800	46·2	The dry residue treated with $KMnO_4$, 28·1 mgrms. CO_2 = 7·7 mgrms. carbon.
1221	„	14	B	45·6	
1245	„	21	2600 B	55·0	
1256	„	23	2550 B	47·4	
1270	„	27	2250 B	46·4	
1269	„	27	1775	42·3	
1272	„	29	0	36·6	
1287	Nov.	2	0	41·8	
1289	„	3	25	33·1	
1294	„	3	400	44·6	
1300	„	5	1500 B	47·5	
1301	„	6	0	35·0	
1313	„	9	1825 B	44·7	
1314	„	10	0	37·3	
1337	„	17	B	44·3	
1342	Dec.	13	0	36·1	
1350	„	14	B	44·4	
1345	„	14	50	41·0	
1348	„	14	300	42·0	
1353	„	16	10	36·1	
1352	„	16	0	37·9	This result is too high. The receiver broke just at the end, and the carbonic acid in U tube had to be neglected.
1363	„	17	B	49·3	
1356	„	17	50	50·4	
1366	„	20	0	47·8	
1367	„	21	0	47·3	
1374	„	23	0	51·2	

Number of Sample.	Date of Collection.	Depth f.	Mgrms. of CO_2 per Litre.	REMARKS.
1375	1875. Dec. 24	0	46·3	Residue treated with 30 c.c. $KMnO_4$, Sol. of 17th October. Deducting 2·26 mgrms. CO_2 leaves 10·7 mgrms. of CO_2 = 2·9 mgrms. carbon.
1378	" 27	0	47·3	
1389	" 28	B	35·6	
1386	" 28	800	53·2	
1385	" 28	400	48·8	
1383	" 28	200	47·3	
1390	" 30	0	48·9	
1393	" 30	100	50·4	
1405	1876. Jan. 2	345 B	45·1	
1424	" 8	0	39·5	
1430	" 10	200	70·8	
1438	" 11	245 B	51·2	
1445	" 21	B	42·4	
1446	" 22	0	42·9	
1459	Feb. 8	1035 B	38·5	
1462	" 11	0	38·3	
1494	" 28	1900 B	43·0	
1496	" 29	2800 (?) B	51·7	
1498	Mar. 1	20	38·5	
1507	" 2	B	50·2	
1508	" 3	0	34·0	
1533	" 10	B	46·6	
1527	" 9	400	43·6	
1531	" 10	800	43·6	
1544	" 13	2025 B	44·5	
1539	" 13	100	37·2	
1573	" 20	0	34·8	
1576	" 21	50	37·3	
1577	" 21	100	36·8	
1578	" 21	200	43·1	
1581	" 22	0	38·2	
1588	" 23	400	43·6	
1590	" 24	0	35·3	
1597	" 24	800	43·6	
1614	" 26	400	44·1	
1621	April 4	25	34·3	
1638	" 6	1875	39·2	
1637	" 6	800	45·5	
1644	" 7	300	45·5	
1663	" 11	0	33·8	
1684	" 28	0	38·2	
1687	May 1	0	37·3	
1693	" 3	200	38·7	
1697	" 3	B (?)	36·8	
1699	" 5	0	33·8	
1707	" 6	400	38·7	

V.—ON THE ALKALINITY OF OCEAN-WATER.

The alkalinity of a sea-water being a measure of its potential carbonate of lime, it is important to have as complete statistics concerning it as possible; and I very much regret now, that I selected only some 130 samples for the determination of this item.

The alkalinity of these samples was determined by Tornøe's method, explained in the chapter on the Carbonic Acid (p. 106). 250 c.c. of sea-water were measured off for each analysis, mixed with an excess of standard hydrochloric acid and boiled for twenty minutes to expel the carbonic acid. The acid left unsaturated was then determined by titration. The standard acid used was a hydrochloric acid, containing $\frac{1}{22} \times 36{\cdot}5$ mgrms. of pure acid $= \frac{1}{22} \times [\mathrm{HCl}]$ mgrms. per cubic centimetre. The standard caustic potash was by intention of equivalent strength; the exact volume of alkali equivalent to 1 c.c. of acid was, of course, determined with great care and used in the calculations. In each case the point of neutrality was determined a number of times by zig-zag titration, and the mean of the last four to six results taken as correct. From the deviations of the separate results from the mean we conclude that each analysis is uncertain by about ±0·05 c.c. of standard acid. Supposing the standard acid required for neutralising the "free" base present to have been 58 c.c. per litre, the "alkalinity" was put down as being = 58 mgrms. per litre, which, of course, means that 1 litre of water contains a quantity of base, not muriate or sulphate, which would require 58 mgrms. of carbonic acid for its conversion into normal carbonate, $\mathrm{MOCO_2}$.

As all the waters had before been tested quantitatively for chlorine, we were in a position to refer the alkalinity to 55·43 mgrms. of chlorine, meaning 100 mgrms. of total salts;* and we did so. The results are given in the following Table I.

Column I. gives the Challenger number assigned to the sample by Mr. Buchanan.

Column II. names the Station where the sample was collected.

Column III., under "Depth," gives the depth at which the sample was taken; surface or bottom waters, however, are simply named as such.

Column IV. gives the "alkalinity" in mgrms. per litre.

Column V. gives the alkalinity in grms. per 55·43 grms. of chlorine, or per 100 grms. of total salts; or, in other words, the weight of carbonic acid which is present as normal carbonates ($\mathrm{R_2CO_3}$) referred to 100 parts by weight of total salts.

Column VI. gives the laboratory number.

When a set of entries is enclosed in brackets [ ], it means that there is some uncertainty in the results, and that they are not taken notice of in the subsequent discussion.

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* This value, 55·43, was adopted at the time, being the result of a calculation based upon part of the 77 complete sea-water analyses. I now know that 55·420 is a closer approximation, but the error is too small to be of consequence.

Table I.

Giving the Alkalinity of a selection of Challenger Waters.

I. Challenger Number.	II. Station.	III. Depth.	IV. Alkalinity per litre in milligrams.	V. Alkalinity per 55·43 parts of Chlorine.	VI. Laboratory Number.
1	1	Bottom	58·76	·1566	200
2	1	Surface	62·83	·1667	201
4	2	Bottom	55·76	·1552	203
[5	2	Surface	28·66	·0756	204*]
9	5	Surface	57·12	·1501	205
13	7	Bottom	55·68	·1577	210
21	10	Bottom	55·90	·1471	214
23	11	Bottom	53·76	·1492	216
38	14	Bottom	53·80	·1499	223
50	18	Bottom	55·44	·1547	224
66	25	Bottom	55·48	·1528	226
1873 [April 25	38	Bottom	55·26	·1542	260]
120	59	Bottom	55·00	·1500	227
126	62	Bottom	55·16	·1476	229
127	62	500 fathoms	54·28	·1498	230
129	62	150 „	54·76	·1461	232
133	65	Bottom	53·08	·1478	234
1873 July 26	92	75 fathoms	57·12	·1509	263
201	97	Surface	53·00	·1462	235
205	97	Bottom	59·24	·1647	237
218	102	50 fathoms	55·00	·1495	238
223	102	Bottom	57·40	·1596	242
220	102	200 fathoms	55·24	·1520	240
237	110	Bottom	53·20	·1477	244
243	116	Bottom	54·08	·1502	246
250	122	Bottom	55·16	·1496	247
263	129	300 fathoms	54·76	·1545	249
265	130	Surface	57·16	·1504	250
283	131	1000 fathoms	53·20	·1489	251
291	133	Bottom	53·16	·1482	252
305	136	Bottom	57·72	·1616	253
308	137	100 fathoms	52·40	·1450	254
309	137	200 „	53·60	·1492	255
312	137	Bottom	56·88	·1588	258
1873 Dec. 19	143	Surface	55·68	·1534	93
„	143	100 fathoms	53·20	·1472	95
„	143	200 „	53·12	·1489	96
„	143	300 „	52·64	·1486	97
„	143	400 „	53·36	·1505	98
„	143	Bottom	56·56	·1576	99
353	146	Bottom	58·16	·1623	101
378	152	Bottom	61·56	·1731	103
384	153	Surface	56·16	·1663	105
383	153	Bottom	53·92	·1511	106
391	154	50 fathoms	53·12	·1500	110

* This bottle contained a large crystalline deposit.

I. Challenger Number.	II. Station.	III. Depth.	IV. Alkalinity per litre in milligrams.	V. Alkalinity per 55·43 parts of Chlorine.	VI. Laboratory Number.
421	158	400 fathoms	51·88	·1476	115
1873. March 7	158	Bottom	55·64	·1573	116
,, 13	160	50 fathoms	55·84	·1563	117
470	165A	400 ,,	54·12	·1492	270
[492	169	Bottom	75·88	·2108	276] *
485	168	Bottom	54·76	·1554	272
500	170	100 fathoms	53·00	·1462	278
503	170	400 ,,	53·24	·1499	281
511	171A	Bottom	56·48	·1562	285
523	175	200 fathoms	52·76	·1442	288
524	175	Bottom	54·48	·1509	289
536	178	50 fathoms	53·28	·1477	291
538	178	200 ,,	52·92	·1460	293
544	179	300 ,,	53·96	·1492	295
546	179	Bottom	56·20	·1560	297
[556	180	Bottom	57·40	·1601	302] †
586	191A	Bottom	60·48	·1707	314
594	193	400 fathoms	53·56	·1502	320
596	193	Bottom	59·88	·1693	322
605	196	Bottom	54·08	·1518	323
616	198	50 fathoms	73·92	·2079	325
635	202	300 ,,	51·56	·1500	333
643	204	Bottom	57·84	·1626	334
656	...	Bottom	60·72	·1704	339
791	225	Bottom	55·08	·1553	342
865	238	Bottom	54·64	·1548	52
874	240	25 fathoms	52·52	·1498	54
878	240	300 ,,	65·60	·1888	57
905 and 906	244	400 & 600 fathoms	52·60	·1508	58
912	245	Bottom	54·56	·1549	60
1221	285	Bottom	57·08	·1590	346
1259	290	Bottom	53·84	·1517	347
1300	295	Bottom	54·44	·1526	348
668	...	Surface	51·44	·1468	350
675	213	Bottom	55·52	·1557	351
678	213	50 fathoms	51·92	·1466	352
753	222	70 ,,	53·12	·1464	355
758	222	Bottom	56·64	·1585	358
806	227	300 fathoms	52·20	·1485	360
1094	268	300 ,,	53·88	·1517	367
1127	272	Surface	52·76	·1433	373
1134	272	800 fathoms	53·68	·1505	379
1148	276	25 ,,	54·60	·1463	380
1154	276	800 ,,	54·16	·1509	385
1157	277	Bottom	54·88	·1538	387
1165	278	Bottom	54·84	·1534	388
1169	280	50 fathoms	54·36	·1456	389
1264	291	100 ,,	51·48	·1457	395
1270	291	Bottom	54·00	·1518	399
1271	...	Surface	51·44	·1454	400

* This bottle contained a large deposit of mud.

† "CO_2 and gases boiled out."

I. Challenger Number.	II. Station.	III. Depth.	IV. Alkalinity per litre in milligrams.	V. Alkalinity per 35·46 parts of Chlorine.	VI. Laboratory Number.
1274	292	Bottom	54·60	·1533	401
1293	294	300 fathoms	57·48	·1618	403
1313	296	Bottom	53·84	·1514	406
1336	300	50 fathoms	51·56	·1483	411
1388	302	Bottom	56·40	·1576	413
1405	306	Bottom	51·68	·1474	415
1427 *	309	Bottom	50·21	·1472	416
1429 †	309	Surface	45·50	·1472	417
1438	311	Bottom	51·12	·1498	419
1443	313	Bottom	51·36	·1522	420
1471	318	Surface	51·72	·1475	423
1494	323	Bottom	54·76	·1497	429
1481	...	Bottom	52·80	·1496	426
1518	329	Bottom	55·36	·1531	436
1529	331	Bottom	54·40	·1521	439
1557	335	Bottom	52·68	·1471	443
1573	...	Surface	54·20	·1448	450
1581	...	Surface	55·00	·1450	451
1583	339	25 fathoms	54·72	·1449	452
1589	339	Bottom	53·16	·1494	456
1616	342	Bottom	52·40	·1457	466
1628	345	Bottom	53·32	·1482	469
1641	347	25 fathoms	53·04	·1435	477
1646	347	Bottom	52·92	·1473	480
1670	351	100 fathoms	52·76	·1454	485
1687	...	Surface	54·52	·1425	489
1690	353	25 fathoms	54·84	·1435	490
1697	...	Bottom (?)	55·76	·1480	497
1700	...	Surface	54·64	·1433	498
1702	354	25 fathoms	53·84	·1435	499
1703	354	50 ,,	53·92	·1438	500
1705	354	200 ,,	53·48	·1428	501
1706	354	300 ,,	52·96	·1428	502
1707	354	400 ,,	52·88	·1465	503
1708	354	600 ,,	53·24	·1455	504
1709	354	500 ,,	53·92	·1446	505
1710	354	Bottom	52·76	·1461	506

* 1424 (?).

† 1421 (?)

Notes on the Anomalous Cases.

(The unbracketed Nos. are the Challenger numbers; those in square brackets the laboratory numbers of the respective waters).

No. 5 [204], page 125. A surface water. The alkalinity determination in two titrations led to the low values of 28·60 and 28·66 per litre. The inside of the bottle was coated with a crystalline deposit up to a line corresponding to 1392 cubic centimetres. Actual contents = 802 c.c. of sea-water, of which 500 c.c. served for the two analyses referred to. The deposit, after having been rinsed twice with distilled water, was dissolved in hydrochloric acid (which caused an evolution of carbonic acid), and the lime and magnesia in the solution determined successively by means of oxalate of ammonia and phosphate of ammonia respectively. The lime (CaO) amounted to 0·1173, the magnesia (MgO) to 0·01964 grm. According to table, page 43, $\chi = 20{\cdot}461$. The lime and magnesia in the water were determined by the method used in the 77 complete analyses (see pp. 9, &c.), and, in 51·26 grms. of water, found to be as follows:—Crude lime = 33·1 and 33·7, mean 33·4; magnesia, as pyrophosphate = 0·3301 and 0·3308, mean = 0·3304. Now, correcting the lime by multiplication with 0·91, and assuming that the results for it and the magnesia hold for all the 1392 c.c. of water originally in the bottle, we arrive at the results, given in the following table, and contrasted therein with the mean values deduced from the 77 complete analyses, as stated at the end of this chapter.

Present in Grms. per 100 *Grms. of Chlorine in*—

	Deposit.	Water.	Total.	Mean of 77 Sea-waters.
Lime, CaO, . .	0·401	2·899	3·300	3·026
Magnesia, MgO, . .	0·0671	11·352	11·419	11·212

The numbers under "Water" are probably a little too low, because the part of the water which had been taken out of the bottle before the present analyses were made must be presumed to have been richer in lime and magnesia than the remaining 802 c.c. But even with the numbers as they stand, this water would appear to have been exceptionally rich in both components originally. Supposing the deposit were redissolved in 1392 c.c. of water like the remnant analysed, the alkalinity per 100 of chlorine would increase by 0·389, or by 0·2156 per 100 of salts, which, when taken together with the alkalinity of the water as it was when titrated, gives, for the original alkalinity the high value of 0·2911. But part of the deposit may have been *sulphate* of lime. The water was collected at Station 2 near the Canary Islands.

[260]; a bottom water collected on the 25th of April 1873, at Station 38 (see page 123). The bottle contained a considerable quantity of a sandy deposit. The alkalinity, which in the table is given as being 55·26 mgrms. per litre, was determined in only 97 c.c. of the filtered water. The alkalinity of the residue was determined, and found equal to 41·66 mgrms. per 250 c.c. of the water still present in the bottle at the time. Unfortunately it was forgotten to note down the volume of the water remaining, and the capacity of the bottle as an approximation to the volume of the original sample. Assuming that volume to have been 2 litres (it certainly was not more), then the residue, supposing its carbonate of lime and magnesia to pass into the water, would have added at least some 21 mgrms. to the alkalinity per litre. The water in the bottle, therefore, we should say, was at the maximum of alkalinity which it could possibly have attained by stagnating in its natural situation.

No. 492 [276]; a bottom water from Station 169; gave the high alkalinity of 75·88 mgrms. per litre, or 0·2108 per 100 of salts (see page 126). The bottle contained a large deposit of light mud. The mud was not examined, but in the filtered water the lime and magnesia were determined, as in the case of No. 5 [204], by duplicate analyses.

Found per 100 *of Chlorine.*

	No. 492.	Average Deep-Sea Water.
Lime,	3·515	3·031
Magnesia,	11·147	11·212

Taking the excess of lime and the deficiency in magnesia as corresponding both to carbonate gained and lost respectively, and starting from the value 0·152 as representing the normal alkalinity of bottom water (*vide infra*), the alkalinity of this water should be equal to 0·3229 instead of 0·2108 as found. This shows that our assumption does not hold; part of the additional lime, probably, is sulphate taken up from the mud after bottling.

No. 31 [221]; a surface water collected at Station 12, as stated on table, page 43. [It is *not* on the Table of Alkalinities.] This water contained a large crystalline deposit, consisting mainly of the carbonates of lime and magnesia. Capacity of the bottle up to upper edge of deposit, *i.e.*, presumable original volume of the sample = 1415 c.c.

Remnant of water left =200 c.c., which would have barely sufficed for one alkalinity determination. We preferred to utilise it for duplicate determinations of the lime and magnesia, which gave, per 51·31 grms. of sea-water, 34·1 and 33·5, mean 33·8 mgrms. of crude lime, and 0·3332 and 0·3332 grm. of pyrophosphate of magnesia. The deposit contained 0·1247 grm. of lime, and 9·48 mgrms. of magnesia. The water under consideration is one of the 77 which were completely analysed. (See table, page 23.) Assuming that all the 1215 c.c., which had been used already when the remnant of 200 c.c. was analysed, had had the composition reported in the table referred to, we have—

Per 100 *parts of Chlorine.*

	Remnant of 200 c.c.	Part completely analysed.	Original Water.	Average Surface Water.
Lime, . . .	2·931	3·103	3·499	3·018
Magnesia, . .	11·442	11·080	11·163	11·203

The results for the quantities of lime are presumably less exact than those for the magnesia; and yet the former are easily interpreted, while the latter are difficult to understand. The water, it appears, was originally very rich in lime, and readily deposited part of this component as carbonate; but it is difficult to believe that the magnesia, after having been precipitated from part of the water, should have dissolved in the remainder to produce the large quantity of 11·44 per 100 of chlorine. It is remarkable that in this case, as in that of No. 5, the lime, though a stronger base and present in the water in a less proportion than the magnesia, is preferably precipitated.

From our Table I. in this chapter it is seen that the alkalinity in our samples rarely rises beyond 60 mgrms. per litre; in one of the abnormal samples it comes up to 75·88. What is the maximum value which the alkalinity *might* attain in the most favourable circumstances? This question suggested the following two experiments, which were made with part of the supply of surface water which was referred to on page 115 as having been collected for me near Ailsa Craig.

Experiment I.—A quantity of Ailsa Craig Water was saturated with carbonic acid at 14°·5 C.; 260 c.c. then were measured off and digested in a stoppered bottle with two grms. of precipitated carbonate of lime for forty-eight hours at the ordinary temperature, with frequent agitation. The still turbid mixture was then filtered, and the alkalinity of 250 c.c. of the filtrate determined as usual.

Found for

Alkalinity per litre,	364·4 mgrms.
Original alkalinity,	50·2 "
Additional alkalinity due to the added lime,	314·2 "

The experiment was then repeated with the water in its original condition, which for the present purpose is sufficiently defined by stating that the water in its natural state, according to a direct determination of the total carbonic acid, contained—

Carbonic acid as R_2CO_3, from alkalinity,	50·2 mgrms.
Additional carbonic acid,	47·5 "

showing that the free base was very nearly in the condition of bicarbonate $RHCO_3$. 260 c.c. when digested with two grms. of carbonate of lime for forty-eight hours and filtered, gave a filtrate exhibiting an alkalinity of 46·96 mgrms. per litre, which is 3·2 mgrms. less than that of the original water. A very irregular result, which I regret it was forgotten to verify by a repetition of the experiment.

Experiment II.—Alkali-free carbonate of magnesia was prepared by passing carbonic acid into a mixture of *magnesia alba* and water, filtering, boiling down the filtrate, and collecting the thus re-precipitated carbonate of magnesia. Two grms. of this preparation were digested for forty-eight hours with 260 c.c. of Ailsa Craig water previously saturated with carbonic acid, the mixture then filtered, and the alkalinity of the filtrate determined. The experiment was then repeated with the natural water. The results were as follows:—

Additional alkalinity, due to the added carbonate of magnesia, per litre:—

In the case of the water saturated with carbonic acid,	1234·0 mgrms.
In the case of the natural water,	10·64 "

From these experiments we see that carbonate of magnesia is far more freely soluble in sea-water than carbonate of lime is.

Mean Results of Alkalinity Determinations.

	Per litre.	Per 55·43 grms. of Chlorine.
Alkalinity of all* (130) =	54·70	·1520
15 Surface Waters =	54·20	·1492
6 25 fathoms, =	53·93	·1453
9 50 " " =	55·77	·1551
1 70 " " =	53·12	·1464
1 75 " " =	57·12	·1509
5 100 " " =	52·57	·1459
1 150 " " =	54·76	·1461
6 200 " " =	53·52	·1472
9 300 " " =	55·03	·1553
7 400 " " =	53·09	·1493
2 500 " " =	54·10	·1472
2 600 " " =	52·92	·1482
2 800 " " =	53·92	·1507
1 1000 " =	53·20	·1489
63 Bottom " =	55·17	·1540
Waters in 1873 (40) =	53·98	·1498
" 1874 (24) =	55·03	·1545
" 1875 (32) =	54·57	·1532
" 1876 (32) =	53·13	·1466

The last four entries in this table of means owe their origin to a suspicion that the alkalinity of the samples, during the long time of their preservation in glass bottles, might have been perceptibly altered by alkali taken up from the glass. Had this been so, the waters collected during 1873 would have been the most strongly alkaline, which we see is not the case. The fear seems to be groundless; at least I hope it is so. The

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* Excepting those containing deposits, &c., enclosed within square brackets.

table of means failed to suggest any conclusions to my mind; I therefore proceeded to tabulate the waters according to regular intervals in the alkalinities (per 55·43 of chlorine)* in the following Table:—

TABLE II.

Classification of Alkalinities.

The Alkalinity ranges.	S stands for the number of the Station, δ the depth in fathoms at which the Sample was taken, B stands for "bottom."									
I. *From* 0·1400 *to* 0·1439.	δ=	0	0	0	25	25	25	50	200	300
	S	272	351	353	353	354	347	354	354	354
II. *From* 0·1440 *to* 0·1479.	δ=	0	0	0	0	0	0	0	25	25
	S	97	291	295	309	318	333	335	276	339
	δ=	50	50	50	100	100	100	100	100	150
	S	178	213	280	137	143	170	291	351	62
	δ=	200	200	400	400	500	600	B.	B.	B.
	S	175	178	158	354	354	354	10	62	65
	δ=	B.	B.	B.	B.	B.	B.	B.		
	S	110	306	309	335	342	347	354		
III. *From* 0·1480 *to* 0·1519.	δ=	0	0	25	50	50	50	75	200	200
	S	5	130	240	102	154	300	92	137	143
	δ=	300	300	300	300	300	400	400	400	500
	S	143	179	202	227	268	143	170	193	62
	δ=	500	800	800	1000	B.	B.	B.	B.	B.
	S	244	272	276	131	11	14	59	116	122
	δ=	B.	B.	B.	B.	B.	B.	B.	B.	B.
	S	133	153	175	196	290	291	296	311	323
	δ=	B.	B.	B.	B. (?)					
	S	(?)	339	345	353					
IV. *From* 0·1520 *to* 0·1559.	δ=	0	200	300	B.	B.	B.	B.	B.	B.
	S	143	102	129	2	18	25	38	168	213
	δ=	B.	B.	B.	B.	B.	B.	B.	B.	B.
	S	225	238	245	277	278	292	295	313	329
	δ=	B.								
	S	331								

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* From this point onwards the word alkalinity is always used, when mentioned as a *quantity*, in this sense.

TABLE II.—*continued.*

The Alkalinity ranges.	S stands for the number of the Station, δ the depth in fathoms at which the Sample was taken, B stands for "bottom."									
V. *From* 0·1560 *to* 0·1599.	δ	50	B.	B.	B.	B.	B.	B.	B.	B.
	S	160	1	7	102	137	143	158	171A	179
	δ=	B.	B.	B.						
	S	222	285	302						
VI. *From* 0·1600 *to* 0·1639.	δ=	300	B.	B.	B.					
	S	294	136	146	204					
VII. *From* 0·1640 *to* 0·1679.	δ=	0	0	B.						
	S	1	153	97						
VIII. *From* 0·1680 *to* 0·1719.	δ=	B.	B.	B.						
	S	191A	193	204						
IX. *Over* 0·1720.	Alkalinity =	0·1731	0·1888	0·2079						
	δ =	B.	300	50						
	S	152	240	198						

The table did not reveal to me any relation between the alkalinity of a sea-water and the region of the ocean from which it comes; but a glance at it very forcibly suggested that, *in general*, bottom-waters are more strongly alkaline than those from the surface or from small depths.

To make sure of this conclusion, I arranged the waters into three classes, namely:—

I. "*Surface-waters*," meaning waters from depths less than 101 fathoms.

II. Waters, not bottom-waters, from greater depths.

III. *Bottom-waters.*

And next collected the cases where we are in a position to compare the alkalinity (b) at the bottom with that (s) at a depth not exceeding 100 fathoms at the same Station, which led to the following series of numbers for the difference in alkalinity ($b-s$) between the corresponding bottom and "surface" waters.

TABLE III.

Giving the difference between the Alkalinity of Bottom and "Surface" Waters.

Station.	$b-s$.
153	−·015
1	−·010
309	0
335	+·002
354	·002
347	·003
339	·004
353	·005
291	·006
213	·009
102	·010
143	·011
222	·013
137	·014
97	·019
15 cases.	

We see that in 12 out of 15 cases the alkalinity was greater at the bottom than at points not deeper than 100 fathoms. But these are only 30 out of 130 determinations. To ascertain the bearing of the rest upon this point, I abstracted from Table II. the following Table (IV.), which, as is seen, for each of four categories of waters, shows the number of cases in which the alkalinity lies within the interval named in the first Column.

TABLE IV.

Giving the number of cases in which different values of the Alkalinity occur.

The alkalinity is within ± ·002 of	Depth not greater than 100 fathoms.		Bottom.		Not Bottom; Depth varies between 150–400	Not Bottom; Depth varies between 500–1000
	Of the 36 cases.	Per Cent.	Of the 63 cases.	Per Cent.	Cases counted.	
·142	7	19	0	0	2	0
·146	17	47	10	16	5	2
·150	7	19	18	29	11	4
·154	1	2·7	16	25	2	0
·158	1	2·7	11	17	0	0
·162	0	0	3	5	1	0
·166	2	5	1	1·6	0	0
·170	0	0	3	5	0	0
·172 to ·208	1	2·7	1	1·6	1	0

In the accompanying diagram the values of the alkalinity, x, are laid down as abscissæ; the ordinate, y, of the thick curve gives the number of cases per hundred in which the alkalinity of a "*surface*" water, in the sense of Table IV., has the value expressed by the abscissa; the ordinates of the thin curve do the same in reference to the bottom waters. We see from the curves that

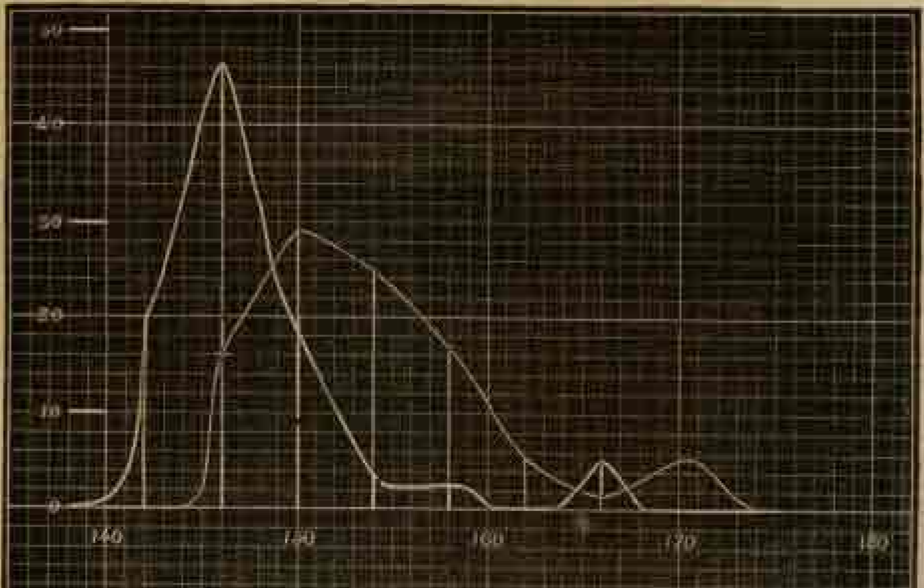
1. The alkalinity ranges substantially from $x=0{\cdot}140$ to $x=0{\cdot}164$.

2. From 0·140 to 0·148 the surface waters, while from 0·148 to 0·160 the bottom waters, are decidedly in the majority.

3. The most probable, *i.e.*, the most frequently occurring value of the alkalinity is—

For the surface-waters, about 0·146±0·002.
For the bottom-waters, about 0·152±0·003.

Assuming the surplus alkalinity in the bottom waters to be owing to additional lime, we have for such extra lime, per 55·43 grms. of chlorine, or per 100 grms. of total salts, the value 0·0075 grm. of lime. The difference brought out by the discussion of our supplementary determinations of lime (page 37) as between waters from greater depths than 1500 fathoms and waters from less than 101 fathoms, was 0·0132 per 100 of chlorine, and consequently 0·0073 per 100 of total salts. The agreement is very satisfactory, though its degree of closeness must be deemed accidental.



With the results of the determinations of the alkalinity, the bromine, and the supplementary lime determinations before us, we are now able to correct the average composition of sea-water salts, as deduced from the 77 analyses tabulated on pages 23 to 25.

The corrections of the numbers for lime, soda, and total salts per 55·42 of chlorine, which are necessitated by the new lime-determinations, might be effected as shown on page 21; but, when we do this, there still results a value for the alkalinity which is by 0·00293 too high. This surplus I ascribe to a constant positive error in the "*total sulphates*," which practically means the soda. Hence we had better discard the direct determinations of the soda, and *calculate* it from the number of equivalents of acid left unsaturated by lime, magnesia, and potash; *i.e.*, from the difference: number of [Cl_2's, SO_3's, CO_2's] minus number of [CaO's, MgO's, K_2O's].

To correct the "chlorine" for the bromine included in it, we have (page 101) for the bromine present per 100 of chlorine 0·3402 part; hence per 55·420 parts of chlorine, we have 0·1885 part of bromine = 0·001178 × 160 part. Whence the quantity of chlorine really is 55·336, so that the numbers stand as follows:—

Per "Chlorine" = . .	55·420 ÷ 70·92	= 0·78144	Number of equivalents of acid radicals.
Sulphuric Acid, . .	6·415 ÷ 80	= 0·08019	
Carbonic Acid, . .	0·152 ÷ 44	= 0·00345	
	Total, .	0·86508	
Lime, ...	1·677 ÷ 56	= 0·02995	Number of equivalents of basic radicals.
Magnesia, . . .	6·214 ÷ 40	= 0·15535	
Potash, . . .	1·333 ÷ 94	= 0·01418	
		= 0·19948	
Soda (by difference), . .	41·267 ÷ 62	= 0·66560	
	Total,	0·86508	

True Chlorine, . . .	55·336
Bromine, . . .	0·1885
Oxygen-equivalent of the two halogens, . . .	−12·503
	100·0795

Referring to 100 parts of total salts we have

Chlorine, ...	55·292
Bromine, ...	0·1884
Sulphuric Acid, ...	6·410
Carbonic Acid, ...	0·152
Lime, ...	1·676
Magnesia, ...	6·209
Potash, ...	1·332
Soda, ...	41·234
−[O] per [Cl_2 or Br_2], . . .	−12·493
	100·0004

In deference to an established custom, and the presumable wishes of some of my readers, I have translated these numbers into the following hypothesis on the

Proximate composition of 100 *parts of Sea-water salts.*

Chloride of sodium,	77·758
Chloride of magnesium,	10·878
Sulphate of magnesium,	4·323
Sulphate of lime,	4·070
Sulphate of potash,	2·465
Bromide of magnesium,	0·217
Carbonate of magnesium,	0·290
	100·001

But the best mode of representing the results, is to express them with reference to 100 parts of chlorine.

To refer them to 100 parts of *pure* chlorine would be of no use, because it is the total halogen determined as chlorine which forms the convenient standard.

With reference to it we have

Per Halogen = 100 *of Chlorine.*[*]

Chlorine.	Bromine.	Sulphur tri-oxide.	Carbon dioxide.	Lime.
99·848	·3402	11·576	·2742	3·026.

Magnesia.	Potash.	Soda.	Total Salts.[†]
11·212	2·405	74·462	180·584.

I am indebted to Mr. John M'Arthur for the scrupulous care with which he performed the whole of the analytical work referred to in this chapter.

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[*] Forchhammer determined the chlorine gravimetrically, and used the atomic weights Cl = 35·5 and Ag = 108. Hence what he calls "100 *parts of chlorine*," would be 99·92 parts of "*chlorine*" with us. The difference is insignificant.

[†] *i.e.*, *true* total salts. What up to here we have called so is the sum total of "chlorine," SO_3, CaO, MgO, K_2O, Na_2O minus (O per Cl_2). To obtain the true *total solids*, we should have to add the traces of silica, alumina, &c., which I did not determine in my analyses. Compare page 2.

VI.—ON THE ABSORBED AIR IN OCEAN-WATER.

METHODS OF INVESTIGATION.

The components of the atmosphere, in obedience to the laws of the absorption and diffusion of gases, must necessarily pervade the ocean everywhere and to its greatest depths; but their quantitative relations to one another and to the solvent are subject to chemical, in addition to purely physical, laws; because the oxygen and carbonic acid at least are no sooner dissolved than they enter into chemical relationships, the former with the dissolved organic matter, and both with the cell-contents of myriads of living organisms which, without them, could have no existence. Yet it is worth while to make a guess at what would be the state of matters if ocean-water were nothing more than a solution in pure water of that complex mixture of salts which, as we have seen, presents such a remarkable constancy in its composition. More highly constant still is that of the atmosphere, for it consists everywhere and always of the same mixture of (very nearly) 0·21 volume of oxygen, and 0·79 volume of nitrogen per unit-volume, contaminated with small variable proportions of vapour of water and carbonic acid. The pressure of the atmosphere is subject to variation, but, at the sea-level, it never deviates much from that of 760 mm. of mercury. Supposing a certain portion of the ocean were separated from the rest, and, after having somehow been deprived of its gaseous contents, exposed to the air at a constant temperature of $t°$. The three gases would stream into the water at a steadily diminishing rate until absorptiometric equilibrium was established, *i.e.*, a point reached when, for instance, the number of molecules of oxygen dissolved in a given small time would be exactly compensated by the same number of previously absorbed oxygen-molecules returning into the atmosphere. In the case of the carbonic acid, the chemical attraction of the "free" base* would make itself felt principally at first; but it is impossible to say, by theory, when this affinity would be satisfied, because the "free" base includes lime and magnesia, whose bicarbonates (we have proved it for the latter, and may assume it for the former), even at ordinary temperatures, are liable to dissociation. Assuming equilibrium of dissociation to have been established, and the carbonic acid to amount to ·0003 of the volume of the atmosphere, one litre of the water, after complete saturation, would contain—

	At $t°$.	At 15° C.
Of Oxygen, ...	0·209β_1 c.c.	5·83 c.c.†
Of Nitrogen, ...	0·791β_2 c.c.	11·34 c.c.†
Of purely absorbed Carbonic Acid, about .	0·0003β_3 c.c.	0·3 c.c.

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* Meaning the base uncombined with muriatic or sulphuric acid.

† According to my own determinations, regarding which *vide infra*.

where the symbols β_1, β_2, β_3 stand for the coefficients of absorption considered with reference to one litre of sea-water, the gas being assumed to be measured in cubic centimetres reduced to 0° C., and the dry-gas pressure $P = 760 \pm x$ at which the absorption takes place.

But this theoretical relation could not be supposed to be realised in nature, even if organic matter were entirely absent. Because there are currents of water constantly flowing forwards and backwards, and preventing the attainment anywhere of an absolutely constant temperature; and even supposing an area of the surface stratum to be stagnant and at a constant temperature, the current of ocean-water containing gas of different composition flowing past underneath, would, by diffusion, constantly either add to or detract from the theoretically calculated proportion of any of the three gases, according to laws as yet unformulated. But the most potent of actual causes of disturbance are the continual processes of life and of decay in the ocean, which constantly tend to diminish the quantity of oxygen, and (on the whole) to add to the quantity of carbonic acid present. The quantity of the nitrogen must be presumed to be at least relatively independent of these influences, and, at any place and any depth, to be approximately equal to that which that portion of water took up, according to the laws of gas-absorption, when it was in contact with the atmosphere. It does not follow in any given case that this quantity can be calculated from any procurable data, because in general any portion of internal ocean water must be presumed to be a mixture of surface waters from a multiplicity of sources. Supposing that the quantity of nitrogen corresponds to complete saturation by air at the surface, at *one* certain temperature, *t*, then the oxygen associated with the nitrogen will in general be less than that calculated from this amount of nitrogen and the temperature, while no calculation will give us, even approximately, the amount of carbonic acid.

Strictly speaking, the same remark, within rather wide limits, holds good for the oxygen and the nitrogen; but since the ocean, during the thousands of years o its existence, must be supposed in every respect to have arrived at a state of approximate dynamic equilibrium, it should be possible, on the basis of a large number of exact experimental determinations, to represent the proportions of the three atmospheric gases present in a given sample as functions of the latitude, longitude, depth, and time at which the sample was taken. At this most important problem of physical oceanography a number of chemists have consciously or unconsciously been working; but there is no need here to trace the history of this subject back any further than the year 1872, when Jacobsen, in his capacity as chemist to the German North-Sea Expedition, investigated the quantity of absorbed nitrogen and oxygen in a most masterly manner, and, for the first time, arrived at really reliable results.* What his predecessors had done is not worth mentioning, because their methods of working fell far short of the necessary degree of precision. Jacobsen, instead of endeavouring, as some of them had done, to determine the

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* *Annalen d. Chemie* (for 1873), Bd. clxvii., p. 1 *et seq.*

proportions of nitrogen and oxygen in the samples of sea-water on board the ship, wisely contented himself there with merely extracting the gases from the recently drawn samples, and then sealing them up in glass tubes for subsequent analysis at his leisure on *terra firma*, in a properly appointed laboratory.

Jacobsen's Method of Extracting Gases from Sea-Water.

The method which Jacobsen used for the extraction of the gases, as will be seen by the following description, was a modification of the one invented long ago by Bunsen, and described in his Gasometrische Methoden. A round-bottomed flask of 500 to 1000 c.c. capacity is provided with a well-fitting soft vulcanised india-rubber stopper, pierced with one perforation. This aperture serves for the attachment of the gas-collecting apparatus as shown by the adjoining figure.

The tube which forms the lower end of this apparatus is closed at the bottom, but has a small aperture at the side. The upper (exit) end of the apparatus is provided with a well-fitting narrow india-rubber tube and a screw-clip, so that it can be closed hermetically when required. In the execution of the process the first step is to fill the flask to overflowing with the water to be examined by means of a wide and long-necked funnel,* which goes to the bottom of the flask, water being poured in in a continuous stream, unbroken by drawn-in air-bells, until some 100 or 200 c.c. of water have run over the edge of the flask, so as to make sure of the contents being unaffected by absorptiometric exchange with the atmosphere. On the other hand, the lower pear-shaped bulb *a* of the gas-collector is charged with a small quantity of pure water, the india-rubber stopper inserted in the flask, and the lower (laterally perforated) end of the bulb *a* pushed down the hole about one-half or two-thirds of the way, so that the flask is hermetically shut off from communication with the interior of the gas-bulbs. The air contained in the

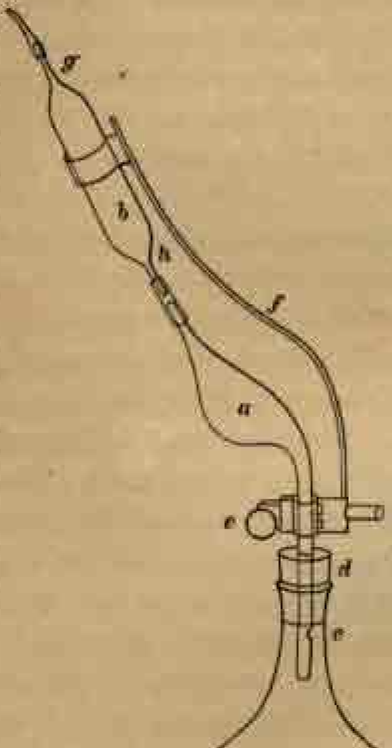

FIG. 3.—Jacobsen's Apparatus for the Extraction of Water-Gases.

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* In the case of a deep-sea water which has been hauled up by means of a pipette-shaped bottle like the one used in the Challenger Expedition, a wide india-rubber tube is attached to the lower end of the "bottle," and, by means of it, the water led to the bottom of the boiling-out flask.

latter is now expelled by keeping the water in the pear-shaped bulb in ebullition for a sufficient time. As soon as all the air has been presumably expelled by the steam, the india-rubber tube at the upper end is closed by the clip, the lamp withdrawn, and the (narrow) exit-tube sealed up. The stem carrying the bulbs is now pushed down into the water, so as to establish a communication between the flask and the bulbs through the lateral hole, and the flask heated over a flame or in a water-bath, so as to boil out the dissolved gases, which, of course, if the bulb apparatus is of sufficient size, can be effected at a temperature considerably below 100° C., and without the pressure inside ever coming up to one atmosphere. After one or two hours' boiling the gases may be assumed to be expelled, and with some practice it is quite possible so to carry out the process that the whole of the gas is in the upper bulb while the lower is filled only with water and steam, so that one can clip the india-rubber joint and seal off the gas-bulb immediately above the water, and thus secure the whole of the extracted gas in a sealed-up glass vessel.

This method, which had worked so well in Jacobsen's hands, was adopted by Mr. Buchanan, and applied by him during the voyage to a large number of recently-drawn waters. He generally operated upon 855 or 900 c.c., in a few cases upon 500 c.c. of sea-water. A number of the many gas samples which he brought home he analysed himself by means of a Doyère apparatus. The majority, however, were placed in my hands by the Director of the Challenger Expedition Commission, with instructions to "analyse them." It was only after I had already made a considerable number of such analyses that I became aware of the existence in Mr. Buchanan's journal of the necessary data for the determination of the *absolute* volume of the gases extracted. Fortunately, although my gas apparatus (which will be described presently) was contrived so that its working did not involve any absolute determinations of the temperature or pressure of the gases analysed, I had always taken these readings and preserved them. And as, in addition, no bell of the gas had ever been allowed to go to waste, my analytical notes enabled me to calculate the absolute volume of the gases as contained in Mr. Buchanan's bulbs. These, however, were all liable to a correction, necessitated by the fact that Mr. Buchanan did not find it convenient to force the whole of the boiled-out gas into the gas-bulb, but allowed a small fraction of it to remain on the wrong side of the point of sealing. But he took care to measure these portions of lost gas under the conditions to which they were subjected at the moment of the sealing-up, and to enter these volumes in his journal. Fortunately the emptied gas-bulbs had been preserved by me (chiefly on account of their labels), and it was easy to measure their contents by means of mercury, so that in the vast majority of cases I was in a position to effect the calculation of the absolute volume.

I will now proceed to describe the apparatus which I used for making the gas analyses.

Method of Gas Analysis.

The volume of sea-water gas in each tube, when measured at the ordinary temperature and pressure, generally amounted to some 15 c.c.; sometimes it was more, but more frequently it was less.

With such small samples, and especially considering the impossibility of replacing them, it would have been imprudent to attempt anything beyond the determination of what were presumably their substantial components. It was also clear to me from the first that in such a case substantial correctness and reliability in the numerical results is worth more than high but unguaranteed precision. Therefore, small as the samples were, I decided upon dividing each into two approximately equal parts, and analysing each separately. Of the several kinds of gas-analysis apparatus which have been invented, Doyère's seemed to me to be the one which would probably best adapt itself to my requirements. But I had not this apparatus in my possession, and to procure one from Paris would have led to considerable loss of time. Besides, a few experiments which, by the kindness of my friend Dr. Ronalds of Bonnington, I had been enabled to make with one in his private laboratory, had revealed to me certain difficulties in its management, which made me shrink from its unqualified adoption, although I felt that they might be purely subjective and conquerable by long practice. At the time I fortunately commanded, in the person of Mr. Robert Lennox, the services of an assistant who, besides being an excellent experimenter generally, is an accomplished glass-blower; and with his help I thought I might try to construct a modified and improved kind of Doyère's apparatus on my own premises. Our joint efforts ultimately resulted in the apparatus represented on Pl. II., which, I may say at once, was found to work very satisfactorily, and served for all the gasometric work to be here reported on.

The apparatus, apart from the two mercurial troughs required, consists of three separate parts, namely—a "measurer," an "exploder," and a "pipette" for the absorptions.

The measurer, as shown by the figure, is a combination of a wide with a narrow glass tube, after the manner of a Gay-Lussac burette. The narrow tube is soldered into the side of the wide one somewhere near its bottom, and is bent up so as to run on alongside of and lie flat against it. The wide tube by its lower contracted end communicates with a long capillary tube of vulcanised india-rubber, and through it with a mercury-reservoir like a Geissler air-pump. At their upper ends the narrow and the wide tube are both provided with good Geissler stop-cocks; to the exit end of the one at the wide tube is soldered a capillary U-tube, similar to the one characteristic of Ettling's gas-pipette. The wide tube bears a millimetre-scale to read off the position of the mercury meniscus inside. The volumes corresponding to the several points of the scale are determined by calibration. The short narrow tube which forms an appendage to the bottom of the burette, serves to insert it, by means of a perforated india-rubber stopper, into an aperture in the centre of the bottom of a water-bath, the front and back of which are made of plate glass. This bath holds a fixed position on a substantial table, and communicates with the service-pipes in such a manner that a continuous current of water from these flows through it, while in use, to maintain an approximately constant temperature.

The exploder is a wide tube with platinum wires soldered-in, provided with a stop-cock and capillary U-tube at the upper end, and connected below with a mercury reservoir like the measurer. It is fixed vertically to a wooden stand. Between it and the measurer stands a pneumatic trough, made out of a block of mahogany, which is provided with two wells of suitable size and shape to accommodate the U-tubes of the measurer and of the exploder respectively. A special similar trough, with one well, is reserved for the *pipette*, the construction of which will easily be understood from the figure. It differs from the original Doyère, or rather, Ettling, pipette (for it was he who invented the instrument) chiefly in this, that the sucking and blowing is effected by means of a small mercury reservoir connected with the gas reservoir by an india-rubber tube, and that the flow of the gas or mercury or liquid reagent is governed by a stop-cock in the capillary part. The vertical side tube and small mercury reservoir soldered on to the horizontal part of the capillary tube may be dispensed with (in fact it did not exist in the original model), but are convenient additions, as will readily be understood (if not divined at first sight) by the following description of the mode of using the apparatus. Long after all our gas analyses had been finished, Mr. Lennox devised an improved form of the pipette, which is represented in Fig. VI. From this figure it will readily be understood that the supplementary mercury reservoir is dispensed with, the metal in the bulb serving to push the gas out of the U-tube.

To analyse a sea-water gas it is transferred from the cylindrical tube containing it to a short wide test-tube made of stout glass, an operation which is greatly facilitated by the deep wells in the pneumatic trough of the measurer. About one-half of the gas is then sucked into the measurer, which is so manipulated that at the end the whole of the U-tube and the capillary part following it are filled with mercury. During this operation the narrow side tube (which, like all the rest of the burette, must be understood to have been quite full of mercury before commencing) remains closed. The mercury reservoir is then shifted so as to bring the menisci in it and in the burette into nearly the same horizontal plane, the stop-cock of the side tube opened, and the reservoir now carefully adjusted, so that the mercury in the side tube is exactly on a level with that in the measuring tube. With some practice this can be effected very accurately by the eye, but the telescope (which, of course, is required for reading the position of the meniscus in the graduated tube in reference to the scale) is provided with a "cross" in the focus to make sure of the accuracy of the adjustment. The burette is then read by means of the telescope, and the height of the barometer and the temperature of the bath noted down at the same time. In other words, the volume of the gas is determined at the temperature of the bath, and the pressure $B+\pi$, where B stands for the height of the barometer, and π for the small excess of the capillary depression in the side tube over that in the measuring tube. The measured gas is now blown back into a test tube, and in it, by means of an iron ladle fixed horizontally to a thick iron wire, transferred to the well of the pipette trough. The pipette is supposed to have been already charged with a small volume of concentrated caustic potash, and to be otherwise full of mercury. It is needless to describe how the gas in being sucked into the bulb of the pipette is deprived of its carbonic acid. When the absorption appears to be completed, the gas is blown back into the test tube, which during this time has been standing, full of mercury, in the well, the flow of liquid reagent being arrested when the latter has come to the safe side of the point where the vertical side tube of the small auxiliary reservoir is joined on. Mercury is then run into the capillary tube from this reservoir, or with the improved form (Fig. VI.), from the absorption-bulb itself, to sweep the gas completely into the test-tube, the liquid reagent sucked back into the body of the pipette, the gas in the test-tube transported to the trough of the measurer, and thence sucked back into the measurer to be measured again. The treatment with potash is repeated to make sure that no carbonic acid has escaped absorption. The gas freed from carbonic acid is now mixed with a sufficiency of hydrogen, again measured, transferred (by means of the test-tube) to the exploder, exploded, taken back into the measurer and again measured. All the several quantities of gas are measured moist. The whole sequence of operations, with some practice, takes little over half an hour, so that, as a rule, corrections for variations in the temperature or pressure are unnecessary. Should such variations occur they are small, and easily allowed for by calculation. Supposing, for instance, in two measurements, I. and II., the temperatures to have been t and $t+(\Delta t)$ respectively, then, to reduce the gas-volume II. from $t+(\Delta t)$ to t we have

$$V_t = V_{(t+\Delta t)} \times \frac{273+t}{273+t+(\Delta t)},$$

for which expression we may safely substitute

$$V_t = V_{(t+\Delta t)} \times \left(1 - \frac{\Delta t}{273+t}\right);$$

and if we keep at hand a table of the reciprocals of all the values $273+t$ that can be expected to occur, the calculation takes very little time. Similarly with the variations in pressure. I had originally devised a disgregation-indicator similar to Doyère's regulator, which gave the correcting factor by one reading. It consisted of a kind of very short but wide Gay-Lussac burette, provided with a very narrow long side tube. The wide tube after having been charged with a little water (and air) was hermetically closed above and below, and suspended in the bath of the measurer. Obviously the factor for reduction to say 15° C. and 760 mm. is a function of the difference of level in the two tubes, and it is easy for a given charge of water to standardise the apparatus by preliminary experiments, and enter in a table the factors for the several values of the difference of level. The apparatus was tested by plunging it into a water-bath of known temperature, and connecting the open end of the narrow tube with an artificial atmosphere, whose excess or deficit of pressure was measured by a water-manometer. It was found to give correct indications. It was more delicate than our barometer and thermometer used conjointly; yet we hardly ever used it in earnest, because we soon found that it took less trouble to make an occasional calculation than to keep the regulator in order. Perhaps the little instrument may be useful to others engaged in gasometric work; hence I have described it here.

The calibration of the measurer is effected by means of an exact balance. We used a "16 inch Oertling." For this purpose the measurer is provided temporarily with a stop-cock below, so that it can be used like a Mohr's burette. It is then filled with mercury, the side tube to overflowing, the graduated tube to a little beyond the stop-cock. The india-rubber tube below, which established communication with the reservoir, is then removed, the stop-cock at the head of the side tube closed, and next mercury run out of the burette until the metal stands just at the inside end of the stop-cock. Everything now is ready for the calibration. As a necessary first step, mercury is first run out very cautiously, so far as to bring the metal to the point where the capillary appendage joins on (abruptly) to the burette, and weighed, and then successive convenient instalments of metal are run out, and at each step the *total* mercury discharged so far is weighed, and the reading of the meniscus in the tube taken by means of the telescope. The telescope and stand I used for all my gasometric work came from Mr. Casella, and I found it in every respect a most excellent instrument, both optically and mechanically.

During all this work the burette stands in the water-bath, and is thus kept at a practically constant temperature. This at first sight may appear to be an unnecessary refinement; but experience showed (in confirmation of what mere thermometer-readings and calculation might have revealed beforehand) that, in an ordinary room of fluctuating temperature, a degree of precision which does justice to an accurate millimetre scale as read by a good telescope, cannot otherwise be attained.

I am indebted to Professor Tait for having kindly placed at my disposal an excellent screw dividing engine, made by Bianchi of Paris, and thus enabled me to provide all my gasometric apparatus with faultless millimetre-scales.

In the calculation of the calibration table, one grm. of mercury was taken as representing "unit-volume," and the final calculation based on the mean of the results of two well-agreeing calibrations. The volumes are counted from the *lower* end of the capillary tube at the head of the measurer, experience proving that the string of mercury suspended in the capillary tube after introducing a gas, never descends by itself.

With a really good telescope, the degree of precision attainable in the analysis is greater than might have been expected from the shortness of the measurer. The following analyses of a number of samples of atmospheric air, which had been collected by Mr. Buchanan during the voyage, are quoted here to show what the apparatus is capable of under the most favourable conditions.

[No. 92.] "Air collected on forebridge, noon, October 29, 1875. Lat. 38° 43′ S., long. 112° 31′ W." Vol. of air taken = 376·22 vol.

After treatment with caustic potash, 375·74. The contraction of 0·48 vol. = about 0·3 mm. of our scale, could not be assumed, in the circumstances, to *measure* the carbonic acid with any degree of precision; it is merely put down to afford an additional datum for criticising the work.

The residue free from carbonic acid was divided into two parts, which were separately analysed by explosion with hydrogen.

Portion I.—Vol. of air taken = 197·51; plus hydrogen = 330·97; after explosion, 206·58; contraction = "e" = 124·39; oxygen = $\frac{e}{3}$ = 41·463 = 20·99 per cent.

Portion II.—Vol. = 178·06; plus hydrogen, 268·91; after explosion, 157·32; e = 111·59; oxygen = $\frac{e}{3}$ = 7·197 = 20·89 per cent.

[No. 194.] "Air from atmosphere, 1 P.M., December 21, 1875, No. 1367." Lat. 37° 5′ S., long. 83° 22′ W.

Vol. of sample = 326·51; *minus* CO_2 = 326·99; contraction = −0·48 (= −0·3 mm.). Residue divided as before.

Portion I.—Vol. of air = 163·83; *plus* hydrogen = 258·84; after explosion, 155·40; e = 103·44; oxygen = $\frac{e}{3}$ = 34·48 = 21·05 per cent.

Portion II.—Vol. of air = 162·73; *plus* hydrogen, 240·20; after explosion = 137·67; e = 102·53; oxygen = 34·177 = 21·00 per cent.

[No. 192.] "Sample of air, February 18, 1874, 3.30 P.M." Lat. 64° 44′ S., long. 83° 26′ E.

Vol. of sample = 315·06; *minus* CO_2 = 314·98; contraction = 0·08. Residue divided.

Portion I.—Vol. = 159·08; *plus* hydrogen = 262·26; after explosion = 162·09; e = 100·17; oxygen = 33·39 = 20·99 per cent.

Portion II.—Vol. = 155·89; *plus* hydrogen = 238·11; after explosion, 139·86; e = 98·25; oxygen = 32·75 = 21·01 per cent.

[No. 193.] "Air collected on deck, 2 P.M., November 6, 1875." Lat. 37° 55′ S., long. 93° 56′ W.

Vol. of sample = 309·64; *minus* CO_2 = 309·41; contraction = 0·23. Residue divided.

Portion I.—Vol. = 162·25; *plus* hydrogen, 286·45; after explosion, 148·28; *c* = 102·17; oxygen = 34·057 = 20·99 per cent.

Portion II.—Vol. = 147·11; *plus* hydrogen = 231·85; after explosion = 139·40; *c* = 92·45; oxygen = 30·817 = 20·95 per cent.

Summary.

Percentage of Oxygen.

[No.]	I.	II.	Mean.
92	20·99	20·89	20·94
194	21·05	21·00	21·02
192	20·99	21·01	21·00
193	20·99	20·95	20·97

By way of comparison, let us state that Regnault found for the percentage of oxygen in air freed from carbonic acid in—

5	samples from the	Atlantic Ocean, ...	from 20·918 to 20·965
1	„	Ecuador, ...	20·960
23	„	Switzerland, ...	„ 20·909 to 20·993

R. Bunsen found, in 28 samples collected at Heidelberg, from 20·84 to 20·963 per cent.; mean of all the 28 results, 20·924.

The composition of unpolluted air, in short, is the same everywhere; hence, the proper mode of interpreting our 8 analyses is to say that they brought out results whose greatest deviation from their mean 20·984 was 0·066, and this for an apparatus of the modest pretensions of mine is a very high degree of precision.

Unfortunately, the same degree of exactitude could not be attained in the analyses of the samples of air from sea-water; the deviations from each other of numerous duplicate analyses were in general considerably greater. I can explain this only by the unavoidable absorptiometric action of the relatively large amount of caustic potash used on the gas samples introduced into the pipette. In the case of atmospheric air analyses, the liquid reagent, by the action of the air of the laboratory, has already come into the absorptiometric condition which it tends to assume in the analysis. In the case of successive analyses of gas from sea-water of *variable* composition, the elimination of the carbonic acid is unavoidably accompanied by addition of nitrogen or oxygen from the reagent to the sample above it. If I had to do the work again, I should certainly use merely moist, instead of dissolved, caustic potash for the absorption of the carbonic acid.

I now give in a tabular form the results of all the sea-water gas measurements carried out by me, or rather (under my constant and direct superintendence, and with my frequent co-operation) by Mr. Robert Lennox, to whom I feel greatly indebted for the conscientiousness and the unflagging zeal and energy with which he devoted himself to his work. These are followed by a statement, also tabular, of the net results of both my own and Mr. Buchanan's gas analyses. After this will be found a research on the coefficients of absorption, by fresh and by sea water, of nitrogen and oxygen gas, which I carried out, in conjunction with Mr. Lennox, in order to be able to interpret the results of the gas analyses. Finally, I devote a few paragraphs to a discussion of the results.

I. *Results of my own Gasometric Analyses.*

In the following table V_0 stands for the total volume of gas (in c.c. reduced to 0° and 760 mm. of dry-gas pressure) in one litre of the respective sea-water, measured at its natural temperature; v_0 designates the conjoint volume of nitrogen and oxygen contained in those V_0 volumes, similarly reduced; so that $V_0 - v_0$ represents the carbonic acid. Whence it will be easily understood that Columns VIII. report the percentage composition of the entire gas, while Columns IX. give the percentage composition of the mixture of nitrogen and oxygen which is left after removal of the carbonic acid.

TABLE I.

SHOWING THE RESULTS OF THE ANALYSIS OF GASES OBTAINED FROM A NUMBER OF SAMPLES OF OCEAN-WATER.

I. *The Surface Water of the North Atlantic.*

(None preserved.)

II. *The Bottom Water of the North Atlantic.*

I.	II.	III.	IV. Position.		V.	VI.	VII.	VIII. Analyses in terms of $V_g=100$.							IX. Analyses in terms of $v_g=100$.			X.
Number of Sample.	Date.	Station.	Latitude.	Longitude.	Depth in Fathoms from which the Sample was obtained.	V_g.	v_g.	Carbonic Acid.			Oxygen.			Nitrogen.	Carbonic Acid.	Oxygen.	Nitrogen.	Laboratory Number.
								First Result.	Second Result.	Mean.	First Result.	Second Result.	Mean.					
	1873.		N. ° '	W. ° '														
72	Mar. 29	29	24 39	65 25	2850	...	...	11·54	11·48	11·51	23·64	23·72	23·68	64·81	13·01	26·76	73·23	181
114	May 26	53	36 30	63 40	2650	...	...	8·46	9·05	8·76	27·66	27·57	27·61	63·63	9·60	30·26	69·74	182
122	June 16	60	34 28	58 56	2675	...	...	4·26	4·07	4·16	29·81	29·63	29·72	66·12	4·34	31·02	68·99	183
138	„ 24	68	38 3	39 19	2175	...	...	8·82	9·11	8·97	26·81	26·56	26·68	64·35	9·85	29·31	70·70	184*

III. *Water from Intermediate Depths in the North Atlantic.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII. CO₂ First	Second	Mean	O First	Second	Mean	Nitrogen	IX. Carbonic Acid	Oxygen	Nitrogen	X.
†1606	1876. May 3	353	26 21	33 37	2500	18·67	14·57	21·98	21·97	21·97	22·08	22·08	22·08	55·95	28·17	28·29	71·71	179

IV. *The Surface Water of the South Atlantic.*

(None preserved.)

V. *The Bottom Water of the South Atlantic.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII. CO₂ First	Second	Mean	O First	Second	Mean	Nitrogen	IX. Carbonic Acid	Oxygen	Nitrogen	X.
	1876.		S.	W.														
1494	Feb. 28	323	35 39	50 47	1900	20·03	15·69	21·85	22·39	22·12	24·58	24·50	24·54	53·34	28·41	31·51	68·50	142
1533	Mar. 10	332	37 29	27 31	2200	23·14	18·59	19·58	19·42	19·50	20·22	20·01	20·11	60·39	24·22	24·98	75·02	191

VI. *Water from Intermediate Depths in the South Atlantic.*

(None preserved.)

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* This tube was cracked at the point of sealing, but the gas inside was at less than half an atmosphere pressure; hence it had probably remained air-tight.

† *Analysis.*—Carbonic acid determined in two separate portions; residue mixed and exploded with fulminating gas ($2H_2+O_2$) to search for organic matter; contraction only 0·1 mm., *i.e.*, practically *nil*. Residue used for determination of oxygen.

VII. *The Surface Water of the Southern Ocean.*

I.	II.	III.	IV. Position.		V.	VI.	VII.	VIII. Analyses in terms of $V_\phi=100$.							IX. Analyses in terms of $v_\phi=100$.			X.
Number of Sample.	Date.	Station.	Latitude.	Longitude.	Depth in Fathoms from which the Sample was obtained.	V_ϕ	v_ϕ	Carbonic Acid.			Oxygen.			Nitrogen.	Carbonic Acid.	Oxygen.	Nitrogen.	Laboratory Number.
								First Result.	Second Result.	Mean.	First Result.	Second Result.	Mean.					
	1874		S. ° ′	E. ° ′														
387	Feb. 17	...	65 10	78 42	Surface.	25·19	20·87	17·23	17·06	17·15	28·73	29·04	28·88	53·97	20·70	34·86	65·15	143
396	" 20	...	64 1	87 41	"	23·60	20·84	11·65	11·76	11·70	30·16	30·18	30·17	58·13	13·25	34·17	65·83	144

VIII. *The Bottom Water of the Southern Ocean.*

(None preserved.)

IX. *Water from Intermediate Depths in the Southern Ocean.*

419	1874. Mar. 7	158	50 1	123 4	50	23·34	20·23	13·50	13·11	13·30	29·68	29·70	29·69	57·01	15·34	34·25	65·75	167

X. *The Surface Water of the South Pacific.*

	1874.																	
*455	June 16	164c	34 27	154 57	Surface.	...	...	6·72	(7·29)	†	30·51	(29·70)	...	62·77	7·20	32·71	67·29	146
471	" 20	...	37 2	160 43	"	21·95	16·37	23·26	22·97	23·12	25·70	25·76	25·73	51·15	30·07	33·47	66·53	147
486	July 9	...	39 18	173 30	"	21·67	16·63	23·33	22·78	23·06	25·56	25·60	25·58	51·36	29·97	33·24	66·74	148
497	" 13	...	31 23	177 48	"	29·15	16·39	18·81	18·50	18·66	26·92	27·05	26·99	54·35	22·94	33·18	66·82	149
			S.	W.														
504	" 15	...	28 25	177 52	"	19·29	15·14	21·54	21·43	21·49	26·12	26·18	26·15	52·36	27·37	33·31	66·70	150
512	" 18	...	23 15	173 26	"	17·85	14·01	21·47	21·50	21·49	25·86	25·89	25·88	52·63	27·37	32·97	67·03	151
515	" 23	...	20 9	176 47	"	15·42	13·12	14·41	15·47	14·94	27·85	27·80	27·83	57·23	17·57	32·72	67·28	152
			S.	E.														
528	Aug. 15	...	18 29	173 49	"	16·24	13·13	17·28	17·31	17·30	27·25	26·93	27·09	55·61	20·92	32·76	67·25	153
557	" 25	181	13 50	151 49	"	16·26	13·21	18·43	18·49	18·46	26·71	26·64	26·68	54·86	22·64	32·72	67·28	154
572	Sept. 1	...	11 37	142 59	"	19·24	14·93	22·22	22·54	22·38	25·52	25·48	25·50	52·12	28·83	32·85	67·14	155A
‡...	...	...	...	...	...	2·22	...	...	99·00	—	—	—	—	...	...	...	...	155B
	1875.																	
722	Feb. 27	...	1 58	148 21	"	15·16	12·53	17·65	17·00	17·33	26·68	26·78	26·73	55·94	20·97	32·34	67·67	163
			S.	W.														
1157	Oct. 7	282	23 46	149 59	"	14·90	13·45	10·25	9·17	9·71	29·52	29·67	29·59	60·70	10·75	32·77	67·24	85
1211	" 12	...	29 25	140 23	"	17·35	14·84	14·19	14·75	14·47	28·89	29·38	29·13	56·40	16·92	34·06	65·95	87
1212	" 13	...	30 50	139 13	"	13·81	12·73	7·74	7·93	7·84	30·63	30·82	30·73	61·43	8·51	33·35	66·67	88
1272	" 29	292	38 43	112 31	"	18·50	14·65	20·88	20·68	20·78	26·68	26·86	26·77	52·45	26·23	33·79	66·21	91
1287	Nov. 2	...	39 19	101 19	"	22·22	17·08	18·95	19·16	19·06	27·47	27·49	27·48	53·46	23·55	33·95	66·04	126
1301	" 6	...	37 55	93 56	"	23·32	18·96	18·71	18·60	18·66	27·89	27·47	27·68	53·64	22·97	34·04	65·96	127

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* "Not satisfactory; good for trial analysis." Note by Mr. Buchanan on label.

† First analysis adopted as being probably nearer the truth. Second cancelled.

‡ Lab. No. 155A is labelled "First Tube"; 155B "Second Tube."

X. *The Surface Water of the South Pacific—continued.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_p.	VII. v_s.	VIII. Analyses in terms of V_p=100. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Analyses in terms of v_s=100. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
	1873.		S.	W.														
1314	Nov. 10	...	38 19	84 25	Surface.	20·68	17·51	13·93	13·90	13·91	29·34	29·36	29·35	56·74	16·16	34·16	65·84	130
1342	Dec. 13	...	33 20	74 24	"	18·69	16·10	11·01	10·94	10·98	26·43	26·75	26·59	62·43	12·33	29·97	70·03	132
1364	" 18	...	24 21	79 11	"	19·57	17·04	13·06	12·83	12·94	29·58	29·53	29·55	57·51	14·36	33·95	66·05	136
1374	" 23	...	28 50	83 53	"	17·82	16·01	10·48	9·78	10·13	30·74	30·78	30·76	59·11	11·28	34·25	65·75	137A
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	137B*
1375	" 24	...	30 41	86 23	"	21·65	17·01	16·98	16·72	16·85	28·65	28·63	28·64	54·51	20·26	34·44	65·56	138
1378	" 27	...	42 19	84 47	"	18·98	16·29	13·91	14·47	14·19	29·12	29·15	29·13	56·68	16·54	33·95	66·05	139
	1876.																	
1462	Feb. 11	318	42 32	56 29	"	19·13	16·33	14·68	14·61	14·63	29·29	29·19	29·24	56·13	17·14	34·25	65·75	141

XI. *The Bottom Water of the South Pacific.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_p.	VII. v_s.	VIII. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
	1874.		S.	E.														
477	June 23	166	38 50	169 20	275	21·96	16·33	25·50	25·77	25·63	19·86	19·87	19·87	54·50	34·47	26·72	73·28	185
558	Aug. 24	180	14 7	152 43	2450	24·58	16·94	31·20	31·00	31·10	13·21	13·45	13·33	55·57	45·14	19·35	80·65	186A
...	...	...	...	...	...	2·09	...	...	—	98·00	—	—	...	...	—	...	—	186B
569	" 29	181	12 8	145 10	1400	17·11	14·06	17·57	18·10	17·83	23·87	24·08	23·97	58·20	21·70	29·17	70·83	187

XII. *Water from Intermediate Depths in the South Pacific.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_p.	VII. v_s.	VIII. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
	1874.																	
461	June 17	165	34 50	155 28	50	19·23	15·33	20·70	19·84	20·27	25·90	25·94	25·92	53·81	25·43	32·51	67·49	168
464	" 18	...	34 42	156 19	5	18·94	15·80	16·90	16·30	16·60	27·51	27·66	27·59	55·81	19·90	33·08	66·92	169
466	" 19	165A	36 41	158 29	5	...	...	18·78	18·29	18·54	26·54	26·68	26·61	54·85	22·78	32·67	67·33	170
489	July 10	169	37 34	179 22	50	...	...	20·73	20·29	20·51	25·23	25·53	25·38	54·11	25·80	31·93	68·07	171
	1875.																	
725	Mar. 1	218	2 33	144 4	10	15·04	12·43	17·17	17·53	17·35	26·96	26·68	26·82	55·83	20·99	32·46	67·54	174
				W.														
1165	Oct. 4	280	18 40	149 52	25	15·20	13·40	11·55	11·71	11·63	29·08	29·04	29·06	59·31	13·16	32·89	67·11	83
1181	" 6	281	22 21	150 17	200	17·88	15·02	16·28	15·53	15·90	23·52	23·75	23·63	60·47	18·91	28·10	71·90	84
1205	" 11	284	28 22	141 22	200	16·68	14·25	15·87	15·35	15·61	23·39	23·60	23·49	60·90	18·50	27·84	72·16	86
1262	" 27	291	39 13	118 49	25	21·89	17·79	18·69	18·85	18·77	26·77	27·11	26·94	54·29	23·11	33·17	66·83	89
1306	Nov. 9	296	38 6	88 2	50	21·36	18·29	14·37	14·29	14·33	30·08	...	30·08	55·59	16·81	35·14	64·86	128
1312	" 9	296	38 6	88 2	1350	†	†	21·94	...	21·94	16·46	...	16·46	61·60	28·11	21·09	78·91	129
1329	" 17	298	34 7	73 56	25	16·75	14·95	10·88	10·57	10·73	30·10	29·79	29·95	59·32	12·02	33·55	66·45	131
1345	Dec. 14	299	33 31	74 43	50	17·84	15·94	10·65	10·60	10·63	27·00	26·98	26·99	62·38	11·89	30·20	69·80	133
‡1353	" 16	...	33 50	77 6	10	17·69	15·84	10·46	10·43	10·45	30·71	30·54	30·63	58·92	11·67	34·21	65·80	134A, B
1356	" 17	300	33 42	78 18	50	19·47	15·44	10·68	11·24	10·96	—	28·50	28·54	60·50	12·31	32·06	67·94	135

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* The tube contained only about 0·5 c.c. of gas, which was almost entirely absorbed by caustic potash.

† Not determined, as part of gas was lost.

‡ The second tube of No. 1353 contained only about ½ c.c. of gas.

XIII. *The Surface Water of the North Pacific.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_0.	VII. v_0.	VIII. Analyses in terms of V_0=100. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Analyses in terms of v_0=100. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
			N. ° ′	E. ° ′														
662	1875. Feb. 10	214	4 33	127 6	Surface.	18·73	11·85	13·54	13·73	13·63	28·69	28·46	28·58	57·74	15·85	33·11	66·90	160
700	" 19	...	1 5	137 10	"	15·82	13·18	16·97	16·44	16·70	27·16	27·45	27·30	56·00	20·05	32·78	67·24	161
759	Mar. 17	...	3 21	145 35	"	15·54	13·47	13·41	13·30	13·35	27·77	28·03	27·90	58·75	15·41	32·20	67·80	163
761	" 18	...	4 21	145 18	"	15·42	12·31	20·33	20·00	20·16	25·87	26·15	26·01	53·83	25·25	32·58	67·42	164
817	" 31	...	21 17	140 40	"	17·01	13·66	19·81	19·63	19·72	26·07	26·33	26·20	54·08	24·56	32·64	67·36	145
820	April 3	...	24 47	139 34	"	16·07	13·64	14·89	15·38	15·14	28·33	28·35	28·34	56·52	17·64	33·40	66·60	165
836	" 7	...	28 23	137 45	"	16·59	14·57	12·22	12·17	12·20	29·07	29·42	29·25	58·55	13·90	33·31	66·69	166
*910	1875. June 29	...	35 55	171 54	"	17·28	14·64	15·73	15·86	15·79	28·67	28·19	28·43	55·78	18·77	33·77	66·23	67
				W.														
926	July 4 bis.	...	36 59	178 56	"	14·96	12·51	16·16	15·93	16·06	29·42	28·30	28·86	55·08	19·18	34·40	65·60	70
949	" 10	...	37 35	163 46	"	...	...	15·44	14·43	14·94	29·29	28·65	28·97	56·59	17·57	33·47	66·53	72
976	" 15	...	37 26	155 22	"	...	...	14·07	14·00	14·05	28·71	29·00	28·86	57·11	16·32	33·57	66·44	73
977	" 16	...	37 8	154 52	"	18·84	15·90	19·72	20·26	19·99	26·60	26·38	26·49	53·52	24·99	33·11	66·90	74
989	" 19	...	32 21	154 37	"	15·64	13·83	lost.	11·57	11·57	lost.	29·96	29·96	58·47	13·09	33·88	66·12	76
990	" 20	...	30 51	154 23	"	15·03	13·10	...	12·87	12·87	28·43 29·09	29·15	29·22	57·91	14·77	33·54	66·47	77
1003	" 22	...	29 5	154 43	"	17·82	13·84	21·74	21·82	21·78	25·76	25·56	25·66	52·56	27·85	32·81	67·20	78
1004	" 23	...	27 40	154 55	"	16·03	13·50	15·65	15·88	15·77	28·11	27·80	27·96	56·27	18·72	33·19	66·80	79
1011	" 24	...	26 24	155 8	"	15·54	12·97	16·61	16·49	16·55	27·49	27·38	27·44	56·01	19·83	32·89	67·13	80
1012	" 25	...	24 31	155 34	"	15·70	13·24	15·60	15·69	15·65	28·08	28·00	28·04	56·31	18·55	33·24	66·76	81

XIV. *The Bottom Water of the North Pacific.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_0.	VII. v_0.	VIII. Analyses in terms of V_0=100. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Analyses in terms of v_0=100. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
			N.	E.														
†922	1875. July 2	246	36 10	178 0	2050	20·94	16·52	20·96	21·27	21·12	...	13·94	13·94	64·94	26·77	17·67	82·32	68
				W.														
‡924	" 3	247	35 49	179 57	2530	19·90	14·31	22·91	27·27	25·09	11·34	11·64	11·49	63·42	33·07	15·98	84·02	69
1024	" 26	250	23 3	156 6	2225	25·63	14·13	44·84	44·90	44·87	9·92	9·82	9·87	45·26	81·40	17·90	82·09	82

XV. *Water from Intermediate Depths in the North Pacific.*

I. Number of Sample.	II. Date.	III. Station.	IV. Position. Latitude.	IV. Position. Longitude.	V. Depth in Fathoms from which the Sample was obtained.	VI. V_0.	VII. v_0.	VIII. Analyses in terms of V_0=100. Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	IX. Analyses in terms of v_0=100. Carbonic Acid.	Oxygen.	Nitrogen.	X. Laboratory Number.
			N.	E.														
752	1875. Mar. 16	222	2 15	140 16	50	14·51	12·70	12·35	12·64	12·50	28·14	28·56	28·35	59·15	14·29	32·40	67·61	175
797	" 25	226	14 44	142 13	200	17·60	13·78	21·98	21·47	21·73	18·16	18·24	18·20	60·07	27·77	23·25	76·75	176
§823	April 1	229	22 1	140 27	300	18·92	15·24	18·91	18·97	18·94	19·26	19·74	19·50	61·56	23·37	24·06	75·95	177
‖830	" 5	230	26 29	137 57	50	18·38	13·39	16·26	—	16·26	26·42	...	26·42	57·32	19·42	31·55	68·45	178
				W.														
¶933	July 5	248	37 41	177 4	400	20·50	14·70	28·02	28·55	28·29	10·42	10·25	10·33	61·38	39·45	14·47	85·53	71
970	" 17	254	35 13	154 43	25	18·69	16·04	14·60	13·71	14·16	28·70	28·74	28·72	57·12	16·50	33·46	66·54	75

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* Note on label, "The dirt comes from the bulb."

† Second tube. Vol. at 0° and 760 mm. = 1·3 c.c. from 900 c.c. of water.

‡ The gas in the second tube amounted to only about 0·2 c.c.

¶ Note by Mr. Buchanan :—"400 fathom water kept over night in a bottle, quite full, with tubular stopper; this to compare with sample boiled out fresh" (on label of gas-tube). Mr. Buchanan's analysis of the other sample gave the following results :—V_0 = 22·74 c.c.; v_0 = 18·12 c.c.

Percentage of carbonic acid = 29·12

" oxygen in gas minus carbonic acid = 12·93

§ With regard to this gas see "Notes to Section I.," p. 153.

‖ Only one analysis made; the second failed.

XVI. *Surface Water.—Miscellaneous Observations.*

I.	II.	III.	IV.		V.	VI.	VII.	VIII.							IX.			X.
			Position.					Analyses in terms of V_0=100.							Analyses in terms of v_0=100.			
Number of Sample.	Date.	Station.	Latitude.	Longitude.	Depth in Fathoms from which the Sample was obtained.	V_0.	v_0.	Carbonic Acid. First Result.	Carbonic Acid. Second Result.	Carbonic Acid. Mean.	Oxygen. First Result.	Oxygen. Second Result.	Oxygen. Mean.	Nitrogen.	Carbonic Acid.	Oxygen.	Nitrogen.	Laboratory Number.
			S. ° ′	E. ° ′														
581	1874. Sept. 14	...	7 13	134 18	Surface.	15·83	13·37	15·05	16·08	15·57	28·12	28·17	28·15	56·28	18·44	33·34	66·66	156
*602	Oct. 12	...	1 42	127 7	„	16·59	13·09	21·03	21·20	21·12	25·90	26·01	25·96	52·92	26·77	32·91	67·09	157
			N.															
612	„ 19	...	2 6½	125 15	„	15·26	14·47	4·95	5·36	5·16	31·56	31·17	31·36	63·48	5·44	33·07	66·93	158
638	„ 29	...	10 20	122 18	„	18·48	13·48	27·11	27·03	27·07	23·99	23·99	23·99	48·94	37·12	32·89	67·11	90
†645	Nov. 3	...	13 31	121 17	„	...	...	16·81	18·36	16·81	27·52	29·56	27·52	55·67	20·21	33·09	66·91	159
	1875		S.	W.														
‡1424	Jan. 8	...	50 17	74 46	„	22·50	19·21	15·14	14·12	14·63	28·41	27·96	28·19	57·18	17·14	33·02	66·97	140

XVII. *Bottom Water.—Miscellaneous Observations.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII. Carbonic Acid. First Result.	Second Result.	Mean.	Oxygen. First Result.	Second Result.	Mean.	Nitrogen.	IX. Carbonic Acid.	Oxygen.	Nitrogen.	X.
			S.	E.														
576	1874. Sept. 11	189	9 36	137 50	25	...	...	26·09	26·20	26·15	23·18	Lost	23·18	50·67	35·42	31·39	68·61	188
			N.															
§629a	Oct. 22	199	5 44	123 34	2600	2·69	0·13	...	...	35·4	...	...	...	...	...	...	...	189a
			S.															
643	Nov. 2	204A	12 43	122 9	100	...	...	...	...	23·98	...	...	9·44	66·58	31·55	12·42	87·58	190

XVIII. *Water from Intermediate Depths.—Miscellaneous Observations.*

I.	II.	III.	IV. Latitude.	IV. Longitude.	V.	VI.	VII.	VIII. Carbonic Acid. First Result.	Second Result.	Mean.	Oxygen. First Result.	Second Result.	Mean.	Nitrogen.	IX. Carbonic Acid.	Oxygen.	Nitrogen.	X.
			N.															
‖630	1874. Oct. 20	198	2 55	124 53	800	21·01	12·26	39·99	43·27	...	14·47	14·74	...	45·54 41·99	66·65 76·28	24·12 25·98	75·89 74·02	172
673	1875 Feb. 6	213	5 47	124 1	50	19·82	12·70	36·08	35·75	35·91	18·99	19·29	19·14	44·95	56·03	29·86	70·13	173

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* End of gas tube secured with india-rubber on account of a crack; but gas inside found at about one-third of an atmosphere pressure; hence it was probably air-tight.

† One of these two analyses must be wrong; probably it is the second; hence the first result may be adopted as probably correct.

‡ "9·30 A.M." (label).

§ This is a "second tube." The first was analysed by Mr. Buchanan himself, who found for—

Per cent. of carbonic acid in the original gas,	.	92·73
Per cent. of Oxygen in the gas deprived of carbonic acid,	.	21·78

I calculate from his data that V_0=21·95; v_0=14·76.

‖ These analyses do not agree, and, unfortunately, I am unable to say which of the two is at fault, which is the more to be regretted, as this is the only 800 fathom gas which I received for analysis. Mr. Buchanan analysed four such gases, and found for the percentage of oxygen in the gas minus carbonic acid, the numbers 22·22, 23·25, 22·95, 22·05.

Notes to Section I.

1. When in the above table V_0 and v_0 are omitted, this means, in the majority of cases, that they were "not determined because the necessary data were wanting." In a few cases, it is true, the omission was caused by mishaps in the laboratory.

2. With respect to the samples No. 823 and No. 1696. Having repeatedly observed that the gases from deep-sea waters more especially possessed a peculiar nauseous smell, strong enough to be perceptible even in the minute bell of gas which failed to find its way into the eudiometer, I made an attempt, in the case of gas No. 823, to determine the organic matter, and also the sulphuretted hydrogen presumably present. For this purpose the gas was treated first of all with solution of acetate of lead. This reagent produced a considerable contraction, but no coloration; hence the contraction was certainly owing to carbonic acid absorbed by the acetate. It was accordingly added on to the amount of carbonic acid found in the residue by means of caustic potash.

The gas free from carbonic acid was exploded with very carefully prepared fulminating gas ($2H_2+O_2$), the change of volume noted, and the residue treated with caustic potash, to determine any carbonic acid produced by the combustion. In this manner two analyses were made (except that in the second the acetate of lead treatment was omitted). In both cases the contraction involved and the carbonic acid apparently produced in the combustion had small positive values, which were separately reduced to the equivalent quantity of marsh gas. The mean of the two results served for the calculation of what in the following report figures as "*per cent. of marsh gas:*"—

	I.	II.
Carbonic acid, ...	18·60	18·97
Marsh gas, ...	0·56	0·33
Oxygen, ...	20·36	20·43
Nitrogen, ...	60·48	60·27
	100·00	100·00

Considering that these analyses (like all the rest) had to be carried out on a very small scale, I felt very diffident as to the real existence of the combustible matter reported above as "marsh gas"; and this impression was confirmed by the result of another attempt at determining the organic matter, which was made with gas No. 1696. In this analysis the contraction observed in the explosion of the gas free from carbonic acid with fulminating gas amounted to only 0·1 of a volume in 182·8 volumes, which is within the limits of unavoidable errors. I therefore, in the case of No. 823 also, put down the assumed marsh gas as imaginary, and re-calculated the analyses on this basis, to obtain the results reported on pages 153 and 150.

II.—SUMMARY OF THE MEASUREMENTS AND ANALYSES OF ALL THE SEA-WATER GASES.

Column I. gives the number assigned by Mr. Buchanan to the respective water; Column II. the Station at which (or the Stations between which) the water was collected, the sign − indicating that the sample was collected before, the sign + that it was collected after reaching the Station; Column III. gives the volume (V_0) of total gas extracted from the water reduced to 0° and 760 mm. and dryness, in c.c. per litre of water; Column IV. the percentage of carbonic acid in the V. c.c. of total gas; Column V. gives the conjoint reduced volume (v_0) of oxygen and nitrogen in c.c. per litre of water; and Column VI. the percentage of oxygen in the gas *after elimination of the carbonic acid.* In Column VII. a B means that the gas was measured and analysed by Mr. Buchanan.

For waters other than surface waters, supplementary columns give, under δ, the depth at which the water was taken; under D, the depth of the sea at that place.

TABLE II.

(A).—*Surface Waters.*

I.	II.	III.	IV.	V.	VI.	VII.
No. of Water.	No. of Station.	(Total Gas.)		(Gas freed from CO_2.)		
		V_0	Per cent. CO_2	v_0	Per cent. O_2	
386	153	28·32	16·75	23·58	35·01	B
387	153 +	25·19	17·15	20·87	34·86	...
389	154	25·79	12·64	22·53	34·25	B
396	154	23·60	11·70	20·84	34·17	...
417	158	24·37	19·02	19·74	34·01	B
817	229 −	17·01	19·72	13·66	32·64	...
455*	164c	...	6·72	...	32·70	...
471	165A–165B	21·95	23·12	16·87	33·47	...
486	168–169	21·67	23·06	16·68	33·24	...
497	170	20·15	18·66	16·39	33·18	...
504	171	19·29	21·49	15·14	33·31	...
512	171A	17·85	21·49	14·01	32·97	...
515	172–173	15·42	14·94	13·12	32·72	...
528	176	16·24	17·30	13·13	32·76	...
532	177	16·85	16·91	14·00	32·35	B
557	181	16·20	18·46	13·21	32·72	...
572	185	19·24	22·38	14·93	32·85	...
581	190	15·83	15·57	13·37	33·34	...
602	196	16·59	21·12	13·09	32·91	...
612	198	15·26	5·16	14·47	33·07	...
638	202	18·48	27·07	13·48	32·89	...
645*	204	...	16·81	...	33·11	...

* Suspected Analyses

I.	II.	III.	IV.	V.	VI.	VII.
No. of Water.	No. of Station.	(Total Gas.)		(Gas freed from CO_2.)		
		V_g	Per cent. CO_2	v_g	Per cent. O_2	
682	214–215	13·73	13·68	11·85	33·11	...
700	216–217	15·82	16·70	13·18	32·78	...
722	218	15·16	17·33	12·53	32·34	...
759	222–223	15·54	13·35	13·47	32·20	...
761	223	15·42	20·16	12·31	32·58	...
826	229–230	16·07	15·14	13·64	33·40	...
836	230–231	16·59	12·20	14·57	33·31	...
910	244–245	17·38	15·79	14·64	33·77	...
926*	247–248	14·90	16·06	12·51	34·40	...
949	251	...	14·94	...	30·47	...
976	253–254	...	14·03	...	33·57	...
977	253–254	18·84	19·99	15·09	33·11	...
989*	255	15·64	11·57	13·83	33·88	...
990	255–256	15·03	12·87	13·10	33·54	...
1003	256–257	17·82	21·78	13·84	32·81	...
1004	257	16·03	15·77	13·50	33·19	...
1011	258	15·54	16·55	12·97	32·89	...
1012	258–259	15·70	15·65	13·24	33·24	...
1097	268	15·20	11·86	13·40	33·13	B
1187	282	14·90	9·71	13·45	32·77	...
1176	281	15·56	10·61	13·91	32·97	B
1211	284–285	17·35	14·47	14·84	34·06	...
1212	284–285	13·81	7·84	12·73	33·35	...
1272	292	18·50	20·78	14·66	33·79	...
1271	292	20·31	13·48	17·57	34·51	B
1287	293–294	22·22	19·06	17·98	33·95	...
1301	295–296	23·32	18·68	18·96	34·04	...
1314	296–297	20·68	13·91	17·81	34·10	...
1342	299	18·09	10·98	16·10	29·87	...
1364	300	19·57	12·94	17·04	33·95	...
1374A	301	17·82	10·18	16·01	34·25	...
1366	301	22·08	18·59	17·98	34·36	B
1367	301	19·87	11·14	17·66	34·66	B
1375	301–302	21·65	16·85	17·01	34·44	...
1378	301–302	18·98	14·19	16·29	33·95	...
1424	309	22·50	14·63	19·21	33·02	...
1462	318	19·19	14·63	16·33	34·25	...
1508	326	18·59	18·44	15·16	33·52	B
1510	327	17·30	15·28	14·66	33·19	B
1514	329	17·33	11·04	15·42	34·07	B
1573	337	17·79	16·00	14·95	32·95	B
1590	340	16·31	12·66	14·25	33·21	B
1629	345	16·68	17·62	13·91	32·93	B
1662	350	...	10·59	...	33·82	B
1683	352–353	18·70	18·30	15·24	32·82	B
1687	353	16·67	13·34	14·45	33·33	B
1699	354	18·70	17·87	15·36	33·26	B

* Suspected Analyses.

Table II.

(B).—*Waters from various Depths.*

I. Water.	II. Station.	Depth of the Sea at the Locality.	Depth from which the Samples were taken.	III. V_r	IV. Per cent. CO_r	V. c_r	VI. Per cent. O_r	VII.
464	165 165A	2600 2600	5	18·94	16·60	15·80	33·08	...
466	165A	2600	5	...	18·54	...	32·67	...
725	218	1070	10	15·04	17·35	12·43	32·46	...
1353	299 300	2160 1375	10	17·69	10·45	15·84	34·21	...
1498	325	2650	20	19·32	19·68	15·52	33·43	B
1168	280	1940	25	15·26	11·63	13·49	32·89	...
1262	291	2250	25	21·89	18·77	17·78	33·17	...
1329	298	2225	25	16·75	10·73	14·95	33·55	...
1621	345	2010	25	16·60	11·36	14·71	32·78	B
1663	350	Not given.	25	16·83	11·94	14·82	31·74	...
979	254	3025	25	18·69	14·14	16·04	33·46	...
994	256	2950	25	18·53	18·57	15·09	33·88	B
397	155	1300	50	25·11	14·27	21·53	30·32	B
419	158	1800	50	23·34	13·30	20·23	34·25	...
461	165	2600	50	19·23	20·27	15·33	32·51	...
489	169	700	50	...	20·51	...	31·93	...
678	213	2050	50	19·82	35·91	12·70	29·86	...
752	222	2450	50	14·51	12·50	12·70	32·40	...
830	230	2425	50	18·38	16·26	15·39	31·55	...
1306	296	1825	50	21·36	14·39	18·29	35·14	...
1345	299	2160	50	17·84	10·63	15·94	30·20	...
1356	300	1375	50	18·47	10·96	16·44	32·06	...
1576	338	1990	50	17·02	12·99	14·81	34·35	B
1539	333	2025	100	18·59	12·08	16·35	30·31	B
1585	339	1415	100	16·92	11·90	14·91	30·02	B
1633	346	2350	100	20·36	23·04	15·67	18·70	B
1704	354	1675	100	17·49	12·99	15·22	30·29	B
543	179	2325	200	20·96	26·75	15·35	23·40	B
797	226	2300	200	17·60	21·73	13·78	23·25	...
1181	281	2385	200	17·86	15·90	15·02	28·10	...
1205	284	1985	200	16·88	15·61	14·25	27·84	...
823	229	2500	300	18·92	18·94	15·34	24·06	...
1661	349	Not given.	300	22·14	30·49	15·39	10·75	B
1672	351	Not given.	300	20·29	31·20	13·96	11·98	B
594	193	2800	400	21·39	31·91	14·56	15·44	B
933	248	2900	400	22·74	29·12	16·12	12·03	B
933	248	2900	400	20·50	28·29	14·70	14·47	...
1605	341	1475	400	21·18	20·99	16·73	18·90	B
620*	198	2150	800	21·01	41·63	12·26	25·01	...
1220	285	2375	800	21·19	16·90	17·61	22·05	B
1528	331	1715	800	23·03	20·38	18·34	22·95	B
1546	334	1915	800	26·89	23·41	20·60	23·25	B
1655	348	2450	800	21·71	29·98	15·20	22·22	B
1615	342	1445	900	23·03	19·21	18·61	27·99	B
1312	296	1825	1350	...	21·94	...	21·09	...
1532	332	2200	1400	22·76	18·55	18·54	27·54	B
1645	347	2250	1500	22·26	30·70	15·42	13·24	B
1296	294	2270	1775	25·23	26·07	18·65	20·72	B
1269	291	2250	1775	23·74	22·24	18·44	28·48	B
1241	287	2400	1925	22·72	21·74	17·78	25·01	B
1209	284	1985	1975	22·52	20·84	17·83	21·38	B

* Suspected Analysis.

I. Water.	II. Station.	Depth of the Sea at the Locality.	Depth from which the Samples were taken.	III. V_{θ}	IV. Per cent. CO_2	V. v_{θ}	VI. Per cent. O_2	VII.
1231	286	2335	2290	27·93	23·55	21·36	22·90	B
1696	353	2965	2465	18·67	21·97	14·57	28·29	...
1009	257	2875	2850	30·62	37·91	19·01	28·31	B
1001	256	2950	2875	22·46	30·20	15·68	3·84	B
1244	288	2600	2125	22·45	20·89	17·83	21·19	B

TABLE II.

(C).—*Bottom Waters.*

I. Water.	II. Station.	Depth of the Sea at the Locality.	III. V_{θ}	IV. Per cent. CO_2	V. v_{θ}	VI. Per cent. O_2	VII.
576	189	25	...	26·15	...	31·39	...
643	204	100–115	...	23·98	...	12·42	...
1438	311	245	21·35	13·79	18·41	32·44	B
477	166	275	21·96	25·63	16·33	26·72	...
1405	306	345	23·47	29·44	16·56	24·20	B
1618	343	425	20·89	27·32	15·18	22·17	B
1388	302	1450	23·94	24·62	18·05	19·26	B
383	153	1675	28·91	22·83	22·32	25·74	B
567	183	1700	26·79	34·84	17·46	20·97	B
569	183	1700	17·11	17·83	14·06	29·17	...
1494	323	1900	20·03	22·12	15·60	31·51	...
395	154	1800	29·81	23·60	22·78	29·46	B
414	157	1950	23·45	14·62	20·02	28·42	B
922	246	2050	20·94	21·12	16·52	17·67	...
428	159	2150	23·65	21·19	18·64	33·69	B
1544	333	2025	24·72	18·56	20·13	26·57	B
138	68	2175	...	8·97	...	29·31	...
1533	332	2200	23·14	19·50	18·59	24·98	...
671	211	2225	20·23	27·35	14·70	29·63	B
1024	259	2225	25·63	44·87	14·13	17·90	...
771	223	2325	27·03	49·98	13·52	17·36	B
1125	271	2425	18·11	22·34	14·06	19·53	B
556	180	2450	24·58	31·10	16·94	19·35	...
924	247	2530	19·90	28·09	14·31	15·98	...
1106	269	2550	22·80	23·14	17·52	22·11	B
122*	60	2575	...	4·16	...	31·02	...
439	160	2600	23·72	22·27	18·43	31·81	B
629	199	2600	21·95	32·73	14·76	21·78	B
114	53	2650	...	8·76	...	30·26	...
1507	325	2650	31·26	23·52	23·91	24·60	B
964	252	2740	27·84	36·53	17·67	16·95	B
1496	324	2800	25·40	25·23	18·99	25·88	B
72	28	2850	...	11·51	...	26·76	...
1096	268	2900	34·11	46·41	18·28	20·40	B
937	249	3000	21·74	26·22	16·04	23·96	B
987	254	3025	20·92	22·29	16·26	26·98	B
947	250	3050	25·52	27·72	18·45	17·48	B
974	253	3125	31·99	44·61	17·72	18·46	B
791	225	4575	16·11	13·75	13·90	20·11	B

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* Is it from "Bottom Water"? The query is Mr. Buchanan's.

III.—On the Coefficients of Absorption of Nitrogen and Oxygen.

In interpreting the results of the gasometric work summarised in the above tables, it is expedient to begin with the carbonic acid, because it can be dismissed in a few words. It is proved by the analyses of the Norwegian chemists, and confirmed by my own work (as reported in the chapter on carbonic acid), that the quantity of carbonic acid present in a litre of sea-water rarely exceeds, and often falls short of, what is required to convert the "free" base into bicarbonate. This explains what Jacobsen and Buchanan found so difficult to understand, namely, the fact that in the expulsion of sea-water gases by boiling the proportion of carbonic acid which goes into the bulb depends very largely on the circumstances under which the process is conducted. It is of course the greater the longer the boiling is continued, and perhaps, we may add, the less the pressure in the gas bulbs, although a diminution of this pressure necessarily involves a lowering of the temperature of the boiling liquid, and consequently so far a diminution in the dissociation tension of the dissolved bicarbonate. But one thing is clear: the carbonic acid enclosed in Mr. Buchanan's gas-tubes must include the whole of the carbonic acid which was present in the respective waters in the free state; and, consequently, it is worth while to take up some of those cases in which the carbonic acid is exceptionally high, in order to form an idea of the proportion of free carbonic acid that a sea-water may actually contain. The following is a selection of cases where both the total volume of absorbed gas and the carbonic acid per unit-volume of gas assume high values:—

No. of Water.	D.	δ.	Carbonic acid per litre in c.c. at 0° and 760 mm.	
1009	2875	2850	11·6	
1024	2225		11·5	Bottom Waters.
771	2325		13·5	
974	3125		14·3	
1096	2900		15·8	

We need not go further in order to see that even in these deep-sea waters the absorbed carbonic acid falls *far* short of what would correspond to, say, 2 per cent. of the greatest quantity which would be absorbed under 760 mm. of pressure from an atmosphere of pure carbonic acid.

In order to understand the values obtained for the oxygen and nitrogen, we must know the value of the coefficients of absorption of these gases for sea-water at the respective temperatures. At the time when I made my preliminary investigations these constants were unknown. We had at our disposal only the corresponding values for pure water, as determined by Bunsen. I accordingly decided upon investigating this matter, and I naturally began with a series of experiments with pure water, so as to have Bunsen's results as a check upon my work. What was meant to form a mere preliminary to the actual work, and not intended for publication, expanded into a rather lengthy and troublesome research; and before going further, I at once acknowledge the very able and zealous manner in which I was supported by Mr. Robert Lennox throughout its unexpectedly slow progress.

Bunsen, in determining the coefficients named, proceeded as follows:—He first determined the coefficient for nitrogen synthetically by means of his absorptiometer; that is, by reading the contraction suffered by a measured volume of the gas when shaken over mercury with a measured volume of previously boiled water at a definite temperature and pressure. The same method when applied to oxygen gave bad results, because the oxygen was found to act promptly, even on the purest mercury, when shaken up with it and water. To avoid this difficulty, Bunsen, by a series of separate experiments, determined the composition of the gas which is absorbed by water when it is again and again shaken up with fresh air free from carbonic acid under the ordinary pressure and at a certain constant temperature, until absorptiometric equilibrium is sure to be established. Large known volumes of such saturated water were boiled to expel the gases, which were then analysed. The result was that at all temperatures from 0° to 23° C. the absorbed air contained 34·91 volumes of oxygen and 65·09 volumes of nitrogen in 100 volumes.* Hence it was easy to calculate the coefficient of absorption of oxygen from that found for nitrogen at the same temperature.

This method, of course, would apply to sea-water as well as to pure, but I had not a Bunsen's absorptiometer in my possession, and besides I thought that, for my special purpose, I had better use a method which adapts itself more directly to the one which Mr. Buchanan had used for extracting the dissolved gases from his sea-water samples. I accordingly drew up the following general scheme for the determinations. Starting with a sufficiency (say from 1 to 1½ litres) of water which in general should be free from gases, shake up this water repeatedly, at a constant temperature (maintained by means of a water-bath), with pure nitrogen, or pure oxygen, or with air deprived of carbonic acid,—in general with a mixture of m_1 volume of oxygen, and $m_2 = (1 - m_1)$ volume of nitrogen, taking care to renew the gas-atmosphere in the bottle after each shaking, and so go on until absorptiometric equilibrium has certainly been established. Then boil a known volume (from ¾ to 1 litre) of the saturated water in a Jacobsen's apparatus, collect, measure, and analyse the extracted gas. Taking t_0 and B_0 as symbols for the temperature and barometric pressure at the time of the absorption; t_1 and B_1 the corresponding values at the time of the analysis (which, of course, was always carried out by means of my apparatus, in which all gas volumes were read moist at the pressure $B_1 + \pi$ mm., see page 145); τ_0 and τ_1 the tension of vapour of water at t_0 and t_1 respectively; supposing m_1 and m_2 to be the volumes of oxygen and nitrogen in a unit volume of the *air* operated upon (which includes the cases of pure oxygen or nitrogen), n_1 and n_2 to have a similar meaning

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* Bunsen in his book reports three experiments—one at 1°, one at 13°, one at 23° C.

in regard to the absorbed gas as extracted from the water and analysed, and λ the total volume of gas (nitrogen + oxygen) absorbed by a unit volume of water at B mm.* dry pressure and t_0 degrees, reduced to 0° C. and B mm. pressure;* β_1 and β_2 the corresponding values which λ assumes when pure oxygen (gas I.), or pure nitrogen (gas II.) are substituted for air, then as the value π in our apparatus amounted to 1·6 millimetres,

$$\lambda=\frac{v(B_1-\tau_1+1\cdot6)}{1+\alpha t_1)(B_0-\tau_0)\times W},$$

where v stands for the volume of gas as read in the measurer, and W for the volume of water used. Whence

$$\beta_1=\lambda\frac{n_1}{m_1}$$

$$\beta_2=\lambda\frac{n_2}{m_2}.$$

In all the experiments to be reported (where air was used) I took $m_1=0·209$, $m_2=0·791$.

Experiments with Pure Water.

Our first series of experiments was made with air, a flask of W = 800 c.c. capacity being used in all cases for boiling out the gases. The results were unsatisfactory. Our numbers for λ, β_1, β_2, were higher than Bunsen's, and, what was worse, they agreed only indifferently with one another. What in the following tabular statement are given as "curve-values," were obtained by the ordinary graphic method:—the values of the t_0 were laid down as abscissæ, the observed values of λ or β as ordinates, and the series of dots obtained connected together as nearly as possible by a continuous curve. For the several temperatures I found the values given below them—

	t_0 = 4·5° C.	16° C.	18° C.	18° C.	35° C.
n_1 =	0·3419	0·3385	0·3418	0·3308	0·3330
Curve n_1 =	0·342	0·3386	0·3380	...	0·3330
Bunsen n_1 =	. . . . . ·3491				
1000 λ =	26·7	18·9	19·0	19·3	14·3
Curve	26·7	20·1	19·2	19·2	14·3
Bunsen	22·08	17·71	17·32	17·32	...
1000 β_1 =	43·7	30·6	31·15	30·57	22·8
Curve	43·6	31·9	30·6	30·6	22·8
Bunsen	36·72	29·49	28·84		Not determined.
1000 β_2 =	22·2	15·8	15·85	16·34	12·1
Curve	22·2	15·8	16·25		12·1
Bunsen	18·16	14·58	14·26		Not determined.

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* For calculating purposes, say 1 mm., instead of B mm.

I was quite dissatisfied with these irregular results, and need not say that I did not by any means feel sure that Bunsen had gone even further wrong than myself. But not being able to discover any flaw in my work serious enough to account, for instance, for the fact that while Bunsen (for the temperature 4°·5) makes $1000\,\lambda = 22·08$, I find it to be 26·7 (*i.e.*, 4 c.c. per litre more), I thought there was no use in simply repeating my determinations, and, instead of doing so, started a series with pure nitrogen gas, prepared by sucking a slow current of dry air free from carbonic acid over a long column of red-hot copper wire-gauze into a Pisani * gas-holder, charged with a very dilute solution of alkaline pyrogallate. As my Jacobsen flask held 800 c.c., I needed for each experiment several litres of gas. We did not always succeed in keeping such large supplies of nitrogen gas absolutely free of adventitious air. The nitrogen, accordingly, was viewed as a mixture of pure nitrogen with a little oxygen; and the formulæ on page 162 employed for calculating the result. After the saturation of the water with the nitrogen had been effected, a sample of the latter was put aside for determining m_1 should the analysis of the absorbed gas give more than a practical *nil* for n_1. As the values n_1 were always very small, the values of m_1 could be calculated from those of n_1, because we evidently have—

$$q_1 = m_1\beta_1\mathrm{P}\,,$$
$$q_2 = m_2\beta_2\mathrm{P}\,,$$

where the symbols q_1 q_2 designate the quantities of oxygen and nitrogen absorbed by the water operated upon from the impure nitrogen with which it was saturated. As an obvious sequence from the two equations, we have—

$$\frac{q_1}{q_1+q_2} = n_1 = \frac{m_1\beta_1}{m_1\beta_1 + m_2\beta_2}\,,$$

and, since approximately, $\beta_1 = 2\beta_2$, we may say—

$$n_1 = 2m_1\frac{1}{1+m_1}\,,$$

or since m_1 is small,

$$n_1 = 2m_1\,.$$

In this manner I generally calculated n_1 and m_1 from each other, and for each adopted the mean of the value calculated and the value found. The greatest value for m_1 which ever occurred was 0·0079. When n_1 was found to be very small, m_1 was merely calculated from it, and not determined at all.

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* Two bottles, provided with cork-holes below, and through these united by means of an india rubber tube. One of the bottles is provided with a glass stop-cock, inserted by an india-rubber stopper in the neck.

In this manner 7 experiments were carried out at the temperatures 16°·5, 17°·3, 17°·4, 19°·0, 20°·0, 21°·0, 25°·2 C., and a curve was drawn through points indicating the values of β_t. The results were less irregular than those of the preceding series, but again they were higher than Bunsen's. In the last two experiments the saturation of the water was effected in the boiling-out flask itself, to avoid transference from one vessel to another, the flask having been provided for this purpose with a kind of egg-shaped "*allonge*," attached to its neck by an india-rubber tube. Before quoting the results, I will state that this "nitrogen series" was followed by a new series of eleven experiments with air free from carbonic acid at the temperatures 3°·3, 4°·5, 4°·7, 16°·7, 17°·0, 17°·8, 18°·5, 20°·2, 20°·2, 26°·1, 30°·0 C. The results again were not up to my expectations; what they were will be stated presently. I prefer first to report on a lengthy series of attempts to determine the coefficient β_1 for oxygen directly by experiments with pure oxygen gas. In all these experiments with oxygen the saturation was effected in the boiling-out flask to avoid absorptiometric exchange with the atmosphere. The oxygen extracted from the liquid in which it had been absorbed was always tested, after having been measured, with alkaline pyrogallate, when it invariably disappeared, leaving no measurable residue.

The first eleven experiments were made at the temperatures 5°·1, 5°·3, 13°·2, 13°·6, 14°·6, 15°·5, 15°·5, 18°·6, 21°·8, 21°·9, 23°·7, 28°·6 C. The results again were not as regular as I should have wished, and the values β_1 were invariably *less* than the corresponding ones calculated from the values of λ of the series of experiments upon air. Whence I concluded that some of the oxygen had been absorbed by the india-rubber stopper of the Jacobsen flask in the boiling-out process. I accordingly caused Mr. Lennox to construct a boiling-out flask entirely of glass, and after numerous failures he succeeded in producing one which worked not unsatisfactorily. The results which we obtained with this apparatus were not any higher than the previous ones, and even less constant. I therefore do not describe it here any further than by saying that the india-rubber stopper was replaced by a hollow glass stopper, to the upper end of which the pear-shaped bulb was fused on. The stopper had a small perforation about half-way between the top and the bottom end of its working surface, which, when the stopper was turned into a certain position, just met the upper end of a groove in the ground neck that extended downwards to the end of the ground part. It will readily be understood that this arrangement was equivalent to the lateral hole in Jacobsen's gas-bulb stem—in theory; in practice, it did not work at all satisfactorily, because very often the stopper would stick so fast that it was impossible to turn it round. On more than one such occasion the apparatus broke and had to be renewed. Of the many endeavours to work it only seven were carried through without accident; and even these I look upon with suspicion, because of the numbers for β_1 which they gave, five were lower than would have been expected from the sum-total of previous corresponding experiments with the ordinary Jacobsen's apparatus. The apparatus was accordingly given up.

Seeing that all our results, especially those of the oxygen experiments, exhibited greater irregularities than could be accounted for by liberal allowance for all the sources of error which I could think of as possible, I concluded that there must be something fundamentally wrong in the method itself independently of our mode of executing it, and I made an attempt to determine the coefficient of absorption of oxygen *synthetically* in the following manner:—A round-bottomed flask of some 800 c.c. capacity was provided with a quill-sized neck and Geissler stop-cock, and its exact weight and capacity determined by means of a fine balance. This flask was charged with water, which was boiled until the air might be assumed to have been expelled, the stop-cock turned off, the apparatus allowed to cool, and weighed to ascertain the weight of the water, for its own sake and as a necessary datum for the subsequent calculation of the empty space in the flask. The necessary supply of oxygen was contained in a graduated U-shaped tube, connected with a moveable mercury reservoir so as to render it possible to keep the pressure at exactly one atmosphere, and immersed in a large water-bath maintaining a constant temperature. To make a determination the flask was totally immersed in a large water-bath of the proper temperature, connected with the oxygen reservoir by means of capillary tubing, the stop-cocks turned open, and absorptiometric equilibrium presumably established by shaking the flask constantly, while an assistant kept the pressure inside at exactly that of the atmosphere. After the necessary (obvious) readings, the temperature in the bath was raised or lowered so many degrees, and another set of readings at *that* temperature taken, and so on. The results were very discouraging, falling far below what by any possibility could be admitted to be the values of β_1 sought. My explanation of this was that a given mass of water to be saturated with oxygen must be *shaken violently* with the gas (which, with the apparatus adopted, was impossible), and that the data for calculating the volume of the residual gas in the empty part of the flask were too uncertain. This latter source of uncertainty might have been removed by a modification in the apparatus, which will readily suggest itself to everybody; but both Mr. Lennox and myself found it necessary to defer the continuation of the investigation for a time.

Before reporting on the manner in which it was subsequently resumed, I propose first to utilise our *final* formulæ for n_0, λ, β_1, and β_2, for reducing the numbers derived from the pioneering work to a few integer temperatures, and in this form place them before the reader. The differences of temperature which entered the calculations were, as a rule, less than ±2° C.

In the following tabular statements, the first line always gives (as "final") the value demanded by the respective interpolation formula, while the succeeding lines report the numbers brought out by the experiments named in Column I., each result standing under the assumed temperature to which it is reduced.

Nos. (1) to (6) denote our very first attempt, as referred to on page 162.

Nos. (7) to (14) refer to the experiments with nitrogen-gas.

Nos. (15) to (26) to the second series of experiments made with air.

Nos. (27) to (37) to the first series of experiments with oxygen-gas.

Nos. (38) to (44) to the (very unsatisfactory) experiments made with the boiling-out flask with a ground-glass stopper.

The symbols *a*, *b*, *c*, &c., denote results obtained in a special series of experiments made merely in order to determine the value n_1 for a series of temperatures.

TABLE III.

Giving the Values of $100 \times n_1$.

Temperature.	4°	15°	18°	20°	25°	30°
Final.	34·51	34·01	33·87	33·78	33·56	33·33
Exp. 1	...	(33·78)†	...	...	...	...
2	...	...	...	34·09	...	...
3	...	33·90	...	...	...	...
4	...	...	...	32·99	...	...
5	...	...	...	...	...	33·53
6	34·21	...	...	...	...	...
15	...	...	...	33·71	...	...
16	...	...	...	33·65	...	...
17	...	...	...	33·74	...	...
18	...	34·15	...	...	...	...
19	...	...	...	34·04	...	...
20	...	...	...	33·80	...	...
21	...	...	...	33·90	...	...
22	...	...	...	...	...	33·41
23	...	...	...	...	33·63	...
24	35·12	...	...	...	...	...
25	34·92	...	...	...	...	...
26	34·06	...	...	...	...	...
a	...	32·50	...	...	...	...
b	...	33·02	...	...	...	...
c	...	33·60	...	...	...	...
d	...	33·70	...	...	...	...
e	...	33·44	...	...	...	...
f	...	...	...	33·09	...	...
g	33·74	...	...	...	...	...
h	(31·76)	...	...	...	...	...
i	...	32·02	...	...	...	...
k	34·25	...	...	...	...	...
m	...	...	...	...	34·31	...
n	...	...	...	...	33·17	...
o	...	...	...	33·03	...	...

TABLE IV.

Giving the Values of 1000 × λ.

Temperature.	4°	15°	18°	20°	25°	30°
Final.	26·72	21·16	20·03	19·33	17·80	16·49
Exp. 1	...	...	...	...	...	...
2	...	...	19·04	...	...	...
3	...	19·30	...	...	...	...
4	...	...	19·31	...	...	...
5	...	...	...	...	...	15·45
6	27·03	...	...	...	...	...
15	...	...	...	19·24	...	...
16	...	...	20·29	...	...	...
17	...	...	20·02	...	...	...
18	...	...	20·11	...	...	...
19	...	...	...	19·26	...	...
20	...	...	20·39	...	...	...
21	...	...	...	19·12	...	...
22	...	...	...	...	...	16·79
23	...	...	...	...	17·49	...
24	26·78	...	...	...	...	...
25	26·65	...	...	...	...	...
26	26·24	...	...	...	...	...

TABLE V.

Giving the Values of 1000 × β_r.

Temperature.	4°	15°	18°	20°	25°	30°
Final.	22·12	17·65	16·74	16·19	14·95	13·90
Exp. 2	...	...	15·85	...	...	...
3	...	16·12	16·34	...	...	...
4	...	...	...	...	...	...
5	...	...	...	...	...	12·99
6	22·47	...	...	...	...	...
Nitrogen Series. 7	...	...	...	...	15·65	...
8	...	...	...	(failure)	...	...
9	...	...	...	17·46	...	...
10	...	...	17·06	16·51	...	...
11	...	...	...	16·45	...	...
12	...	19·69	...	...	...	...
13	...	...	16·39	...	...	...
14	...	...	16·37	...	...	...
15	...	...	...	16·12	...	...
16	...	...	17·00	...	...	...
17	...	...	16·74	...	...	...
18	...	17·67	16·76	...	...	...
19	...	...	...	16·06	...	...
20	...	...	17·04	...	...	...
21	...	...	...	15·98	...	...
22	...	...	...	...	...	14·13
23	...	...	...	...	14·66	...
24	21·96	...	...	...	...	...
25	21·92	...	...	...	...	...
26	21·87	...	...	...	...	...

TABLE VI.

Giving the Values of $1000 \times \beta_1$.

	Temperature.	4°	15°	18°	20°	25°	30°
	Final.	44·12	34·44	32·46	31·25	28·57	26·29
	Exp. 2	...	...	31·15	...	...	...
	3	...	31·32	...	...	...	...
	4	...	...	30·57	...	...	...
	5	...	...	...	...	...	24·78
	6	44·24	...	...	...	...	...
	15	...	...	...	31·03	...	...
	16	...	...	32·77	...	...	...
	17	...	...	32·40	...	...	...
	18	...	34·67	...	...	...	...
	19	...	...	...	31·37	...	...
	20	...	...	33·06	...	...	...
	21	...	...	...	31·01	...	...
	22	...	...	...	...	...	26·84
	23	...	...	...	...	28·12	...
	24	45·00	...	...	...	...	...
	25	44·54	...	...	...	...	...
	26	42·65	...	...	...	...	...
Oxygen Experiment. I. Series.	27	...	33·69	...	...	...	...
	28	...	33·18	...	...	...	...
	29	...	33·13	...	...	...	...
	30	...	...	...	31·38	...	...
	31	...	...	...	...	...	26·32
	32	...	...	...	31·43	...	...
	33	...	...	...	...	28·28	...
	34	...	...	32·16	...	...	...
	35	...	34·62	...	...	...	...
	36	42·67	...	...	...	...	...
	37	42·84	...	...	...	...	...
Oxygen Experiment. II. Series. Glass Joints.	38	...	33·05	...	...	...	...
	39	...	31·27	...	...	...	...
	40	...	30·41	...	...	...	...
	41	...	33·05	...	...	...	...
	42	...	...	33·85	...	...	...
	43*	...	(34·01)	...	...	...	...
	44	...	...	...	33·26	...	...

Final Experiments with Water and Sea-Water.

The determination of the coefficients of absorption of oxygen and nitrogen may obviously be effected in two ways, namely, either by separate experiments with these two gases, or by single experiments with "pure" air. The second method is the simpler of the two, and furnishes more directly what I wanted for the discussion of the sea-water gas analyses;

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* Some air slipped in, hence the value of β_1 is too high.

besides it was the one which in my hands had given the less irregular results; hence, when I came to resume my absorptiometric work, I at once decided upon confining myself to experiments with air. But the air method might be brought into a variety of forms other than the one I had adopted in my experiments. One might, for instance, start with a known quantity of water and a *known* quantity of air, shake them up together in a vessel at a constant *volume*, not greater than necessary but exceeding that of the water, and determine the ensuing changes of composition and tension in the unabsorbed residual gas. This method for a while seemed to me to be particularly promising, the more so as it obviously lends itself to successive determinations at different temperatures with the same *quantity* of water; but I could not see my way towards devising an adequate apparatus, and therefore fell back upon the original form of the method, from which, however, I took care to eliminate what I had been led, rightly or wrongly, to regard as its principal sources of error.

When water in which air is absorbed is boiled in a Jacobsen (or similar) apparatus, the "vacuum" present at the commencement is, of course, quickly lost, and at the end of the process the water boils under a pressure of something like one-fourth or one-third of an atmosphere, and at a temperature at which either of the two coefficients of absorption may still have a very appreciable value. Hence, in successive experiments a gas-residue, variable in relative magnitude and in composition, may be retained by the water. To avoid this error, all that needs to be done is to suck out and remove the gas, as quickly as it is liberated, by a mercurial air-pump. This, in short, is the method which we adopted in the final experiments now to be reported on. The boiling-out flask (A Pl. III.) differed from Jacobsen's only in this, that the bulbs were replaced by a plain upright tube, surrounded by a cold-water jacket, and communicating by its upper end with a mercurial air-pump. As we had not a Geissler air-pump in the laboratory, and I thought that Sprengel's apparatus (which could easily have been procured) would work too slowly, I designed a new form of the instrument, which Mr. Lennox had no difficulty in constructing. It is represented on Pl. III., and as the drawing is made to scale, I can be very brief in its explanation. The pump proper is seen to consist of two cylindrical glass reservoirs, united by a stout U-tube, so that the one is above the other, and is fixed vertically to a wooden stand. The upper reservoir, by a narrow side tube fused in somewhere near its lowest point, communicates with the exit end of the gas-tube of the modified Jacobsen's flask, the bent capillary tube soldered on to its top serves to discharge the sucked-in gas into a test-tube inserted into a small mercurial trough. The lower bulb, by a Y-tube inserted into its neck by an india-rubber stopper, can be made to communicate either with a copper ball containing a supply of sufficiently compressed air, or with a Sprengel water-pump, as used for accelerating filtrations. A perfect vacuum is obtained by the sucking power of the vertical column of mercury suspended in the U-tube adding itself to that of the partial vacuum of the water-pump.

There is no need for any further description; the principle of the apparatus is sufficiently explained; and whosoever may reproduce and use the apparatus will, of course, have to acquire a certain degree of familiarity with the apparatus before he can work it properly.

To determine a value λ, about 1 to 1½ litres of water or sea-water were placed in a "Winchester quart" bottle, standing in a large water-bath of rigorously-constant temperature, and exposed for several hours to a current of air free from carbonic acid sucked in from the outside open atmosphere, first through a large soda-lime tower, and then through the water by means of a filter-pump. Very frequently the bottle was lifted out of its bath for a few seconds, violently shaken, and immediately replaced in the bath. The temperature of the water operated upon was always taken directly by means of a delicate thermometer plunged into it; the thermometer in the bath merely served to control the temperature there with regard to its constancy. When absorptiometric equilibrium was supposed to have been attained, the water, by means of a wide and long-necked funnel, was transferred to the Jacobsen flask, a considerable quantity being allowed to flow over to eliminate the influence of the outer air as much as possible, the perforated india-rubber stopper inserted, and the stem of the "gas-tube" inserted so that the lateral hole was shut up by the mass of the india-rubber. The pump was then worked until the gas-tube was completely exhausted. The gas-tube stem was then pressed down so as to bring the lateral hole within the water, and the water heated to boiling while the pump was being wrought at short intervals to maintain a sufficient vacuum, which at the end was raised to the highest attainable pitch. The boiling was continued until after the exhaust-bulb of the pump was emptied for the last time, five minutes' further boiling failed to extract a visible gas bell. The gas was then measured and analysed.

We began with a long series of trials with distilled water, and then passed on to experiments with sea-water. The latter was prepared synthetically on a large scale from pure salts and distilled water, so as to represent about an average Challenger water. Care was taken to give to the solutum very nearly the quantitative composition demanded by my own analyses, as reported in the first part of this memoir. The "alkalinity" was established by addition of the calculated proportion of ignited carbonate of soda to a neutral, but otherwise correctly adjusted, water. The following is a statement of the results.

Experiments upon Pure Water.

27 experiments were made at temperatures varying from 0°·5 to 47° C. The values of the absorbed gas were plotted and united by the nearest curve, which enabled me to single out a few results which were obviously infected with bad unobserved errors, and to obtain good enough values for the expression $\frac{\Delta\lambda}{\Delta t}$ to reduce any group of values obtained

at nearly the same temperature to one and the same intermediate temperature. The following eight groups were thus formed :—

Group I.—7 experiments. Adopted standard temperature $(t) = 14°{\cdot}5$. Mean value of $\lambda = 21{\cdot}32$ $(\div 1000)$. This divisor must be supposed to be appended to all the λ's down to group VIII.

Group II.—2 experiments ; $t = 13°{\cdot}0$; $\lambda = 21{\cdot}68$.

Group III.—1 experiment ; $t = 20°{\cdot}4$; $\lambda = 19{\cdot}05$ (not allowed any influence in the calculation).

Group IV.—2 experiments ; $t = 18°{\cdot}0$; $\lambda = 20{\cdot}09$.

Group V.—2 experiments ; $t = 29°{\cdot}5$; $\lambda = 16{\cdot}40$.

Group VI.—4 experiments ; $t = 1°{\cdot}0$; $\lambda = 28{\cdot}94$.

Group VII.—3 experiments ; $t = 5°{\cdot}5$; $\lambda = 25{\cdot}72$.

Group VIII.—2 experiments ; $t = 45°{\cdot}0$; $\lambda = 13{\cdot}98$.

A few preliminary calculations based on convenient ordinates taken from the curve showed that an equation of the form $\lambda = \lambda_0 - at + bt^2$ gave no sufficient approximation. A formula of the form

$$\lambda = \frac{A}{B + t}$$

worked better ; yet the difference between observed and calculated values in some cases was inconveniently great. When the same function was treated according to the method of least squares, quite satisfactory results were obtained. In this final calculation groups I. and VI. were each allowed two votes ; group VIII., half a vote ; the rest one vote each, except group III., which was not taken into account at all. The resulting formula was

$$1000 \times \lambda = \frac{1119{\cdot}4}{37{\cdot}9 + t} ;$$

whence we have—

Group.	t.	λ Calculated.	λ Found.
VI.	1°·0	28·78	28·94
VII.	5°·5	25·79	25·72
II.	13°·0	21·99	21·68
I.	14°·5	21·36	21·32
IV.	18°·0	20·03	20·09
III.	20°·4	19·20	19·05
V.	29°·5	16·61	16·40
VIII.	45°·0	13·50	13·98

In a similar manner the values for n_1 (the volumes of oxygen in unit-volume of absorbed gas) were dealt with. The resulting formula, calculated by the method of the least squares, was

$$100 \times n_1 = 34{\cdot}693 - 0{\cdot}04545t .$$

t.	Mean values found.	n_1 calculated.
1°	34·47	34·65
6°	34·55	34·42
14°	33·97	34·06
18°·0	33·89	33·87
30°·0	33·39	33·33
45°·0	32·58	32·65

Hence, we have for the coefficient of absorption of oxygen β_1,

$$1000\,\beta_1 = \frac{1119{\cdot}4 \times n_1}{(37{\cdot}9 + t) \times 0{\cdot}209},$$

or

$$1000\beta_1 = \frac{1858{\cdot}1}{(37{\cdot}9 + t)}(1 - 0{\cdot}00131t).$$

And for the nitrogen:

$$1000\beta_2 = \frac{924{\cdot}3}{(37{\cdot}9 + t)}(1 + 0{\cdot}000696t).$$

These formulæ served for the calculation of the following tables:—

TABLE VII.

Showing the Absorption of Air by Pure Water.

(Values of 100 × n_1 and of 1000 × λ.)

t.	100 n_1.	1000λ.	Δλ.	t.	100 n_1.	1000λ.	Δλ.
0°	34·69	29·54	·80	20°	33·78	19·33	·34
1	·65	28·78	·76	21	·74	19·01	·32
2	·60	28·06	·72	22	·69	18·69	·32
3	·55	27·37	·69	23	·65	18·38	·31
4	·51	26·72	·65	24	·60	18·08	·30
5	·47	26·09	·63	25	·56	17·80	·28
6	·42	25·50	·59	26	·51	17·52	·28
7	·38	24·93	·57	27	·47	17·25	·27
8	·33	24·39	·56	28	·42	16·99	·26
9	·28	23·87	·52	29	·37	16·73	·26
10	·24	23·37	·50	30	·33	16·49	·24
11	·19	22·89	·48	31	·28	16·25	·24
12	·15	22·43	·46	32	·24	16·01	·24
13	·10	21·99	·44	33	·19	15·79	·22
14	·06	21·57	·42	34	·15	15·57	·22
15	·01	21·16	·41	35	·10	15·36	·21
16	33·97	20·77	·39				
17	·92	20·39	·38	40	32·88	14·37	...
18	·87	20·03	·36	45	·65	13·50	...
19	·83	19·67	·36	50	·42	12·73	...
20	·78	19·33	·34	...	...	...	...

TABLE VIII.

Showing the Absorption of Oxygen and Nitrogen by Pure Water.

(Values of $1000\beta_1$ and $1000\beta_2$.)

t.	$1000\beta_1$	$\Delta\beta_1$	$1000\beta_2$	$\Delta\beta_2$	t.	$1000\beta_1$	$\Delta\beta_1$	$1000\beta_2$	$\Delta\beta_2$
0°	49·03	1·39	24·40	·63	21°	30·68	·57	15·92	·27
1	47·70	1·33	23·78	·62	22	30·13	·55	15·67	·25
2	46·45	1·25	23·21	·57	23	29·59	·54	15·42	·25
3	45·25	1·20	22·65	·56	24	29·07	·52	15·18	·24
4	44·11	1·14	22·12	·53	25	28·57	·50	14·95	·23
5	43·03	1·08	21·62	·50	26	28·09	·48	14·73	·22
6	41·99	1·04	21·14	·48	27	27·62	·47	14·51	·22
7	41·00	·99	20·69	·45	28	27·16	·46	14·30	·21
8	40·06	·94	20·25	·44	29	26·72	·44	14·10	·20
9	39·15	·91	19·83	·42	30	26·29	·43	13·90	·20
10	38·28	·87	19·43	·40	31	25·87	·42	13·70	·20
11	37·45	·83	19·05	·38	32	25·47	·40	13·52	·18
12	36·65	·80	18·68	·37	33	25·07	·40	13·34	·18
13	35·88	·77	18·32	·36	34	24·69	·38	13·16	·18
14	35·15	·73	17·98	·34	35	24·32	·37	12·99	·17
15	34·44	·71	17·65	·33					
16	33·75	·69	17·34	·31	40	22·60	...	12·20	...
17	33·09	·66	17·03	·31	45	21·02	...	11·50	...
18	32·46	·63	16·74	·29	50	19·75	...	10·88	...
19	31·84	·62	16·46	·28	...	...	...	...	...
20	31·25	·59	16·19	·27	...	...	...	...	...
21	30·68	·57	15·92	·27	...	...	...	...	...

Sea-Water.

The experiments with sea-water were carried out and the immediate results treated exactly as in the case of pure water. The process offered no special difficulty, yet the results were, on the whole, less satisfactory; a greater number of them than in the case of pure water failed to stand the critique of the first curve, and had to be thrown out.

Values for λ.

Groups I. and II.—8 experiments; t from 12°·8 to 14°·4. Adopted mean temperature, $t_0=14°·0$; λ (mean)$=17·31$.

Group III.—4 experiments at $t=20°·1$ to $20°·3$. $t_0=20°·0$; $\lambda=15·69$.

Group IV.—2 experiments at 17°·1 and 18°·0. λ for $18°·0=16·67$.

Groups III. and IV. combined, and reduced to 19°·0; $\lambda=16·10$.

Group V.—2 experiments at 1°·2 and 1°·8. λ for 1°·5=23·18.

Group VI.—2 experiments at 5°·8 and 6°·5. λ for 6°·0=20·20.

Group VII.—2 experiments at 33°·6 and 33°·3, taken as one experiment made at 33°·45. λ for 33°·5=12·80. These mean λ's were treated according to the method of least squares, the following number of votes being allowed to the several groups:—

	Groups I. and II.	III. and IV.	V.	VI.	VII.
Votes, . .	4	3	1	1	½

The resulting formula was—

$$1000\lambda_1 = \frac{927{\cdot}31}{39{\cdot}02+t}.$$

By giving *one* vote to each group I arrived at the formula—

$$1000\lambda_2 = \frac{924{\cdot}71}{38{\cdot}90+t}.$$

t.	λ_1.	λ_2.	λ Observed.
14°	17·49	17·48	17·42
19°	15·98	15·97	16·10
1°·5	22·89	22·89	23·18
6°·0	20·60	20·59	20·20
33°·5	12·79	12·77	12·80

I adopted the formula—

$$1000\lambda = \frac{927{\cdot}31}{39{\cdot}00+t}$$

and by means of it calculated the subjoined tables.

Values for n_1.

The mean temperatures and mean values of n_1 for the several groups were as follows:—

$t=$	14°	20°	18°	0°	6°	33°
$100\,n_1=$	33·98	33·78	33·58	34·37	34·18	33·29

Rectilinear *graphic* interpolation led to the formula—

$$100 \times n_1 = 34{\cdot}40 - 0{\cdot}0311t,$$

which was utilised for calculating the values $\frac{n_1}{n_2}$ in Table IX.

TABLE IX.

Showing the Absorption of Air and Nitrogen by Sea-Water.

[One litre of sea-water, when saturated with (infinite) excess of air at $t°$ absorbs 1000λ c.c. of gas, containing n_1 volumes of oxygen and n_2 volumes of nitrogen in unit volume.]

t.	1000λ	Diff.	$1000\lambda n_2$	Diff.	$n_1 \div n_2$	$100 \times n_1$
−5	27·27	...	17·85	...	·5280	34·56
−4	26·49	·78	17·35	·50	·5273	·52
−3	25·76	·73	16·87	·48	·5266	·49
−2	25·06	·70	16·43	·44	·5258	·46
−1	24·40	·66	16·00	·43	·5251	·43
0	23·78	·62	15·60	·40	·5244	·40
+1	23·18	·60	15·21	·39	·5237	·37
2	22·62	·56	14·85	·36	·5229	·34
3	22·08	·54	14·50	·35	·5222	·31
4	21·57	·51	14·18	·32	·5215	·28
5	21·08	·49	13·86	·32	·5208	·24
6	20·61	·47	13·56	·30	·5200	·21
7	20·16	·45	13·26	·30	·5193	·18
8	19·73	·43	12·99	·27	·5186	·15
9	19·32	·41	12·73	·26	·5179	·12
10	18·92	·40	12·47	·26	·5172	·09
11	18·54	·38	12·23	·24	·5165	·06
12	18·18	·36	11·99	·24	·5158	·03
13	17·83	·35	11·77	·22	·5150	·00
14	17·50	·33	11·56	·21	·5143	33·96
15	17·17	·33	11·34	·22	·5136	·93
16	16·86	·31	11·14	·20	·5129	·90
17	16·56	·30	10·95	·19	·5122	·87
18	16·27	·29	10·76	·19	·5115	·84
19	15·99	·28	10·58	·18	·5108	·81
20	15·72	·27	10·41	·17	·5101	·78
21	15·46	·26	10·24	·17	·5094	·75
22	15·20	·26	10·07	·17	·5087	·72
23	14·96	·24	9·92	·15	·5079	·68
24	14·72	·24	9·77	·15	·5072	·65
25	14·49	·23	9·62	·15	·5065	·62
26	14·27	·22	9·48	·14	·5058	·59
27	14·05	·22	9·34	·14	·5051	·56
28	13·84	·21	9·20	·14	·5044	·53
29	13·64	·20	9·07	·13	·5037	·50
30	13·44	·20	8·94	·13	·5030	·47
31	13·25	·19	8·82	·12	·5023	·44
32	13·06	·19	8·70	·12	·5016	·40
33	12·88	·18	8·58	·12	·5009	·37
34	12·70	·18	8·47	·11	·5002	·34
35	12·53	·17	8·36	·11	·4995	·31

TABLE X.

To find the Temperature (t°) from the number of cubic centimetres of Nitrogen ($1000n_2\lambda$) absorbed from pure air by one litre of Sea-Water.

$1000n_2\lambda$.	t.	Δt.	$1000n_2\lambda$.	t.	Δt.
18·0	− 5·29°	...	13·4	+ 6·54°	·35
17·9	− 5·10	·19	13·3	6·89	·35
17·8	− 4·91	·19	13·2	7·25	·36
17·7	− 4·71	·20	13·1	7·61	·36
17·6	− 4·51	·20	13·0	7·98	·37
17·5	− 4·30	·20	12·9	8·35	·37
17·4	− 4·10	·21	12·8	8·72	·37
17·3	− 3·90	·20	12·7	9·11	·39
17·2	− 3·69	·21	12·6	9·50	·39
17·1	− 3·48	·21	12·5	9·90	·40
17·0	− 3·27	·21	12·4	10·30	·40
16·9	− 3·06	·21	12·3	10·71	·41
16·8	− 2·84	·22	12·2	11·13	·42
16·7	− 2·61	·22	12·1	11·55	·42
16·6	− 2·39	·23	12·0	11·98	·43
16·5	− 2·17	·22	11·9	12·42	·44
16·4	− 1·94	·23	11·8	12·87	·45
16·3	− 1·70	·24	11·7	13·33	·46
16·2	− 1·47	·23	11·6	13·79	·46
16·1	− 1·24	·23	11·5	14·26	·47
16·0	− 1·00	·24	11·4	14·74	·48
15·9	− 0·76	·24	11·3	15·23	·49
15·8	− 0·51	·25	11·2	15·72	·49
15·7	− 0·25	·26	11·1	16·23	·51
15·6	0·00	·25	11·0	16·74	·51
15·5	+ 0·25	·25	10·9	17·27	·53
15·4	0·51	·26	10·8	17·80	·53
15·3	0·77	·26	10·7	18·35	·55
15·2	1·04	·27	10·6	18·91	·56
15·1	1·31	·27	10·5	19·48	·57
15·0	1·59	·28	10·4	20·05	·57
14·9	1·87	·28	10·3	20·64	·59
14·8	2·15	·28	10·2	21·24	·60
14·7	2·43	·28	10·1	21·86	·62
14·6	2·72	·29	10·0	22·48	·62
14·5	3·01	·29	9·9	23·13	·65
14·4	3·31	·30	9·8	23·78	·65
14·3	3·61	·30	9·7	24·45	·67
14·2	3·92	·31	9·6	25·13	·68
14·1	4·23	·31	9·5	25·83	·70
14·0	4·54	·32	9·4	26·53	·70
13·9	4·86	·32	9·3	27·26	·73
13·8	5·19	·33	9·2	28·00	·74
13·7	5·52	·33	9·1	28·77	·77
13·6	5·85	·33	9·0	29·54	·77
13·5	6·19	·34	8·9	30·35	·81
13·4	6·54	·35	8·8	31·16	·81

By means of these two tables I was enabled to re-calculate the results of Mr. Buchanan's and my own analyses of the gas extracted from sea-water, so as to bring them into a more convenient form for interpretation. The results of my calculations are embodied in the following tables:—

In Table XI. for the *Surface-Waters* Column I. gives the number assigned to the respective sample of water by Mr. Buchanan.

Column II. names the Station at which the water was collected. The symbol + attached to a number means that the water was collected shortly after passing the Station; the sign − shortly before arriving at it.

Column III. gives the temperature t_0 of the water when collected; the numbers are transcribed from Mr. Buchanan's printed report on the specific gravities.

Columns IV. and V. give, the former the nitrogen, the latter the oxygen, gas found per litre of water analysed, in cubic centimetres reduced to 0° C. and 760 mm. dry pressure.

Columns VI. and VII. give the volumes of nitrogen and oxygen which the water, at $t_0°$, according to my determinations, would take up if fully saturated by exposure to an infinitely great volume of air at 760 mm. dry pressure.

Column VIII. (as IV. $\times \frac{n_1}{n_2}$) gives the volume of oxygen which, according to my experiments, should be present along with the volume of nitrogen recorded in Column IV. as having been found. This volume of oxygen is in general greater than that of the oxygen brought out by analysis.

Column IX. gives the difference between the amount of oxygen obtained by calculation and that found by the analysis, *i.e.*, the value of entry in Column VIII. *minus* entry in Column V.

Table XII. is devoted to the "intermediate waters," meaning waters neither surface nor bottom waters. They are arranged in the order of the depths (δ) at which the samples were taken. The entries in Columns I. and II. have the same meaning as in Table XI.

Column III. under D gives the depth of the sea at the respective place.

Column IV. the depth (δ) at which the sample of water was taken.

Column V., under t_0, the natural temperature of the water when the sample was collected. (Taken from Mr. Buchanan's specific gravity tables.)

Columns VI. and VII. give the volumes of nitrogen and oxygen found per litre of water, reduced to 0° and 760 mm. of dry-gas pressure.

Column VIII. gives the temperature t_1 at which one litre of sea-water, according to my experiments, would take up the volume of nitrogen found (Column VI.) from pure air of 760 mm. dry pressure.

Column IX., under $(O_2)_1$, gives the volume of oxygen which, according to my experiments, would be present along with the nitrogen found (Column VI.) in water fully saturated with air at t_1 degrees. This calculated oxygen is in general greater than the oxygen actually found, as stated in Column VII. The oxygen deficit in the water is registered in Column X.

The headings of the several columns in Table XIII. for the *bottom waters* have the same meaning as the same symbols have in Table XII.

When the absolute volume V of the gas remained undetermined, then, *in the case of Table XI.*, I took the "nitrogen found" (Column IV.) from the entry, for t_0, in Table IX. These numbers and those derived from them are enclosed in brackets, [ ]. *In Tables XII. and XIII.* (when V is unknown) I give in Column VII., *in lieu* of the "oxygen found," the *percentage* of oxygen found in the gas freed from carbonic acid, in parenthesis, ( ), with the symbol % attached.

TABLE XI.

Surface-Water Gases.

			Found.		Calculated.				VI.–IV.
I. No. of Water.	II. Station.	III. t_0.	IV. Nitrogen.	V. Oxygen.	VI. Nitrogen.	VII. Oxygen.	VIII. IV. × $\frac{n_1}{n_2}$	IX. Oxygen deficit.	X. Nitrogen deficit.
386	153	– 0·7	15·32	8·26	15·88	8·33	8·04	– ·22	·56
387	153 +	+ 0·7	13·60	7·27	15·33	8·03	7·13	– ·14	1·73
389	154	– 1·7	14·81	7·72	16·30	8·56	7·78	·06	1·49
396	154	+ 0·4	13·72	7·12	15·44	8·10	7·19	·07	1·72
417	158	7·2	13·03	6·71	13·21	6·86	6·76	·05	·18
817	229 –	25·8	9·20	4·46	9·51	4·80	4·66	·20	·31
*455	164c	17·5	[10·85]	[5·27]	10·85	5·56	[5·56]	[·29]	...
471	165 $\frac{\text{A}}{\text{B}}$	15·6	11·22	5·65	11·22	5·76	5·76	·11	0·00
486	168 +	14·0	11·14	5·54	11·56	5·94	5·73	·19	·42
497	170	17·8	10·95	5·44	10·80	5·53	5·60	·16	– ·15
504	171	19·4	10·10	5·04	10·51	5·37	5·16	·12	·41
512	171A	21·9	9·39	4·62	10·09	5·14	4·78	·16	·70
515	172 +	24·5	8·83	4·29	9·70	4·91	4·47	·18	1·07
528	176	25·5	8·83	4·30	9·55	4·83	4·47	·17	·72
532	177	25·1	9·47	4·53	9·61	4·86	4·80	·27	·14
557	181	26·7	8·89	4·32	9·38	4·74	4·49	·17	·49
572	185	25·0	10·03	4·90	9·62	4·87	5·08	·18	– ·41
581	190	26·4	8·91	4·46	9·42	4·76	4·51	·05	·51
602	196	27·9	8·78	4·31	9·21	4·65	4·43	·12	·43
612	198	28·3	9·69	4·78	9·16	4·62	4·88	·10	– ·53
638	202	29·4	9·05	4·43	9·02	4·54	4·56	·13	– ·03
645	204	28·6	[9·12]	[4·52]	9·12	4·60	[4·60]	·08	...
682	214 +	26·9	7·93	3·92	9·33	4·70	4·00	·08	1·40
790	216 +	27·8	8·87	4·31	9·23	4·65	4·47	·16	·36
722	218	28·6	8·51	4·07	9·12	4·60	4·29	·22	·61
759	222 +	28·6	9·13	4·34	9·12	4·60	4·60	·26	– ·01
761	223	28·7	8·30	4·01	9·11	4·59	4·18	·17	·81
826	229 +	21·8	9·08	4·56	10·10	5·15	4·62	·06	1·02

* Suspected analysis ; compare footnote p. 145.

			Found.		Calculated.				VI.–IV.
I. No. of Water.	II. Station.	III. t_{ψ}	IV. Nitrogen.	V. Oxygen.	VI. Nitrogen.	VII. Oxygen.	VIII. IV. × $\frac{n_1}{n_2}$	IX. Oxygen deficit.	X. Nitrogen deficit.
836	230 +	20·8	9·72	4·85	10·27	5·24	4·95	·10	·55
910	244 +	21·7	9·70	4·94	10·12	5·16	4·93	− ·01	·42
926	247 +	21·9	8·21	4·30	10·09	5·14	4·18	− ·12	1·88
949	251	17·9	[10·78]	[4·72]	10·78	5·52	5·52	·80	...
976	253 +	20·6	[10·31]	[5·21]	10·31	5·25	[5·25]	·04	...
977	253 +	21·7	10·09	5·00	10·12	5·16	5·14	·14	·03
*989	255	23·3	9·14	4·69	9·88	5·01	4·64	− ·05	·74
990	255 +	23·9	8·71	4·39	9·79	4·95	4·42	·03	1·08
1003	256 +	24·0	9·30	4·54	9·77	4·95	4·72	·18	·47
1004	257	24·1	9·02	4·48	9·77	4·95	4·57	·07	·75
1011	258	25·0	8·70	4·27	9·62	4·87	4·41	·14	·92
1012	258 +	Not found.	8·84	4·40	...	...	...	...	...
1097	268	26·8	8·96	4·44	9·37	4·72	4·53	·09	·41
1187	282	22·9	9·04	4·41	9·94	5·04	4·59	·18	·90
1176	281	24·2	9·32	4·59	9·74	4·93	4·78	·19	·42
1211	284 +	19·5	9·79	5·05	10·49	5·37	4·99	− ·06	·70
1212	284 +	18·9	8·49	4·24	10·56	5·40	4·35	·11	2·07
1272	292	11·8	9·71	4·95	12·04	6·21	5·01	·06	2·33
1271	292	11·9	11·51	6·06	12·01	6·21	5·94	− ·12	·50
1287	293 +	12·5	12·15	5·83	11·88	5·13	6·12	·29	− ·27
1301	295 +	14·7	12·51	6·45	11·41	5·86	6·43	− ·02	− 1·10
1314	296 +	13·6	11·74	6·07	11·64	5·99	6·04	− ·03	− ·10
1342	299	16·9	11·29	4·81	10·93	5·60	5·78	− ·03	− ·36
1364	300	16·5	11·25	5·79	11·05	5·36	5·77	− ·02	− ·15
†1374A	301	14·2	10·53	5·48	11·52	5·91	5·41	− ·07	·99
1366	301	15·5	11·80	6·18	11·24	5·78	6·06	− ·12	− ·56
1367	301	15·5	11·54	6·12	11·24	5·78	5·92	− ·20	− ·30
1375	301 +	13·9	11·15	5·86	11·58	5·95	5·74	− ·12	·43
1378	301 +	12·7	10·76	5·53	11·84	6·10	5·54	·01	1·08
1424	309	9·4	12·87	6·34	12·63	6·53	6·66	·32	− ·24
1462	318	14·2	10·74	5·59	11·52	5·91	5·52	− ·07	·78
1508	326	20·0	10·08	5·08	10·41	5·31	5·14	·06	·33
1510	327	21·0	9·79	4·87	10·24	5·22	4·99	·12	·45
1514	329	18·4	10·17	5·25	10·69	5·47	5·20	− ·05	·52
1573	337	25·1	10·02	4·93	9·61	4·86	5·08	·15	− ·41
1590	340	25·1	9·52	4·73	9·61	4·86	4·82	·09	·09
1629	345	27·9	9·33	4·58	9·19	4·63	4·71	·13	− ·14
1662	350	Not found.	...	[33·82%]	...	...	...	...	...
1683	352 +	22·5	10·24	5·00	10·00	5·08	5·20	·20	− ·24
1699	354	20·5	10·25	5·11	10·32	5·27	5·23	·12	·07
1687	353	22·8	9·63	4·82	9·95	5·06	4·89	·07	·32

* Bad analyses.

† 1374 (?)

TABLE XII.

Gases from Waters from various Depths, not Bottom Waters.

I. No.	II. Station.	III. D.	IV. δ.	V. t_0	VI. Nitrogen.	VII. Oxygen.	VIII. t_1.	IX. $(O_2)_1$.	X. Oxygen deficit.
464	165 +	2600	5	18°·0	10·57	5·23	19°·1	5·40	0·17
466	165A	2600	5	17·0	...	(32·67%)	...	...	...
725	218	1070	10	28·4	8·40	4·03	34·6	4·20	0·17
1353	299 +	...	10	16·7	10·42	3·11	19·95	5·32	2·21
1498	325	2650	20	21·5	10·33	5·19	20·5	5·27	·08
1168	280	1940	25	25·0	9·05	4·44	29·2	4·56	·12
1262	291	2250	25	11·2	11·88	5·90	12·5	6·12	·22
1329	298	2225	25	13·2	9·93	5·02	22·05	5·05	·03
1621	345	2010	25	27·1	9·89	4·82	23·2	5·02	·20
1663	350	(?)	25	22·0	10·12	4·70	21·7	5·15	·45
979	254	3025	25	16·8	10·68	5·36	18·5	5·46	·10
994	256	2950	25	21·1	9·98	5·11	22·6	5·07	– ·04
397	155	1300	50	not found	15·00	6·53	1·6	7·85	1·32
419	158	1800	50	6·9	13·30	6·93	6·9	6·91	– ·02
461	165	2600	50	13·9	10·35	4·98	20·4	5·27	·29
489	169	700	50	13·7	...	(31·93%)	...	...	...
678	213	2050	50	not found	8·91	3·79	30·3	4·48	·69
752	222	2450	50	27·8	8·59	4·11	33·0	4·30	·19
830	230	2425	50	18·9	10·53	4·86	19·3	5·38	·52
1306	296	1825	50	12·5	11·86	6·43	12·6	6·11	– ·32
1345	299	2160	50	11·7	11·13	4·81	16·1	5·71	·90
1356	300	1375	50	12·0	11·17	5·27	15·9	5·73	·46
1576	338	1990	50	21·9	9·72	5·09	24·6	4·93	– ·16
1539	333	2025	100	12·8	11·39	4·96	14·8	5·85	·89
1585	339	1415	100	15·4	10·68	4·23	18·5	5·33	1·10
1633	346	2350	100	12·9	12·74	2·93	9·0	6·60	3·67
1704	354	1675	100	17·3	10·61	4·61	18·9	5·42	·81
543	179	2325	200	13·0	11·76	3·59	13·0	6·06	2·47
797	226	2300	200	11·5	10·58	3·20	18·8	5·40	2·20
1181	281	2385	200	13·4	10·80	4·22	17·8	5·53	1·31
1205	284	1985	200	12·5	10·28	3·97	20·8	5·24	1·27
823	229	2500	300	11·1	11·65	3·69	13·6	5·99	2·30
1661	349	...	300	6·7	13·74	1·65	5·4	7·15	5·60
1672	351	...	300	6·9	12·29	1·67	10·7	6·35	4·58
594	193	2800	100	6·4	12·31	2·25	10·7	6·36	4·11
933*	248	2900	400	4·2	14·18	1·94	3·9	7·40	5·46
1605	341	1475	400	4·6	13·57	3·16	6·0	7·06	3·90
620	198	2150	800	3·9	9·19	3·07	28·1	4·64	1·57
1220	285	2375	800	3·2	13·73	3·88	5·4	7·14	3·26
1528	331	1715	800	2·8	14·13	4·21	4·1	7·37	3·16
1546	334	1915	800	2·9	15·81	4·79	– 0·5	8·30	3·51
1655	348	2450	800	4·2	11·82	3·38	12·8	6·09	2·71
1615	342	1445	900	3·5	13·40	5·21	6·5	6·96	1·75
1312	296	1825	1350	2·4	...	(21·09%)	...	...	...
1532	332	2200	1400	2·9	13·43	5·11	6·4	6·98	1·87
1645	347	2250	1500	3·3	13·38	2·04	6·6	6·95	4·91
933†	248	2900	400	4·2	12·57	2·13	9·6	6·51	4·38
1296	294	2270	1775	1·7	14·79	3·86	2·2	7·73	3·87
1269	291	2250	1775	1·7	13·19	5·25	7·3	6·85	1·60
1241	287	2400	1925	1·7	13·33	4·45	6·8	6·93	2·48
1209	284	1985	1975	1·8	14·02	3·81	4·5	7·31	3·50
1231	286	2335	2290	1·8	16·47	4·89	– 2·1	8·66	3·77

* J. Y. B. † W. D.

I. No.	II. Station.	III. D.	IV. δ.	V. t_0	VI. Nitrogen.	VII. Oxygen.	VIII. t_1	IX. $(O_2)_1$	X. Oxygen deficit.
1696	353	2965	2465	3·1	10·45	4·12	19·8	5·33	1·21
1009	257	2875	2850	1·6	13·63	5·38	5·8	7·09	1·71
1001	256	2950	2875	1·8	15·08	0·60	1·4	8·21	7·61
1244	288	2600	2125	1·7	14·05	3·78	4·4	7·32	3·54

TABLE XIII.

Bottom-Water Gases.

I. No.	II. Station.	III. D = δ.	IV. t_θ	V. N_θ	VI. O_θ	VII. t_1	VIII. $(O_2)_1$	IX. O_2-def.
576	189	25	...	...	(31·39%)	...	...	...
643	204	110–115	...	...	(12·42%)	...	...	...
1438	311	245	7·8	12·44	5·97	10·1	6·43	0·46
477	166	275	10·4	11·97	4·36	12·1	6·17	1·81
1405	306	345	7·8	12·55	4·01	9·7	6·49	2·48
1618	343	425	4·6	11·81	3·37	12·8	6·09	2·72
1388	302	1450	2·0	14·57	3·48	2·8	7·61	4·13
383	153	1675	...	16·57	5·75	2·3	8·67	2·92
567	183	1700	2·2	13·80	3·66	5·2	7·18	3·52
569	183	1700	2·2	9·96	4·10	22·7	5·06	0·96
1494	323	1900	0·6	10·68	4·92	18·5	5·46	0·54
395	154	1800	...	16·07	6·71	− 1·2	8·44	1·73
414	157	1950	0·0	14·33	5·69	3·5	7·48	1·79
922	246	2050	1·7	11·95	4·57	12·2	6·17	1·60
428	159	2150	1·2	12·36	6·28	10·5	6·39	0·11
1544	333	2025	1·8	14·78	5·35	2·2	7·73	2·38
138	68	2175	2·3	...	(29·31%)	...	...	...
671	211	2225	10·3	10·34	4·36	20·4	5·27	0·91
1024	259	2225	1·6	11·60	2·53	13·8	5·97	3·44
771	223	2325	1·9	11·17	2·35	15·9	5·73	3·38
1125	271	2425	1·7	11·31	2·75	15·2	5·81	3·06
556	180	2450	2·2	13·66	3·28	5·7	7·11	3·83
924	247	2530	1·8	12·02	2·29	11·9	6·20	3·91
1533	332	2200	1·1	13·95	4·64	4·7	7·27	2·63
1106	269	2550	1·8	13·65	3·87	5·7	7·10	3·23
122*	60	2575	2·3	...	(31·02%)	...	...	...
439	160	2600	1·1	12·57	5·86	9·6	6·50	0·64
629	199	2600	3·7	11·55	3·21	14·0	5·94	2·73
114	53	2650	2·4	...	(30·26%)	...	...	...
1507	325	2650	0·4	18·03	5·88	− 5·4	9·52	3·64
964	252	2740	1·8	14·67	3·00	2·5	7·67	4·67
1496	324	2800	0·3	14·08	4·91	4·3	7·34	2·43
72	28	2850	2·4	...	(26·76%)	...	...	...
1096	268	2900	1·5	14·55	3·73	2·9	7·60	3·87
937	249	3000	1·8	12·20	3·84	11·1	6·30	2·46
987	254	3025	1·7	11·87	4·39	12·6	6·12	1·73
947	250	3050	1·7(?)	15·23	3·22	1·0	7·97	4·75
974	253	3125	1·7	14·45	3·27	3·2	7·34	4·27
791	225	4575	1·8	9·85	4·05	23·5	5·00	0·95

* Is it a bottom water? The query is Mr. Buchanan's.

IV.—Interpretation of the Results.

I am sorry to have to confess that I have not been as successful as I should have wished in drawing general conclusions from my numbers, and if I here reproduce my endeavours in this direction, I do so chiefly in the hope that some other person, having more experience than I in dealing with statistics, may take up the problem after me, and perhaps be able to extract the latent propositions which are therein concealed. In the tables which I propose to give, he will find all the data arranged in the most convenient form, so that all he needs is at hand.

To begin with the surface-water gases, a glance at Table XI. shows that the volumes of nitrogen and oxygen brought out by analysis (Columns IV. and V.) differ more or less from the numbers (Columns VI. and VII.) calculated on the assumption that the water, at its natural temperature t_0, had been shaken with constantly renewed air to complete saturation under 760 mm. dry pressure. This is no more than one would expect. Even the surface water of the ocean cannot be expected, at any time and any place, to be in a state of absorptiometric equilibrium: and for a number of causes which I will proceed to enumerate, beginning with what I conceive to be the less important of disturbing influences. (1) The pressure of the atmosphere is inconstant, though not in general far removed from what my calculations suppose to prevail.* (2) The water is in a state of constant progressive motion; the sample collected at a certain place was only travelling through that place at the time, coming, in general, from a region of different temperature. (3) Supposing even the water at a given place were in a state of stagnation, its temperature would be subject to periodic variation; it would reach a maximum at a certain hour during the day, and fall to a minimum at a certain hour after midnight. Hence the quantity (q) of air contained in a litre of water must be a periodic function of time (T) likewise; and supposing we could assume that the absorptiometric condition of the water (in the sense of perfect air-saturation) always adjusted itself instantaneously to the prevailing temperature, the variation of q would follow a curve $q=f$ (T), the maxima of which would correspond precisely to the minima, and the minima to the maxima, of the temperature curve $t=\phi$ (T). But absorptiometric exchange is a thing of slow progress; hence the actual curve $q_0=\text{F}$ (T) will, so to speak, lag behind the theoretical one, and the actual q_0 will never quite rise to the maximum nor quite fall to the minimum of q. At some hour in the early morning and at some hour after sunset, the two curves would I presume intersect each other, so that q_0 would become equal to q. But the Challenger samples were probably all collected at hours between these two points; hence, on the basis of our assumption, we should presume the actual q_0 (and in a lesser sense the actual ratio $n_1 : n_2$ of oxygen to nitrogen) to be somewhat greater than the

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* But it is as well to keep in mind that the conjoint dry-gas pressure of the nitrogen and oxygen, especially at high temperatures, is appreciably *less* than the total pressure of the atmosphere, and consequently on an average less than 760 mm.

theoretical values calculated from the observed temperature by means of our formulæ. (4) The oxygen, we should say, *a priori*, can never quite come up to the calculated value corresponding to t_0, because it is constantly being utilised in processes of oxidation and respiration going on within the water. The nitrogen is not subject to *this* disturbing influence; hence we should expect it to accommodate itself more closely to the law of gas absorption. And yet, on comparing the volumes of nitrogen found with the volumes calculated for the observed t_0, we find the latter to be in general greater than the former. These nitrogen deficits were given in Table XI. Column X.; in Table XIV. I have enumerated these nitrogen-deficits in the order of their magnitudes. I have vainly endeavoured to find some relation between them on the one hand, and temperature or geographical position on the other. Considering the great frequency of values from 0·4 to 0·5, I am inclined to assume that, in virtue of some general constant influence,* this deficit tends to assume some value like, say, 0·42, subject to variation in either direction, as seen in the table, which, besides, exhibits numerous cases of negative values, *i.e.*, of nitrogen *excesses*. These latter, although in accordance with what we said under (3), are explained more plausibly as resulting from an intermixture of surface water with deep-sea water richer in nitrogen. If the variations in the nitrogen deficits were owing to accidental causes, then counting off eight entries (*i.e.*, $\frac{1}{2}$ of $0·26 \times 62$) from the neutral point either way, we should arrive at half the value of the probable "error," and we indeed arrive in either case at the value $\pm 0·1$, so that the probable "error" would appear to be $= \pm 0·2 = r$. But adopting this value, we have

Deviations under $\pm r$	Number of Cases counted.		Total.
	+ Deviations.	− Deviations.	Calculated.
$\frac{1}{2}r = \cdot 1$	8	8	16
$r = \cdot 2$	11	9	31
$\frac{3}{2}r = \cdot 3$	13	11	42·6
$2r = \cdot 4$	18	14	51
$3r = \cdot 6$	21	21	59·3
$4r = \cdot 8$	24	26	61·6
$5r = 1·0$	25	30	62
∞	31	31	62

The nitrogen-deficits may be represented by naming the temperature t_1 at which a water would have to be completely saturated with air to take up the observed volume of nitrogen per litre. These values t_1 are given in the last column of Table XIV. I have not utilised these values t_1, but assuming the actual values of nitrogen to have been brought about by incomplete (or super-) saturation at the observed temperature t_0, I have calculated the volumes of oxygen corresponding to the observed quantities of nitrogen

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* In air of 760 mm., fully saturated with water at 22°, the dry-air pressure is only (1 − ·026) 760 mm., corresponding to a nitrogen deficit of 0·26 or 10 units.

according to my determinations of $\frac{n_1}{n_2}$ for this temperature t_w. These calculated oxygens being in most cases greater than the observed ones, I calculated the "*oxygen deficits*," and entered them in Table XI., Column IX.

In Table XV. they are arranged in the order of their magnitude.

TABLE XIV.

Surface Water Gases. The Nitrogen Deficits Classified.

Less than	No. of Cases.	N_2-def.	O_2-def.	t_w	No. of Water.	Station.	t_s
− ·5	3	− 1·10 − ·56 − ·53	− ·02 − ·12 + ·10	14°·7 15·5 28·3	1301 1366 612	295 301 198	9°·9 8·7 24·5
− ·4	2	− ·41 − ·41	+ ·15 + ·18	25·1 25·0	1573 572	337 185	22·4 22·4
− ·3	1	− ·36	− ·03	16·9	1342	299	15·3
− ·2	4	− ·30 − ·27 − ·24 − ·24	− ·20 + ·29 + ·32 + ·20	15·5 12·5 9·4 22·5	1367 1287 1424 1683	301 293 + 309 352 +	14·1 11·3 8·5 21·0
− ·1	3	− ·15 − ·15 − ·14	+ ·16 − ·02 + ·13	17·8 16·5 27·9	497 1364 1629	170 300 345	17·0 15·5 27·0
·0	3	− ·10 − ·03 − ·01	− ·03 + ·13 + ·26	13·6 29·4 28·6	1314 638 759	296 + 202 222 +	13·2 29·2 28·5
+ ·1	4	0·0 + ·03 ·07 ·09	+ ·11 + ·14 + ·12 + ·09	15·6 21·7 20·5 25·1	471 977 1699 1590	165A/B 253 + 354 340	15·6 21·9 20·9 25·7
·3	2	·14 ·18	+ ·27 + ·05	25·1 7·2	532 417	177 158	26·0 21·9
·4	4	·31 ·32 ·33 ·36	+ ·20 + ·07 + ·06 + ·16	25·8 22·8 20·0 27·8	817 1687 1508 700	229 − 353 326 216 +	28·0 24·9 22·0 30·6

Less than	No. of Cases.	N_2-def.	O_2-def.	t_w	No. of Water.	Station.	t_v
·5	10	·41	+ ·12	19·4	504	171	21·9
		·41	+ ·09	26·8	1097	268	29·9
		·42	+ ·19	14·0	486	168 +	16·0
		·42	− ·01	21·7	910	244 +	24·5
		·42	+ ·19	24·2	1176	281	27·1
		·43	+ ·12	27·9	602	196	31·3
		·43	− ·12	13·9	1375	301 +	16·0
		·45	+ ·12	21·0	1510	327	23·8
		·47	+ ·18	24·0	1003	256 +	27·3
		·49	+ ·17	26·7	557	181	30·4
·6	5	·50	− ·12	11·9	1271	292	14·2
		·51	+ ·05	26·4	581	190	30·3
		·52	− ·05	18·4	1514	329	21·4
		·55	+ ·10	20·8	836	230 +	24·3
		·56	− ·22	− ·7	386	153	+ 0·7
·7	1	·61	+ ·22	28·6	722	218	34·4
·8	6	·70	+ ·16	21·9	512	171A	26·6
		·70	− ·06	19·5	1211	284 +	23·8
		·72	+ ·17	25·5	528	176	30·9
		·74	− ·05	23·3	989*	255	28·5
		·75	+ ·07	24·4	1004	257	29·5
		·78	− ·07	14·2	1462	318	18·1
·9	1	·81	+ ·17	28·7	761	223	35·6
1·0	3	·90	+ ·18	22·9	1187	282	29·2
		·92	+ ·14	25·0	1011	258	31·2
		·99	− ·07	14·2	1374A	301	19·3
1·1	3	1·02	+ ·06	21·8	826	229 +	28·9
		1·08	+ ·03	23·9	990	255 +	31·9
		1·08	+ ·01	12·7	1378	301 +	18·0
2·0	5	1·40	+ ·08	26·9	682	214 +	39·1
		1·49	+ ·06	− 1·7	389	154	5·2
		1·72	+ ·07	+ ·4	396	154	5·5
		1·73	− ·14	+ ·7	387	153 +	5·9
		1·88	− ·12	21·9	926	247 +	36·4
2·33	2	2·07	+ ·11	18·9	1212	284 +	33·8
		2·33	+ ·06	11·8	1272	292	24·4

* Suspected analysis.

TABLE XV.

Surface Water Gases. Classification of the Oxygen Deficits.

Oxygen deficit less than	Number of Cases.											
-·20	1	No.	386									
		St.	153									
		t_w	-0°·7									
-·16	1	No.	1367									
		St.	301									
		t_w	15°·5									
-·12	1	No.	387									
		St.	153+									
		t_w	0°·7									
-·08	3	No.	1271	1366	1375							
		St.	292	301	301+							
		t_w	11°·9	15°·5	13°·9							
-·04	4	No.	1211	1402	1514	1374 *						
		St.	284	318	329	301						
		t_w	19°·5	14°·2	18°·4	14°·2						
·00	5	No.	910	1301	1314	1342	1364					
		St.	244+	295+	296+	299	300					
		t_w	21°·7	14°·7	13°·6	16°·9	16°·5					
+·04	2	No.	990	1378								
		St.	255+	301								
		t_w	23°·9	12°·7								
·08	10	No.	389	396	417	826	[976]	1004	1272	1508	1687	581
		St.	154	154	158	229+	253+	257	292	326	353	190
		t_w	-1°·7	0°·4	7°·2	21°·8	20°·6	24°·4	11°·8	20°·0	22°·8	26°·4
·12	8	No.	471	612	[645]	682	836	1097	1212	1590		
		St.	165½	198	204	214+	230+	268	284+	340		
		t_w	15°·6	28°·3	28°·6	26°·9	20°·8	26°·8	18°·9	25°·1		

The label attached to this sample was "1374A"; I presume it was the same as No. 1374 of Mr. Buchanan's list.

Oxygen deficit less than	Number of Cases.													
·16	9	No.	504	602	638	977	1011	1510	1573	1629	1699			
		St.	171	196	202	253^{+}	258	327	337	345	354			
		t_w	19°·4	27°·9	29°·4	21°·7	25°·0	21°·0	25°·1	27°·9	20°·5			
·20	12	No.	486	497	512	515	528	557	572	700	761	1003	1187	1176
		St.	168^{+}	170	171_{A}	172^{+}	176	181	185	216^{+}	223	256^{+}	282	281
		t_w	14°·0	17°·8	21°·9	24°·5	25°·5	26°·7	25°·0	27°·8	28°·7	24°·0	22°·9	24°·2
·24	3	No.	817	722	1683									
		St.	229 –	218	352^{+}									
		t_w	25°·8	28°·6	22°·5									
·28	2	No.	759	532										
		St.	222^{+}	177										
		t_w	28°·6	25°·1										
·32	3	No.	[455]	1287	1424									
		St.	164_{C}	293^{+}	309									
		t_w	17°·5	12°·5	9°·4									
·80	1	No.	[949]											
		St.	251											
		t_w	17°·9											
Total = 65 Cases.														

This table, as it stands here before us, looks almost like the area of a probability curve; but it does not follow that the variations in the oxygen deficit are a matter of accident. In fact, if we search on the Challenger track-map for the Stations registered in our table as corresponding to oxygen deficits from $-0{\cdot}20$ to $+0{\cdot}08$ (inclusive), we see that most of the respective waters came from one or other of two areas, namely, either from one in the Indian Ocean, south of lat. 50° S., or from another enclosed very nearly between the parallels lat. 30° S. and 55° S., and the longitudes 120° W. and 30° W. Only the following 7 out of 27 waters did not come from one of these two areas, viz. :—

No. of Water, .	581	826	910	976	990	1004	1687
Station, . .	190	229	244	253	255	257	353
Long., . .	136° 5′ E.	140° 27′ E.	169° 53′ E.	156° 25′ W.	154° 33′ W.	154° 55′ W.	33° 37′ W.
Lat., . .	8° 56′ S.	22° 1′ N.	35° 22′ N.	38° 9′ N.	32° 28′ N.	27° 33′ N.	26° 21′ N.
Temperature of water when collected (t_0).	26°·4	21°·8	21°·7	20°·6	23°·9	24°·4	22°·8

That these waters were relatively rich in oxygen, notwithstanding their high temperature, is rather curious.

This fact in the case of the first of our areas is easily accounted for by the low temperature prevailing there, which, of course, is unfavourable both to marine life and purely chemical oxidation. It is not so easily accounted for in the case of the second area, the less so, as the waters were collected there in summer-time (from November 1875 to March 1876).

What puzzled me very much at first was the not unfrequent occurrence, in our table, of *negative* oxygen deficits. It is difficult to see how a sea-water can contain more oxygen per litre than is demanded by the law of gas-absorption. I tried to account for the apparent anomaly in a variety of ways, and at last was led to suspect that it may be the result of observational errors. Take, for instance, the first three entries in Table XV., that is, the three most striking cases. We have

Water No.,	386	1367	387
Station,	153	301	153 +
Temperature of water when collected (t_0),	−0°·7	15°·5	+0°·7
Oxygen per litre found = a,	8·26	6·12	7·27
Oxygen " calculated = b,	8·33	5·78	8·03
Oxygen " calculated from N_2 found = c,	8·04	5·92	7·13
$(b-a)=$	+0·07	−0·34	+0·76
$(c-a)=$	−0·22	−0·20	−0·14

We need only assume that the values for oxygen found, and those calculated from the quantities of nitrogen *found*, are wrong, the one by + the other by $-\frac{1}{100}$ of its value, and $c-a$ (*i.e.*, the oxygen deficit as reported in the table) would be wrong by

0·16 0·12 0·14

Supposing these errors to have been committed, the *residual* oxygen deficits are not worth discussing.

It is worth while to note, in passing, that the differences $b-a$, *i.e.*, the excess of the oxygen calculated from the observed temperature t_0, and the assumed (dry) pressure of 760 mm., over the oxygen found, in two out of our three cases, has a positive value.

Does the law of gas-absorption really hold for the ocean, in the circumstances prevailing at its surface? I do not know whether it does or not. Imagine a mass of ocean-water in a state of incomplete saturation with air. It is in contact with a *constantly renewed* atmosphere, consisting always of very nearly 21 per cent. of oxygen and 79 per cent. of nitrogen gas. Will the successive instalments of oxygen q_1 and nitrogen q_2 be in the exact ratios of $q_1=0·21\ \beta_1$ to $q_2=0·79\ \beta_2$? It is not possible that at any stage short of absolutely complete saturation, as enforced by repeated shaking with air, which is renewed only after it has come to a state of absorptiometric equilibrium with the water it is being shaken with, say the oxygen, in virtue of a specifically strong affinity for sea-water, is taken up in a preponderating proportion? It was this consideration chiefly which caused me to re-discuss the results of the water-gas analyses on their own basis, independently of my laboratory experiments. Thinking that of the several data of the analyses the relative volumes of oxygen and nitrogen (the values n_1 and n_2) were more exactly determined than the absolute volumes of the two gases, I tabulated all the values n_1 found along with the corresponding observed temperatures; and then, for easier comparison, reduced the several results to the nearest of the temperatures 0°, 5°, 10°, 15°, 20°, 25°, 30°, by assuming my value for $\frac{\Delta n_1}{\Delta t}$ to hold good. This led to the following Table XVI., in which

Column I. gives the number of the water analysed.

Column II. its natural temperature, t_0.

Column III. the temperature t to which the value for n_1 found was reduced by means of Table IX. page 175.

Column IV. the value for n_1 thus corrected.

TABLE XVI.

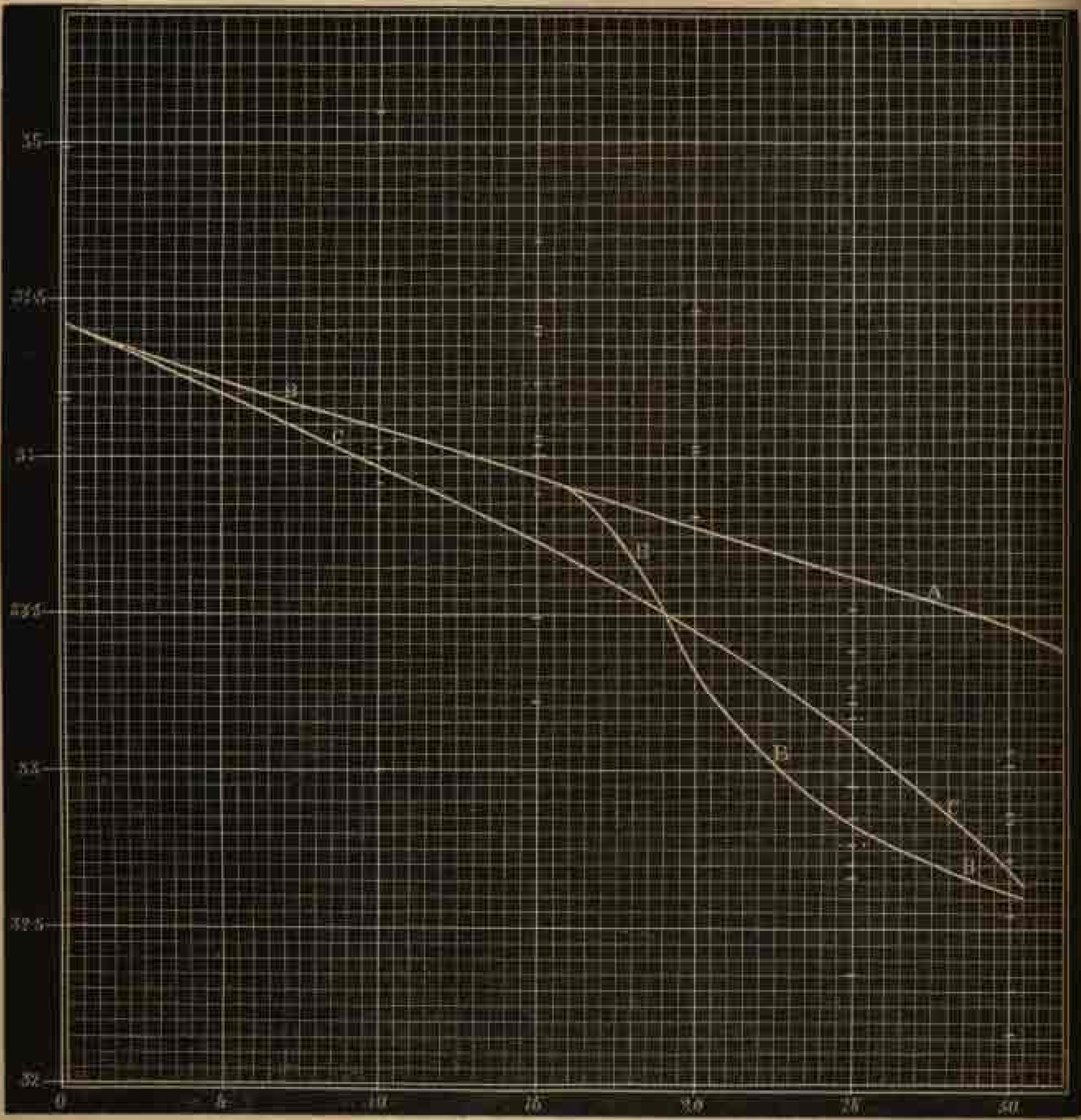
Surface-Water Gases. Values of n_1 *found for* t_0 *reduced to assumed temperatures* t.

I. No. of Water.	II. t_0.	III. t.	IV. 100 n_1, at t.	I. No. of Water.	II. t_0.	III. t.	IV. 100 n_1 at t.
386	− 0°·7	0°	34·99	1510	21°·0	20°	33·22
389	− 1·7	0	34·20	977	21·7	20	33·16
396	0·4	0	34·18	512	21·9	20	33·03
[417	7·2	5	34·08]	1683	22·5	20	32·90
271	11·9	10	35·10	949	17·9	20	30·40
1287	12·5	10	34·03	990	23·9	25	33·51
[417	7·2	10	33·92]	581	26·4	25	33·38
272	11·8	10	33·85	1687	22·8	25	33·26
1424	9·4	10	33·00	1590	25·1	25	33·21
1367	15·5	15	34·68	682	26·9	25	33·17
1375	13·9	15	34·41	1004	24·4	25	33·17
1366	15·5	15	34·38	1176	24·2	25	32·95
1374	14·2	15	34·23	1573	25·1	25	32·95
1462	14·2	15	34·23	572	25·0	25	32·85
1314	13·6	15	34·06	557	26·7	25	32·77
1301	14·7	15	34·03	528	25·5	25	32·78
1364	16·5	15	34·00	1003	24·0	25	32·77
1378	12·7	15	33·88	1187	22·9	25	32·70
471	15·6	15	33·49	515	24·5	25	32·70
486	14·0	15	33·21	817	25·8	25	32·66
1342	16·9	15	29·93	532	25·1	25	32·35
926	21·9	20	34·46	645	28·6	30	33·07
1211	19·5	20	34·04	612	28·3	30	33·02
1514	18·4	20	34·02	638	29·4	30	32·87
910	21·7	20	33·82	1629	27·9	30	32·86
976	20·6	20	33·59	602	27·9	30	32·84
1508	20·0	20	33·52	700	27·8	30	32·71
826	21·8	20	33·46	761	28·7	30	32·54
836	20·8	20	33·33	722	28·6	30	32·30
1212	18·9	20	33·32	759	28·6	30	32·16
1699	20·5	20	33·28	...	...	...	...

The following diagram gives the temperatures t as abscissæ, and the several values $n_1 \times 100$ registered in the table as dots on the respective ordinates. The straight line BA represents the relation

$$n_1 = 34{\cdot}4 - 0{\cdot}0311t$$

which was brought out by my laboratory experiments. Assuming it to be reasonable to



search for an equation $n_1=f(t)$, which would sum up the values n_1 brought out by the gas analyses, curve B is one approximation, and curve C another to this function. Either curve is given for what it is worth. My interpretation of the diagram is that, while at low temperatures (up to about 15°) the processes of oxidation which go on in the water are too slow to interfere materially with the establishment of absorptiometric equilibrium, they do so more and more markedly at higher temperatures. Assuming the curve BB, in a rough sense at least, to represent the average state of matters, I have selected a number of exceptionally high and low values found for the amount of absorbed oxygen, and traced the samples to their place of collection, as shown in Table XVII.

TABLE XVII.

Showing the position whence Samples were obtained which gave exceptionally High and Low Values of n_1.

High Values of n_1.

No. of Water.	t_w	n_1 for	t.	Station.	Geographical Position.
1271	11·9	35·10	10	292	40° W. of Valparaiso.
1367	15·5	34·68	15	301	Lat. 37½° S. About 12° W. of coast of Chili.
926	21·9	34·46	20	247+	Midway between San Francisco and Yeddo.
990	23·9	33·51	25	255*	North Pacific. Long. 155° W., lat. 32° N.

Low Values of n_1.

No. of Water.	t_w	n_1 for	t.	Station.	Geographical Position.
1424	9·4	33·0	10	309	Lat. 60° S. Close to west coast of South America.
471	15·6	33·49	15	165½	About 10° E.S.E. of Sydney.
486	14·0	33·21	15	168+	„ 1° E. of North New Zealand.
1342	16·9	29·93	15	299	„ 7° W. of Valparaiso.
512	21·9	33·03	20	171A	„ 34° E. of Brisbane.
1683	22·5	32·90	20	352+	North Atlantic. Somewhere about the Cape Verde Islands.
977	21·7	33·16	20	253+	About 34° W. of San Francisco.
919	17·9	30·40	20	251	„ 42° „ „
1003	24·0	32·77	25	256*	North Pacific. About long. 155° W., lat. 30° N.
528	25·5	32·78	25	176	About 4° W. of Fiji Islands.
1187	22·9	32·70	25	282	South Pacific. Lat. 23° S., long. 150° W.
513	24·5	32·70	25	172	7° S.E. of Fiji Islands.
817	25·8	32·66	25	229−	About 15° S. of Yeddo.
532	25·1	32·35	25	177	South Pacific. Near New Hebrides.
761	28·7	32·54	30	223	North Pacific. Long. 145° E., lat. 6° N.
722	28·6	32·30	30	218	About 3° N. of Humboldt Island.
759	28·6	32·16	30	222+	„ 6° „ „

The four high values for n_1, as we see, all belong to places in the Pacific, far away from the land. This is all that I am able to see.

The nitrogen contained in a litre of surface water always tends to assume the value $1000\ \lambda n_2$, corresponding to the prevailing temperature t_0. This suggested to me the calculation of the following Table XVIII., which reads as follows :—

Column I. gives the number of the water analysed.

Column II. its natural temperature, t_0.

Column III. as t the one of the values 0°, 5°, 10°, &c., which is nearest to t_0.

Column IV. the volume of nitrogen (in c.c. reduced to 0° and 760 mm.) found in 1 litre of the water at t_0, corrected up or down to t by means of Table IX., page 175, on the assumption that, for the same interval of temperature, Δ (the volume of nitrogen per litre) is the same as the Δ $(1000\lambda n_2)$ of Table IX.

Table XVIII.

The Quantity of Nitrogen in Surface-Waters reduced to certain fixed Temperatures.

I. No. of Water.	II. t_0.	III. t.	IV. Nitrogen found at t_0 degrees reduced to t degrees.	V. Nitrogen calculated for t degrees.	I. No. of Water.	II. t_0.	III. t.	IV. Nitrogen found at t_0 degrees reduced to t degrees.	V. Nitrogen calculated for t degrees.
396	0·4	0	13·88	15·60	1510	21·0	20	9·96	10·41
389	−1·7	0	14·11	15·60	1508	20·0	20	10·08	10·41
386	−0·7	0	15·04	15·60	1699	20·5	20	10·34	10·41
417	7·2	5	13·68	13·86	977	21·7	20	10·38	10·41
1272	11·8	10	10·14	12·47	1683	22·5	20	10·65	10·41
1271	11·9	10	11·97	12·47	682	26·9	25	8·22	9·62
1424	9·4	10	12·71	12·47	990	23·9	25	8·54	9·62
1287	12·5	10	12·74	12·47	1187	22·9	25	8·72	9·62
1378	12·7	15	10·26	11·34	1004	24·4	25	8·87	9·62
1374	14·2	15	10·35	11·34	528	25·5	25	8·90	9·62
1462	14·2	15	10·56	11·34	817	25·8	25	9·09	9·62
1375	13·9	15	10·91	11·34	581	26·4	25	9·11	9·62
486	14·0	15	10·92	11·34	557	26·7	25	9·13	9·62
471	15·6	15	11·34	11·34	1003	24·0	25	9·15	9·62
1314	13·6	15	11·44	11·34	1176	24·2	25	9·20	9·62
1364	16·5	15	11·54	11·34	1687	22·8	25	9·30	9·62
1367	15·5	15	11·64	11·34	532	25·1	25	9·48	9·62
1342	16·9	15	11·70	11·34	1590	25·1	25	9·53	9·62
1366	15·5	15	11·90	11·34	1573	25·1	25	10·03	9·62
1301	14·7	15	12·44	11·34	572	25·0	25	10·03	9·62
1212	18·9	20	8·34	10·41	761	28·9	30	8·13	8·94
926	21·9	20	8·53	10·41	722	28·6	30	8·33	8·94
826	21·8	20	9·39	10·41	602	27·9	30	8·51	8·94
1211	19·5	20	9·71	10·41	700	27·8	30	8·58	8·94
512	21·9	20	9·71	10·41	759	28·6	30	8·95	8·94
836	20·8	20	9·86	10·41	638	29·4	30	8·97	8·94
1514	18·4	20	9·89	10·41	1629	27·9	30	9·08	8·94
910	21·7	20	9·99	10·41	612	28·3	30	9·47	8·94

Column V. gives the value $1000\lambda n_2$, *i.e.*, the volume (in c.c. reduced to 0° and 760 mm.) of nitrogen, which 1 litre of sea-water, according to my experiments, absorbs when saturated with a very large volume of air at t degrees and 760 mm. dry-air pressure. For an exact comparison, the values in Column IV. ought to have been corrected for the deviation of the existing dry-air pressure from 760 mm., but I had not the necessary barometric observations, and therefore took the values (Column IV.) as they stand. In each group for a given temperature (t), the values (Column IV.) are arranged according to their magnitude.

Diagram p. 194 is to Table XVIII. what diagram p. 190 is to Table XVI. Curve A, A, A, corresponds to the function from which the values λn_2 on Table IX. were calculated; curve A, B, B, B, is an approximation to the function which the water gas-analyses tend to establish, the dots registering the individual observations. At 15° the observed values of nitrogen tend to be higher; at 20°, 25°, 30° they are, on the whole, lower than the values corresponding to complete saturation by air.

Gases from Waters NOT *Surface-Waters.*

I treat the intermediate along with the bottom waters, because I have not been able to discover anything in the results which is characteristic of bottom-waters as such. The mode I adopted for manipulating these is founded upon the obvious proposition that water from any depth must have obtained its oxygen and nitrogen from the surface, and consequently, gasometrically speaking, may be viewed as a sea-water saturated completely with air under 760 mm. dry-air pressure at some temperature t_1 different in general from its temperature t_0 *in situ*. I accordingly calculated from the quantity of nitrogen (per litre) found (for t_0) the temperature t_1 at which that volume of nitrogen would have been absorbed under 760 mm. from air, and then, by means of my table of values of $\frac{n_1}{n_2}$ calculated the volume of oxygen which, in the imaginary surface absorption, would have accompanied the nitrogen found. On Tables XII. and XIII. these calculated volumes of oxygen are entered as $(O_2)_1$—in Column IX. and in Column VIII. respectively. The next column in either table gives the "oxygen deficits"—$(O_2)_1$ *minus* (O_2) found.

In the following Table XIX., the oxygen deficits from both Tables XII. and XIII. are arranged according to their magnitudes in Column V.; Column I. gives the number of the water (enclosed in brackets when it is a bottom-water); Column II. the Station whence it was obtained; Column III. the depth δ at which the water was collected; Column IV. its natural temperature t_0.

A glance at Tables XII. and XIII. shows that the calculated temperatures are in the overwhelming majority of cases higher than the observed temperatures t_0. Table XIX. shows that small oxygen deficits occur more frequently in waters from small depths, and that these deficits in waters from great depths sometimes assume very considerable

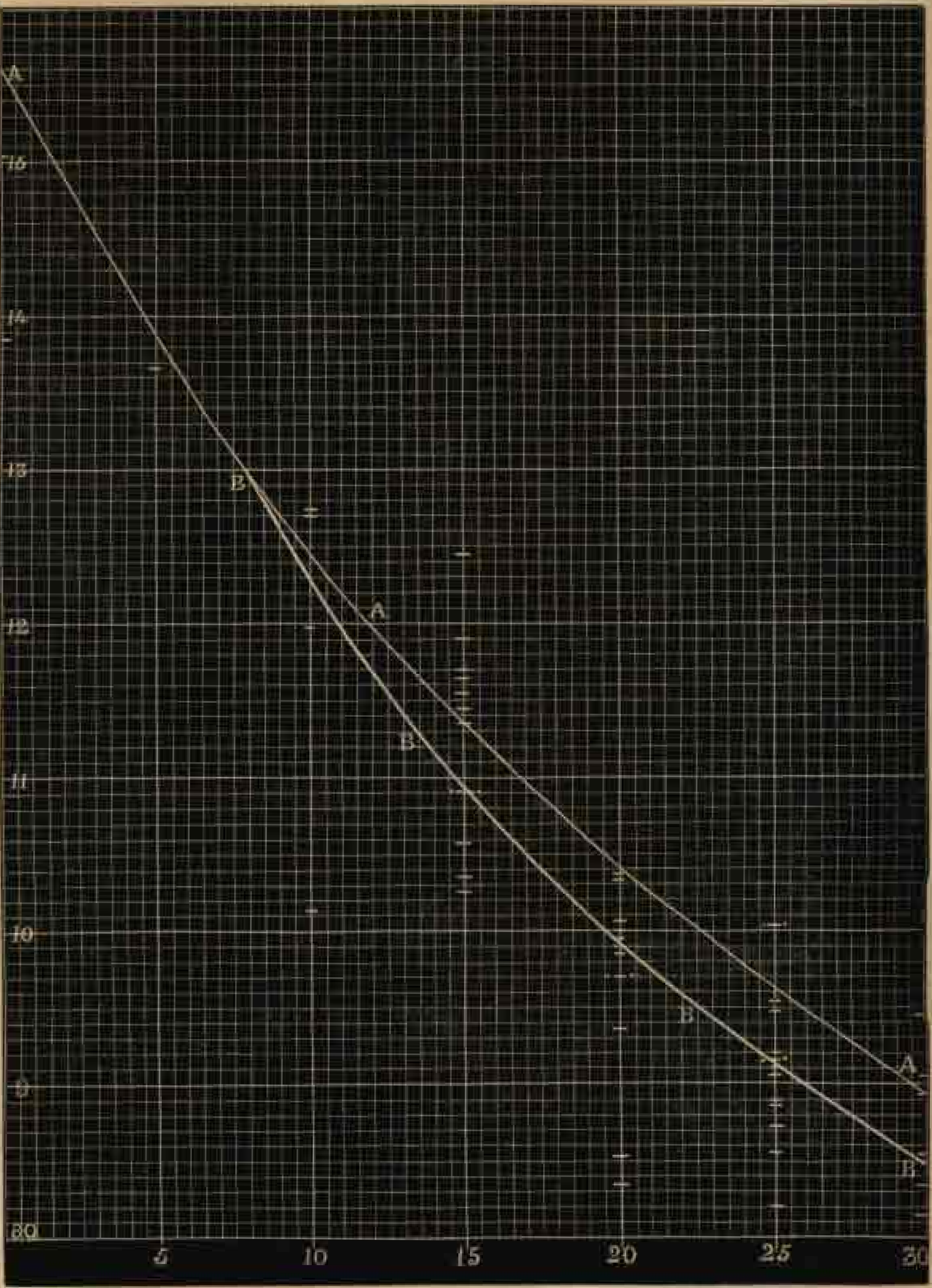


Diagram constructed from Table XVIII., showing in curve B the volumes of nitrogen found at 0°, 5°, 10°, &c., in 1 litre of sea-water, in curve A the corresponding volumes ($1000\,\lambda n_2$) calculated from laboratory experiment.

values. All this is exactly what one would expect. I am not able to formulate the obviously existing relation between oxygen deficit and depth (δ) in more precise terms.

Mr. Buchanan, by comparing the several values of n_1 which he had at his disposal, arrived at the conclusion that this quantity attains a minimum at a depth of about 800 fathoms. This is not confirmed by the sum total of *all* the results as they are now before us.

TABLE XIX.

Oxygen Deficits arranged in the order of their Magnitude.

Bottom Waters have their numbers enclosed within parentheses ( ).

No.	Station.	δ	t_0	O_2 deficit.
1306	296	50	12·5	− ·32
1576	338	50	21·9	− ·16
994	256	25	21·1	− ·04
419	158	50	6·9	− ·02
1329	298	25	13·2	+ ·03
1498	325	20	21·5	·08
979	254	25	16·8	·10
(428)	159	2150	1·2	·11
1168	280	25	25·0	·12
464	165 +	5	18·0	·17
725	218	10	28·4	·17
752	222	50	27·8	·19
1621	345	25	27·1	·20
1262	291	25	11·2	·22
461	165	50	13·9	·29
1663	350	25	22·0	·45
1356	300	50	12·0	46
(1438)	311	245	7·8	·46
(1494)	323	1900	0·6	·54
(439)	160	2600	1·1	·64
678	213	50	...	·69
1704	354	100	17·3	·81
1539	333	100	12·8	·89
1345	299	50	11·7	·90
(671)	211	2225	10·3	·91
(791)	225	4575	1·8	·95
(569)	183	1700	2·2	·96
1585	339	100	15·4	1·10
1696	353	2465	3·1	1·21
1205	284	200	12·5	1·27
1181	281	200	13·4	1·31
397	155	50	...	1·32*
620	198	800	3·9	1·57
1269	291	1775	1·7	1·60
(922)	246	2050	1·7	1·60
1009	257	2850	1·6	1·71
(395)	154	1800	...	1·73

Suspected analysis.

No.	Station.	z	t_z	O_2 deficit.
(987)	254	3025	1·7	1·73
1615	342	1900	3·5	1·75
(414)	157	1950	0·0	1·79
(477)	166	275	10·4	1·81
1532	332	1400	2·9	1·87
797	226	200	11·5	2·20
1353	299 +	10	16·7	2·21
823	229	300	11·1	2·30
(1544)	333	2025	1·8	2·38
(1496)	324	2800	0·3	2·43
(937)	249	3000	1·8	2·46
543	179	200	13·0	2·47
1241	287	1925	1·7	2·48
(1465)	306	345	7·8	2·48
(1533)	332	2200	1·1	2·63
1655	348	800	4·2	2·71
(1618)	343	425	4·6	2·72
(629)	199	2600	3·7	2·73
(383)	153	1675	...	2·92
(1125)	271	2425	1·7	3·06
1528	331	800	2·8	3·16
(1106)	269	2550	1·8	3·23
1220	285	800	3·2	3·26
(771)	223	2325	1·9	3·38
(1024)	259	2225	1·6	3·44
1209	284	1975	1·8	3·50
1546	334	800	2·9	3·51
(567)	183	1700	2·2	3·52
1244	288	2125	1·7	3·54
(1507)	325	2650	0·4	3·64
1633	346	100	12·9	3·67
1231	286	2290	1·8	3·77
(556)	180	2450	2·2	3·83
1296	294	1775	1·7	3·87
(1096)	268	2900	1·5	3·87
1605	341	400	4·6	3·90
(924)	247	2530	1·8	3·91
594	193	400	6·4	4·11
(1388)	302	1450	2·0	4·13
974	253	3125	...	4·27
933	248	400	4·2	4·38*
(964)	252	2740	1·8	4·67
1672	351	300	6·9	4·68
(947)	250	3050	1·7 (?)	4·75
1645	347	1500	3·3	4·91
933	248	400	4·2	5·46†
1661	349	300	6·7	5·50
1001	256	2875	1·8	7·61

My own analysis. † Mr. Buchanan's analysis.

In the course of this memoir I had occasion to acknowledge the services of Messrs. John M'Arthur, Robert Lennox, Thomas Barbour, and W. G. Johnston. In addition to these gentlemen, I must now thank Messrs. James M. Bowie, James B. M'Arthur, G. A. Darling, and Moses T. Buchanan, for having assisted me in my analytical Challenger work. The last-named young chemist indeed has the credit of having borne the burden of the work involved in those numerous analyses of fossils, bones, and oceanic deposits which are recorded under my name in other volumes of this publication.

In conclusion, I have to record my grateful appreciation of the ready furtherance always accorded to me by the Editorial Department, and, in addition, to express my obligations to my friend Mr. George Cranston for the untiring way in which he, at great inconvenience to himself, aided me in correcting the proof sheets of this memoir.

SUMMARY OF RESULTS.

The foregoing memoir, though ostensibly only a report on a series of investigations into the composition of ocean-water, which it has been my privilege to carry out under the auspices of the Director of the Expedition, includes also the final elaboration of all Mr. Buchanan's work connected therewith, and is, consequently, a complete record of what the Challenger Expedition has added to our knowledge on the subject. But the greater part of my paper consists of more or less lengthy discussions of chemical methods and matters of calculation, which, as mere means to an end, are of little interest to the general reader, and may prove tiresome even to the scientific critic, if he do not happen to be a professional chemist.

This is my reason for drawing up the following summary, in which I have endeavoured to collect the general results of the whole investigation, and, for the benefit of non-professional readers, to explain their oceanographic significance.

The configuration of the ocean, broadly speaking, must have been the same as it is now for thousands of years. Hence its bed may be regarded by this time as having been almost deprived of all the more soluble components. No mineral, it is true, is absolutely insoluble in water; the ocean, consequently, must still be presumed to continue taking up soluble matter from the volcanic and other minerals with which it is in contact on the floor of the ocean, and what it thus gains is probably in excess over what it contributes towards the matter of new deposits. It must be granted also that it is continuously taking in large masses of dissolved mineral matter from rivers, and that what it receives from these two sources in a single year, if measured by ordinary standards, amounts to an immense quantity. But the gain even in a century is a mere trifle in comparison with what it already contains,—far less no doubt than the relative errors in our most exact methods of measurement.

The ocean, of course, takes in gases from the air as well as solids from the earth's crust; but this is a case of mutual exchange, in which the gain and loss, on either side, must long since have arrived at a state of equilibrium.

Hence the absolute composition of the ocean as a whole, meaning the total number of kilograms of water, chloride of sodium, &c., &c., present in it, though subject probably to an extremely slow increase in the dissolved saline matter, is practically constant and invariable. The percentage composition of a given sample of ocean-water is, of course, liable to variation according to the place where and the time when it was collected. This holds true more especially of the volatile components, viz., for the dissolved nitrogen and oxygen, the merely dissolved part of the carbonic acid, and last, and not least, of the water which forms the bulk (some 96 per cent. or more) of the whole.

Water, even at the lowest temperatures occurring on the surface of the globe, is appreciably volatile, and its volatility, as part of the sea, is not very materially diminished by the salts dissolved in it. Hence, from the whole of the area of the ocean, myriads of molecules of vapour of water are continuously being given out into the atmosphere; at the same time molecules previously given out are returning whence they came, the tendency, however, in every portion of atmosphere touching the ocean being to establish the maximum vapour-tension corresponding to the prevailing temperature. This vapour-tension is the greater the higher the temperature, and it increases more rapidly than does the temperature. Hence the rate at which the air takes up water from the sea is very great in the tropics, less in our latitudes, and far less in the circumpolar regions. On the basis of some law of distribution of temperatures, it would be a matter of calculation to inquire what this would lead to if the atmosphere were in a state of stagnation. But the atmosphere is not in such a state, and cannot be. The moist air in the equatorial regions, being relatively warm and consequently light, ascends, while relatively cold and dry air streams into its place from the north and south: a corresponding part of the uppermost stratum of the aerial ocean wells over and flows towards the poles. The consequence is that the greater part of the moisture taken up by the warm air of the tropics is not recondensed there, but is deposited as rain in the colder latitudes. Hence the sea must be less saline there than in the lower latitudes; but the permanence of a great excess of salinity anywhere is precluded by the oceanic currents.

To map these currents accurately and determine their velocities is the most important problem of general oceanography, and the solution of this problem would obviously be greatly facilitated if we had a correct and complete representation of the contour surfaces of equal salinity. As a means towards this end, Mr. Buchanan, in the course of the Expedition, collected thousands of samples of ocean-water from a great variety of places and depths, and defined their salinity by determining their specific gravity at known temperatures. His results are detailed and discussed by himself in his Report on the Specific Gravity of Ocean-Water.[*] My own connection with this part of his work is but slight. All I did was,—firstly, to work out experimentally the mathematical relation between salinity and temperature on the one hand, and specific gravity on the other, so that Mr. Buchanan's numbers might be reduced to a standard temperature, and be translated into salinities; and secondly, to determine the salinities of some 160 of Mr. Buchanan's

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water samples by a more direct (chemical) method, and compare the resulting values with those computed from Buchanan's specific gravities by my formula. This comparison led to the very satisfactory result, that the "probable error" in any one of Mr. Buchanan's specific gravities is rather less than ±0·1; that of pure water being taken as =1000.

A little reflection shows that no number of analyses will enable one to calculate with any degree of exactitude the mean salinity of the ocean as a whole; but even my 160 salinity determinations, since they correspond to a great variety of places, suffice to give an idea of the limits between which the quantity fluctuates. Expressing the salinity in "parts of total salts per 1000 parts of sea-water," I find that (of the 160 values)

The lowest (from the southern part of the Indian Ocean, south of 66° lat.) is . .	33·01
The greatest (from the middle of the North Atlantic, at about 23° lat.) is . .	37·57

(Some few samples from narrow straits or close to certain coasts are omitted, as being probably diluted to an abnormal extent with fresh water.)

So much as to the ratio of the water to the sum total of the salts dissolved in it. Let us now inquire into the percentage composition of the salt mixture itself.

A priori, we should say that this composition cannot be subject to any great variation; because, if there were no chemical changes going on in the ocean, and no gain or loss of dissolved individual salts, this composition would now, after thousands of years' constant intermixture, be absolutely the same everywhere; and what is going on in the shape of reactions and importation or exportation of individual salts, really amounts only to an extremely minute fraction of the whole, even in the course of a century. This conclusion is confirmed by the analyses of several hundred samples of surface-waters, which were carried out by Forchhammer in connection with a great research which he published in 1864.* According to his results, if we confine ourselves to the open ocean, we find that everywhere the ratios to one another of the quantities of chlorine, sulphuric acid, lime, magnesia, and total salts, exhibit practically constant values. With the view chiefly of supplementing Forchhammer's work, I have made exact determinations of the chlorine, sulphuric acid, lime, magnesia, potash, and soda in 77 samples of water collected by the Challenger from very different parts of the ocean:—

12 from the surface.
10 from depths of 25 to 100 fathoms.
21 from depths of over 100 to 1000 fathoms.
34 from greater depths.

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* *Phil. Trans.*, 1865, vol. clv. p. 203.

The results, while fairly agreeing with Forchhammer's, were in still closer accordance with one another, and thus showed that Forchhammer's proposition may be extended from surface-waters to ocean-waters obtained from all depths.

The solid matter dissolved in sea-water, though strictly speaking, and we may add necessarily, of a very complex composition, consists substantially of the muriates and sulphates of soda, magnesia, lime, and potash. Forchhammer, after having satisfied himself that all the other constituents taken conjointly amount to only a small fraction of one per cent. of the total solids, in his individual analyses limited himself to exact determinations of the chlorine, sulphuric acid, lime, and magnesia. The potash he determined only in a comparatively small number of samples; and where he reports the soda this component is calculated by difference, on the assumption that the acids and bases present exactly neutralise each other. But this assumption had never been proved to be correct, and *à priori*, is improbable, because it leaves out of reckoning the carbonate of lime which many animals need for forming their shells. I therefore in my analyses made it a special point, in addition to the other bases, to determine also the soda by a method independent of the assumption quoted; and on calculating my first set of (21) Challenger water analyses, had the satisfaction of finding that they had all given a small surplus of base, amounting on an average to 86 equivalents per 10,000 equivalents of acid present, corresponding (if we assume the excess of base to be present as normal carbonate) to about 0·11 gram of carbonic acid, equivalent to 0·25 gram of carbonate of lime per 1000 grams of sea-water analysed. While recognising the importance of this result, I was keenly alive to the possibility of its having been brought about by a constant positive error in my sum total of base determinations, and accordingly sought for an exact direct method for the determination of the surplus base in a given sea-water.

One of the methods I tried was to distil a measured volume of the sea-water with a certain proportion of sulphate of ammonia; then in a strictly comparative manner to repeat the experiment with an exactly neutral artificial sea-water substituted for the natural sea-water, and to determine the ammonia in the two distillates. There was a distinct surplus of ammonia in the distillate from natural as compared with that from the artificial sea-water, proving the existence of surplus fixed base in the former; but the results were not sufficiently constant to pass for quantitative determinations of the "alkalinity." The problem was subsequently solved in a surprisingly simple manner by the chemists of the Norwegian Expedition.* I lost no time in testing their method by synthetical trials, and finding it trustworthy, applied it to 154 samples of Challenger water. They all proved to be alkaline, but the mean value corresponded to only 54·7 milligrams of carbonic acid (CO_2 present as R_2CO_3) per kilogram of sea-water, which showed that my complete analyses had considerably over-estimated the surplus base. I refer to my memoir in regard to the manner in which I utilised my

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* The Norwegian North Atlantic Expedition, 1876 to 1878; Chemistry by Tornoe, Christiania, page 21.

alkalinity determinations in the final adjustment of my numbers for the average composition of ocean-water salts, as deduced originally from the 77 complete analyses; but I must not omit to state that in this final calculation the values for the lime were taken, not from those analyses, but from the results of a later series of more exact determinations made with three mixtures of Challenger waters representative of certain ranges of depth; namely, a mixture (I.) for depths from 0 to 50 fathoms; a mixture (II.) for depths from 300 to 1000 fathoms; a mixture (III.) for depths from 1500 fathoms and more. As shallow shore waters do not occur in the series of Challenger samples, I also analysed, as No. IV., a water which had been collected for me near Port Louis in Arran, Scotland, at a shallow place where there is abundance of marine vegetation.

The same set of four waters had before served for an elaborate research on the relative quantity of bromine in ocean-water salts.

From the 77 complete analyses, as thus corrected and supplemented, I calculated the following numbers for the average composition of ocean-water salts. The numbers under Forchhammer are transcribed from his memoir.

Average Composition of Ocean-Water Salts.

	Per 100 parts of Total Salts.	Per 100 of Halogen calculated as Chlorine.	
	Dittmar.	Dittmar.	Forchhammer.
Chlorine, ...	55·292 }[*]	99·848	Not determined.
Bromine, ...	0·1884 }	0·3402	Not determined.
Sulphuric Acid, SO_3, ...	6·410	11·576	11·88
Carbonic Acid, CO_2, ...	0·152	0·2742	Not determined.
Lime, CaO, ...	1·676	3·026	2·93
Magnesia, MgO, ...	6·209	11·212	11·03
Potash, K_2O, ...	1·332	2·405	1·93
Soda, Na_2O, ...	41·234	74·462	Not determined.
(Basic Oxygen equivalent to the Halogens), .	(−12·493)	...	...
Total Salts, . .	100·000	180·584	181·1

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[*] Equal conjointly to 55·376 parts of chlorine, which accordingly is the percentage of "halogen reckoned as chlorine" in the *real* total solids. Compare second footnote on page 138.

Combining Acids and Bases in the (arbitrary) mode shown, we have from my Numbers—*

Chloride of Sodium,	77·758
Chloride of Magnesium,	10·878
Sulphate of Magnesium,	4·737
Sulphate of Lime,	3·600
Sulphate of Potash,	2·465
Bromide of Magnesium,	0·217
Carbonate of Lime,	0·345
Total Salts,	100·000

As a general result of Forchhammer's and my own analyses, *the above numbers may be taken as holding approximately for any sample of ocean-water.* Of the degree of approximation we can form an idea by comparing my numbers for the percentages of chlorine, sulphuric acid, magnesia, and potash, with the corresponding entries in the 77 reports tabulated on pages 23 to 25, and the numbers for the lime there with one another. The percentages of soda being too largely affected by the cumulative error of the other determinations, had better be left out of consideration. But even if we do so, we often meet with fluctuations which are too great to be taken as arising from analytical errors, and consequently must correspond to differences in the actual composition. I have taken great pains in trying to explain these differences by natural causes, but have not been very successful. The final results of my inquiries may be summed up as follows:—

From my analyses (which I do not pretend exhaust the subject), it would appear that the composition of sea-water salt is independent of the latitude and longitude whence the sample is taken. Nor can we trace any influence of the depth from which the sample comes, if we confine ourselves to the ratio to one another of chlorine, sulphuric acid, magnesia, potash, and *bromine*. I emphasise the bromine because, while present in very small proportion, it is taken up preferably by sea-plants, and consequently must be presumed to be more liable than any of the major components to at least temporary local diminution. And yet my analyses of the three mixtures of Challenger waters, and of the Arran water referred to, gave identical values for the bromine present per 100 of chlorine. But the determinations of the lime in the same set of waters make it most highly probable that the proportion of this component increases with the depth. Referring to 100 parts of halogen calculated as chlorine, we find for the quantity of lime:—

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* The mode here chosen differs somewhat from the one I adopted on page 138, which represents the carbonic acid as carbonate of magnesia. Neither can claim to be the true mode; but I now think the one chosen here is the more accurate.

In deep-sea waters—	
Mixture III.,	3·0307
In surface waters—	
Mixture I.,	3·0175
Difference,	0·0132

In medium depth waters—	
Mixture II.,	3·0300
In surface waters,	3·0175
Difference,	0·0125

and either of the two differences is five to six times as great as even the absolute sum of the probable errors of the respective two terms. A discussion of the quantities of lime brought out by the 77 analyses had given a similar result, but exaggerated the difference between deep-sea on the one hand and shallow or medium depth on the other.

But there can be no doubt that, if I had applied even as exact a method in the 77 analyses as I did subsequently in the special investigation on the lime, I should have arrived at a greater difference than 0·013 between certain individual samples.

The result under discussion received a valuable confirmation from the alkalinity determinations to which I had occasion to refer above. Following the example of the Norwegian chemists, I measured the surplus base (*i.e.*, the base left unsaturated by the sulphuric and hydrochloric acid) by the weight of carbonic acid (CO_2) which it would need to convert it into normal carbonate, and referred it to 1 litre of water analysed. But it struck me that in discussing any series of such determinations, they must be referred to a constant salinity, and I accordingly reduced all my numbers to 100 parts of total salts or 55·42 of halogen counted as chlorine; so that with me "alkalinity," as designating a quantity, means "the weight of carbonic acid (CO_2) present as normal carbonate (*i.e.*, in forms similar to carbonate of lime) in every 100 parts of total salts," which, on an average of 130 cases, and if the number of parts by weight of carbonic acid be taken in grams, corresponds to 2·78 litres. Omitting a number of abnormally high or low values, and a few suspected analyses, which left 130 cases for discussion, I found the alkalinity in the whole set to range substantially from 0·140 to 0·164, and then, confining myself to "surface" waters (meaning waters from depths not exceeding 100 fathoms) and bottom waters, and referring on both sides to 100 samples, I found that alkalinities from 0·140 to 0·148 occur preferably in surface waters, while from 0·148 to 0·160 the bottom waters were in the majority. From a graphic representation[*] showing the frequency of occurrence of certain narrow ranges of alkalinity, I concluded that the most frequently occurring value is

For surface waters,	0·146 ± 0·002
For bottom waters,	0·152 ± 0·003

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[*] See diagram on p. 130.

which values may be adopted, *provisionally*, for the two kinds of ocean-water. In fifteen cases I was in a position to compare with one another the alkalinity of a surface water and the bottom water at the same Station. In two cases the balance was in favour of the surface water, the numbers being 0·015 and 0·010 respectively; in one case the difference was *nil*; in the remaining twelve cases it was in favour of the bottom water, the differences ranging from 0·002 to 0·019. According to the above two averages the alkalinity of bottom water exceeds that of surface water by 0·006, meaning of course 0·006 grams of carbonic acid per 100 grams of total salts, or 0·014 grams of lime CaO per 100 of chlorine, if we assume the increase in alkalinity to be owing to additional lime. My determinations of the lime, as stated, had shown the presence of 0·013 grams of extra lime in deep-sea as compared with shallow waters. The *closeness* of the agreement is of course accidental. That the surplus base in a sea-water is not owing entirely to carbonate of lime is too obvious to be specially pointed out. In sea-water (as in any mixed salt solution) each base is combined with each acid, and as there are four acids and four bases there must be sixteen salts, the individual percentages of which we have no means of determining. But there are reasons for assuming that the carbonic acid being a feeble acid, is combined chiefly with the weakest bases, and consequently chiefly with the magnesia, and in the second instance with the lime. So we should say, if the arrangement of the bases and acids into salts were a mere matter of tendency to form simple salts. But magnesium has a characteristic tendency to form double chlorides with potassium and sodium, and there is superabundance of chloride of sodium in sea-water. Hence, probably, most of the magnesium is not there as carbonate but as double sodio-chloride, and the lime takes the greater share of the carbonic acid. The alkalinity in any case represents the potential, and may fairly be presumed to measure approximately the actual, carbonate of lime. This is the only answer to that often raised question about the presence of ready-formed carbonate of lime in sea-water, which some chemists, who at the time must have deliberately shut their eyes to the established propositions of chemistry, have endeavoured to solve by direct experiment. Supposing actual carbonate of lime could be extracted from sea-water without the co-operation of external matter (I greatly doubt whether this has ever been done), the weight of such extracted carbonate of lime could not reasonably be assumed to be equal to that which was originally present in the water. Sea-water is alkaline, all the alkalinity must be owing to carbonates, and of these carbonate of lime must be one. This is, and for a time is likely to be, the sum total of our knowledge on this point.

When I said that the alkalinities in the samples considered ranged on the whole from 0·140 to 0·164, I meant to hint that these limits do not embrace even all the 130 cases admitted for the general discussion. Less values than 0·140, it is true, do not occur; but there are seven cases in which the alkalinity was decidedly greater than 0·164, as shown in the following table, in which the first column gives the Challenger number of the respective sample, the fourth names the Station, and the fifth gives further geographical notes. "B" in Column II. means that the sample came from the bottom.

I. No.	II. Depth if not B.	III. Alkalinity per 100 of Solids.	IV. Station.	V.
586	B.	0·1707	191A	All those waters came from that archipelago north of Australia, and the Stations lie within the latitudes 5° S. and 18° N., and the longitudes 117° E. and 135° E.
596	B.	0·1693	193	
616	50 fathoms	0·2079	198	
656	B.	0·1704	206	
295	B.	0·1847	97	Atlantic, 11° N., 5° west of coast of Africa.
378	B.	0·1731	152	Southern Indian Ocean; latitude 61° S., longitude of Madras.
878	300 fathoms.	0·1858	240	North Pacific, latitude 35° N., 14° east of Yeddo, Japan.

The very alkaline water No. 616 came from a point close to Celebes, in the Molucca Passage. Of the few anomalous alkalinities which were excluded from the general discussion, those in which the abnormal results could be accounted for by an abnormal condition of the samples (generally the presence in the bottle of mud or other kind of ocean-deposit) may well be passed over. If we do so there remain only two cases, which however are very interesting; I refer to the two following samples: No. 5, a surface water from Station 2, North Atlantic, near the Canary Islands; and No. 31, a surface water from Station 12, about the middle of the ship's track from the Canaries to the West Indies. The latter is one of the waters which had been completely analysed for chlorine, sulphuric acid, lime, magnesia, potash, and soda, long before the alkalinity was determined. Both samples had deposited in their respective bottles large quantities of crystalline matter, which exhibited the reactions of a mixture of carbonates of lime and magnesia, and *may* have included sulphate of lime; but I unfortunately neglected to test for sulphuric acid.

In No. 5 the alkalinity per 100 of salts amounted to only 0·0756; but adding in that corresponding to the lime and magnesia in the deposit, on the supposition of its being all carbonate, I calculated that the original alkalinity must have had the high value 0·291, and the original lime must have amounted to 3·300 per 100 of chlorine instead of the 3·026 brought out as a general mean by the 77 analyses which have been so frequently referred to.

No. 31. There was not enough of this water left for a satisfactory determination of the alkalinity by Tornoe's method, and the calculation of the alkalinity from the complete analysis would be of no value. From the analyses of the deposit and the water-remnant left, and the complete analysis previously made, I calculated that the original water should have contained, per 100 of chlorine, the quantities of lime and magnesia given below and contrasted with those present in average surface water, *according to the 43 analyses quoted on pp. 30 and 31*—

	Lime.	Magnesia.
Water (No. 31) in its original condition by calculation, . .	3·496	11·163
Average surface or small-depth water, ...	3·018	11·203

Hence, taking 0·146 as corresponding to ordinary surface-waters, I calculate for the surplus alkalinity 0·1779, which, together with the normal value 0·146, gives 0·324 per 100 of salts for the original water. The calculations which led to these high values for Nos. 5 and 31, do not, it is true, rest upon a perfectly secure basis; but I believe the results are approximately correct, and besides the high number 0·2079, which was found quite directly for the normal water, No. 616 is beyond suspicion. I have no doubt that far higher alkalinities than even 0·33 occur locally in many parts of the ocean, wherever there is abundance of carbonic acid and of carbonate of lime or magnesia at the same time. To obtain some insight into the possible extreme limit, I took a sea-water whose alkalinity was 50·2 milligrams per litre, the surplus base being present substantially as bicarbonate, and after having saturated it with carbonic acid, I digested it, in one case with carbonate of lime, in another with carbonate of magnesia. The filtered liquors showed immense alkalinities, the increase being

	Lime.	Magnesia.
Increase of alkalinity, . .	314·2 mgrms. per litre,	1234·0 mgrms. per litre.

A similar set of trials with the *natural* water gave, in the case of magnesia, an increase in alkalinity of 10·6; in the case of lime there was a decrease of 3·2 milligrams per litre.[*] The decrease of alkalinity caused by the addition of carbonate of lime is difficult to explain. Perhaps it is only the outcome of an observational error; but in any case my experiments show that it would be quite possible for the alkalinity to increase beyond the maxima that occurred in the 130 samples. It is very curious that in my experiments with sea-water saturated with carbonic acid, carbonate of magnesia proved far more abundantly soluble than carbonate of lime. My explanation is that a considerable portion of the magnesia, immediately after having been dissolved by the carbonic acid, suffered double decomposition by the large mass of chloride of sodium present, with formation of carbonate of soda and a double chloride of sodium and magnesium; so that for this part of the process a very small proportion of free or loosely combined carbonic acid would have sufficed, as it always comes back in the reaction, which I suppose to go on, as an equivalent quantity of bicarbonate of soda. The tendency of magnesium to form such double salts explains how those Challenger waters deposited

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[*] Compare page 131.

their large excess of surplus base, as carbonate of lime and not as carbonate of magnesia, although the latter is the weaker and more abundant base. Reference may here be made to certain observations of Sterry Hunt's, which he made in the course of his experiments on the formation of dolomites. He found that a litre of water, containing 3 to 4 grams of sulphate of magnesia, can dissolve 1·2 grams of carbonate of lime, and in addition thereto 1 gram of carbonate of magnesia, forming a strongly alkaline solution, which, on long standing, deposits the whole of its lime as crystals of hydrated carbonate ($CaCO_3\ 5H_2O$).

Our hypothesis, that a small quantity of free carbonic acid in sea-water enables its chloride of sodium to dissolve carbonate of magnesia as a double chloride of magnesium and sodium, would explain the local prevalence in the sea of excessive alkalinity, without the assumption of the presence of any exceptional proportion of carbonic acid. But the presence of excess of carbonic acid, whether the sea be in contact with carbonate of lime or with carbonate of magnesia, strongly adds to its tendency towards an increase in the alkalinity. The question of alkalinity is, in fact, inseparable from that of the carbonic acid in ocean-water, to which we now turn.

Carbonic Acid in Ocean-Water.

At the time when the Challenger Expedition set out, it had long been known that sea-water does contain carbonic acid (it is obvious that such will be the case, because this gas will necessarily be absorbed along with the other gases of the atmosphere), but chemists generally were of opinion that this carbonic acid was present for the most part in a state of absorption. The presence of carbonates in sea-water would not have been denied by any chemist, the less as Bibra, as early as 1851, and others after him, had proved that it is alkaline to test paper; but it had somehow come to be assumed that they were present only in minute quantities. This general impression is well illustrated by the attitude taken up in regard to this question by Jacobsen, the chemist to the German North Sea Expedition* (who has done so much towards rendering our knowledge of chemical oceanography more definite), and subsequently by Mr. Buchanan. Jacobsen found that while the dissolved nitrogen and oxygen could easily be expelled from sea-water by boiling in "vacuo," the carbonic acid most tenaciously clung to the water. On the other hand, he found that the carbonic acid is driven out completely when the sea-water (without any addition of reagents) is distilled nearly to dryness. His explanation of these facts was that the carbonic acid was combined chemically, or semi-chemically, with the chloride of magnesium in the sea-water. Mere boiling (without sensible evaporation) has no effect upon this quasi-compound;†

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* *Annalen der Chemie* (for 1873), Bd. clxvii. p. 1.

† According to an experiment of my own, almost *all* the carbonic acid of a sea-water is expelled without evaporation, if it is being boiled in a current of air which takes away the gas as quickly as it is liberated. See page 115, third paragraph.

distillation nearly to dryness decomposes it. Mr. Buchanan adopted the views of this high authority; but, as a series of experiments of his own had led him to the conclusion that the sulphates in the water are amongst the substances to which the carbonic acid adheres, he subsequently, in his numerous carbonic acid determinations during the cruise, always expelled this component by distillation nearly to dryness with *chloride of barium.**

When some years ago my attention was directed to the matter, I adopted Buchanan's views as probably correct, and continued to hold them until the results of my first instalment of complete sea-water analyses (*vide supra*) led me to take a different view of the matter.

These analyses, as already stated (on page 202), brought out a very appreciable proportion of base combined with carbonic acid, and although they did so, as I subsequently found, chiefly through an over-estimation of the soda, the fact, in a qualitative sense, was established beyond doubt by an independent method. But all this does not detract from the great merit of Tornøe in having been the first to prove, by a long series of combined determinations of alkalinity and carbonic acid in sea-waters, that the carbonic acid in *those waters at least* was present as bicarbonate, in general more or less incompletely saturated. After this discovery Jacobsen's and Buchanan's observations are easily explained. The fact that bicarbonates, being real compounds, are slow in giving up their surplus carbonic acid is evident, and if all their carbonic acid is given off on distillation nearly to dryness, this, I submit, is the effect of a slowly progressing decomposition of the hydrated chloride of magnesium into magnesia and hydrochloric acid, which latter expels all the carbonic acid. And if Buchanan found that in the distillation of a sea-water addition of chloride of barium accelerates the liberation of the carbonic acid, this obviously arises from the fact that this reagent decomposes the normal carbonate in the bicarbonate into carbonate of baryta and chlorides of the respective basilous metals. But why did Buchanan always obtain far less carbonic acid per litre than Jacobsen had obtained? Why did not the decomposition of the chloride of magnesium bring about the decomposition of his carbonate of baryta as it had disposed of Jacobsen's original sea-water carbonates? This would be a difficult question to answer if we did not know from experiments of Rose's that a mixed precipitate of sulphate and carbonate of baryta is only *very slowly* attacked by dilute hydrochloric acid.

In the course of one of my critical experiments on Buchanan's method I once, by mistake, added a quantity of chloride of barium insufficient to bring down all the sulphuric acid. The carbonic acid eliminated on distillation increased beyond what was obtained in experiments with excess of reagent. The chloride of barium in this case had been substantially decomposed by the sulphates, and thus been prevented to a great extent from acting on the carbonates of the water, which thus (to this extent) were exposed to the influence of the chloride of magnesium.

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* See note by Mr. Buchanan at the end of this Report, page 245.

The action of hydrochloric acid (and consequently also that of dissociating chloride of magnesium) on a mixture of carbonate and sulphate of bartya cannot be presumed to be absolutely *nil;* besides, as part of the bicarbonate in sea-water must be presumed to exist as lime and magnesia salt, it is questionable whether all the carbonic acid of the *normal* carbonate was always precipitated as carbonate of baryta; hence, Mr. Buchanan's method cannot be relied on as having always eliminated *exactly* that part of the carbonic acid which is present over and above that of the normal carbonate, and we cannot be sure even of the error always lying in the same direction. My critical trials tend to confirm this suspicion. But these trials, so far as they accommodated themselves in all strictness to Buchanan's method, are very few; while I have no doubt that Buchanan's experiments on board ship were executed with his characteristic exactness and with business-like uniformity. Hence his results (as reproduced in my memoir) are, after all, very valuable; because, apart from their giving, in the worst case, a *minimum* limit for the total, they may fairly be assumed to give an approximation to the loose carbonic acid (meaning what was there over and above the normal carbonate).

Admitting this, their general result may be formulated by saying that ocean-water from any place or depth contains its surplus base in the form of normal carbonate combined with additional carbonic acid, which latter in the majority of cases falls short of, in a minority of cases comes up to, and very rarely exceeds, that which would produce bicarbonate ($RHCO_3$).

I might now proceed to a more detailed discussion of Buchanan's numbers, but prefer first to refer to a few synthetical experiments of my own, the primary object of which was to ascertain whether or not it was expedient for me to endeavour to add to Buchanan's work by determinations of the carbonic acid in my numerous samples of Challenger water. These experiments of mine are fully described in my memoir (page 108 *et seq.*); I content myself here with stating the most important result, which was that an imitation sea-water, prepared from pure common salt, Epsom salt, and bicarbonate of magnesia (which I then rightly or wrongly looked upon as sufficiently representing an ocean-water), when shaken with air in the summer, at which season our experiments was made, loses carbonic acid, and on subsequent repetitions of the operation continues doing so, the bicarbonate being thus brought nearer and nearer to the composition of normal carbonate. After this result I saw that there would be no use in my analysing many of my water samples for carbonic acid, and it was more for the purpose of satisfying my curiosity concerning the extent to which the bicarbonate-dissociation in my long preserved samples of sea-water had gone, than with any oceanographic object, that I carried out those few determinations which are tabulated on page 118 of my memoir. To my surprise, five out of the thirteen samples analysed still contained their surplus base as fully saturated bicarbonate.*

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* A noteworthy result, because in a sense it confirms my critical trials on Buchanan's method, which tend to show that this method, even as a mode of measuring the *loose* carbonic acid, is infected with a negative error.

If it be permissible to accept my artificial, as a sufficient substitute for natural, sea-water, my synthetical experiments may claim a certain degree of oceanographic significance. According to the current notions on "dissociation," the liberation of carbonic acid from bicarbonates in sea-water by repeated shaking with air should come to a stop as soon as the partial tension of the carbonic acid in the air-residue has come up to a limit value, which is a function of temperature alone, as long as there is any bicarbonate left in the water undecomposed. Hence, supposing at a certain constant temperature we shake 1 volume of a sea-water with say 5 volumes of air, then remove the air-residue and shake with 5 volumes of renewed air, and so on, although the quantity of carbonic acid in the water gets less and less at each stage, the proportion of carbonic acid in the successive air-residues removed should retain a constant value. I take "5 volumes" of air as an example, because this is the exact proportion of air which I consistently applied in the one series of experiments in which I have most confidence, and which is reported on page 115 of the memoir. What I really did in this, as in my other synthetical experiments, was to determine the number of milligrams of carbonic acid contained—firstly, in the original water; secondly, in the residue after the first shaking; thirdly, in the residue left after two successive shakings with 5 volumes of air, of a fresh volume of the original water, &c. But this comes to the same result as if the same volume of water had been operated upon successively, and from the weight of carbonic acid found we can calculate the successive portions of the gas which were carried away. I have done so and found that the carbonic acid tensions in the three successive volumes of air removed were 5·7, 5·5, and 3·9 ten-thousandths of an atmosphere. These three numbers, considering the difficulties involved, are sufficiently near to their mean of 5 of the above units, and this value, accordingly, may be provisionally adopted as an approximation to the dissociation tension of sea-water bicarbonates at the temperature at which I operated, and which, quoting from memory, I may say lay between 18° and 21° C.

I am aware that this part of my work lacks the degree of precision which would be desirable for my present train of reasoning. But I had not the time to embark in the far more elaborate investigation which would have been desirable. I have, however, quite lately resumed the matter on a new basis, and hope before long to be able to formulate the exact conditions of stability in sea-water bicarbonates as they exist when dissolved in real sea-water, and amongst others to decide the question whether in this process they quite directly tend to become normal, and do not perhaps more directly gravitate towards the state of sesqui-carbonate. In the meantime we must reason on what data we have.

Considering that at a temperature of 18° to 21° C. the dissociation tension of the bicarbonates in sea-water is 5 ten-thousandths of an atmosphere, at temperatures not differing by more than one or two degrees from 0° C., such as prevail in the arctic and antarctic circles, it is far more likely than not to fall below 3 ten-thousandths, which is about the partial tension of the carbonic acid in the atmosphere. Admitting this, and assuming the ocean at a given time everywhere contained its surplus base as sesqui-carbonate, then the water of the tropics would constantly give out carbonic acid to the atmosphere and tend to raise its 0·0003 atmosphere of carbonic acid pressure to the dissociation tension corresponding to the temperature. Passing now from the equator, either way, to colder and colder latitudes, this carbonic acid emission becomes less and less intense, until, in a certain belt of temperature which prescribes to the dissociation tension the value 0·0003, this emission becomes *nil*, and proceeding towards the pole to colder and colder latitudes, the water will take in carbonic acid at a greater and greater rate, and tend to convert its surplus base into fully saturated bicarbonate, which stage of saturation is the more likely to be reached the nearer we come to either pole. The number of equivalents of carbonic acid present for every one equivalent of surplus base would, in fact, be a function of the temperature of the water, or approximately of the latitude. But the actual relations are far more complicated: the excess of carbonic acid taken up in the polar regions is constantly being conveyed to warmer latitudes by the polar currents, to make up for loss of carbonic acid constantly suffered by the water there. It may be pointed out that, assuming (as we have tacitly done so far) there were no other source of carbonic acid than the atmosphere, the sea-water even in the arctic and antarctic circles could not contain more than traces of actually free carbonic acid in addition to fully saturated bicarbonate. According to Bunsen, one volume of even pure water of 0° C., when shaken with excess of pure carbonic acid of 760 mms. dry gas pressure, absorbs only 1·8 volumes of the gas (measured dry at 0° C. and 760 mms.). Even in the polar regions, the temperature of liquid sea-water never sinks by more than 2 or 3 degrees below 0° C., hence the maximum proportion of carbonic acid which such polar sea-water could possibly take up from the atmosphere may be roughly estimated at $0·0003 \times 1800$, or to ·54 cubic centimetres, or about 1 milligram per litre of water. And supposing at a given place a larger proportion were produced by an influx of gas from below, this excess of carbonic acid, over and above the 0·5 c.c., would speedily diffuse out into the atmosphere.

That there are supplies of carbonic acid in the ocean itself cannot be doubted. One of them is afforded by the decay of marine animals and plants; but this supply, although very large, doubtless amounts to very little, when compared with the immense quantities supplied by the sub-marine volcanic carbonic acid springs which no doubt exist at the bottom of the sea as they do on dry land. It is well known that carbonic acid is one of the most abundant after products of volcanic eruptions, and we have good evidence for supposing that volcanic eruptions frequently take place over the floor of the ocean. If we nowhere see these springs coming up in the ocean as jets of frothy carbonic acid water, such as issue from the earth on dry land, this proves only that the springs do not happen to exist in any of the shallow places. And where they do exist at average ocean-depths they have no chance of becoming "*springs*" in the strictest sense of the word. Under a pressure of from 1000 to 3000 fathoms of superincumbent sea-water, carbonic acid assumes the form of a very dense liquid, which, far from issuing forth into the water above, must be presumed to be only gradually washed away by the currents, and in this manner distributed throughout the ocean. But be this as it may, it is reasonable to suppose that in the depths of the ocean there must be numerous bodies of richly carbonated water, and it is interesting to search in the Challenger records for evidence of their existence. The analyses of the numerous samples of sea-water air which were extracted by Mr. Buchanan in the course of the cruise, may be referred to here. These gases must contain all the free carbonic acid in addition to part of the loosely combined carbonic acid of the bicarbonate which was present in the original water. I have collected a few cases, in which both the volume of total gas extracted from a litre of water and the percentage of carbonic acid in the gas assumed high values; and for the convenience of the reader transcribe them from my memoir:—

No. of Water.	D	δ	Carbonic Acid per Litre.
1009	2875	2850	11·6 c.c.
1024	2225		11·5 „
771	2325		13·5 „
974	3125		14·3 „
1096	2900		15·8 „

D stands for the depth of the sea at which the sample named in Column I. was taken; δ for the depth at which the sample was collected. The last four entries refer to bottom waters. The carbonic acid is given in c.c. measured dry at 0° C. and 760 mms. pressure. These samples, as we see, all come from enormous depths, where the carbonic acid might most readily accumulate and assume an exceptionally high value; and yet, even granting that the carbonic acid found in the boiled-out gas had all been in the water operated upon as *free* carbonic acid, its volume is less than 16 c.c. per litre, *i.e.*, less than $\frac{16}{1800}$th $= \frac{1}{112}$th of that which the water might have taken up under 1 atmosphere's pressure from an atmosphere of the pure gas.

Passing now to the samples of sea-water which were analysed for carbonic acid by Mr. Buchanan during the cruise, we meet with only two samples which contain a noteworthy quantity of free carbonic acid in addition to bicarbonate; but even these could be designated "carbonic acid waters" only by unduly stretching the definition of the term.

Obviously the Challenger staff in collecting their samples of sea-water never happened to strike on one of the carbonic acid springs, except perhaps when the samples No. 383 and 532 were collected; it would have been remarkable if they had done so.

Let us now proceed to a more detailed description of Mr. Buchanan's carbonic acid determinations, as transcribed from his journal on pages 119 to 123 of the memoir.

Since the Norwegian method of alkalinity determination was not invented before the setting out of the Challenger Expedition, only those 27 of Mr. Buchanan's 195 samples which appear in my list of alkalinities are susceptible of a precise interpretation.

The following table gives:—

The Loose Carbonic Acid in 27 Challenger Waters, as determined by Mr. Buchanan in the freshly drawn samples by his own method, contrasted with the alkalinity according to Dittmar.

In Column I. bottom waters are designated by a "B," surface waters by an "S"; for intermediate waters the depth in fathoms whence the water came is given. Column V., under "CO_2-deficit," gives the weight of supplementary carbonic acid which the carbonate present in a litre of water requires to become bicarbonate.

A *negative* deficit, of course, means an excess of carbonic acid present over and above that combined in the bicarbonate.

I.	Chall. No.	CO_2 present per litre as R_2CO_3, Dittmar.	CO_2 present per litre Besides. Buchanan.	CO_2 Deficit.	
B.	21	55·9	40·0	15·9	
B.	66	55·5	57·0	−1·5	
B.	120	55·0	47·2	7·8	
S.	265	57·2	59·1	−1·9	
1000	283	53·2	55·6	−2·4	
B.	353	58·2	59·5	−1·3	
B.	378	61·6	67·9	−6·3	
B.	383	53·9	95·9	−42·0	Corrected by CO_2 in boiled-out air.
B.	[556]	57·4	43·4	14·0	
400	594	53·6	40·0	13·6	
B.!	791	55·1	31·2	23·9	
B.	912	54·6	35·3	19·3	
B.	1221	57·1	45·6	11·5	
B.	1300	54·4	47·5	6·9	
60	678	51·9	29·8	22·1	
B.	1270	54·0	46·4	7·6	
B.	1313	53·8	44·7	9·1	
50	1356	51·6	50·4	1·2	
B.	1388	56·4	55·6	0·8	
B.	1405	51·7	45·1	6·6	
B.	1438	51·1	51·2	−0·1	
B.	1494	54·8	43·0	11·8	
S.	1573	54·2	34·8	19·4	
S.	1581	55·0	38·2	16·8	
S.	1687	54·5	37·3	17·2	
B. (?)	1697	55·8	36·8	19·0	
400	1707	52·9	38·7	14·2	

Notes.—No. 265.—"Sample shaken with air, so as to saturate it at 22°·8 C." (J. Y. B.). This, according to my laboratory experiments, as above referred to, would remove carbonic acid even from a water of the composition given in the table, and as the water even after having been thus manipulated apparently contained fully saturated bicarbonate, it should originally have contained a very appreciable proportion of *free* carbonic acid.

No. 383.—"Gases boiled out of water and 225 c.c. of remaining water distilled with $BaCl_2$ as usual. Hence CO_2 in gas-tube must be added" (J. Y. B.). I have done so; without this correction the loose carbonic acid per litre would be 82·9 mgrms.; and the deficit, consequently, −29·0.

No. 556.—"CO_2 and gases boiled out" was on the label of the bottle which came to me. Hence the alkalinity may to a slight extent be owing to dissolved glass, and the recorded value 57·4 be a little too high.

Mr. Buchanan's numbers for the "carbonic acid per litre," even when taken in a purely empirical sense, *i.e.*, as referring to the carbonic acid which actually was eliminated in the distillation, are, in my opinion, uncertain by about ±2 mgrms. Admitting this, the results are compatible with the following conclusions.

Seven out of the 27 waters contained their surplus base substantially as unmixed bicarbonate. Five of these 7 waters came from the bottom or great depths, only 2 being from depths of 50 fathoms or less.

Two of the 27 waters contained free carbonic acid in addition to bicarbonate. I refer to Nos. 378 and 383, both bottom waters.

In No. 383 the actually free carbonic acid would appear to have amounted to 42 mgrms. per litre!

In 18 of the 27 waters the carbonic acid deficit has tangible positive values; they all contain their surplus base as a mixture of normal carbonate and bicarbonate. In regard to their depths they may be arranged as follows:—

Surface.	50 Fathoms.	400 Fathoms.	Bottom.
3	1	2	12

To pass now to the remaining 168 determinations of loose carbonic acid by Buchanan, for which we have not the corresponding alkalinities:—To be able to interpret them at all, we must assume my average value of 54·7 for the alkalinity per litre to hold for them all, and we may well permit ourselves to use the approximate value 55. If we do so it takes in each case 55 mgrms. of loose carbonic acid to produce bicarbonate. Of the 168 waters under consideration only 15 yielded more than this limit proportion of carbonic acid, and two of the determinations (Nos. 114 and 497) are probably erroneous.[*]

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[*] No. 114, as Mr. Buchanan states, was slightly turbid with carbonate of lime. Hence the high carbonic acid (64 mgrms. per litre) which he found counts for nothing. It is sure to have been produced partly by the action of the hydrochloric acid liberated from the chloride of magnesium during the process of distillation. No. 497 gave 59·4 mgrms. of carbonic acid per litre, but the result, in Mr. Buchanan's opinion is "probably false." (Compare remarks on table, page 119 and 120 of memoir.)

Adding to the remaining 13 cases the 2 corresponding ones out of the set of 27 previously considered, we see that out of all the 195 waters only 15 probably contained free carbonic acid. But Mr. Buchanan's method, as appears from my critical experiments (see memoir, pages 110, *et seq.*), is liable to give low results; so we had perhaps better group our 13 together with all the 9 out of the set of 27 which exhibited no carbonic acid deficit, and say that out of Mr. Buchanan's 195 waters 22 contained their surplus base in the form of *at least* fully, if not more than fully, saturated bicarbonate.

Of these 22 waters—

Six came from the surface;
Nine from the bottom, the depth varying from 1260 to 3875 fathoms.*

Of the waters not bottom waters,

Four came from depths varying from 25 to 100 fathoms;
One from a depth of 400 fathoms;
Two from depths greater than 1000 fathoms.

The 6 surface waters, and the 4 from depths not exceeding 100 fathoms, are traced to their Stations in the following table, which gives also the dates of collection and the temperature of the water.

The Six Surface Waters.

No.	When Collected.	Temperature of Water.	Free Carbonic Acid. Milligrams.	
†265	1873. October 1	22°·8	1·9†	South Atlantic, 8° east of Rio Janeiro.
380	1874. February 12	1°·1	10	South Indian Ocean at latitudes south of 60° S.
382	February 13	0°·7	10	
386	February 16	−0°·7	1	
515	July 23	24°·5	6	South Pacific, lat. 20° S.
532	August 17	25°·1	41	Do. lat. 17° S.

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* In 8 out of the 9 cases. One of the waters, collected in Magellans Strait, or one of the passages leading thereto, came from a depth of only 245 fathoms.

† Calculated from ascertained alkalinity.

The Four Waters from depths not exceeding 100 *fathoms.*

No.	When Collected.	Temperature of Water.	Free Carbonic Acids. Milligrams.	Depth.	
	1873.				
355	December 30	3°·0	2	100 fathoms.	Indian Ocean, lat. 47° S.
	1874.				
397	February 21	not found.	16	50 "	Do. lat. 65° S.
419	March 7	6°·9	13	50 "	Do. lat. 50° S.
	1875.				
*1356	December 17	12°·0*	none.	50 "	South Pacific, lat. 33° 42′ S.; about 8° west of Valparaiso.

Six of our 10 waters are from a cold region in the Southern Indian Ocean; hence their richness in carbonic acid needs not surprise us. It is more difficult to account for the richness in carbonic acid of the other four, and more especially of No. 532. The extraordinary amount of carbonic acid in this water (which, as I am assured by Mr. Buchanan, is not a clerical or observational error) seems to point to the existence of a carbonic acid spring in the neighbourhood,—lat. 17° 25′ S., long. 169° 5′ W.

After having thus completed my review of the samples rich in carbonic acid, I turned my attention to those cases where the proportion of carbonic acid assumes *low* values, but, in doing so, confined myself to surface waters. I divided them into four categories as follows:—

The Carbonic Acid in Milligrams per Litre ranges	Number of Cases.
From less than 55 to 50 exclusive, ...	8
From 50 to 45 exclusive, ...	13
From 45 to 40 exclusive, ...	12
From 40 to 19·3, the least value, ...	36

Of this last category of waters, twenty-five had temperatures ranging from 20° to 29° C.; fourteen came from latitudes of 20° or less; nineteen from latitudes of 22° to 37°; three from latitudes of 42° ½ S., 51° S., 50° S., respectively.

Temperatures less than 20°, and values of carbonic acid less than 40 milligrams per litre, were found combined in the following cases:—

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* Calculated from ascertained alkalinity.

No.	Temperature C.	CO_2, mgrms. per litre.	Latitude.	
389	5°·4	37·3	50° S. near Kerguelen Islands.	
1272	11°·8	36·6	38° 43′ S.	Stations 292 to 309, South Pacific, from about 44° W. of Chili to channels between Gulf of Pennaz and Magellans Strait.
1301	14°·7	35·0	38° S.	
1314	13°·6	37·3	37° to 38° S.	
1342	16°·9	36·1	33° S.	
1352	17°·5	37·9*	33° S.	
1424	9°·4	39·5	51° S.	
1462	14°·2	38·5	Lat. 42° 30′ S., Station 318; 10′ east of east coast of South America.	
949	17°·9	29·1	Station 251; Lat. 37° 37′ N.	

I thought I might collect all those cases of surface waters which gave less than 30 milligrams of carbonic acid per litre and put them down as cases of exceptionally low values of carbonic acid in surface water—

No. 572. $CO_2=27·3$; Station 185+; lat. 11° 35′ S., between Australia and Humboldt Island.
" 682. $CO_2=25·1$; Station 214; lat. 4° 33′ N., 3° N.E. of Celebes.
" 760. $CO_2=30·3$; Station 223−; lat. 5° 31′ N., 10° N. of Admiralty Islands.
" 817. $CO_2=24·7$; Station 229−; lat. 22° N., 13° S. of Yeddo.
" 826. $CO_2=20·7$; Station 230−; lat. 26° 29′ N., 10° S. of Yeddo.
" 926. $CO_2=26·7$; Station 247–248; lat. 35° to 37° N., middle of North Pacific.
" 949. $CO_2=29·1$; Station 251; lat. 37° 37′ N., middle of North Pacific.
" 990. $CO_2=19·3$; Station 255–256; lat. 32° to 30° N., middle of North Pacific.
" 1097. $CO_2=28·9$; Station 368+; lat. 7° 35′ N., middle of North Pacific.

Seeing that these low proportions of carbonic acid all come from the Pacific, I collected all the values of carbonic acid in surface waters—*a*, from the Atlantic; *b*, from the Pacific respectively—and extracted their temperatures from Buchanan's specific gravity tables. Including only those cases in which the temperature of the sample was not less than 20° C., I found:—

Atlantic, 20 cases; mean loose carbonic acid = 41·0. Pacific, 18 cases; mean loose carbonic acid = 36·1. If we exclude No. 532, on account of its abnormally high carbonic acid, we have 32·53.

In the case of the Pacific there are 15 entries in which the temperature ranges from

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* "Too high" (Buchanan).

9°·4 to 19°·4, but in most cases it is about 15° C. The mean loose carbonic acid for these is 42·35, *i.e.*, barely more than is found in the Atlantic at high temperatures.

The Pacific surface water would appear to be less rich in carbonic acid than that of the Atlantic.

From all the evidence afforded by the Challenger research we see:—

1st. Free carbonic acid in sea-waters is the exception. As a rule the carbonic acid is less than the proportion corresponding to bicarbonate.

2nd. In surface waters the proportion of carbonic acid increases when the temperature falls, and *vice versa*.

3rd. Within equal ranges of temperature it seems to be lower in the surface water of the Pacific than it is in the surface water of the Atlantic Ocean.

We explained on page 213 how the atmosphere contributes towards keeping up the balance of the carbonic acid in the ocean. As a consequence the ocean, but in a far higher degree, acts as a regulator of the carbonic acid in the atmosphere.

To Schlösing belongs the credit of having been the first to point this out clearly.

In speculating on the quantity of carbonic acid in the atmosphere, he comes to the conclusion that its balance is maintained chiefly by the terrestrial volcanic carbonic acid springs and by the ocean, the combined influence of plant and animal life sinking into insignificance in comparison with these two agencies.

I think he is right; but if so, then the proportion of carbonic acid in the atmosphere should be more in the tropics than in the temperate zones and polar regions. In reference to this conclusion, the numerous determinations of atmospheric carbonic acid which were made by Thorpe in the Irish Channel in August 1865, and subsequently during a voyage to Brazil in 1866, may be quoted.

The air over the Irish Channel (lat. 54° 21′), in 26 analyses, gave a mean value of 3·089 volumes of carbonic acid per 10,000 volumes of air analysed, the extremes being 2·92 to 3·32. In the air collected during his voyage to Brazil he found (in 51 samples) from 2·70 to 3·26 volumes per 10,000; mean 2·953. The difference is in favour of the Irish Channel, but it is less than the limit fluctuations on either side. Possibly the difference would have been less or even have become negative if the Irish Channel analyses had been made in winter instead of in August. In a most suggestive memoir on the subject by Dumas, I find it quoted that Franz Schulze of Rostock, in a very numerous series of analyses, made there during 1869–71, found the proportion of carbonic acid to be subject to very slight fluctuation, and to have amounted on an average—

In 1869 (the whole year) to,	2·8668
,, 1870 ,,	2·9052
,, 1871 (first six months) to,	3·0126

Similar results were arrived at by Reiset after a most elaborate series of analyses, which comprised 193 samples. Reiset worked in each case on 600 litres of air, and used that admirable (baryta-water) method which had been worked out by Pettenkofer in connection with his great research on respiration. He found the volume of carbonic acid per 10,000 to vary only within the narrow limits of 2·94 to 3·1. But his experiments (like Schulze's) were all carried out at pretty much the same latitude, and, as Dumas points out, since each of Reiset's analyses involved the continued aspirating of air for some twelve hours, when there was a moderate wind, so that he may have started with the air of the place, and wound up practically with air from some place hundreds of miles away.*

It is clear that the analyses of air at present at our disposal show only that whatever the *rôle* of the ocean may be, its local influence on the air is too quickly obliterated by the constant commotion in the atmosphere to fall within the grasp of our present analytical methods.

There is one point in Dumas's memoir with which I cannot agree. Speaking of the absorption of atmospheric carbonic acid by the sea, he says:—"Quand la dose d'acide carbonique" (in the water of the sea) "diminue, le bicarbonate de chaux marine se dissocie et le carbonate neutre de chaux *se precipite.*"

The evidence seems to me to point the other way. I have had hundreds of bottles of samples of Challenger sea-water standing in my laboratory throughout the last three or four years. Many are more than half or three-fourths empty, and having passed through three summers must have lost a deal of their loose carbonic acid. And yet, apart from the two or three exceptional samples mentioned in the discussion on alkalinity, none of them shows any deposit of carbonate of lime. I have just engaged in experiments to ascertain the proportion of carbonate of lime which sea-water for a given degree of saturation in its carbonates is capable of dissolving. In the meantime, and as a general result of my experience, I presume that the water of the ocean in its present condition, and even where it contains its minimum of carbonic acid, is not yet saturated with carbonate of lime, but is ready to dissolve whatever of this compound the rivers send into it.

Mr. Murray tells me that extensive deposits of pelagic Foraminiferal and Molluscan shells are found in the ocean bed only at depths not exceeding a certain limit for each latitude with similar surface temperature conditions. For instance, in the tropics Pteropod shells are abundant at the bottom in depths of 1200 or 1400 fathoms, but in latitudes higher than 45° they are not met with in the deposits. The same remark applies to the more delicate Foraminiferal shells. At the greatest depths of the ocean all these calcareous shells disappear from the deposits in all latitudes. The cause of this, in

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* This objection possibly applies to Schulze's analyses as well; but I have not his memoir at my disposal. Thorpe's analyses were made by Pettenkofer's method, in which the air to be analysed is collected within a few minutes.

my opinion, is not that deep sea-water contains any abnormal proportion of loose or free carbonic acid (Buchanan's analyses tend to prove the erroneousness of such a presumption), but the fact that even alkaline sea-water, if given sufficient time, will take up carbonate of lime in addition to what it already contains. The Foraminiferal shells disappear at great depths, because it took them so long to reach these depths they had time to pass into solution.

I had just completed this part of my Summary, when I found in the Chemical News* an interesting article by Alexander Winchell, who, following up certain researches of Sterry Hunt and Ebelmen, arrives at the conclusion that the immense quantity of carbonic acid which must have served for the formation of the deposits of coal and of limestone (amounting as it does to far more than the quantity of carbonic acid which would be yielded by the whole of the oxygen now present in the atmosphere), cannot be accounted for otherwise than by assuming that it must have come in from interplanetary space. The atmosphere with Winchell, in fact, is nothing but that part of the general atmosphere of the universe which our planet has, in the course of time, attracted towards itself. I see no necessity for this hypothesis, which I suspect is not in accordance with what we know of the constancy in the rate of rotation of the earth. All the immense mass of carbonic acid sought to be accounted for may have come out of the bowels of the earth, whence this gas is still being emitted in enormous quantities. The difficulty, I apprehend, lies in the other direction. Our atmosphere would long have become unfit for respiration, if the volcanic carbonic acid were not constantly being removed by the bases of disintegrating silicates, chiefly as carbonate of lime, of which a considerable portion goes down the rivers into the ocean. The latter will "soon" (in the geologist's sense) have arrived at a state of saturation in regard to this component.

Absorbed Nitrogen and Oxygen.

From the carbonic acid in ocean-water, it is an easy transition to pass to the absorbed nitrogen and oxygen which must prevade the whole of the ocean, because its surface is in contact everywhere with the atmosphere. The composition of the latter, in reference to its two principal components, is substantially the same in all its parts, the two gases being always associated in very nearly the ratio of 21 volumes of oxygen to 79 volumes of nitrogen. Jolly, it is true, in a long series of analyses of the air collected at a station near Munich, made out that the percentage of oxygen (in the air freed of its carbonic acid and water) varies with the seasons and the direction of the wind, as shown by the following table which I borrow from Landolt and Börnstein's Physikalisch-chemische Tabellen. The original is in Wiedemann's Annalen der Physik, ser. 2, vol. vi. p. 520.

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* Original in *Science*, December 28, 1883, vol. ii. p. 820. For Sterry Hunt's papers we are referred by the author to the *Amer. Journ. of Sci. and Arts*, May 1880, and other publications.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1877. June, . . July, . .	20·95	20·71	20·66	...	20·61	20·59	20·53	...
October, . . November, . .	21·01	20·91	20·80	20·56	...	...	20·76	20·78

Hence it would appear that this natural "constant" is subject to greater variation than has hitherto been suspected. But the well-known extensive research of Regnault,* who, in 106 samples of air collected in different parts of the world (including 2 from the top of Pichincha (4800 metres), and 19 from the polar regions), found the percentage to vary only from 20·908 to 20·999, is sufficient to prove that lower values than 20·9 are the rare exception, and 21 per cent. may well be adopted for oceanographic purposes as holding universally.

As the pressure of the atmosphere at the sea-level does not differ very greatly from 760 millimetres, the two gases may be assumed everywhere to press on the ocean, the oxygen with a force equivalent to 0·21 times $(760-p)$, the nitrogen with a force equivalent to 0·79 times $(760-p)$ millimetres of mercury, where p stands for the tension of the vapour of water, which of course is very little in the polar regions, while in the tropics it may assume greater values up to some 33 millimetres (the tension of steam saturated at 30° C.). According to the law of gas absorption, a given volume of sea-water, when shaken up with a given volume of air at a given temperature, takes up both gases, the dissolved quantity of each being proportional to the product of its coefficient of absorption into its partial pressure in the undissolved residue, and as the coefficient of absorption of oxygen is greater than that of nitrogen, the percentage of oxygen in the dissolved air is greater, and that in the undissolved residue is less, than that prevailing in the natural air. The ratio of the two percentages obviously depends on the relative volume of air used, but we need not trouble ourselves with the somewhat complex general formula, because for our purpose it is sufficient to consider the special case which applies to the ocean surface, and which presents itself when the shaking is repeated with constantly renewed air until the last instalment of air remains unchanged. In this case (which for us is the general case) the volume of air dissolved at a given temperature t by one litre of sea-water is a quantity λ, which is a function only of t and the pressure of the atmosphere, and every c.c. of dissolved gas contains n_1 c.c. of oxygen and n_2 c.c. of nitrogen, where n_1 and n_2 depend only on t, but change very slowly with the latter.

According to my own determinations, as fully reported in the memoir,

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* *Comptes rendus*, t. xxxiv. p. 863, 1852; also *Ann. Chim. Phys.*, sér. 3, t. xxxvi. p. 385.

One litre of Sea-Water when saturated with (constantly renewed) air at t° and a pressure of (760 mm. plus the tension of vapour of water at t°) takes up the following volumes (measured dry at 0° and 760 mm. pressure) of the two gases:—

Temperature. Centigrade.	Dissolved Nitrogen and Oxygen in Cubic Centimetres.		Percentage of Oxygen in dissolved Gas.
	Nitrogen.	Oxygen.	
0°	15·60	8·18	34·40
5°	13·86	7·22	34·24
10°	12·47	6·45	34·09
15°	11·34	5·83	33·93
20°	10·41	5·31	33·78
25°	9·62	4·87	33·62
30°	8·94	4·50	33·47
35°	8·36	4·17	33·31

The temperature of the surface water of the ocean never falls very far below 0° C., even in the polar regions (the Challenger registered 27° F in the Antarctic ocean), while even in the tropics it rarely rises above 30° C. The corresponding tensions of aqueous vapour are 4·6 and 33·2 millimetres respectively. Now the sea, as far as we know, derives all its absorbed oxygen and nitrogen from the atmosphere,—neither gas can come in from any other source, apart *perhaps* from a small quantity of nitrogen produced in the putrefaction of the bodies of marine animals and plants, which may, however, be safely neglected. Hence, we should say the ocean can nowhere contain more than 15·6 c.c. of nitrogen and 8·18 c.c. of oxygen gas per litre, and the quantity of nitrogen per litre will never fall below $\frac{760-33}{760} \times 8{\cdot}94 = 8{\cdot}55$ c.c. We cannot make a similar assertion in regard to the oxygen, and for it put down the minimum at $\frac{727}{760} \times 4{\cdot}50 = 4{\cdot}30$ c.c., because it is liable to constant diminution by the processes of life and putrefaction and processes of oxidation generally.

At any point in the surface of the ocean the air dissolved in the water constantly tends to assume the composition demanded for the prevailing temperature by the absorptiometric equations which served to calculate our table. But it is rarely possible for it to assume this composition. Because, the water being in a continual state of progressive motion constantly flows from one set of conditions into others. And supposing even a certain area of the ocean surface were in a state of stagnation, the temperature would vary in diurnal cycles, and even the calculated value of the volume of nitrogen per litre would be a periodic function of time, exhibiting its maximum at the hour corresponding to the minimum temperature and its minimum at the time of maximum temperature. The process of absorptiometric exchange, however, even at the constantly oscillating surface of the sea, is a thing of slow progress: it could not keep pace with the change of temperature, and the actual nitrogen curve would never go as high up or as low down as the theoretical one. In addition to this, the lower strata of the water will constantly add to or take away from the surface nitrogen by diffusion and occasional intermixture. All this holds for the oxygen likewise, except that the latter is liable to constant diminution by processes of oxidation. On the whole, however, we may assume that all the disturbing influences will only modify, but not efface, the course of events as prescribed by the law of gas-absorption.

In regard to non-surface water, we have to confront a greater complexity of phenomena. The gas contents of a deep-sea water of course have nothing to do with the, in general low, temperature and high pressure prevailing at the respective place; because the air was not taken up there but at the surface. Any given sample of deep-sea water must be presumed, in general, to be the result of the conflux of a number of surface-waters from a variety of places, but for the purpose of a preliminary survey, we may permit ourselves to view each sample of deep-sea water as having taken up its air at the surface at some *one* temperature t, and then sunk down unmixed. The volumes of nitrogen and oxygen per litre then should have the values assigned to them by the absorptiometric equations for this temperature. But while the nitrogen (as long as that portion of water remains unmixed with other different water) remains constant, the oxygen will become less and less, through the processes of oxidation which in the deep go on without compensation. Hence, if there were absolute stagnation in the ocean anywhere, the proportion of dissolved oxygen there might be reduced ultimately to nothing. Amongst the many deep-sea waters which were analysed for their gas contents, we found none that were quite free from absorbed oxygen, which confirms our conviction that absolute stagnation nowhere exists in the ocean, not even at its greatest depths.

The actual relations can of course be ascertained only by observation and experiment. Mr. Buchanan, accordingly, in the course of the expedition, devoted a considerable portion of his time to the extraction of the gases from a great number of samples recently drawn from a variety of depths and geographical positions. He used for this purpose a method which had been worked out by Jacobsen, and employed by him successfully in the course of the German North Sea Expedition. The method is fully described on pages 141 and 142 of my memoir. It consists, essentially, in this, that the gas from a measured volume of the water is expelled by boiling, and driven into a previously evacuated glass tube, in which it is subsequently sealed up to be measured gasometrically and analysed in the laboratory. Of the many gas samples which Mr. Buchanan thus collected, a good number were analysed by himself, but the majority were analysed by me, and my report contains both his results and mine.

The method which I used in the absorptiometric determinations referred to, consisted essentially in this, that I saturated a quantity of sea-water with air at a known temperature, and then from a measured volume extracted the gases by a method similar to Jacobsen's, but in its final form differing from it in this, that the vacuum in the gas-collecting tube was maintained by a mercurial air-pump, which sucked out and removed the gas as quickly as it was liberated. I was led to adopt this improvement, because I had found it impossible to obtain sufficiently constant results by the Jacobsen method in its original form, and ascribed the fluctuations to the obvious fact that the vacuum originally existing in the gas-collecting tube, is soon destroyed by the gas going into it, so that necessarily a small but variable portion of the gas, corresponding to the coefficient of absorption at the temperature at which the water boils at the end and to the final pressure in the tube, must remain in the water. The results of our analyses, as interpreted on the basis of my absorptiometric work, agreed on the whole with the inferences which have just been deduced from known physical laws. In the surface waters the volumes of nitrogen and oxygen present in a litre of water were found to be functions of the temperature whose general course was similar to the theoretical functions determined by my laboratory experiments. In the deep-sea waters the volumes of the nitrogen varied within the same limits as those in the surface waters; but the volumes of oxygen were, in general, less than those calculated from the nitrogen-volumes on the hypothesis of surface absorption of air at the temperature corresponding to the nitrogen found.

In waters from great depths the actual volume of oxygen was often very small, as illustrated by the following two examples:—

No. of Water.	C.c. per litre.		O_2 calculated.	δ
	N_2	O_2		
1001	15·08	0·6	8·21	2875
1645	13·38	2·04	6·95	1500

The occurrence of such very small values for the dissolved oxygen proves that at many places of the ocean bottom the progressive motion of the water and the rate at which it exchanges gases, or mixes, with the upper strata, must be very slow indeed.

It is worth noting, however, that very small quantities of oxygen present themselves occasionally even at moderate depths, as shown by the following example:—

No. of Water.	C.c. per litre.		O_2 calculated.	δ
	N_2	O_2		
1661	13·74	1·65	7·15	300

There was no lack of anomalous results, but I did not succeed in tracing these to natural causes. I suspect that some of the anomalies must be referred back to the difficulty of exhaustively extracting the gases from a sample of water by Jacobsen's method. Sometimes, also, the bottle used on board the Challenger for collecting the deep-sea waters may not have worked correctly, and may have brought up water from a depth different from that intended. Now and again, also, in the working of the Jacobsen process, atmospheric air may have leaked into the tube intended to receive the water gases only. Even on shore it is not always possible to prevent the occurrence of such accidents, and on board ship they are still more likely to occur.

There was no need for a special investigation to prove that in the ocean the equilibrium, in regard to the absorbed nitrogen and oxygen, is maintained by the atmosphere; and it stands to reason, likewise, that the ocean constantly adds to the atmospheric oxygen in the tropics, while it takes away from it in the colder latitudes. But as even the corresponding influence on the atmospheric carbonic acid has so far defied the powers of chemical analysis, the fluctuations of the percentage of oxygen in the air, which are caused by the sea, must be immeasurably small.

Suggestions for Future Work.

In conclusion, I may be permitted to offer a few suggestions in regard to the manner in which these researches on the composition of ocean-water should be continued.

That they ought to be continued, and extended, and that it is the special vocation of this country to take the matter in hand, will be admitted.

The work involved may be arranged under two heads, one of which would comprise the various kinds of observations and experiments which might easily be carried on by any intelligent seafaring man, even if he were devoid of all professional knowledge of chemistry. I here refer chiefly to,—(1) Salinity determinations by means of the hydrometer and a good thermometer. A set of handy and relatively small hydrometers, graduated so as to give the specific gravity for say 60° F. quite directly and without the aid of attached weights, would easily be supplied by a good mechanician for a few pounds sterling; and any intelligent man would soon learn to use these. Each of Her Majesty's ships should be provided with such a set, and a number of good thermometers, both verified by a scientific chemist or physicist. (2) Observations on the behaviour of sea-water on standing in a bottle of clear hard glass and provided with a good glass stopper, to see whether any deposit of carbonate of lime is formed, and in order to identify the places where the water has already come up to the state of saturation in regard to this component. (3) Alkalinity determinations by the method of Tornøe, as described on pages 106 and 124. The standard solution of hydrochloric acid could easily be provided in large quantities and at a low price, and even when used by itself, *i.e.*, without an auxiliary solution of caustic alkali (which probably only a chemist could manipulate correctly on board a ship), would give valuable approximations in the hands of any intelligent man who had been taught to use it in a laboratory. (4) Rough determinations of the carbonic acid by means of aurine as an indicator, and the normal hydrochloric acid for the alkalinities. I found by experiments made a short time ago that a sea-water becomes neutral to aurine, when, by addition of hydrochloric acid, the ratio of surplus base to carbonic acid has come down to the value 1 [NaOH] to 1·36 or 1·46 times [CO_2]. Hence, supposing 1 litre of a sample of sea-water to contain surplus base equal to 50 mgrms. of carbonic acid as normal carbonate, and 1 litre of the same water, after adding aurine and then hydrochloric acid in the cold, required hydrochloric acid equal to 10 mgrms. of carbonic acid before the violet aurine colour gives way to the yellow tint, then the total carbonic acid present would amount to $(50-10) \times 1{\cdot}4 \times 2$ mgrms. And a sea-water which does not become violet on addition of aurine, but yellow, is sure to contain at least $0{\cdot}41 \times 44$ mgrms. of free carbonic acid for every 1 mgrm. equivalent of base (meaning $\frac{1}{2}$ Na_2O or $\frac{1}{2}$ CaO, etc.) present as bicarbonate, *i.e.*, for every one molecule of bicarbonate CO_3 R′H. Hence, if Tornøe and Buchanan assure us that all sea-water becomes violet on addition of aurine, this *in itself* is quite compatible with the assumption that all the samples which they thus examined contained *free carbonic acid gas* in addition to fully saturated bicarbonate. The free carbonic acid must rise to 0·8 mgrms. for every one mgrm. of CO_2 in the R_2CO_3 part of the bicarbonate (*i.e.*, for every one mgrm. of "alkalinity per litre") before the aurine reaction ceases. Of all the 195 samples of sea-water which Mr. Buchanan analysed for carbonic acid, only two (Nos. 532 and 383) came even approximately up to this limit.

Let seafaring men search for waters which assume a *yellow* colour on addition of aurine. Wherever such water is found a volcanic carbonic acid spring must be close at hand.

Under my second heading fall such kinds of work as demand a skilled chemist for their performance, and it will be convenient to take them up in the order in which they appear in my memoir.

1. *Further researches on the Composition of Ocean Salt.*—By Forchhammer's and my own analyses it is proved that the percentages of the several components are subject to only slight variations. Apart from the one success with the lime, I was not able to trace back the fluctuations to natural causes. Hence new analyses are absolutely useless

unless these are executed with the highest attainable precision. All the components must be determined in the style adopted for the lime (in the supplementary work) and for the bromine. I could not possibly have determined all the saline components in my 77 waters by similarly refined methods for sheer want of material, and besides, the large number of analyses required would have rendered the work almost impracticable.

What ought to be done is to collect waters at different times throughout the year at two stations, one might be selected somewhere in the middle of the Pacific, and a second at some place in the middle of the Atlantic Ocean. In each case two large samples should be taken, one from a little *below* the surface (to preclude abnormal dilution with rain-water), another at some 50 fathoms above the bottom to avoid admixture of solid bottom matter, which in the bottle would gradually dissolve.

Supposing we had, from each of the stations, six surface and six bottom samples, or twenty-four samples in all, we should begin by determining the chlorine in each sample *à haute précision*, and then do the same with the lime. The six samples from each place should then be mixed together (in equal volumes), so as to produce four samples, each representative of one of the four places. In each of them the chlorine, lime, sulphuric acid, magnesia, potash, and alkalinity should now be determined by at least triplicate analyses executed with the highest precision. Ships which happen to pass the localities might be instructed to collect samples as indicated, and bring them home.

This would enable us, before trying to find out the difference between Atlantic water on the one hand and Pacific on the other, to inform ourselves as to the extent to which Pacific or Atlantic water at a given place is liable to vary. But before even this can be done successfully we must have sufficiently exact methods for the execution of the analyses. Hence, first and foremost, a chemist should be appointed to work out (by synthetical experiments in the first instance, and repeated analyses of some one sea-water in the second) a series of methods by means of which the sulphuric acid, magnesia, and potash could be determined with at least that degree of precision which I attained in regard to the lime.

Another useful investigation would be the exact determination of the minor components (iodine, silica, fluorine, iron, aluminium, manganese) in a large mass of some one kind of sea-water. If a chemist succeeded in devising easy and yet sufficiently exact routine methods for determining one or other of these components, its comparative determination in different sea-waters might be undertaken.

2. *Alkalinity.*—Tornøe's method is sufficiently exact, and if applied to a very large number of judiciously-selected samples would be sure to give valuable results.

3. *Carbonic Acid.*—In regard to the methods for determining the carbonic acid, there is room for much improvement. For oceanographic purposes, carbonic acid deter-

minations are of little use henceforth, unless carried out with a multitude of freshly drawn samples, and coupled with alkalinity determinations. The difficulty is to discover a method which would combine high precision with sufficient ease and rapidity of execution.

My method, described in the memoir as the "vacuum method," would work as easily as Buchanan's did on board ship, but either is troublesome, and would become very tedious if duplicate or triplicate analyses were demanded, as they ought to be. The most practical plan, perhaps, would be to combine the determination of the carbonic acid with that of the nitrogen and oxygen, as proposed by me on page 105; that is to boil out the gases in Jacobsen's apparatus in the presence of hydrochloric acid, to seal them up, and subsequently analyse them at home.

4. *The Absorbed Oxygen and Nitrogen.*—Jacobsen's method is the only one which would work on board ship, and it certainly is susceptible of a fair degree of exactitude. But in any future expedition it would be desirable to have all gas-extractions done in duplicate or triplicate, in order to supply the one item without which no series of analyses can be properly discussed, namely, the probable error in the single determination.

Meanwhile the best thing that could be done in regard to all the analytical problems referred to would be to work many times on samples of the same kind of water, with a view of improving upon the methods and ascertaining the extent to which that one water fluctuates in its composition.

NOTE ON TABLE XIII.

BY J. Y. BUCHANAN.

I am indebted to Mr. Murray for the opportunity of perusing Prof. Dittmar's Memoir, and I have read it with the greatest interest.

In connection with Table XIII., which gives the results of the determinations of carbonic acid in sea-water, made at sea, and is an extract from my journal, it is right that I should state that the method employed was adopted on my responsibility, as the best available at the time.

From the experiments of Himly and Jacobsen, it was known that sea-water, on being boiled, continued to give off carbonic acid until it was reduced almost to dryness.

It was evident that this was due to some one or more of the saline ingredients, but much uncertainty prevailed as to the particular salt or salts to which it should be ascribed. In order to be sure of eliminating all the carbonic acid, I proposed to acidify the water, boil it, and collect the carbonic acid evolved by absorption in baryta-water. In whatever way the carbonic acid might be combined in the water, I believed that the compound would certainly be decomposed by boiling with an excess of a mineral acid, and I proposed to use sulphuric acid. This method was objected to on the ground that the carbonic acid so determined would include all that might be present as bicarbonate of lime. The principal object which we had in view in boiling out the gases and in estimating the carbonic acid, was to determine the nature of the atmosphere afforded to the animals living in the water. It was thought that only one half of the carbonic acid in the bicarbonate could be looked upon as forming part of the aqueous atmosphere, the other half certainly forming part of the mineral constituents of the water.

In the course of some investigations which I carried out before the Expedition sailed, I observed that solutions of sulphate of magnesia and sulphate of lime when saturated with carbonic acid did not give it up completely on boiling, but continued to give it off till evaporated nearly to dryness. I therefore determined at any rate to eliminate the sulphates, which was done by adding a sufficiency of saturated chloride of barium solution. The effect of this was to make the water boil quietly and without bumping, and to make the carbonic acid come off more quickly, though there was still a slight evolution of carbonic acid during the passage of the last half of the distillate. I also expected that increasing the quantity of the other chlorides in the water would make the chloride of magnesium less likely to decompose on concentration, and I believe that it had this effect.

After the work of the Norwegian chemists and Prof. Dittmar in this field, future carbonic acid determinations will doubtless be made by one of their simple and elegant methods, by which the double determination of the carbonic acid and the carbonate is made in one operation.

During the cruise I frequently tested the freshly collected sea-water, and I always found it to have a slightly alkaline reaction. On a number of occasions I determined the amount of hydrochloric acid required to neutralise it in the cold, as indicated by the usual rosolic acid solution. This is not to be confounded with Tornøe's alkalinity test, which is conducted at a boiling temperature and has a great value as a quantitative method. My object was more to accentuate the fact that the water is alkaline in its natural state than to show how alkaline it is, for I noticed that after neutralisation the water became alkaline again on standing.

The few determinations of "organic carbon" by means of permanganate of potash (p. 122) were experimental, and were entered in my journal in course. I was, however, so dissatisfied with the experiments that I soon gave them up, and I attach no value to the results.

APPENDIX.

SUPPLEMENTARY NOTES TO CHAPTER I.

The proof sheets of this chapter had long passed through my hands when, through the kindness of Mr. Murray, I came into possession of Number IX. of the Reports on the Norwegian North Atlantic Expedition, which includes one by Schmelck on a series of sea-water analyses executed by him.

Schmelck examined some 51 waters, and in most of these determined the quantities of sulphuric acid, lime, and magnesia. In only six samples he determined also the potash. The chlorine he never determined himself, but adopted for it the values which had been ascertained on board ship by Tornøe's method (titration with neutral nitrate of silver, using chromate of potash as an indicator, and a gravimetrically analysed sea-water as a standard chloride). With 16 of his samples these determinations, it appears, had not been executed, so that only the results of the remaining 35 could be referred to chlorine = 100.

The following is an extract from his tabular statements of results:—

Found per 100 *parts of Chlorine.*

	Sulphuric Acid, SO_3.	Lime, CaO.	Magnesia, MgO.
Number of samples analysed, .	31	35	31
Minimum, ...	11·136	2·790	10·903
Maximum, ...	11·643	3·088	11·773
Mean, ...	11·46	2·99	11·40
My mean numbers, as quoted on page 138, are, . . .	11·576	3·026	11·212
Forchhammer found, . .	11·88	2·93	11·03

The quantities of potash in Schmelck's memoir are given only in terms of K_2O per 100 parts by weight of sea-water analysed. I have reduced his numbers to 100 of chlorine, and in this form reproduce them in the following statement:—

Schmelck found in one sample by two analyses 2·440 and 2·420, mean = 2·430, parts of potash, K_2O, per 100 of chlorine.* The other six numbers to be given are based on

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* The chlorine for this sample is not given; I therefore reduced from the quantities of sulphuric acid given to the 11·46 parts of sulphuric acid, which correspond, according to Schmelck, to 100 of chlorine.

single analyses. Results, 2·474, 2·338, 2·544, 2·492, 2·362, mean of the six results = 2·440; probable error of the single determination = ±0·053. My number is 2·405, and the probable error lies at about ±0·036. I very much wondered at the close agreement of Schmelck's value for potash with mine, because he used an analytical method of which I should never have thought that it could yield anything better than a rough approximation. What he did was to first precipitate lime and magnesia by Classen's method,[*] as oxalates, to filter, evaporate to dryness, expel the ammonia-salts by ignition, and then to convert the sulphates into chlorides by repeated ignition with sal-ammoniac. From the "alkaline chlorides" thus obtained, the potash was separated by Fresenius's method as chloroplatinate and weighed as such.

Schmelck himself says that his alkaline chlorides always contained magnesia and sulphuric acid, so that the chloroplatinate was contaminated correspondingly; but he states that duplicate determinations agreed with one another. Now the Finkener method, as applied by me to sea-water, as I state in the context (page 16), owes its exactitude to some extent to a compensation of errors. I therefore considered it quite possible that Schmelck's method might perhaps be more exact than mine, and for the purpose of a preliminary inquiry into the matter, caused Mr. Barbour to apply it to 50 c.c. of a sea-water of known composition. The result was not very encouraging; the chloroplatinate of potash obtained was obviously impure, and its weight short of what it ought to have been. This in itself, of course, might have been owing to Mr. Barbour's want of practice, but about one thing the experiment left no doubt in my mind, namely, that the Classen method, when applied to sea-water, fails to effect anything like a satisfactory elimination of the magnesia. I did not consider it necessary to inquire into the sal-ammoniac method for substituting chlorine for the SO_4 of the sulphates, because I knew it to be tedious and unsatisfactory. But all this I thought might be rectified by a new combination of methods; and supposing the problem of eliminating the alkalies of a given sea-water in the form of pure chlorides to be solved, Fresenius's process might possibly be the most exact method for the determination of the potash in these. In order to settle this question, I caused Mr. John M'Arthur to carry out the following two test experiments. In both the general scheme followed was the same, namely, as follows:—A known weight of chloride of sodium, and a known weight of a standard solution of pure chloride of potassium, equivalent conjointly to the potassium and sodium in about 100 grms. of ocean-water, are dissolved in water, the solution is mixed with a little more chloride of platinum than is needed to convert both metals into chloroplatinates, and the mixture evaporated on a water-bath very nearly to dryness. The residue, after cooling, is digested (cold) in 30 c.c. of pure (non-methylated) alcohol of 80 per cent. by volume, the liquid decanted through a small filter, and the residue continued to be exhausted with the same alcohol, until the last runnings, when tested

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[*] Fresenius, *Zeitschr. für anal. Chemie*, 1879, p. 374.

with nitrate of silver, give only an opalescence of chloride of silver. The precipitate of chloroplatinate is dissolved on the filter in hot water, and the solution allowed to run into a tared porcelain crucible, recovered by evaporation and weighed, first after drying at 100° to 105° C., then after further drying at 130° C. From the weight of the precipitate, the potash is calculated as K_2O, in order to see what the exact but unreasoning application of Fresenius's method would lead to.

But the precipitate can neither be presumed to be pure nor to contain the whole of the potassium, hence,—*Firstly*, the crude precipitate is reduced in hydrogen, the residue treated with water, the platinum metal weighed, and from the solution the potassium present reprecipitated by a renewed application of Fresenius's method. To check the result the pure chloroplatinate, after having been weighed, is reduced in hydrogen, its platinum thus separated out and weighed. The mother-liquor obtained in the preparation of the pure chloroplatinate of potash is evaporated to dryness, the residue heated in hydrogen, the salt extracted with water, made into normal sulphate, and subjected to Finkener's method to extract and determine the potassium. *Secondly*, the same process is applied to the filtrate from the crude chloroplatinate, to determine the potassium, which from the first escaped precipitation. This method was faithfully adhered to, except that we soon discarded the drying of the chloroplatinate at two successive temperatures. Having found that the additional loss of weight involved in the passing from 105° to 130° amounts to less than the thousandth part of the weight of the precipitate, we subsequently dried at once at 130°, and calculated from the weight thus found.

First Experiment.—The preparations used for the synthesis were a perfectly pure chloride of potassium made from recrystallised chlorate, and a chloride of sodium made from recrystallised bicarbonate and pure hydrochloric acid, and purified by crystallisation in the heat, the mother-liquor being rejected. This mode of preparation I thought would ensure complete absence of potash; and yet, when the results came to be calculated it turned out that the sum of the several instalments of potash found came to more than the potash of the chloride of potassium taken. Hence the chloride of sodium used was suspected to contain potassium; 5·042 grms. of it were made into normal sulphate, and the latter subjected to that form of Finkener's method in which the mixture of sulphate of soda and chloroplatinate of potassium is lixiviated with concentrated sal-ammoniac solution, to eliminate the sodium salt. The residual chloroplatinate was ignited in hydrogen and the potash calculated from the weight of the metallic platinum. We obtained 6·5 mgrms. of platinum, equal to 3·09 mgrms. of K_2O,* or 1·79 mgrms. of K_2O for the 2·91 grms. of chloride of sodium which had been used in the test experiment. The chloride of potassium obtained from the chloroplatinate was not weighed, but identified by re-conversion into chloroplatinate. In the following statement of the results

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* Or 4·89 mgrms. of chloride of potassium = 0·097 per cent. of the whole.

the several quantities of potassium are all expressed in milligrams of K_2O. For each of these latter quantities, as is seen, two numbers are given: the numbers under "*old atomic weights*" were calculated by means of the set of atomic weights which I had used in my potash determinations in the Challenger waters, viz.,—K=39, Cl=35·5, Pt=198, O=16. The numbers under "*new atomic weights*" are calculated from Stas's values for K and Cl, and Seubert's for Pt, viz.,—K=39·13, Cl=35·454, Pt=194·83, O=16.

From the following little table it is seen how the several ratios change when we pass from one set of constants to the other.

Ratios.	Numerical Values calculated from Old Atomic Weights.	Numerical Values calculated from New Atomic Weights.	New Factor divided by Old Factor
$\frac{K_2O}{K_2Cl_2}$	0·63087	0·63193	1·00168
$\frac{K_2O}{Pt}$	0·47474	0·48385	1·0192
$\frac{K_2O}{PtCl_6K_2}$ . .	0·19223	0·19405	1·0095

I will now pass to the statement of the results:—

Milligrams of K_2O *present.*

		Old Atomic Weights.	New Atomic Weights.
	Synthesis.		
	In the chloride of potassium, ...	49·89	49·98
	In the chloride of sodium, ...	1·79	1·82
		51·68	51·80
	Analysis.		
I.	In the crude chloroplatinate of potassium by calculation on the assumption of its being unmixed $PtCl_6K_2$, .	49·44	49·91
Ia.	By calculation from the metallic platinum obtained therefrom, ...	49·08	50·03
II.	In the pure chloroplatinate of potassium, . .	47·78	48·22
IIa.	Calculated from the metallic platinum therefrom, .	47·56	48·48
III.*	In the filtrate from the crude chloroplatinate, . .	3·78	3·82
IV.	In filtrate from the pure chloroplatinate, . .	0·38	0·38
	Sum of II., III., and IV., ...	51·94	52·42
	Excess over synthetical value, ...	0·26	0·62
	Sum of IIa, III., and IV., ...	51·72	52·68
	Excess over synthetical value, ...	0·04	0·88

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* Alkali made into sulphate; potassium extracted by sal-ammoniac form of Finkener's method, as $PtCl_6K_2$. Platinum obtained therefrom = 10·6 mgrms. = 5·03 mgrms. of K_2O. The solution from this metal worked up according to Fresenius: $PtCl_6K_2$ obtained = 19·7 mgrms. = 3·78 mgrms. of K_2O by old atomic weights. This latter result adopted.

Second Experiment.—Before entering upon a second trial, I thought I should endeavour to prepare an absolutely potash-free chloride of sodium, and succeeded in this (more nearly than I had done before) by decomposing commercially pure crystallised sulphate of soda with *fuming* hydrochloric acid, washing the precipitated chloride of sodium with hydrochloric acid, drying, dissolving in water, and reprecipitating with hydrochloric acid. The dried salt contained only a trace of sulphuric acid (which was neglected). To test quantitatively for potash, a portion of the salt was made into normal sulphate, and 23·25 grams of the latter (corresponding to 19·1 grams of chloride) dissolved in water, mixed with 1 c.c. of pure chloride of platinum (converted into $PtCl_6H_2$ by addition of a measured volume of standard acid), evaporated to near dryness, and the residue mixed with 10 volumes of absolute alcohol and 5 volumes of ether, allowed to stand, and the deposit of salts washed with ether-alcohol. Saturated sal-ammoniac solution was now applied in successive instalments until about $\frac{9}{10}$ths of the sulphate of soda had dissolved. The residual salt was then ignited, finally in hydrogen, the platinum removed by dissolving in water and filtering, the salt in the filtrate reconverted into pure normal sulphate, and the Finkener (sal-ammoniac) process again applied. The chloroplatinate ultimately obtained was reduced in hydrogen, and gave 0·8 mgrms. of $Pt = 0{\cdot}38$ mgrms. of K_2O, and the KCl filtrate by Fresenius's method 2·4 mgrms. of $PtCl_6K_2 = 0{\cdot}43$ mgrms. of K_2O. This latter chloroplatinate was identified by microscopic inspection. From the mean (0·40 mgrms.) of the two quantities of potash found, it follows that 100 grams of the chloride of sodium contained 0·0021 grams of K_2O or 0·061 mgrms. for the 2·9 grams which were employed in the test analysis to be reported on.

The *modus operandi* was essentially the same as the one used in the first trial, except that a perfectly pure chloride of platinum (made from platinum purified by Schneider's method) was employed, and that, to make assurance doubly sure, a fresh standard solution of chloride of potassium was used instead of the old one.

Milligrams of Potash (K_2O) *present.*

Synthesis.	Old Atomic Weights.	New Atomic Weights.
In the chloride of potassium, ...	50·04	50·12
In the chloride of sodium, ...	0·06	0·06
Summa, . . .	50·10	50·18

	Analysis.	Old Atomic Weights.	New Atomic Weights.
I.	In the crude chloroplatinate, by calculation,	47·90	48·35
Ia.	By calculation from the metal obtained therefrom,	47·62	48·53
II.	In the pure chloroplatinate,	47·06	47·50
IIa.	Calculating from the metal obtained therefrom,	46·62	47·51
III.*	In filtrate from the crude chloroplatinate,	2·64	2·68
IV.	In filtrate from the pure chloroplatinate,	0·85	0·87
	Sum of II., III., and IV.,	50·55	51·05
	Excess over synthesis,	0·45	0·87
	Sum of IIa, III., and IV.,	50·11	51·06
	Excess over synthesis,	0·01	0·88

Both trials, as critiques of Fresenius's method, led to the same result. Supposing even we had succeeded in obtaining the potash and soda of a sea-water in the shape of pure chlorides and without loss of potash, Fresenius's method, when applied to such a mixture, would lead to a deficit in the potash found. According to the second trial (which I consider to be the more exact of the two), this deficit, even if we accept the crude chloroplatinate as pure and calculate

a, by the old atomic weights, amounts to 2·20 mgrms. per 50·10 of K_2O given, or 4·4 per cent.

b, by the new atomic weights, amounts to 1·83 mgrms. per 50·18 of K_2O given, or 3·7 per cent. of the quantity to be determined.

The error of the Finkener method, in the form in which I used it, as appears from my memoir, amounts to only about ± 1 per cent. Hence I was right in preferring the Finkener method; and if Schmelck's results come so near to mine, this is owing to an accidental combination of errors in the execution of his method.

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[*] The $PtCl_6K_2$ obtained by Finkener's method gave Pt equal to 2·75 mgrms. of K_2O; the filtrate by Fresenius's gave $PtCl_6K_2$ equal to 2·55 mgrms. of K_2O; the Pt from the latter corresponded to 2·52 mgrms.; mean of 2·535 and 2·75 adopted (old atomic weights).

SUPPLEMENTARY NOTES TO THE CHAPTER ON BROMINE.

Pages 89 *et seq.*

Mr. John M'Arthur's determinations of the ratios of bromine to chlorine in the three Challenger water mixtures and the Arran water left nothing to be desired in point of relative precision; but from the synthetical experiments previously made it appeared that the results are all liable to a small constant positive correction. Unfortunately those synthetical trials are not equal to the analyses themselves in precision, so that it would hardly be allowable to calculate the correction from them.

In order, therefore, to finish satisfactorily a piece of very troublesome work, I, some time ago, caused Mr. M'Arthur to carry out the following series of critical experiments. I will begin by enumerating the several reagents which were employed, and explaining how they were prepared.

1. *Pure Chloride of Silver.*—A quantity of pure hydrochloric acid, containing about [HCl]=36·5 grams of acid per litre, was added to its equivalent of an approximately deci-normal solution of nitrate of silver, the precipitate washed by decantation, then dried on a water-bath, and finally in an air-bath at 150° C. All the operations were conducted in dim gaslight, and the preparation preserved in a blackened bottle.

2. *Pure Bromide of Silver.*—A quantity of pure hydrobromic acid (*vide infra* under 3), representing very nearly 126·6 milligram equivalents (meaning 126·6 times 80 milligrams) of bromine, was diluted to 1266 cubic centimetres, and mixed with 633 c.c. of deci-normal (acid) nitrate of silver solution, so as to bring down one-half of the bromine as silver-salt, and leave the chlorine, which might be present, in the mother-liquor. This operation was carried out twice in the same way, to produce about 24 grams of pure bromide of silver, which was washed, collected, dried (at 150° C.), and preserved with the same precautions as the chloride.

3. *Pure Aqueous Hydrobromic Acid.*—Ordinary bromine (proved to be free from iodine) was dissolved in bromide of potassium solution, and then recovered by distillation. The bromine thus purified was placed under a mass of water, and sulphurous acid passed into it to dissolve it as hydrobromic acid. The resulting mixture then was subjected to distillation, and the receiver changed when all the excess of sulphurous acid had been expelled. The distillation was stopped before the sulphuric acid had become strong enough to react on the hydrobromic acid left. The hydrobromic acid was redistilled, to remove any trace of sulphuric acid from it. Its strength was determined by

titration with nitrate of silver, and found to correspond to 31·00 per cent. of HBr. Most of this preparation was diluted so as to produce "normal" acid (containing [HBr] grams per litre); and 106·5 grams of the latter, equal to very nearly 8 grams of bromine, utilised for a quantitative examination for chlorine. For this purpose about $\frac{9}{10}$ths of the halogen was precipitated by addition of a roughly standardised (acid) deci-normal solution of nitrate of silver, and the precipitate removed and preserved as bromide. The decantate was precipitated with a slight excess of silver solution, and the precipitated haloid chlorinated in the manner described in my memoir, to determine the chlorine in it. The haloid operated upon weighed, after fusion in air, 1·9714 grams; after chlorination and expulsion of the chlorine by a current of dry air its weight was less by 0·4661 grams.

This loss of weight corresponds to 1·9683 grams of pure bromide in the 1·9714 of haloid used, which leaves 3·1 mgrms. of chloride of silver, or about 0·8 mgrms. of chlorine against the 8000 mgrms. of bromine contained in the 106·5 grams of standard acid analysed. This means, practically, that the acid is free from the foreign halogen.

4. *Standard Hydrobromic Acid Solution.*—The normal hydrobromic acid referred to in the last paragraph served for the preparation of a deci-normal solution for the subsequent test analyses. According to the data of the synthesis, 100 grams of this solution should have contained 794·9 milligrams of bromine as hydrobromic acid. The final "titre" was determined by three gravimetric analyses, carried out each with 50 c.c. (which in each case were weighed out in grams), and one titrimetric analysis carried out in the way of the final chlorine determinations in the Challenger waters.

The results were as follows:—

100 *grams of Solution contain*

	Milligrams of Bromine.
Gravimetric analysis, No. 1,	797·4
" " No. 2,	797·7
" " No. 3,	796·5
Titrimetric analysis,	797·9
Mean,	797·4

5. *An Artificial Sea-water free from Bromine.*—It was made up on the basis of the numbers found by me for the average composition of ocean-water salts, as given on page 138 of the Memoir, from the following materials:—best commercial calcined magnesia, recently ignited in a muffle before use; pure precipitated carbonate of lime; pure sulphate of potash; and "natrium chloratum purissimum" from Trommsdorff in Erfurt, ignited in a platinum basin immediately before use. The calcined magnesia, of course, could not be

presumed to be chemically pure, nor was I absolutely sure of the purity of the chloride of sodium; but as the sea-water was intended merely for critical trials of my method of bromine determination, the preparations were accepted as sufficiently pure. A quantity of the sulphate of potash, representing the potash present according to my sea-water analyses beside 160 grams of halogen reckoned as chlorine, was weighed out, which at the same time gave part of the sulphuric acid. The rest of the latter was added in the form of normal sulphuric acid as used for alkalimetry. The correct volume of this acid, together with a measured volume of normal hydrochloric acid, served to dissolve the magnesia; but as an excess of the latter had been employed intentionally to hasten on its action, this excess was subsequently compensated by the addition of the correct volume of a standard solution of pure caustic soda. The carbonate of lime was dissolved in ½ c.c. more than the calculated volume of normal hydrochloric acid, and the excess of acid neutralised by the caustic soda solution. The several instalments of chlorine thus introduced were added up and made up to 160 grams by addition of the calculated weight of the chloride of sodium. The magnesia, potash, and chloride of sodium solutions were mixed and diluted to 4 kilograms. On the other hand, the lime solution was made up to 4213·9 grams in a separate flask. The two solutions were then mixed to produce 8213·9 grams, equal to very nearly 8 litres, of "sea-water."

This water on standing deposited a small gelatinous precipitate which settled firmly. The clear supernatant liquor was drawn off by means of a syphon and preserved in well-stoppered bottles.

The chlorine in a known weight of this water was determined by my gravimetric modification of Volhard's method, and found equal to 19·455, 19·448; mean, 19·452 grams of chlorine per kilogram of sea-water.

To test this water for bromine, 1 kilogram of it was precipitated with 50 c.c. of acid deci-normal silver solution (see page 99), the precipitate collected and washed, by decantation, dried, weighed, and chlorinated. The chlorination involved a loss of 0·20 mgrms., corresponding to 0·36 mgrms. of bromine; but whether it really does so or is a mere observational error, the water may be accepted as being practically free from bromide.

6. To pass now to the critical experiments, the first question which we sought to answer was whether fused chloride of silver, when heated in dry chlorine, and then allowed to cool in a current of dry air, as had been done in the analyses of the Challenger sea-waters, retains its correct weight. To enable the reader to form his own opinion in regard to the unavoidable uncertainties in the weighings, I give all the weighings which were made in the first experiment.

Tube and boat, ...	= 36·9073 grams.
Do. + chloride of silver as it came out of the bottle,	= 39·7358 „
Chloride of silver taken, ...	= 2·8285 „

This chloride of silver, then, in order to remove from it every trace of moisture, was heated to 150° C. in the current of dry air, when the following weighings were obtained:—

Tube and boat and AgCl,	1	= 39·7357	grams.
Do. do.	2	= 39·7359	,,
Do. do.	3	= 39·7361	,,
Mean,		= 39·7359	
Chloride of silver dried at 150° C.,		= 2·8286	

This chloride of silver was next *fused* repeatedly in a current of dry air, the operation in each case being continued for about 20 minutes, and again weighed.

Tube and boat and AgCl fused in air,	1	= 39·7352	grams.
Do. do.	2	= 39·7354	,,
Do. do.	3	= 39·7354	,,
Do. do.	4	= 39·7354	,,
Do. do.	5	= 39·7354	,,
Number adopted,		= 39·7354	,,
Chloride of silver fused in air,		= 2·8281	,,

This fused chloride of silver was then again fused in a current of dry chlorine, and the exposure to this gas continued for about 20 minutes, the chlorine displaced by a quick current of dry air, of just sufficient duration to clear the atmosphere of the apparatus, allowed to cool, and weighed. After chlorination in this way, the chloride of silver was next fused, and kept in that state for about 25 minutes, in a current of dry air, allowed to cool, and weighed. The weighings obtained after heating alternately, first in chlorine followed by a little air, and then in a long lasting current of air, were as follows:—

Tube and boat and AgCl fused in chlorine,	1	= 39·7349	grams.
Do. do. in air,	1	= 39·7350	,,
Do. do. in chlorine,	2	= 39·7354	,,
Do. do. in air,	2	= 39·7353	,,
Do. do. in chlorine,	3	= 39·7354	,,
Do. do. in air,	3	= 39·7356	,,
Mean weight of AgCl after heating in chlorine,		= 2·8279	,,
And then in air,		= 2·8280	,,

Another experiment gave similar results, as seen by the following summary:—

	Exp. I.	Exp. II.	
Chloride of silver, as taken from bottle (*i.e.*, dried at 150° C.),	2·8285	3·1683	grams.
After heating in a current of air at 150° C.,	2·8286	3·1687	,,
After fusion in a current of dry air,	2·8281	3·1682	,,
After fusion in dry chlorine,	2·8279	3·1681	,,
After prolonged fusion in current of dry air,	2·8280	3·1680	,,

Hence we see that although fused chloride of silver may absorb chlorine, such chlorine is readily and exhaustively expelled by a short exposure of the fused product to dry air. This point being settled, the second question was—Does pure bromide of silver, when chlorinated and otherwise manipulated as the mixed haloid precipitates in the sea-water analyses were, yield the exact proportion of chloride demanded by the atomic weights? In the first experiment 3·4538 grams of dry pure bromide of silver were operated upon, with the following results:—

Weight of bromide after renewed drying in dry air at 150° C., . .	3·4543 grams.
After fusion in dry air, ...	3·4541 ,,

The boat cracked, but nothing ran out of it;[*] hence the experiment was continued.

Haloid after treatment with chlorine,—2·6354 grams. Hence, calculating from the fused bromide of silver, loss in chlorination is 0·8187 grams, corresponding, by calculation, to 1·4712 grams of bromine. The original bromide, by calculation, contained 1·4699; error in analysis = +1·35 mgrms. of bromine, corresponding to 3·27 mgrms. of bromide of silver.

Two other similar experiments were made; the following is a summary of the results:—

	Experiment		
	I.	II.	III.
Fused bromide of silver taken, .	3·4541	2·4659	2·5814 grams.
Containing bromine by theory, . .	1·4699	1·0493	1·0985 ,,
Loss on chlorination, ...	0·8187	0·5838	0·6115 ,,
Corresponding to bromine, . .	1·4712	1·0491	1·0989 ,,
Error in bromine found, . . .	+1·35	−0·24	+0·39 mgrms.
Mean absolute error, ...	± 0·66 milligrams.		

This was very satisfactory, but it remained to be seen what degree of exactitude could be obtained in the chlorination of a mixture of much chloride and little bromide of silver, similar to those which presented themselves in the sea-water analyses.

In these analyses, as stated in the memoir, the bromine had been eliminated from 1 kilo of sea-water, in each case, as far as possible, by two successive precipitations each time

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[*] The boat, as the reader remembers, always remained within its piece of Bohemian tubing, which would collect the result of any leakage.

with a quantity of acid deci-normal solution of nitrate of silver, corresponding to 3·9 per cent. of the total halogen present. From the report in the memoir it is easily calculated that a mixture of 0·1473 grm. of bromide and 2·9510 grms. of chloride of silver would be a very close imitation of the "first precipitates" obtained in the bottom water analyses. In the test analyses, accordingly, quantities of the two haloids nearly equal to these were operated upon. The chloride of silver was first weighed out in the boat, fused, and weighed again within its tube. The proper quantity of bromide of silver (dried at 150° C.) was then added from a preparation-tube and spread over the surface of the chloride.

The two haloids were then fused together, and their conjoint weight redetermined; and the mixture, lastly, was chlorinated repeatedly until the residue was constant in weight. Two experiments were thus carried out with the following results:—

	Experiment I.	*Experiment II.*
Weight of fused chloride of silver taken, . .	2·9511 grms.	2·9487 grms.
Weight of bromide of silver added—		
a, By loss of weight of the preparation tube, .	0·1465 „	
b, By excess of mixed haloid after fusion over chloride, ...	0·1466 „	0·1497 „
Bromine in 0·1466 grams. by calculation from *b*, .	62·38 mgrms.	63·70 mgrms.
Loss on chlorination, ...	35·0 „	35·7 „
Hence bromine found, ...	62·90 „	64·15 „
Error, ...	+ 0·52 „	+ 0·45 „

We see that the absolute error is about the same as in the case of pure bromide; but just on that account the relative error is necessarily far greater, amounting as it does to about $\frac{1}{120}$th of the bromine to be determined. From the two analyses made it would appear that the method is liable to a constant positive error equal to about 0·5 mgrms. of bromine. But this would be an unsafe conclusion to draw from so small a number of experiments. It would be well to regard their results as simply confirming what the trials with pure bromide of silver have brought out.

After the above experiments, all that remained to be done was to see whether the method which I had adopted for separating out the bromine from a sea-water as a mixed haloid precipitate, does its work exhaustively, and if not, what proportion of the bromine escapes precipitation.

For this special purpose the artificial sea-water had been prepared, and the mode in which it was utilised hardly needs description. In each of a series of test analyses one kilogram of the artificial sea-water was mixed with a known weight of the standard (approximately deci-normal) solution of hydrobromic acid, containing a weight of bromine approximately equal to that in a natural sea-water per 19·45 grams of chlorine, and the water thus supplemented was then analysed for bromine in exact accordance with the method described on page 98 as having served for the Challenger water mixtures.

The following is a summary of the results:—

Experiment.	Bromine due. Mgrms.	Bromine found.			Error.
		I. Precip.	II. Precip.	Total	
I.	66·09	61·31	5·22	66·53	+0·44
II.	66·26	61·57	5·04	66·61	+0·35
III.	66·10	61·15	4·32	65·47	−0·63
IV.	66·21	62·37	4·14	66·51	+0·30

The error in three out of the four cases was positive, and amounted to about 0·4 ÷ 66 or 0·00606 of the quantity to be determined. If we apply the corresponding correction to the value 0·3402 which we found for the bromine present in our Challenger waters, for every 100 of chlorine we arrive at the number 0·3381; but I think we had better allow the original number 0·3402 to stand as it is. Strictly speaking, we ought to subtract from each of the quantities of bromine found the 0·36 mgrms. of *quasi*-bromine which the blank analysis of the original water had brought out (see page 238). If we did so, the errors would be reduced in—

Experiment	I.	II.	III.	IV.
To	+0·08	−0·01	−0·99	−0·06

In any case the number 0·3402, which I adopted as representing the weight of bromine present in 100 of halogen reckoned as chlorine, may, I think, be adopted as coming very near the truth.

Effect of Freezing on the Distribution of the Bromine in Sea-Water Salts.

At an early stage of the Bromine Investigation I made an elaborate series of experiments for ascertaining whether a sea-water which has lost water by partial freezing contains more or less bromine per 100 of chlorine than it did before. Unfortunately the bromine determinations involved were made according to the faulty method referred to in the memoir on page 90, as having served for those fourteen abortive analyses quoted there, and as the method, moreover, was applied to sea-waters of abnormal salinity, it gave what I now know to be insufficiently exact results.

While writing this summary I remembered these old experiments, and caused Mr. John M'Arthur to repeat them, on a smaller scale, and (in addition to the quantities of chlorine) to determine the quantities of bromine by our present exact method. Mr. Robert Anderson was directed at the same time to determine the corresponding quantities of sulphuric acid, and to adhere strictly to the method laid down on page 8.

The water selected for the experiments was the remainder of that mixture of Challenger water samples, designated as "II. mixture of seventy-one samples of medium depth waters, from 300 to 1000 fathoms inclusive" on page 98.

First Experiment.—2199·35 grms. of the sea-water, contained in a stoppered bottle, were exposed to a mixture of ice and salt until apparently nine-tenths of the whole were frozen, and ice and mother-liquor were then separated as far as possible by decantation and draining. The ice was then allowed to thaw, and both it and the mother-liquor were weighed after they had assumed the temperature of the laboratory. The mother-liquor, weighing 252·44 grms., was marked "No. I."; the molten ice, weighing 1946·63 grms., was preserved as "No. II."

Second Experiment.—2260·84 grms. of the same water kept in ice and salt until apparently one-half had become solid, and ice and mother-liquor separated and weighed as in the preceding case. The mother-liquor (1096·12 grms.) was called "No. III.," the molten ice (1163·93 grms.) "No. IV."

In each of these four waters the halogen was determined and calculated as chlorine by that modification of Volhard's method which has been so frequently referred to, and, in order to check the analyses, the absolute weights of chlorine in the two portions of original water operated upon were calculated, firstly, from the weights and analyses of the two fractions, and, secondly, from the weight of the whole and the proportion of chlorine in the original water, as it had been determined in the course of the bromine investigation (page 99). The agreement in both cases was very satisfactory.

In each of these waters the bromine was determined by rigorous application of the method laid down on page 98, except that in two cases less than the equivalent of 1 kilogram of original water was used (for obvious reasons), but care was taken in the case of the two mother-liquors to dilute them, before addition of silver solution, to very near the salinity of the original water. On the same principle, the two kinds of molten sea-water ice ought to have been concentrated by evaporation, but through fear of accidents we preferred to use them as they were. The results are given in the following table:—

No. of the water analysed,	I.	II.	III.	IV.
"Chlorine" per kilogram,	53·800	14·880	25·053	13·972
Weight of water taken for the bromine determination, grams,	138·80	1299·01	771·56	999·46
Bromine found in milligrams,—				
1st precipitate,	23·04	60·58	61·40	44·37
2nd precipitate,	1·98	3·60	4·14	2·88
Total,	25·02	64·18	65·54	47·25
Probable uncertainty,	±0·5	±0·5	±0·5	±0·5
Bromine per 100 of "chlorine,"	0·3351	0·3321	0·3390	0·3384
Probable uncertainty,	±0·0067	±0·0026	±0·0026	±0·0036
Deviation from 0·3398,	−0·0047	−0·0077	−0·0008	−0·0014
Sulphuric acid, So_3, per 100 of "chlorine,"	11·64	11·77	11·60	11·90
Deviations from average 11·58, given page 138,	+0·06	+0·19	+0·02	+0·32

The number 0·3398 is the quantity of bromine per 100 of chlorine which follows from the four analyses reported on page 99. The number 0·3414 which is there given is the result of a slip in a calculation, which, however, is of no moment, as the substitution of the correct number would diminish the grand average given on page 101 as 0·3402, by only 0·0004. Considering that half a milligram of absolute error in the total bromine obtained in an analysis corresponds to only 0·25 milligram of cumulative effect of the errors in the four weighings involved, we may well take our numbers as being compatible with the assumption that the partial freezing of a sea-water involves no change in the ratio of bromine to chlorine.

The quantities of sulphuric acid found (all except No. 1, the result of single analyses) do not agree so well with the general mean of 11·576, which was deduced from the seventy-seven analyses, as I should wish; but their evidence, like that afforded by the bromine determinations, tends to show that the partial freezing of a sea-water (which constantly occurs as a natural phenomenon in the polar circles) does not involve the formation of any cryohydrate. Sea-water ice, it would appear, is just ice enclosing drops of highly saline mother-liquor.

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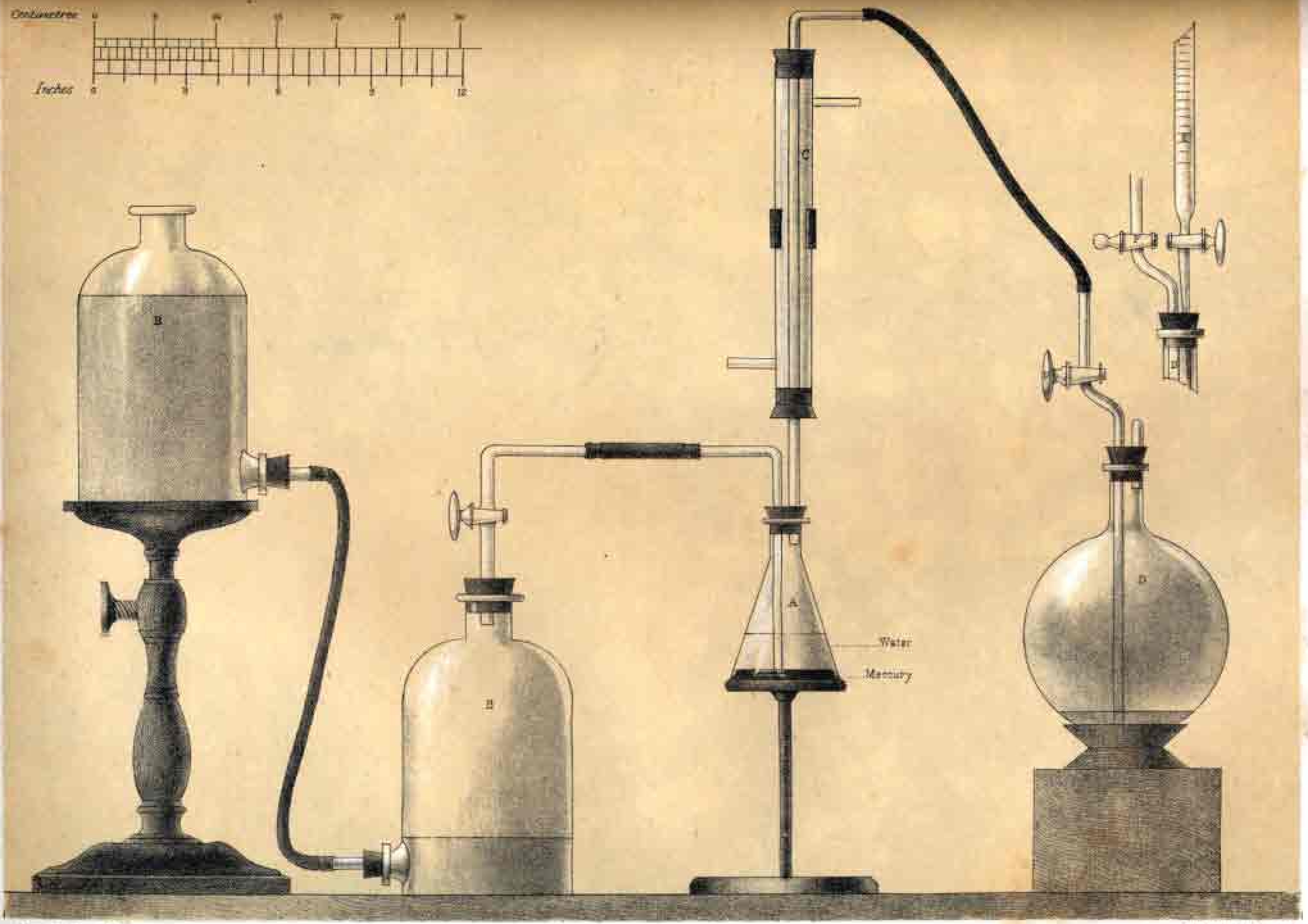
D.—Evacuated flask, charged with known volume of standard baryta water.

D, E, F shows how standard hydrochloric acid is run into D, out of a burette at the end of the experiment.



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APPARATUS FOR DETERMINING THE CARBONIC ACID IN SEA WATER.

PLATE II.

APPARATUS FOR GAS-ANALYSIS.

Fig. I.—Side view of pneumatic trough for gas-burette and exploder.

Fig. I*a*.—Ground plan of same; *r*, the two wells for the U-tubes of the burette and exploder.

Fig. II.—F, graduated tube; *f*, narrow side tube communicating therewith; M, mercury reservoir, communicating with F through india-rubber tube *m*; O, inlet, P, outlet tube for water of the bath.

Fig. II*a*.—Ground plan of same; H, water-bath; N, outlet pipe, other letters as in first figure.

Fig. III.—D, explosion tube, communicating by india-rubber tube *b* with mercury reservoir *a*; *c*, capillary U-tube, filled with mercury, to connect terminal of induction coil with one of the platinum wires.

Fig. IV.—Pneumatic trough belonging to the gas-pipette; side view.
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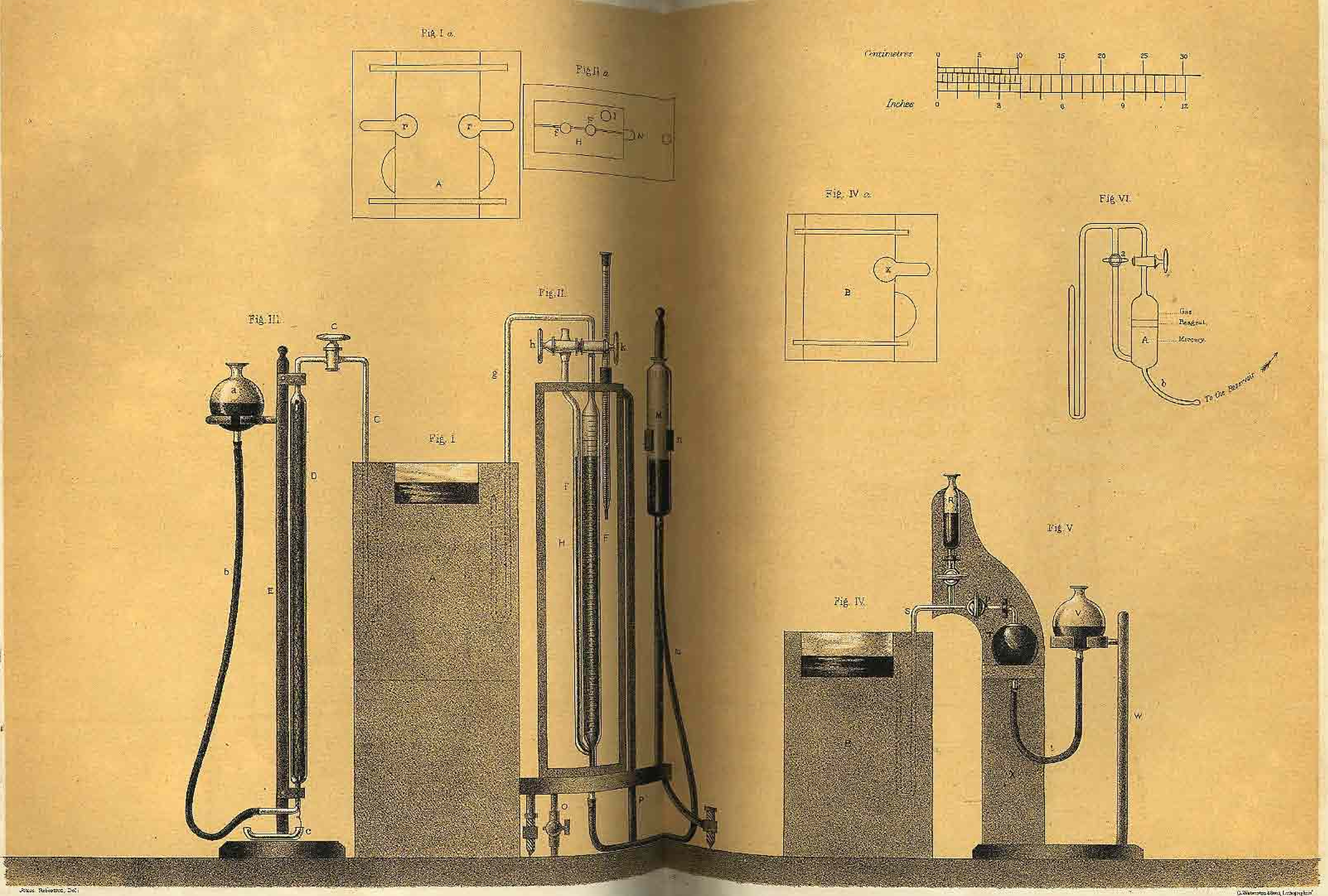
Fig. V.—Gas-pipette. T, glass ball containing mercury and liquid reagent, connected by india-rubber tube *t* with mercury reservoir V; R, lateral supplementary mercury reservoir to enable one to sweep gas from capillary U-tube into the tube standing in B.

Fig. VI.—Improved form of gas-pipette devised by Mr. Lennox. A corresponds to T and R in fig V.; *b* serves to connect mercury-reservoir (V, fig. V.) with pipette A proper.



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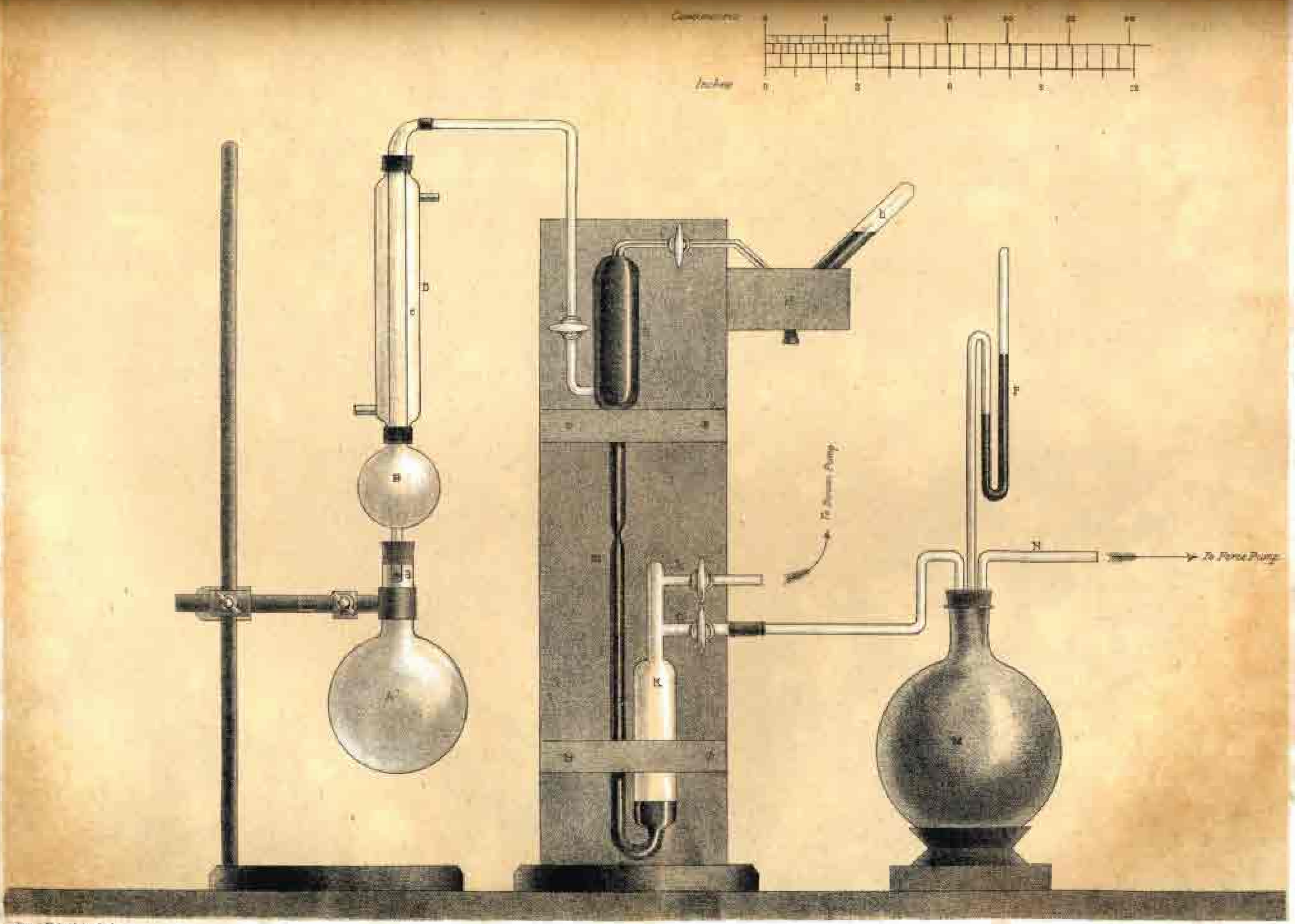
APPARATUS FOR GAS ANALYSIS.

PLATE III.

Apparatus for Extracting Gases from Water.

A flask containing water from which the gases are to be boiled out; B, gas-bulb, terminating in a Jacobsen's connecting tube with lateral orifice *a* below, and into a condenser-tube *c* above; D, jacket of condenser; E and K, cylindrical gas-bulbs communicating through *n*. The gas aspired goes into E by *d*, and is driven out by *f* into *h*, standing in the mercurial trough H. K is the mercury-reservoir, its atmosphere can be rarefied by connection with a Bunsen pump through *k*, or condensed by connecting it through *n* with the copper-ball M, containing compressed air; P, manometer for M.



James Robertson, Del.

G. Waterston & Sons, Lith.

APPARATUS FOR EXTRACTING GASES FROM WATER.

THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on the SPECIFIC GRAVITY of Samples of OCEAN WATER, observed on board H.M.S. Challenger during the years 1873–76. By J. Y. BUCHANAN, Esq., M.A., F.R.S.E., Chemist and Physicist of the Expedition.

THE variation in the specific gravity of the water which forms the ocean is, comparatively speaking, so slight, that an instrument of considerable delicacy is necessary for determining it. So far as I have hitherto been able to observe, it lies between the extremes 1·02780 and 1·02400, the specific gravity of pure water at 4° C. being taken as the unit; the results, therefore, if they are to be of any value, must be correct to at least the fourth place of decimals. In mentioning these extremes, it must be observed that they refer to *ocean* waters, and not to the mixtures of fresh and salt water to be found in bays and estuaries, where waters of all degrees of saltness may be found, from perfectly fresh to even much salter water than is represented by the above superior extreme, according to the climate of the locality. In deciding on the kind of instrument to be used, the hydrometer was selected as the only reliable one capable of being used at sea. Before starting I was in some doubt about the latter property, but it was evident that, in any case, the water samples had only to be stored till reaching harbour, when their specific gravities could be taken, if necessary, on shore, where the trustworthiness of the results would depend solely on the care with which the instrument had been constructed. It was found, however, that, except in very heavy weather, the observations could be satisfactorily made without storage being necessary.

The hydrometer was made of glass. Metal instruments were rejected because they are liable to deformation by violence, and consequently to alteration of volume.

A hydrometer of the delicacy required for our work has necessarily a very limited range, otherwise its dimensions would be inconveniently large. In order to avoid the necessity of taking a number of different instruments adapted to different ranges of density, a number of brass weights capable of being attached to the top of the stem of the hydrometer were provided. By this means the weight of the hydrometer could be varied at will within certain limits. One of these weights was in the form of a small brass table, and when more were required they were laid upon it.

The instrument which was used during the whole cruise answers perfectly the purpose for which it was designed, and may here be particularly described (fig. 1). Preliminary calculations showed that convenient dimensions would be about 3 mm. for the diameter of the stem and about 150 c.c. for the volume of the body, and from 10 to 12 cm. for the length of the stem. The tube for the stem was selected with great care from a large assortment, and no want of uniformity in its outward shape could be detected with the callipers. The tube for the body of the instrument was also selected from a number, in order to secure such a diameter as would give the instrument a suitable length. In order to provide against accidents, I had four instruments made from the two lengths of tubing. The glass work of the instrument being finished—except that the top of the stem, instead of being sealed up, was slightly widened out into a funnel—the instrument was loaded with mercury, until the lower end of the stem was just immersed in distilled water of 16° C. A millimetre scale on paper was then fixed in the stem, and the calibration carried on by placing decigramme weights on the funnel-shaped top, and noting the consequent depression on the scale. The whole length of the scale was 10 cm., and this portion of the stem proved to be of perfectly uniform calibre. Several series of observations were made in order to determine accurately the volume of any length of the stem.

Table I. gives the results of two series of these observations. Pure distilled water of the temperature of the laboratory (16° C.) was used.

Fig. 1.—Completed Hydrometer.

The temperature of the water was carefully checked with one of Geissler's standard thermometers, divided into tenths of a centigrade degree; it varied from 16°·0 to 16°·2 C. We may therefore take the mean temperature to be 16°·1 C. In the first series the mean depression per decigramme is 11·525 mm.; in the second it is 11·587 mm. The mean of these is 11·556 mm. This length of stem is immersed by 0·1 grm.; the volume therefore of 11·556 mm. of the stem is equal to that of 0·1 grm. water at 16°·1 C., or 0·100097 c.c. Hence the volume of the graduated portion of the stem (100 mm.) is

0·865 c.c. Both series of observations show that the stem is uniform, so that we take the volume of 1 mm. to be 0·00865 c.c.

When this operation of calibration was finished, the end of the stem was carefully closed before the blow-pipe.

TABLE I.

SHOWING THE VALUES OBTAINED IN TWO PRELIMINARY TRIALS OF THE HYDROMETER.

Lead. Gramme.	First Series.		Second Series.	
	Stem. Millimetres.	Differences.	Stem. Millimetres.	Differences.
0·0	98	...	98·9	...
0·1	85·2	12·8	87·0	11·9
0·2	73·8	11·4	75·1	11·9
0·3	62·3	11·5	64·0	11·1
0·4	51·0	11·3	53·0	11·0
0·5	39·5	11·5	40·8	12·2
0·6	28·0	11·5	29·6	11·2
0·7	17·2	10·8	17·9	11·7
0·8	5·8	11·4	6·2	11·7
0·85	−0·2	...	...	...
Mean, . . .		11·525	11·587	...

The hydrometer was now carefully weighed on one of Oertling's best balances with the following result:—

Weight in air, ...		160·0405
Add for air displaced by hydrometer, ...	0·1968	
Less buoyancy of weights, ...	0·0245	
		0·1723
Weight in vacuo, ...		160·2128 grms.

When the hydrometer floats in a liquid, then the true weight of the volume of liquid displaced is equal to the weight in vacuo of the hydrometer, less the weight of the volume of air displaced by the part of the instrument which protrudes above the surface of the liquid. In the case of our hydrometer the maximum volume of air displaced would be not more than 1 c.c., weighing about 0·0012 grm. The maximum error therefore due to this cause would be the same as that caused by an error of one-tenth of a scale division on the stem of the hydrometer. As this reading cannot be made with certainty to less than half a division the correction for displaced air may be omitted. The effective weight, therefore, of the hydrometer is constant, and is 160·2128 grms. In order from its reading, when floating in a liquid, to know the volume of the liquid displaced by this weight, we must know to what variations the volume of the instrument is subject. These are due solely to changes of temperature.

In determining the volume of the instrument at different temperatures, we confine our attention to the body of the instrument and neglect the stem, because it is immersed to a variable extent, and even if completely immersed, its bulk is so small that the variations of it may be neglected.

The coefficient of expansion was determined by floating the instrument in distilled water of different temperatures and observing the displacement. For water of temperature below 15° C., the hydrometer was loaded with the small brass table, which weighed 0·836 grm.

TABLE II.

SHOWING THE VOLUMES OF THE BODY OF THE INSTRUMENT AT DIFFERENT TEMPERATURES.

		With Brass Table.			Without Brass Table.		
Temperature of water (° C.), . .	t	4·5	6·0	11·4	15·7	20·1	25·9
Weight of hydrometer (grms.), . .	W	161·0488			160·2128		
Reading of do., ...	r	13·2	13·2	9·2	98·7	85·2	63·6
Volume (c.c.) of stem immersed (100 − r) 0·00865, . . .	v	0·751	0·751	0·777	0·011	0·128	0·315
Volume of W grms. water at $t°$, . .	V	161·049	161·054	161·110	160·361	160·487	160·704
Volume of body of hydrometer at $t°$ (V − v),	V_t	160·298	160·303	160·333	160·350	160·359	160·389

If these values for the volume of the body at the different temperatures be laid off as ordinates, the corresponding temperatures being abscissæ, a straight line can be drawn, passing through the points representing the observations at 4°·5, 6°, 15°·7 and 25°·9, and giving a higher value by 0·01 c.c. at 20°·1 C., and a lower one by 0·005 c.c. at 11°·4 C. than the observed values. This line may therefore fairly be taken to represent the thermal expansion of the body of the thermometer. According to it the volume at 0° is 160·277 c.c. and at 25° C. it is 160·391 c.c. Taking these figures as correct, the coefficient of expansion of the body of the hydrometer is 0·0000285.

The volume of the body of the hydrometer up to the first division on the stem (100) being 160·277 c.c. at 0° C., and the mean volume of each stem division being 0·00865 c.c., Table III. has been constructed, giving the volume immersed when the hydrometer floats at each division in liquid of 0° C. If the temperature of the liquid is not 0° C., then the volume has to be corrected in terms of the coefficient of expansion. Table IV. gives those corrections for all temperatures between 0° and 30° C. These corrections are to be added to the volumes found from Table III.

TABLE III.

GIVING THE IMMERSED VOLUME (V.) OF HYDROMETER No. 0 AT A TEMPERATURE OF 0° C. FOR EVERY SCALE DIVISION (R.) ON THE STEM.

R.	V.	R.	V.	R.	V.	R.	V.
100	160·277	74	160·502	49	160·718	24	160·934
99	285	73	511	48	727	23	943
98	294	72	519	47	735	22	951
97	303	71	528	46	744	21	960
96	311	70	537	45	753	20	969
95	320	69	545	44	761	19	977
94	329	68	554	43	770	18	986
93	337	67	562	42	779	17	995
92	346	66	571	41	787	16	161·003
91	355	65	579	40	796	15	012
90	363	64	588	39	805	14	021
89	372	63	597	38	813	13	029
88	381	62	605	37	822	12	038
87	389	61	614	36	831	11	047
86	398	60	623	35	839	10	055
85	407	59	631	34	848	9	064
84	415	58	640	33	857	8	073
83	424	57	649	32	865	7	081
82	433	56	657	31	874	6	090
81	441	55	666	30	882	5	099
80	450	54	675	29	891	4	107
79	459	53	683	28	899	3	116
78	467	52	692	27	908	2	125
77	476	51	701	26	917	1	133
76	485	50	709	25	925	0	142
75	493						

TABLE IV.

GIVING THE CORRECTION TO BE ADDED TO THE IMMERSED VOLUME OF THE HYDROMETER FOUND FROM TABLE III., FOR EVERY DEGREE CENTIGRADE FROM 1° C. TO 30° C.

Temp. °C.	Volume c.c.	Temp. °C.	Volume c.c.	Temp. °C.	Volume c.c.
1	0·0046	11	0·0502	21	0·0958
2	0091	12	0547	22	1003
3	0137	13	0593	23	1049
4	0182	14	0638	24	1094
5	0228	15	0684	25	1140
6	0274	16	0730	26	1186
7	0319	17	0775	27	1231
8	0365	18	0821	28	1277
9	0410	19	0866	29	1322
10	0456	20	0912	30	1368

Proportional parts for Tenths of a Degree.	
0·1	0·0005
2	0009
3	0014
4	0018
5	0023
6	0027
7	0032
8	0037
9	0041
...	...

By means of these two tables the volume of water displaced at any temperature can be found. It has been observed above that the hydrometer, as it stands and without any added weight, would be useful only through a very limited range of densities. Its weight is 160·2128 grms., and the total volume of the divided stem is 0·865 c.c., that of the body of the instrument being at ordinary temperatures 160·35 c.c. We have thus an extreme range in volumes of 160·350 to 161·206 c.c., and by consequence in density of 0·99914 to 0·99384, equal to 0·0053. Were the density of the water dependent solely on its saltness, this range would have sufficed for all the waters met with during the cruise. That is to say, the extreme range of specific gravities at constant temperature was not greater than 0·0053. The range is doubled when the effect of variation of temperature is remembered, and it is still further extended when account is taken of the condensation produced by the pressure of the overlying water at the bottom and intermediate depths. In order to make it possible, by means of the hydrometer above described, to observe all densities from that of distilled water up to that of the densest sea-water, a small brass table was made to fit on to the top of the stem of the hydrometer. Its weight was 0·836 grm., so that when the instrument was floating in distilled water of about 16° C. at about 97 mm., it depressed it to about 1 mm. A series of six weights were then made, each as nearly as possible a simple multiple of the weight of the table. It is not necessary that they should be exact multiples, they are brought approximately to the desired weight, and then their actual weight is accurately determined on the balance. The following are the weights which were used:—

No.	I.	II.	III.	IV.	V.	VI.
Weight grms.,	0·8560	1·6010	2·4225	3·2145	4·0710	4·8245

The hydrometer which we have described was designated No. 0, and the table was also designated No. 0. In the tabulated results the combination used is indicated in the column headed "Number of Hydrometer." Thus 00v means that hydrometer No. 0 table No. 0 and weight No. v were used. The combinations almost exclusively used were 00iv and 00v, which weighed 164·2633 and 165·1198 grms. respectively.

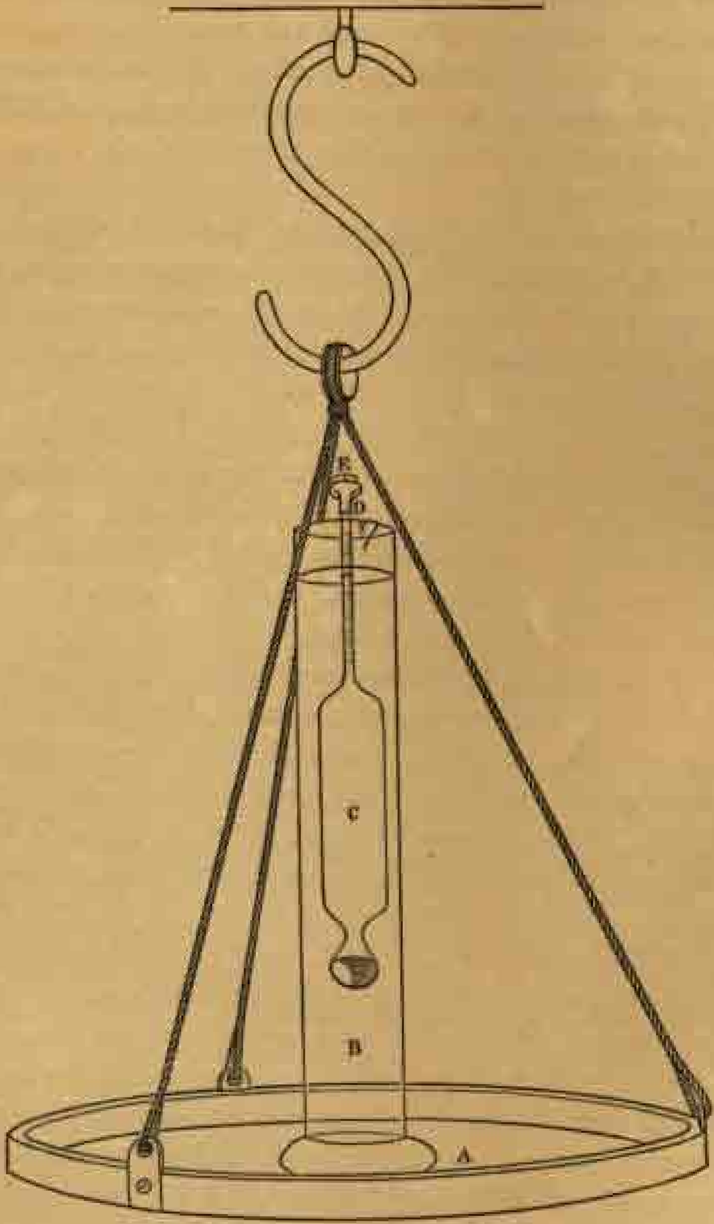


FIG. 2.—View of the Hydrometer in use; showing brass weight and method of suspension.

Suppose, for example, that when floating in a liquid of 20° C., the hydrometer, loaded with the table and weight No. iv (the combination 00iv) weighing together 164·2633 grms., is immersed as far as No. 74 on the stem, we find from Table I. that had the temperature been 0° C. the immersed volume would have been 160·502 c.c. From Table II. we find that at 20° C. the volume of the body of the instrument is greater by 0·0912 c.c. than it is at 0° C., neglecting as insignificant the variation in volume of the immersed portion of the stem, and adding the above correction 0·091 to the volume 160·502 at 0° C. found in Table I., we have for the correct immersed volume at 20° C. 160·593. This volume of the liquid is equal in weight to that of the displacing instrument (00iv), which is, as above, 164·2633 grms.

Dividing the weight by the volume we have the *density* of the liquid =164·2633 ÷ 160·593 = 1·02285. The specific gravity of a substance is the ratio of its density to some standard density. If we choose as our standard density that of distilled water at 4° C., at which temperature, by definition, a cubic centimetre weighs a gramme, our *densities* are identical with *specific gravities*, "water at 4° C. being unity."

Fig. 2 shows the hydrometer C, loaded with the table D, and weight E, floating in the surface of water contained in the cylinder B, of about one litre capacity. The cylinder stands on the tray A, suspended by a hook from the beams above. As the ship rolls the cylinder preserves a sensibly vertical position, and in all ordinary weather the observations could be made easily and accurately.

The volume of the body of the instrument may be taken to vary between 160·27 and 160·42 c.c. If we add the volume of the stem (0·865 c.c.) to the last, we have the extreme variations of the volume of displaced liquid between 160·27 and 161·285 c.c. From these volumes and the weights of the combinations, namely, 00iv=164·2633 and 00v=165·1198 grms., Table V. is constructed, in which under V. we have the volume of liquid displaced, and under $D_{iv.}$, $D_{v.}$ the corresponding densities, with the combinations 00iv and 00v respectively.

By the use of Tables III., IV., and V. we find without calculation the density corresponding to the observed readings of hydrometer and thermometer.

For purposes of future reduction it is necessary that the temperature of the water at the time of the hydrometer observation should be accurately ascertained. For this purpose one of Geissler's "normal" thermometers, divided into tenths of a degree centigrade, was used. Its zero was frequently checked in melting ice, and the correction applied. At low temperatures (below 10° or 12° C.) a tenth of a degree makes no sensible difference in the resulting density; but at the high temperatures (25° to 30° C.) common in tropical and equatorial waters, a difference of even 0°·1 C. in the temperature makes a difference of three to four in the fifth place of decimals in the density. In these warm latitudes, and with so delicate a hydrometer, it was absolutely essential that the water under observation should have sensibly the temperature of the atmosphere.

It was therefore my unvarying custom when samples of water were collected from the bottom or intermediate depths, to keep them over night in the laboratory, and determine the densities of the series at the same temperature. The results give the relative densities of the waters at the Station, independently of tables of reduction.

TABLE V.

SHOWING THE DENSITY (D_{iv}, D_v) OF THE WATER, THE IMMERSED VOLUME (V.) OF THE HYDROMETER BEING GIVEN.

Volume of Hydrometer Immersed. c.c.	Density with Instrument Weighing		Volume of Hydrometer Immersed. c.c.	Density with Instrument Weighing		Volume of Hydrometer Immersed. c.c.	Density with Instrument Weighing	
	164·2633 grammes. 00iv.	165·1198 grammes. 00v.		164·2633 grammes. 00iv.	165·1198 grammes. 00v.		164·2633 grammes. 00iv.	165·1198 grammes. 00v.
V.	D_{iv}.	D_v.	V.	D_{iv}.	D_v.	V.	D_{iv}.	D_v.
160·26	1·02499	1·03032	160·61	1·02276	1·02807	160·96	1·02052	1·02584
27	492	026	62	269	801	97	046	578
28	486	019	63	263	795	98	040	572
29	480	013	64	255	788	99	033	565
30	473	007	65	250	782	161·00	027	559
31	467	000	66	243	775	01	020	553
32	459	1·02994	67	237	769	02	014	546
33	453	987	68	231	763	03	007	540
34	447	981	69	224	756	04	001	533
35	440	975	70	218	750	05	1·01995	527
36	434	968	71	212	743	06	988	521
37	428	962	72	205	737	07	982	514
38	421	955	73	199	731	08	976	508
39	415	949	74	193	724	09	969	501
40	409	943	75	186	718	10	963	495
41	402	936	76	180	711	11	957	489
42	396	930	77	174	705	12	950	482
43	390	923	78	167	700	13	944	476
44	383	917	79	160	693	14	938	470
45	377	911	80	154	687	15	932	464
46	371	903	81	147	680	16	925	458
47	364	897	82	141	674	17	919	451
48	358	890	83	135	668	18	912	445
49	352	884	84	128	661	19	906	439
50	345	878	85	122	655	20	901	431
51	339	871	86	117	648	21	894	425
52	333	865	87	109	642	22	888	418
53	326	859	88	103	636	23	882	412
54	320	852	89	097	629	24	875	406
55	314	846	90	090	623	25	869	399
56	307	839	91	084	616	26	863	393
57	301	833	92	078	610	27	856	387
58	295	827	93	071	604	28	850	380
59	288	820	94	065	597	29	844	374
60	282	814	95	059	591	30	837	367

Having obtained the density of the water at the temperature which it had during the observation, we have to reduce it to its value at some standard temperature. It is only after this reduction that we can compare the densities of waters observed at different times and places in their bearing on the saltness of the water.

During the cruise the only available tables of the expansion of sea-water for temperature were those of Prof. Hubbard (Tables VI., VII.).

In Hubbard's Table[1] the volumes of a mass of sea-water at different temperatures are given referred to that at 15°·56 C. (60° Fahr.) as unity. In using it for reducing my observations to their value at a common temperature, I adopted the same standard temperature, as involving the least amount of calculation. It has, however, the advantage over lower temperatures that the amount of the correction to be applied to each observation is much smaller than if such a temperature as 4° or 0° C. were chosen.

TABLE VI.

COPY OF HUBBARD'S ORIGINAL TABLE FOR FAHRENHEIT'S DEGREES.

Temp.	Dilatation.	Temp.	Dilatation.	Temp.	Dilatation.	Temp.	Dilatation.
22°	0·99807	32°	0·99795	50°	0·99895	110°	1·00950
23	801	33	797	55	943	120	218
24	798	34	800	60	1·00000	130	506
25	795	35	803	65	067	140	1804
26	793	36	806	70	142	150	2118
27	792	37	810	75	221	160	2460
28	791	38	814	80	309	170	2823
29	791	39	819	85	402	180	3192
30	792	40	823	90	503	190	3588
31	793	45	856	100	716	200	3993

TABLE VII.

GIVING HUBBARD'S VALUES FOR THE VOLUME (CALLED IN THE ORIGINAL "DILATATION") AT EVERY DEGREE CENTIGRADE, THAT AT 15°·56 C. BEING UNITY.

Temp.	Volume.	Temp.	Volume.	Temp.	Volume.	Temp.	Volume.	Temp.	Volume.
−1°	0·99792								
0	795	6°	0·99840	12°	0·99927	18°	1·00059	24°	1·00224
1	799	7	853	13	947	19	086	25	256
2	804	8	866	14	967	20	111	26	288
3	812	9	878	15	987	21	137	27	320
4	820	10	893	16	1·00010	22	164	28	352
5	830	11	910	17	034	23	194	29	385
								30	420

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[1] Published in Maury's Sailing Directions, 1858, I. p. 237.

Hubbard believed from his experiments that, for all ordinarily occurring ocean waters the volume ratios were the same. The later observations of Thorpe and Rücker, Ekman, Tornøe, and Dittmar have shown that this is not strictly the case.

In the Meteorological Observations published in the second volume of the Narrative,[1] the specific gravities are reduced by Hubbard's Tables, the reductions having been performed during the cruise. The specific gravities in the following tables have been reduced by the table compiled by Prof. Dittmar.[2] They are therefore free from the error attaching to Hubbard's experiments. The results of Prof. Dittmar's Table are shown graphically in Pl. I., in which specific gravities at the temperature of observation are ordinates, and those at 15°·56 C. are abscissæ; the diagonal lines are isothermals, showing the variation of observed and reduced specific gravities for every degree of temperature. This chart enables reductions to be carried out rapidly and easily by inspection. For instance, let the density observed at 3° C. be 1·02800. Find the point on the isothermal of 3° C. whose ordinate is 1·02800, its abscissa is 1·02600, and that is the density at 15°·56 C.

For a discussion of the observations by various experimenters on the expansion of sea-water, the reader is referred to Prof. Dittmar's Report on the Composition of Ocean Water.[2]

In order practically to test the accuracy of the observations, occasion was taken when the temperature and salinity of the water were such as to immerse nearly the whole stem, when weight No. v was used, to take a reading immediately afterwards with weight No. iv, which immersed very little more than the body of the instrument. The effect of this was to obtain two observations of the density of the same water at the same temperature, one from a reading near the top of the scale, and the other from one near the bottom (Table VIII.).

TABLE VIII.

GIVING DUPLICATE OBSERVATIONS OF THE SAME SAMPLE OF WATER WITH THE SAME HYDROMETER DIFFERENTLY WEIGHTED.

No. of Sample.	Density observed with		Difference	No. of Sample.	Density observed with		Difference
	00iv.	00v.	00iv-00v.		00iv.	00v.	00iv-00v.
120	1·02412	1·02411	+1	274	1·02416	1·02412	+4
127	1·02414	1·02409	+5	826	1·02411	1·02411	0
135	1·02406	1·02413	−7	829	1·02411	1·02408	+3
139	1·02407	1·02414	−7	830	1·02400	1·02405	−5
181	1·02428	1·02427	+1	831	1·02411	1·02418	+3

The agreement between these results, dependent only on the hydrometer and the accuracy of observation, gave me much confidence in the correctness of my work.

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[1] Narrative, Chall. Exp., vol. ii. pp. 300–744.

[2] Phys. Chem. Chall. Exp., part i.

In order to form some idea of the trustworthiness of the *reduced* results, I kept a few samples of water, differing considerably in salinity, and determined their densities at different dates and under different states of atmospheric temperature. The observed densities were reduced in terms of Hubbard's Table. The results are given in Table IX., and show a very satisfactory amount of agreement. It will be observed that in this table there are no observations at temperatures of 25° C. and upwards, compared with those at moderate and low temperatures. Recent experience shows that, had these been so, the deficiencies of Hubbard's Table would have shown themselves. It shows that for non-tropical waters Hubbard's Table is sufficiently accurate.

TABLE IX.

SHOWING THE RESULTS OF DETERMINATIONS OF THE SPECIFIC GRAVITIES OF THE SAME SAMPLES OF WATER AT DIFFERENT TEMPERATURES.

N.	T_1.	S_1.	T_2.	S_2.	T_3.	S_3.	T_4.	S_4.	T_5.	S_5.	T_6.	S_6.
162	20·0	102629	24·1	102629	...	...	...	...	...	...	...	...
179	23·9	102717	24·1	102713	...	...	...	...	...	...	...	...
181	24·0	102656	24·7	102655	...	...	...	...	...	...	...	...
182	24·0	102630	24·8	102627	...	...	...	...	...	...	...	...
184	24·1	102695	21·0	102698	...	...	...	...	...	...	...	...
193	26·1	102618	25·9	102618	...	...	...	...	...	...	...	...
270	21·7	102692	17·2	102690	18·6	102691	11·4	102683	...	...	...	...
271	21·5	102659	16·1	102651	17·3	102653	18·8	102652	...	...	...	...
272	21·5	102618	16·8	102615	17·8	102611	...	...	...	...	...	...
273	21·6	102583	16·8	102578	17·9	102584	...	...	...	...	...	...
279	18·5	102639	15·6	102634	17·0	102635	11·5	102633	...	...	...	...
280	18·5	102612	15·4	102609	17·3	102609	11·4	102608	...	...	...	...
282	18·7	102550	15·4	102547	17·3	102555	11·4	102547	...	...	...	...
283	18·7	102582	16·1	102582	17·4	102585	...	...	...	...	...	...
289	15·6	102581	12·3	102584	...	...	...	...	...	...	...	...
294	14·6	102587	12·7	102585	...	...	...	...	...	...	...	...
353	8·7	102574	10·3	102564	7·1	102567	7·9	102564	7·0	102571	5·8	102575
357	8·9	102532	7·2	102533	...	...	...	...	...	...	...	...
A	12·0	102621	9·9	102627	8·8	102616	7·7	102614	6·8	102615	5·9	102618
B	12·4	102692	9·9	102694	8·9	102686	8·0	102686	6·9	102688	5·8	102680
C	12·4	102608	9·8	102621	9·0	102610	8·0	102622	6·9	102615	5·8	102620

In this table, under column N, are found the sample-numbers of the sea-waters used. Under T_1, T_2, &c., are found the temperatures (centigrade) at which the specific gravities S_1, S_2, &c., were obtained.

The results of the investigation have been placed on the accompanying chart and sections, from an inspection of which a general idea of the distribution of density in the ocean can be formed. The discussion of the bearing of these results on ocean physics is deferred for the present.

TABLES OF THE SPECIFIC GRAVITY OF OCEAN WATER.

An * signifies that the sp. gr. of the water at the bottom was ascertained, and a † that the sp. gr. of the water at depths intermediate between the surface and the bottom was determined.

I. *The Surface Water of the North Atlantic.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1873.		N.	W.									
*2	Feb. 15	1	27 24	16 55	Surface.	18·0	18·5	00 V.	44	1·02653	1·02730	1·02671	Teneriffe to Sombrero Island, West Indies.
3	" 16	...	26 49	17 58	"	18·2	17·9	"	47	1·02673	1·02732	1·02660	
*5	" 17	2	25 52	19 22	"	18·9	19·2	"	42	1·02609	1·02729	1·02636	
6	" 18	3	25 45	20 14	"	18·3	19·6	"	39	1·02579	1·02719	1·02654	
7	" 19	4	25 28	20 22	"	18·9	20·2	"	35	1·02561	1·02720	1·02637	
8	" 20	...	24 56	21 39	"	19·3	19·9	"	38	1·02610	1·02727	1·02623	
9	" 21	...	24 22	24 11	"	19·4	20·5	"	40	1·02629	1·02753	1·02659	
11	" 22	...	24 15	24 59	"	19·4	20·5	"	39	1·02606	1·02750	1·02656	
12	" 23	...	23 52	27 49	"	20·0	20·6	"	41	1·02633	1·02750	1·02650	
14	" 24	...	23 15	30 56	"	20·6	20·7	"	41	1·02632	1·02765	1·02653	
*17	" 25	8	23 12	32 56	"	19·4	21·3	"	40	1·02627	1·02773	1·02677	
*18	" 26	9	23 23	35 11	"	20·5	21·0	"	38	1·02613	1·02778	1·02658	
20	" 27	...	23 28	36 43	"	21·1	22·0	"	37	1·02608	1·02773	1·02632	
*22	" 28	10	23 10	38 42	"	21·7	22·5	"	35	1·02595	1·02774	1·02617	
†*26	Mar. 1	11	22 45	40 37	"	21·7	22·4	"	34	1·02591	1·02767	1·02614	
28	" 2	...	22 20	42 6	"	21·7	22·5	"	33	1·02583	1·02774	1·02617	
†*31	" 3	12	21 57	43 29	"	22·9	22·6	"	32	1·02579	1·02761	1·02575	
†*35	" 4	13	21 38	44 39	"	22·4	22·8	"	34	1·02589	1·02777	1·02597	
37	" 5	14	21 1	46 29	"	23·3	23·7	"	29	1·02543	1·02750	1·02553	
†*39	" 6	15	20 49	48 45	"	23·5	23·3	"	30	1·02566	1·02768	1·02549	
†*47	" 7	16	20 39	50 33	"	23·8	24·4	"	25	1·02536	1·02770	1·02568	
*48	" 8	17	20 7	52 32	"	23·3	24·2	"	25	1·02538	1·02760	1·02564	
*51	" 10	18	19 41	55 13	"	23·3	24·4	"	18	1·02498	1·02732	1·02530	
*52	" 11	19	19 15	57 47	"	23·9	24·9	"	15	1·02480	1·02728	1·02509	
*55	" 12	20	18 56	59 35	"	23·9	24·7	"	14	1·02485	1·02737	1·02508	
†*61	" 13	21	18 54	61 28	"	24·1	25·1	"	6	1·02431	1·02685	1·02451	
62	" 14	22	18 40	62 56	"	24·4	25·8	"	5	1·02423	1·02698	1·02464	
64	" 15	23	18 25	63 25	"	24·4	25·4	"	4	1·02430	1·02692	1·02459	
65	" 25	24a	18 43	65 5	"	24·4	25·7	"	6·5	1·02432	1·02704	1·02470	St. Thomas Island to Bermuda.
*67	" 26	25	19 41	65 7	"	24·4	25·2	"	7	1·02435	1·02692	1·02458	
*68	" 27	26	21 26	65 16	"	24·4	25·4	"	8	1·02441	1·02704	1·02470	
*71	" 28	27	22 49	65 19	"	24·2	25·2	"	10	1·02453	1·02719	1·02484	
*73	" 29	28	24 39	65 25	"	23·9	25·0	"	11	1·02459	1·02716	1·02491	
74	" 30	...	26 58	65 16	"	23·3	24·2	"	19	1·02504	1·02732	1·02530	
†*79	" 31	29	27 49	64 59	"	22·3	23·4	"	24	1·02531	1·02729	1·02571	
*82	April 1	30	29 5	65 1	"	22·2	24·1	"	20	1·02510	1·02735	1·02568	
84	" 2	...	29 51	65 8	"	21·4	22·1	"	29	1·02564	1·02732	1·02583	
87	" 3	32a	32 1	64 51	"	20·9	21·7	"	30	1·02571	1·02729	1·02610	
88	" 22	36	32 26	65 9	"	20·0	20·7	"	32	1·02585	1·02716	1·02604	Bermuda to New York.
89	" 25	38	33 3	66 22	"	21·1	21·7	"	29	1·02566	1·02723	1·02583	
90	" 26	...	34 11	67 37	"	18·6	18·4	"	40	1·02635	1·02704	1·02632	
91	" 27	39	34 8	67 22	"	18·3	18·0	"	41	1·02642	1·02701	1·02636	
92	" 28	40	34 51	68 30	"	20·8	18·1	"	38	1·02637	1·02698	1·02566	
93	" 29	41	36 5	69 54	"	18·2	19·5	"	35	1·02605	1·02703	1·02637	
*94	" 30	42	35 58	70 35	"	18·3	17·6	"	43	1·02647	1·02695	1·02629	
96	May 1	43	36 23	71 46	"	23·9	22·8	"	16	1·02486	1·02674	1·02455	
97	" 2	44	37 25	71 40	"	13·8	14·4	"	25	1·02566	1·02541	1·02583	
98	" 3	45	38 34	72 10	"	9·7	10·6	"	30	1·02603	1·02504	1·02615	

1. *The Surface Water of the North Atlantic*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (Distilled Water at 4° C. = 1.)			
				Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at		
												15°·56 C.	T° C.	
						D	T	t		R	S_t	$S_{15 \cdot 56}$	S_T	
	1873.			N.	W.									
99	May	5	...	39° 50′	69° 14′	Surface.	7°·2	11°·1	60 V.	38	1·02652	1·02562	1·02712	New York to Halifax.
100	"	6	46	40 17	66 49	"	4·4	6·1	"	21	1·02568	1·02403	1·02580	
101	"	7	47	41 14	65 45	"	5·5	6·2	"	25	1·02582	1·02419	1·02590	
*102	"	20	49	43 3	63 39	"	4·7	8·0	"	16	1·02520	1·02354	1·02534	Halifax to Bermuda.
*104	"	21	50	42 8	63 39	"	7·2	9·6	"	25	1·02582	1·02451	1·02602	
†*107	"	22	51	41 19	65 12	"	15·0	15·1	"	38·5	1·02635	1·02635	1·02636	
†*110	"	23	52	39 44	63 22	"	19·5	20·1	"	34·5	1·02601	1·02714	1·02619	
†*116	"	26	53	36 30	63 40	"	22·8	23·9	"	16	1·02489	1·02708	1·02520	
117	"	27	54	34 51	63 59	"	21·4	22·8	"	22·5	1·02527	1·02715	1·02567	
118	"	28	55	33 20	64 27	"	21·4	22·6	"	23	1·02529	1·02711	1·02562	
*119	June	14	59	32 54	63 22	"	22·8	25·4	"	10	1·02452	1·02715	1·02512	Bermuda to the Azores.
121	"	15	...	33 41	61 28	"	22·8	23·5	"	17·5	1·02498	1·02705	1·02517	
*122	"	16	60	34 28	58 56	"	21·9	23·0	"	20·5	1·02516	1·02700	1·02546	
124	"	17	61	34 54	56 38	"	21·7	22·8	"	21	1·02520	1·02703	1·02551	
†*125	"	18	62	35 7	52 32	"	21·1	22·5	"	24	1·02537	1·02716	1·02577	
*131	"	19	63	35 29	50 53	"	21·7	23·1	"	22	1·02524	1·02720	1·02562	
132	"	21	...	36 22	48 37	"	22·5	23·2	"	21·5	1·02522	1·02721	1·02543	
*134	"	22	66	37 24	44 14	"	21·1	22·4	"	24	1·02538	1·02712	1·02571	
136	"	23	...	37 52	42 1	"	21·1	21·7	"	24·5	1·02542	1·02699	1·02554	
†*142	"	24	68	38 3	39 19	"	21·1	23·4	"	15	1·02483	1·02688	1·02548	
143	"	25	69	38 22	37 21	"	21·7	23·2	"	20	1·02513	1·02712	1·02553	
144	"	26	70	38 25	35 50	"	21·1	22·1	"	24·5	1·02540	1·02708	1·02568	
*145	"	27	71	38 18	34 48	"	21·7	22·4	"	21	1·02520	1·02696	1·02537	
147	"	28	72	38 34	32 47	"	21·7	22·6	"	24	1·02536	1·02718	1·02561	
148	"	29	...	37 47	31 2	"	21·1	21·8	"	24	1·02539	1·02699	1·02556	
†*151	July	3	76	38 11	27 9	"	21·1	21·4	"	26	1·02550	1·02609	1·02559	
154	"	4	...	37 47	26 9	"	20·8	21·5	"	21	1·02534	1·02686	1·02555	
†*155	"	12	80	35 3	21 25	"	21·7	22·2	"	24	1·02535	1·02706	1·02549	Azores to Madeira.
158	"	13	81	34 11	19 52	"	21·7	22·7	"	22	1·02525	1·02710	1·02556	
*159	"	14	82	33 46	19 17	"	21·5	21·8	"	27	1·02555	1·02715	1·02563	
*161	"	15	83	33 13	18 13	"	21·7	21·7	"	22·5	1·02565	1·02742	1·02565	
163	"	18	84	30 38	18 5	"	21·7	22·0	"	29	1·02564	1.02729	1·02574	Madeira to C. Verde I.
164	"	19	85	28 42	18 6	"	20·7	22·6	"	30	1·02570	1·02735	1·02608	
165	"	20	...	27 0	19 38	"	22·2	22·8	"	29	1·02563	1·02751	1·02583	
167	"	21	87	25 40	20 12	"	22·2	23·2	"	26·5	1·02548	1·02747	1·02582	
†*168	"	22	88	23 38	21 18	"	22·2	23·8	"	25·5	1·02539	1·02755	1·02592	
171	"	23	89	22 18	22 2	"	23·0	24·1	"	17	1·02494	1·02719	1·02532	
†*172	"	24	90	20 58	22 57	"	23·3	23·9	"	12·5	1·02469	1·02688	1·02490	
179	"	25	...	19 11	24 7	"	23·6	23·9	"	16·5	1·02491	1·02710	1·02500	
185	"	25	...	19 0	24 8	"	23·6	24·2	"	13	1·02478	1·02706	1·02503	
†186	"	26	92	17 54	24 41	"	23·7	24·6	"	11	1·02460	1·02699	1·02493	
190	"	27	...	17 10	24 55	"	23·9	25·1	"	8	1·02442	1·02696	1·02483	
191	Aug.	6	...	15 43	24 15	"	25·5	26·1	"	5	1·02422	1·02706	1·02444	C. Verde I. to St. Paul's Rocks.
192	"	10	...	13 58	23 5	"	26·2	26·7	60 IV.	94	1·02377	1·02680	1·02394	
194	"	11	...	12 30	22 38	"	26·2	26·6	"	89	1·02351	1·02651	1·02366	
200	"	12	...	11 59	21 12	"	26·1	26·5	"	84·5	1·02326	1·02622	1·02340	
†*201	"	13	97	10 25	20 30	"	25·5	26·2	"	84·5	1·02328	1·02610	1·02346	
*206	"	14	98	9 21	18 28	"	25·6	26·5	"	82	1·02312	1·02605	1·02339	
208	"	15	...	8 13	17 50	"	25·6	25·9	"	84	1·02325	1·02600	1·02333	
209	"	16	...	7 7	16 11	"	25·7	26·3	"	84·5	1·02325	1·02612	1·02328	
213	"	17	—	6 44	16 42	"	26·1	26·2	"	87	1·02340	1·02627	1·02343	
214	"	18	...	6 15	16 5	"	25·9	26·3	"	88·5	1·02347	1·02637	1·02360	
215	"	19	101	5 48	14 20	"	26·2	26·5	"	87	1·02339	1·02635	1·02348	
216	"	20	—	4 34	13 52	"	26·1	26·4	"	85	1·02328	1·02621	1·02337	
†*217	"	21	102	3 8	14 49	"	25·5	25·8	"	82·5	1·02317	1·02589	1·02324	

I. *The Surface Water of the North Atlantic*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (Distilled Water at 4° C. = 1). Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D.	T.	t.		R.	S_t	$S_{15·56}$	S_T	
				N.	W.									
	1873.			° ′	° ′		°	°						
224	Aug.	22	...	2 52	17 4	Surface.	25·8	26·0	66 IV.	87	1·02341	1·02621	1·02347	C. Verde I. to St. Paul's Rocks.
*225	,,	23	104	2 25	20 1	,,	25·5	25·9	,,	85	1·02330	1·02602	1·02339	
227	,,	24	...	2 13	22 21	,,	25·8	26·1	,,	84	1·02323	1·02604	1·02332	
228	,,	25	106	1 47	24 26	,,	26·0	26·1	,,	86	1·02334	1·02615	1·02337	
†229	,,	26	107	1 22	26 36	,,	26·0	26·0	,,	88	1·02335	1·02613	1·02335	
230	,,	27	...	1 7	28 48	,,	25·5	25·7	,,	92	1·02368	1·02641	1·02374	
*238	,,	30	110	0 9	30 18	,,	25·3	25·8	,,	98	1·02402	1·02667	1·02408	St. Paul's Rks. to Fernando Noronha.
	1876.													
1647	April	8	...	1 30	14 6	,,	28·0	27·75	,,	76	1·02274	1·02605	1·02268	Ascension to Cape Verde Islands.
†1648	,,	9	348	3 10	14 51	,,	28·9	29·05	,,	61	1·02188	1·02578	1·02210	
1656	,,	10	...	5 20	14 46	,,	29·0	28·45	,,	72·5	1·02259	1·02616	1·02241	
1662	,,	11	...	7 10	15 10	,,	28·6	28·3	,,	74	1·02262	1·02615	1·02256	
1667	,,	12	...	9 3	16 35	,,	27·7	27·6	,,	85	1·02323	1·02653	1·02323	
1673	,,	13	...	10 48	17 48	,,	25·8	25·9	,,	95	1·02384	1·02662	1·02390	
1679	,,	14	...	11 23	18 42	,,	23·6	23·5	66 V.	12·5	1·02489	1·02676	1·02486	
1680	,,	15	...	12 29	21 26	,,	22·8	22·7	,,	16	1·02490	1·02675	1·02492	
1681	,,	16	...	13 56	23 11	,,	22·8	22·7	,,	12	1·02468	1·02653	1·02470	
1682	,,	26	...	16 48	25 14	,,	22·9	22·8	,,	18·5	1·02504	1·02692	1·02507	Cape Verde Islands towards England.
1683	,,	27	...	17 14	26 22	,,	22·5	22·6	,,	18	1·02509	1·02691	1·02512	
1684	,,	28	...	17 49	28 29	,,	22·7	22·6	,,	17·5	1·02499	1·02687	1·02503	
1685	,,	29	...	18 29	30 10	,,	23·6	23·5	,,	24	1·02533	1·02740	1·02530	
1686	,,	30	...	20 5	30 44	,,	23·0	23·1	,,	28	1·02555	1·02751	1·02557	
1687	May	1	...	21 33	31 15	,,	22·5	22·7	,,	32	1·02578	1·02763	1·02575	
1688	,,	2	...	24 0	32 38	,,	21·7	21·7	,,	38	1·02613	1·02779	1·02613	
†*1689	,,	3	353	26 21	33 37	,,	21·5	21·4	,,	39	1·02619	1·02768	1·02622	
1698	,,	4	...	28 10	34 55	,,	21·1	21·2	,,	38	1·02612	1·02755	1·02610	
1699	,,	5	...	29 30	35 55	,,	20·5	21·5	,,	33	1·02566	1·02734	1·02615	
1700	,,	5	...	30 20	36 6	,,	21·9	21·9	,,	32	1·02580	1·02743	1·02580	
†*1701	,,	6	354	32 41	36 6	,,	21·1	21·6	,,	31	1·02575	1·02729	1·02593	
1711	,,	7	...	34 22	34 22	,,	19·9	20·2	,,	37	1·02607	1·02723	1·02616	
1712	,,	8	...	36 1	33 23	,,	18·6	18·5	,,	38	1·02621	1·02693	1·02620	
1713	,,	9	...	38 27	33 28	,,	18·5	18·55	,,	38·5	1·02613	1·02689	1·02620	
1714	,,	10	...	40 20	32 2	,,	16·9	17·65	,,	42	1·02631	1·02685	1·02659	
1715	,,	11	...	42 6	31 4	,,	15·55	15·7	,,	44·5	1·02668	1·02671	1·02673	
1716	,,	16	...	41 59	20 54	,,	14·7	14·9	,,	50	1·02700	1·02683	1·02701	
1717	,,	17	...	42 6	18 12	,,	14·4	14·7	,,	48·5	1·02691	1·02672	1·02697	
1718	,,	19	...	42 48	12 35	,,	13·2	13·2	,,	55	1·02732	1·02681	1·02732	

II. *The Bottom Water of the North Atlantic.*

	1873.													
*1	Feb.	15	1	27 24	16 55	1890	2·7	17·9	66 V.	31	1·02594	1·02650	1·02854	Teneriffe to Sombrero Island.
*4	,,	17	2	25 52	19 22	1945	2·7	18·3	,,	22	1·02537	1·02602	1·02801	
10	,,	21	5	24 20	24 28	2740	2·8	20·0	,,	41	1·02633	1·02744	1·02942	
13	,,	23	6	23 14	28 22	2950	2·8	19·6	,,	43	1·02645	1·02745	1·02949	
15	,,	24	7	23 23	31 31	2750	2·7	20·3	,,	15	1·02492	1·02609	1·02808	
*16	,,	25	8	23 12	32 56	2700	2·8	19·6	,,	19	1·02514	1·02613	1·02811	
*19	,,	26	9	23 23	35 11	3150	2·7	20·2	,,	23	1·02537	1·02653	1·02857	
*21	,,	28	10	23 10	38 42	2720	2·5	22·1	,,	53	1·02585	1·02753	1·02950	
†*23	Mar.	1	11	22 45	40 37	2575	2·5	21·6	,,	11	1·02409	1·02621	1·02821	
†*30	,,	3	12	21 57	43 29	2025	2·7	21·7	,,	14	1·02484	1·02641	1·02845	
†*33	,,	4	13	21 38	44 39	1900	2·7	22·1	,,	22	1·02527	1·02695	1·02890	
†*38	,,	6	15	20 40	48 45	2325	2·3	21·0	,,	13	1·02480	1·02619	1·02813	
†*42	,,	7	16	20 39	50 33	2435	2·3	22·0	,,	33	1·02556	1·02754	1·02959	
*50	,,	10	18	19 41	55 13	2650	2·2	23·8	,,	0	1·02403	1·02615	1·02818	

II. *The Bottom Water of the North Atlantic*—continued.

Number of Sample.	Date.	Corresponding Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (*Distilled Water at 4° C. = 1.*) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°56 C.	Specific Gravity. Reduced to its Value at 4° C.	
					D	T	t		R	S_t	$S_{15\cdot56}$	S_4	
			N. ° ′	W. ° ′		°	°						
	1873.												
*53	Mar. 11	19	19 15	57 47	3000	1·9	22·9	00 V.	4	1·02426	1·02614	1·02819	Teneriffe to Sombrero Island.
*54	,, 12	20	18 56	59 35	2975	2·3	22·6	,,	26	1·02545	1·02727	1·02930	
†*62	,, 13	21	18 54	61 28	3025	1·9	21·5	,,	23	1·02526	1·02688	1·02889	
*66	,, 26	25	19 41	65 7	3875	...	23·7	...	2	1·02418	1·02631	...	St. Thomas to Bermuda.
*69	,, 27	26	21 26	65 16	2800	...	24·3	00 IV.	91	1·02368	1·02594	...	
*70	,, 28	27	22 49	65 19	2960	2·3	24·7	,,	90	1·02361	1·02601	1·02803	
*72	,, 29	28	24 39	65 25	2850	2·4	25·2	,,	89	1·02354	1·02608	1·02809	
†*76	,, 31	29	27 49	64 59	2700	2·4	22·8	00 V.	4	1·02427	1·02607	1·02808	
*83	April 1	30	29 5	65 1	2600	2·5	22·1	,,	29	1·02606	1·02774	1·02980	
85	,, 3	31	31 24	65 6	2475	2·5	20·6	,,	21	1·02527	1·02651	1·02857	
88	,, 3	32	31 49	64 55	2200	2·6	21·2	,,	19	1·02464	1·02605	1·02805	
*95	,, 30	42	35 58	70 35	2425	2·7	15·0	,,	33	1·02500	1·02568	1·02772	Bermuda to New York.
*102	May 20	49	43 3	63 39	85	1·7	5·6	,,	21·5	1·02570	1·02400	1·02608	Halifax to Bermuda.
*105	,, 21	50	42 8	63 39	1250	3·3	10·4	,,	37·5	1·02645	1·02546	1·02740	
†*106	,, 22	51	41 19	63 12	2020	2·2	11·8	00 IV. + 0·5 g.	83	1·02672	1·02595	1·02798	
†*113	,, 23	52	39 44	63 22	2800	2·3	19·8	00 V.	23·5	1·02536	1·02701	1·02905	
†*114	,, 26	53	38 20	63 40	2850	2·4	22·2	,,	22	1·02526	1·02706	1·02907	
*120	June 14	59	32 54	63 22	2360	2·4	24·6	00 V. 00 IV.	3 92	1·02411 1·02412	1·02650	1·02857	Bermuda to the Azores.
*122	,, 16	60	34 28	58 56	2575	2·3	24·0	00 V.	15	1·02482	1·02704	1·02912	
†*126	,, 18	62	35 7	52 32	2875	2·4	23·2	,,	10·5	1·02510	1·02709	1·02916	
*130	,, 19	63	35 29	50 53	2750	...	19·7	,,	18	1·02512	1·02613	...	
132	,, 21	65	36 33	47 58	2700	2·3	23·7	00 IV.	92	1·02367	1·02598	1·02800	
*135	,, 23	66	37 24	44 14	2750	2·3	23·6	00 V.	3	1·02412	1·02621	1·02821	
137	,, 23	67	37 54	41 44	2700	2·4	21·0	,,	12·5	1·02475	1·02614	1·02815	
†*139	,, 24	68	38 3	39 19	2175	2·3	20·6	,,	15	1·02487	1·02612	1·02814	
*146	,, 27	71	38 18	34 48	1675	2·7	20·0	,,	26·5	1·02557	1·02668	1·02872	
149	,, 30	73	38 30	31 14	1000	4·1	19·2	,,	24	1·02601	1·02691	1·02888	
†*150	July 3	75	38 11	27 9	900	4·4	18·4	,,	37	1·02619	1·02688	1·02878	
153	,, 4	77	37 52	26 26	750	...	20·8	,,	24	1·02543	1·02675	...	
†*157	,, 12	80	35 9	21 25	2660	2·5	20·5	,,	12	1·02478	1·02601	1·02801	Azores to Madeira.
*160	,, 14	82	33 46	19 17	2400	2·5	21·2	,,	38	1·02552	1·02686	1·02891	
*162	,, 15	83	33 13	18 12	1650	2·8	20·0	,,	19	1·02517	1·02628	1·02834	
168	,, 21	86	25 45	20 14	2300	2·5	26·1	,,	15·5	1·02313	1·02626	1·02832	Madeira to Cape Verde Islands.
†*169	,, 22	88	23 58	21 18	2300	2·4	24·2	00 IV.	95·5	1·02393	1·02618	1·02819	
†*178	,, 24	90	20 58	22 57	2400	2·5	23·5	00 V.	6·5	1·02438	1·02645	1·02851	
†184	,, 29	91	19 4	24 6	2075	2·5	21·9	,,	27	1·02558	1·02698	1·02902	
193	Aug. 10	95	13 36	22 49	2300	2·5	26·1	00 IV.	64	1·02324	1·02605	1·02805	Cape Verde Island to St. Paul's Rocks.
†*205	,, 13	97	10 25	20 30	2575	2·6	25·0	,,	85	1·02329	1·02604	1·02804	
*207	,, 14	98	9 21	18 28	1750	2·6	26·2	,,	83·5	1·02321	1·02665	1·02865	
†*222	,, 21	102	3 8	14 49	2450	2·4	25·1	,,	87	1·02314	1·02595	1·02796	
*226	,, 23	104	2 25	20 1	2500	2·5	24·9	,,	89	1·02356	1·02601	1·02801	
*237	,, 30	110	0 9	30 18	2275	1·5	25·8	,,	85*	1·02330	1·02602	1·02809	St. Paul's Rks. to Fernando Noronha.
	1876.												
†*1697	May 5	353	26 21	33 37	2965	3·1	21·5	00 V.	37	1·02538	1·02708	1·02908	Cape Verde Islands, towards England.
†*1710	,, 6	354	32 41	36 6	1675	2·2	20·2	,,	24·5	1·02544	1·02660	1·02880	
1710a	,, 6						20·3	,,	21	1·02580	1·02699	1·02899‡	
1710b	,, 6						19·95	,,	20	1·02521	1·02630	1·02890‡	

‡ Water from Baillie's Tube.

III. *Water from Intermediate Depths in the North Atlantic.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (Distilled Water at 4° C. = 1). Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at 0° C.	
					D	T	t		R	S_t	$S_{15.56}$	S_0	
	1873.		N. ° ′	W. ° ′		°	°						
21	Mar. 1	11	22 45	40 37	2100	2·5	21·4	00 V.	9	1·02158	1·02602	1·02802	Teneriffe to Sombrero Island.
23	" 1				500	6·9	21·2	"	12	1·02474	1·02615	1·02769	
27	" 1				850	4·4	22·5	"	8	1·02448	1·02620	1·02803	
29	" 3	12	21 57	43 29	988	3·7	21·9	"	8	1·02450	1·02611	1·02801	
32	" 3				400	3·7	22·4	"	11	1·02482	1·02654	1·02750	
34	" 4	13	21 38	44 39	300	12·5	20·6	"	25	1·02550	1·02641	1·02728	
36	" 4				200	15·7	21·4	"	40	1·02626	1·02775	1·02772	
40	" 6	15	22 49	48 45	500	6·2	21·3	"	31	1·02579	1·02722	1·02839	
41	" 6				300	12·1	21·8	"	17	1·02488	1·02648	1·02721	
43	" 7	16	20 39	50 33	200	16·0	21·6	"	21	1·02520	1·02679	1·02669	
44	" 7				500	6·6	20·5	"	42	1·02629	1·02755	1·02915	
45	" 7				400	6·9	20·9	"	13	1·02482	1·02615	1·02741	
46	" 7				200	12·3	21·1	"	29	1·02539	1·02680	1·02729	
49	" 9	17	20 7	52 32	1370	3·1	22·6	"	4	1·02427	1·02607	1·02803	
56	" 13	21	18 54	61 28	500	6·55	22·9	"	8	1·02450	1·02613	1·02772	
57	" 13				200	15·9	22·5	"	18	1·02508	1·02682	1·02674	
58	" 13				150	18·9	22·4	"	27	1·02550	1·02732	1·02698	
59	" 13				100	20·4	22·7	"	25	1·02537	1·02740	1·02619	
60	" 13				50	22·4	25·5	"	9	1·02446	1·02712	1·02536	
77	" 31	29	27 49	64 59	100	19·6	23·8	"	14·5	1·02563	1·02782	1·02723	St. Thomas to Bermuda.
78	" 31				200	17·1	23·6	"	18	1·02498	1·02706	1·02672	
79	" 31				300	14·4	24·1	"	8·3	1·02447	1·02672	1·02697	
80	" 31				400	9·9	23·4	"	6	1·02435	1·02640	1·02753	
81	" 31				500	7·0	22·6	"	5	1·02432	1·02612	1·02765	
108	May 22	51	41 19	63 12	250	6·9	12·5	"	42	1·02662	1·02598	1·02752	Halifax to Bermuda.
109	" 22				500	2·8	12·7	"	46	1·02652	1·02592	1·02781	
111	" 23	52	39 44	63 22	100	18·2	19·0	"	24·5	1·02602	1·02710	1·02646	
112	" 23				300	16·3	19·8	"	32	1·02588	1·02693	1·02679	
115	" 28	53	36 30	63 40	200	16·6	23·7	"	17·5	1·02497	1·02710	1·02686	
127	June 18	62	35 7	52 32	500	7·0	23·25	"	1	1·02409	1·02607	1·02757	Bermuda to the Azores.
128	" 18				250	15·7	23·2	"	15·5	1·02488	1·02687	1·02684	
129	" 18				150	17·2	23·3	"	19	1·02506	1·02708	1·02670	
139	" 24	63	35 3	52 19	500	8·8	23·25	00 IV.	87	1·02407	1·02605	1·02733	
140	" 24				250	15·3	23·3	00 V.	7·5	1·02443	1·02645	1·02651	
141	" 24				150	17·0	23·2	"	14·5	1·02482	1·02681	1·02648	
152	July 3	76	38 11	27 9	150	12·8	18·7	"	31	1·02555	1·02662	1·02721	
156	" 13	80	35 2	21 25	600	8·5	18·4	"	35	1·02598	1·02687	1·02798	Azores to Madeira.
170	" 22	88	23 58	21 18	400	8·2	24·2	00 IV.	96·5	1·02388	1·02627	1·02767	Madeira to C. Verde I.
173	" 24	90	26 58	22 57	500	6·7	20·7	00 V.	12	1·02477	1·02605	1·02762	
174	" 24				400	8·2	23·5	"	9·5	1·02405	1·02610	1·02747	
175	" 24				300	10·4	23·5	"	6·5	1·02438	1·02645	1·02740	
176	" 24				150	15·0	23·3	"	9·5	1·02454	1·02661	1·02674	
177	" 24				100	16·8	23·5	"	23	1·02528	1·02735	1·02706	
180	" 25	91	19 4	24 6	100	15·5	23·9	"	3	1·02418	1·02637	1·02633	
181	" 25				200	12·2	24·0	"	5	1·02427	1·02649	1·02739	
182	" 25				300	9·7	23·9	00 IV.	98	1·02407	1·02623	1·02732	
183	" 25				400	7·9	23·9	"	95	1·02390	1·02608	1·02747	
187	" 26	92	17 54	24 41	45	20·3	23·4	00 V.	25	1·02540	1·02745	1·02626	
188	" 26				75	18·3	23·0	"	21·5	1·02522	1·02715	1·02649	
189	" 26				100	16·7	22·8	"	16	1·02492	1·02680	1·02634	
195	Aug. 11	96	12 15	22 28	25	13·7	25·6	00 IV.	95	1·02360	1·02655	1·02652	C. Verde I. to St. Paul's Rks.
196	" 11				50	12·3	25·55	"	91	1·02363	1·02659	1·02699	
197	" 11				100	11·3	25·0	"	90	1·02358	1·02627	1·02717	
198	" 11				200	9·5	25·7	"	87	1·02341	1·02610	1·02727	
199	" 11				300	7·7	25·6	"	87·5	1·02340	1·02606	1·02730	

III. *Water from Intermediate Depths in the North Atlantic*—continued.

Number of Sample	Date	Distinguishing Number of Station	Position.		Depth in Fathoms from which Sample was obtained	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D.	T.	t.		R.	S_t	$S_{15.56}$	S_T	
	1873.		N.	W.									
202	Aug. 13	97	10° 25′	20° 30′	50	15·2	26·1	00 IV.	88·5	1·02340	1·02632	1·02641	Cape Verde Islands to St. Paul's Rocks.
203	,, 13				100	11·8	25·9	,,	88	1·02347	1·02625	1·02703	
204	,, 13				300	7·2	26·1	,,	86	1·02335	1·02616	1·02766	
210	,, 18	100	7 1	15 55	40	17·9	25·2	,,	96·5	1·02295	1·02652	1·02596	
211	,, 18				100	12·9	25·2	,,	91·5	1·02360	1·02626	1·02683	
212	,, 18				200	9·7	25·2	,,	87	1·02343	1·02597	1·02711	
218	,, 21	102	3 8	14 49	50	19·9	25·3	,,	97·5	1·02401	1·02661	1·02553	
219	,, 21				100	13·9	25·2	,,	95	1·02388	1·02645	1·02681	
220	,, 21				200	8·2	25·2	,,	91	1·02365	1·02619	1·02756	
221	,, 21				300	5·4	25·2	,,	89	1·02355	1·02609	1·02782	
222	,, 21				400	4·8	25·2	,,	93	1·02376	1·02633	1·02817	
230	,, 26	107	1 22	26 36	25	23·9	25·2	,,	87	1·02344	1·02598	1·02382	
231	,, 26				50	18·3	25·1	,,	88	1·02377	1·02631	1·02565	
232	,, 26				90	13·5	25·0	,,	93	1·02378	1·02629	1·02673	
233	,, 26				200	7·8	25·0	,,	89·5	1·02358	1·02606	1·02748	
234	,, 26				300	6·4	25·0	,,	91·5	1·02369	1·02617	1·02778	
235	,, 26				400	5·4	25·0	,,	82·5	1·02319	1·02567	1·02740	
	1876.												
1649	April 9	348	3 10	14 51	25	24·7	27·7	,,	75	1·02289	1·02590	1·02359	Ascension Island to Cape Verde Islands.
1650	,, 9				50	15·3	27·7	,,	80	1·02296	1·02629	1·02635	
1651	,, 9				100	13·4	27·7	,,	79·5	1·02294	1·02627	1·02673	
1652	,, 9				200	9·5	27·7	,,	73	1·02259	1·02589	1·02700	
1653	,, 9				300	6·5	27·6	,,	76·5	1·02275	1·02602	1·02761	
1654	,, 9				385	5·4	27·6	,,	72	1·02253	1·02580	1·02753	
1655	,, 9				800	4·2	28·1	,,	66·5	1·02222	1·02565	1·02751	
1657	,, 10	349	5 28	14 38	25	19·0	27·9	,,	79	1·02290	1·02630	1·02546	
1658	,, 10				50	15·1	27·9	,,	78	1·02284	1·02624	1·02611	
1659	,, 10				100	13·2	27·7	,,	78·5	1·02287	1·02620	1·02660	
1660	,, 10				200	9·7	27·7	,,	75	1·02269	1·02599	1·02713	
1661	,, 10				300	6·7	27·9	,,	71	1·02247	1·02583	1·02740	
1663	,, 11	350	7 33	15 16	25	22·0	27·6	,,	80	1·02297	1·02627	1·02482	
1664	,, 11				50	16·8	27·6	,,	80	1·02297	1·02627	1·02599	
1665	,, 11				100	13·7	27·7	,,	78	1·02286	1·02619	1·02659	
1666	,, 11				200	7·2	27·5	,,	72·5	1·02256	1·02580	1·02730	
1668	,, 12	351	9 9	16 41	25	17·8	26·3	,,	88·5	1·02347	1·02637	1·02583	
1669	,, 12				50	15·4	26·4	,,	89	1·02350	1·02643	1·02647	
1670	,, 12				100	13·2	26·2	,,	86	1·02333	1·02620	1·02671	
1671	,, 12				200	8·9	26·3	,,	83·5	1·02319	1·02606	1·02732	
1672	,, 12				300	6·9	26·2	,,	79	1·02295	1·02582	1·02736	
1674	,, 13	352	10 55	17 46	25	18·1	21·5	00 V.	16	1·02493	1·02645	1·02558	
1675	,, 13				50	14·9	21·5	,,	12	1·02472	1·02621	1·02639	
1676	,, 13				100	12·8	21·5	,,	11·5	1·02468	1·02618	1·02676	
1677	,, 13				200	10·4	21·5	00 IV. + 0·1z.	92·5	1·02446	1·02596	1·02698	
1678	,, 13				300	8·3	21·5	00 V.	8	1·02450	1·02600	1·02740	
1690	May 3	353	26 21	33 37	25	20·3	21·2	,,	37	1·02610	1·02753	1·02634	C. Verde I. towards England.
1691	,, 3				50	19·5	21·4	,,	33	1·02567	1·02730	1·02658	
1692	,, 3				100	17·9	21·5	,,	28	1·02560	1·02712	1·02656	
1693	,, 3				200	14·0	21·5	,,	22·5	1·02531	1·02683	1·02698	
1694	,, 3				300	12·2	21·4	,,	21·5	1·02542	1·02691	1·02782	
1695	,, 3				400	9·7	21·4	,,	14·5	1·02487	1·02636	1·02752	
1696	,, 3				2500	3·1	21·2	00 IV. + 0·2z.	97	1·02535	1·02678	1·02879	
1702	,, 6	354	32 41	36 6	25	20·1	20·0	00 V.	33·5	1·02593	1·02704	1·02591	
1703	,, 6				50	19·0	20·1	,,	31	1·02580	1·02693	1·02609	
1704	,, 6				100	17·3	20·4	00 IV. + 0·3z.	99	1·02571	1·02695	1·02657	
1705	,, 6				200	14·4	20·1	00 V.	32·5	1·02588	1·02701	1·02726	
1706	,, 6				300	11·9	20·0	,,	27	1·02558	1·02669	1·02740	

III. *Water from Intermediate Depths in the North Atlantic*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1876.		N. ° ′	W. ° ′		°	°						
1707	May 6	354	32 41	36 6	400	9·8	20·0	00 V.	21	1·02543	1·02654	1·02768	C. Verde I. towards England.
1708	,, 6				600	6·9	20·0	,,	19	1·02516	1·02627	1·02785	
1709	,, 6				1200	3·5	20·0	00 IV. + 9·3g.	99·5	1·02591	1·02726	1·02923	

IV. *The Surface Water of the South Atlantic.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
	1873.		S.	W.									
239	Aug. 31	...	2 6	31 4	Surface.	25·7	26·2	00 IV.	96	1·02390	1·02677	1·02405	St. Paul's Rocks to Fernando Noronha.
241	Sept. 1	...	3 42	32 21	,,	25·8	26·1	,,	95	1·02385	1·02669	1·02396	
*242	,, 4	116	5 1	33 50	,,	25·5	25·4	,,	91	1·02365	1·02628	1·02362	Fernando Noronha to Bahia.
244	,, 5	...	4 45	33 7	,,	25·8	25·2	,,	98	1·02405	1·02662	1·02389	
245	,, 6	...	5 54	34 30	,,	25·5	25·5	,,	98·5	1·02407	1·02673	1·02407	
246	,, 7	...	6 38	34 33	,,	25·5	25·5	,,	100	1·02414	1·02680	1·02414	
247	,, 8	119	7 39	34 12	,,	25·3	25·7	00 V.	14	1·02473	1·02745	1·02480	
248	,, 9	...	8 33	34 30	,,	25·5	25·9	,,	12	1·02462	1·02740	1·02478	
*249	,, 10	122c	9 10	34 49	,,	25·3	25·8	,,	12·5	1·02464	1·02739	1·02480	
*252	,, 12	125	10 46	36 2	,,	25·6	25·8	,,	13·5	1·02471	1·02746	1·02495	
254	,, 13	...	11 52	37 10	,,	24·7	25·0	,,	18	1·02497	1·02748	1·02506	
255	,, 26	...	13 48	37 59	,,	25·3	25·0	,,	23	1·02524	1·02775	1·02517	Bahia to Tristan d'Acunha Islands.
256	,, 27	...	14 51	37 1	,,	25·3	25·6	,,	18·5	1·02497	1·02766	1·02508	
257	,, 28	...	17 7	36 50	,,	24·7	24·9	,,	23·5	1·02527	1·02775	1·02535	
258	,, 29	...	19 6	35 40	,,	23·6	24·0	,,	25·5	1·02540	1·02762	1·02552	
†259	,, 30	129	20 13	35 19	,,	23·3	24·3	,,	23·5	1·02528	1·02659	1·02557	
265	Oct. 1	...	22 15	35 37	,,	22·8	22·9	,,	28	1·02557	1·02747	1·02560	
267	,, 2	...	24 43	34 17	,,	21·0	21·5	,,	30	1·02572	1·02724	1·02587	
†*268	,, 3	130	26 15	32 56	,,	20·5	21·6	,,	27	1·02556	1·02710	1·02587	
276	,, 4	...	27 54	31 22	,,	19·4	20·1	,,	34	1·02598	1·02711	1·02619	
277	,, 5	...	29 1	28 59	,,	18·9	19·4	,,	32	1·02583	1·02678	1·02598	
†278	,, 6	131	29 35	28 9	,,	18·3	19·1	,,	31	1·02585	1·02672	1·02607	
284	,, 7	...	29 20	26 20	,,	18·3	18·7	,,	32	1·02586	1·02663	1·02598	
285	,, 8	...	31 22	26 54	,,	16·7	16·8	,,	36	1·02618	1·02647	1·02620	
286	,, 9	...	33 57	24 33	,,	14·9	15·4	,,	43·5	1·02662	1·02658	1·02672	
†*287	,, 10	132	35 25	23 40	,,	14·4	15·3	,,	36·5	1·02625	1·02619	1·02643	
293	,, 11	133	35 41	20 55	,,	14·4	15·2	,,	38	1·02634	1·02626	1·02650	
295	,, 12	...	36 10	17 52	,,	12·6	13·2	,,	40	1·02650	1·02600	1·02662	
296	,, 13	...	36 7	14 27	,,	12·0	12·3	,,	42	1·02660	1·02593	1·02668	
*297	,, 14	134	36 12	12 16	,,	12·5	13·0	,,	43·5	1·02670	1·02616	1·02679	
299	,, 19	...	37 5	9 40	,,	12·0	12·5	,,	46	1·02686	1·02622	1·02695	Tristan d'Acunha to Cape of Good Hope.
†*300	,, 20	136	36 43	7 13	,,	12·2	13·0	,,	43·5	1·02670	1·02616	1·02685	
306	,, 22	...	35 57	0 15	,,	13·6	13·8	,,	42	1·02660	1·02623	1·02664	
			S.	E.									
†*307	,, 23	137	35 59	1 34	,,	13·4	13·6	,,	45·5	1·02679	1·02637	1·02681	
313	,, 24	...	36 2	5 27	,,	12·2	13·0	,,	40	1·02650	1·02596	1·02665	
*314	,, 25	138	36 22	8 12	,,	13·4	15·2	,,	39	1·02639	1·02631	1·02674	
316	,, 26	...	36 1	11 26	,,	15·6	15·6	,,	42·5	1·02663	1·02664	1·02663	
317	,, 26	...	35 54	12 31	,,	14·5	14·7	,,	46	1·02679	1·02660	1·02682	
318	,, 26	...	35 49	13 19	,,	13·3	12·9	,,	45	1·02678	1·02622	1·02670	
*319	,, 27	139	35 35	16 9	,,	13·4	13·7	,,	41	1·02654	1·02614	1·02660	
†321	,, 28	...	34 39	18 28	,,	17·2	17·1	,,	30·5	1·02587	1·02622	1·02585	
324	,, 28	...	34 18	18 32	,,	15·0	15·9	,,	34·5	1·02612	1·02620	1·02632	
	1876.		S.	W.									
*1442	Jan. 20	313	52 20	67 39	,,	9·0	10·1	,,	19	1·02544	1·02437	1·02562	Magellan Sts. to Falkland Ids.
*1444	,, 21	314	51 35	65 39	,,	8·9	11·9	,,	19·5	1·02543	1·02468	1·02595	
†*1446	,, 22	314a	51 24	61 46	,,	9·4	12·2	,,	22	1·02553	1·02488	1·02605	
1450	,, 23	...	51 23	57 48	,,	8·9	9·9	,,	28	1·02593	1·02482	1·02610	

IV. *The Surface Water of the South Atlantic*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at:		
											15°·56 C.	T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
			S. ° ′	W. ° ′		°	°						
1451	1876. Feb. 7	...	50 41	58 20	Surface.	7·8	8·3	00 V.	36	1·02637	1·02517	1·02658	Falkland Islands to Monte Video.
†*1452	,, 8	317	48 37	55 17	,,	8·2	9·9	,,	38	1·02635	1·02534	1·02660	
1460	,, 9	...	47 50	56 9	,,	10·3	10·7	,,	36	1·02634	1·02587	1·02641	
1461	,, 10	...	45 1	56 9	,,	11·1	11·7	,,	31·5	1·02608	1·02529	1·02620	
†*1462	,, 11	318	42 32	56 29	,,	14·2	13·7	,,	33·5	1·02564	1·02534	1·02552	
1471	,, 12	...	41 30	54 48	,,	15·3	16·5	,,	21	1·02528	1·02555	1·02561	
1472	,, 13	...	39 33	54 20	,,	12·2	15·4	,,	25	1·02565	1·02522	1·02591	
1474	,, 13	...	38 54	54 17	,,	12·6	18·6	,,	8	1·02450	1·02582	1·02459	
†*1475	,, 14	320	37 17	53 52	,,	19·7	17·8	,,	9·5	1·02470	1·02523	1·02425	
1482	,, 15	...	35 4	55 6	,,	21·1	21·1	00 III.	50	1·01655	1·01794	1·01655	Off the River Plate.
1483	,, 15	...	35 1	55 18	,,	21·9	21·9	00 II.	62·5	1·01215	1·01367	1·01215	
1484	,, 28	...	35 12	53 7	,,	22·0	22·3	00 IV.	44	1·02116	1·02288	1·02122	
1485	,, 27	...	35 25	52 35	,,	23·0	23·3	00 V.	8	1·02444	1·02654	1·02461	Monte Video towards Tristan d'Acunha Islands.
†*1486	,, 28	323	35 39	50 47	,,	23·0	23·3	,,	11	1·02460	1·02670	1·02477	
*1492	,, 29	324	36 9	48 22	,,	21·9	22·0	,,	6·5	1·02440	1·02603	1·02443	
†1497	Mar. 1	...	36 0	47 50	,,	21·7	21·5	,,	15·5	1·02492	1·02644	1·02488	
†*1499	,, 2	325	36 44	46 16	,,	21·5	22·4	,,	17·5	1·02499	1·02675	1·02523	
1508	,, 3	...	36 55	44 50	,,	20·0	21·5	00 IV.	84·5	1·02341	1·02491	1·02382	
1510	,, 4	...	36 58	42 50	,,	21·9	21·6	00 V.	14	1·02481	1·02633	1·02495	
1512	,, 5	...	37 34	41 51	,,	20·9	21·1	,,	10	1·02462	1·02601	1·02475	
1513	,, 6	...	37 38	39 16	,,	17·5	18·8	,,	14·5	1·02485	1·02571	1·02528	
1514	,, 7	...	37 31	38 27	,,	18·4	18·7	,,	21	1·02530	1·02606	1·02540	
1519	,, 8	...	37 45	33 33	,,	17·9	18·5	,,	24·5	1·02540	1·02620	1·02555	
†*1521	,, 9	331	37 47	30 20	,,	18·0	18·7	,,	23·5	1·02544	1·02626	1·02563	
†*1530	,, 10	332	37 29	27 31	,,	17·8	18·8	,,	21	1·02531	1·02604	1·02551	
1534	,, 11	...	36 30	26 11	,,	17·5	17·5	,,	22	1·02540	1·02585	1·02540	
1535	,, 12	...	35 52	24 12	,,	20·0	20·2	,,	12	1·02481	1·02598	1·02490	
1536	,, 13	...	35 36	20 52	,,	19·7	20·7	,,	14	1·02484	1·02612	1·02511	
†*1543	,, 14	334	35 45	18 31	,,	20·3	20·8	,,	12	1·02473	1·02604	1·02486	
1548	,, 15	...	34 0	15 46	,,	21·7	22·3	,,	10	1·02450	1·02633	1·02473	
†*1549	,, 16	335	32 24	13 5	,,	23·9	23·9	,,	11·5	1·02464	1·02686	1·02473	Tristan d'Acunha to Ascension.
1552	,, 17	...	30 21	13 12	,,	24·4	24·0	,,	13	1·02462	1·02684	1·02450	
1559	,, 18	...	27 43	13 13	,,	24·4	24·5	,,	11	1·02457	1·02690	1·02460	
†*1568	,, 19	337	24 38	13 36	,,	25·0	25·1	,,	10	1·02450	1·02704	1·02453	
1573	,, 20	...	23 27	13 51	,,	25·1	25·1	,,	11	1·02456	1·02710	1·02456	
†1574	,, 21	338	21 15	14 2	,,	24·7	24·9	,,	19·5	1·02504	1·02752	1·02510	
1581	,, 22	...	19 55	13 56	,,	24·7	25·0	,,	18·5	1·02498	1·02749	1·02507	
†*1582	,, 23	339	17 26	13 52	,,	24·4	24·6	,,	22	1·02518	1·02773	1·02524	
1590	,, 24	...	14 50	13 42	,,	25·1	25·3	,,	17·5	1·02492	1·02752	1·02498	
1599	,, 25	...	12 29	13 44	,,	25·9	26·1	,,	5·5	1·02422	1·02706	1·02428	
1608	,, 26	...	10 6	13 44	,,	26·7	26·7	,,	5	1·02418	1·02721	1·02418	
*1617	,, 27	343	8 3	14 27	,,	27·1	26·8	00 IV.	95	1·02382	1·02688	1·02373	
1619	April 3	344	7 54	14 28	,,	27·8	27·4	,,	87	1·02334	1·02638	1·02320	Ascension to St. Vincent.
†*1620	,, 4	345	5 45	14 25	,,	28·2	28·0	,,	78	1·02284	1·02627	1·02278	
1622	,, 5	...	4 22	14 34	,,	27·9	28·1	,,	72	1·02251	1·02594	1·02257	
†*1630	,, 6	346	2 42	14 41	,,	28·2	28·2	,,	76·5	1·02275	1·02624	1·02275	
1640	,, 7	347	0 15	14 25	,,	27·8	27·7	,,	82	1·02306	1·02639	1·02303	

V. *The Bottom Water of the South Atlantic.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at		
											15°.56 C.	T° C.	
					D	T	t		R	S_t	$S_{15.56}$	S_T	
240	1873. Sept. 1	112	3 33	32 16	2200	1·1	24·3	00 IV.	93	1·02379	1·02607	1·02817	St. Paul's Rocks to Fernando Noronha.
*243	,, 4	116	5 1	33 50	2275	1·3	25·4	,,	88	1·02349	1·02609	1·02816	Fernando Noronha to Bahia.
*250	,, 10	122b	9 10	34 49	400	...	26·2	,,	94	1·02379	1·02689	...	
251	,, 11	124	10 11	35 22	1600	...	26·3	,,	94·5	1·02381	1·02671	...	
*253	,, 12	125	10 46	36 2	1200	...	26·2	00 V.	9	1·02443	1·02730	...	
†*275	Oct. 3	130	26 15	32 56	2350	1·5	21·5	,,	28	1·02562	1·02714	1·02928	Bahia to Tristan d'Acunha.
†*292	,, 10	132	35 25	23 40	2050	1·7	15·9	,,	29	1·02582	1·02590	1·02796	
*294	,, 13	133	35 41	20 55	1900	1·9	14·6	,,	33	1·02608	1·02587	1·02792	
*298	,, 14	134	36 12	12 16	2025	2·2	11·5	,,	42	1·02666	1·02583	1·02786	
†*305	,, 20	136	36 43	7 13	2100	1·8	14·0	,,	35	1·02625	1·02593	1·02798	Tristan d'Acunha to C. of Good Hope.
†*312	,, 23	137	S. 35 59	E. 1 34	2550	1·4	12·8	,,	38·5	1·02643	1·02585	1·02793	
*315	,, 25	138	36 22	8 12	2650	1·7	13·2	,,	35·5	1·02624	1·02580	1·02788	
*320	,, 27	139	35 35	16 9	2325	1·2	14·6	,,	34	1·02615	1·02582	1·02791	
*1442	1876. Jan. 20	313	S. 52 20	W. 67 39	55	8·8	12·2	,,	13·5	1·02508	1·02439	1·02567	Magellan Strait to Falkland Islands.
*1445	,, 21	314	51 35	65 39	70	7·8	10·9	,,	24	1·02560	1·02476	1·02618	
†*1449	,, 22	314a	51 24	41 46	110	5·4	11·3	,,	28	1·02590	1·02504	1·02677	
†*1459	Feb. 8	317	48 37	55 17	1035	2·0	11·5	00 IV. + 0·3g.	95	1·02614	1·02531	1·02735	Falkland Islands to Monte Video.
†*1470	,, 11	318	42 32	56 29	2040	0·9	16·3	,,	89	1·02567	1·02584	1·02795	
1472	,, 12	319	41 54	54 48	2425	0·4	15·9	00 V.	22	1·02544	1·02552	1·02765	
†*1481	,, 14	320	37 17	53 52	600	2·9	16·9	,,	16·5	1·02510	1·02541	1·02738	
†*1494	,, 28	323	35 39	50 47	1900	0·6	23·1	,,	8	1·02445	1·02641	1·02860	Monte Video to Tristan d'Acunha.
*1496	,, 29	324	36 9	48 22	2800	0·3	22·2	,,	5·0	1·02433	1·02602	1·02816	
1496a	,, 29					0·3	22·4	,,	2·0	1·02418	1·02592	1·02806‡	
1496b	,, 29					0·3	22·6	00 IV.	98·5	1·02416	1·02596	1·02810‡	
1496c	,, 29					0·3	22·6	00 IV. + 0·1g.	89	1·02427	1·02607	1·02821‡	
†*1507	Mar. 2	325	36 44	46 16	2650	0·4	23·2	00 IV.	94	1·02388	1·02583	1·02796	
1507a	,, 2						23·7	,,	99	1·02363	1·02574	1·02787‡	
1507b	,, 2						23·0	00 IV. + 0·1g.	89	1·02428	1·02614	1·02827‡	
1509	,, 3	326	37 3	44 17	2775	0·4	21·6	00 IV.	100	1·02433	1·02585	1·02798‡	
1511	,, 4	327	36 48	42 45	2900	0·4	22·2	00 IV. + 0·1g.	93	1·02447	1·02616	1·02829‡	
1511a	,, 4						21·8	00 V.	9	1·02454	1·02612	1·02825‡	
†1518	,, 7	329	37 31	36 7	2675	0·2	19·6	,,	12	1·02477	1·02576	1·02790	
1520	,, 8	330	37 45	33 0	2440	0·4	20·3	,,	11	1·02491	1·02608	1·02821	
†*1529	,, 9	331	37 47	30 20	1715	1·9	20·7	,,	9	1·02457	1·02585	1·02790	
1529a	,, 9						18·8	00 IV. + 0·2g.	92	1·02514	1·02592	1·02797‡	
†*1533	,, 10	332	37 29	27 31	2200	1·1	17·9	00 V.	19·5	1·02525	1·02580	1·02790	
†1544	,, 13	333	35 36	21 12	2025	1·8	22·6	00 IV.	97	1·02404	1·02584	1·02790	
†*1547	,, 14	334	35 45	18 31	1915	2·1	21·4	00 V.	9	1·02457	1·02604	1·02808	
†*1557	,, 16	335	32 24	13 5	1425	2·3	24·1	00 IV.	90	1·02383	1·02585	1·02783	Tristan d'Acunha to Ascension.
†1567	,, 18	336	27 54	13 13	1890	2·5	24·5	,,	89	1·02356	1·02590	1·02790	
†*1572	,, 19	337	24 38	13 36	1240	2·6	24·3	00 V.	2	1·02408	1·02639	1·02842	
†*1589	,, 23	339	17 26	13 52	1415	2·9	25·1	00 IV.	82·5	1·02317	1·02568	1·02765	
†1598	,, 24	340	14 33	13 42	1500	3·1	25·2	,,	88	1·02344	1·02598	1·02794	
†1607	,, 25	341	12 16	13 44	1475	3·4	26·4	,,	82	1·02311	1·02661	1·02794	
†1616	,, 26	342	9 43	13 51	1445	3·0	26·7	,,	80·5	1·02301	1·02600	1·02797	
*1618	,, 27	343	8 3	14 27	425	4·6	25·7	,,	88	1·02343	1·02612	1·02793	

‡ Water procured from Baillie's Rod.

V. *The Bottom Water of the South Atlantic*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at		
											15°56 C.	T° C.	
					D	T	t		R	S_t	$S_{15 \cdot 56}$	S_T	
			S.	W.									
	1876.												
†*1628	April 4	345	5° 45′	14° 25′	2010	2°·7	27°·9	00 IV.	74	1·02263	1·02599	1·02798	Ascension to Cape Verde Islands.
†*1639	,, 6	346	2 42	14 41	2350	1·1	27·8	,,	75	1·02285	1·02622	1·02858	
†*1646	,, 7	347	0 15	14 25	2250	2·3	26·9	,,	77·5	1·02294	1·02589	1·02791	

VI. *Water from Intermediate Depths in the South Atlantic.*

	1873.												
260	Sept. 30	129	20 13	35 19	50	20·3	23·9	00 V.	21·5	1·02519	1·02738	1·02619	Bahia to Tristan d'Acunha Islands.
261	,, 30				100	17·3	23·9	,,	21·5	1·02519	1·02738	1·02697	
262	,, 30				200	10·8	23·8	,,	21·5	1·02519	1·02735	1·02832	
263	,, 30				300	6·4	24·0	00 IV.	80	1·02341	1·02560	1·02721	
264	,, 30				400	4·5	23·9	00 V.	20·5	1·02514	1·02733	1·02920	
269	Oct. 3	130	26 15	32 56	4	20·5	21·4	,,	26	1·02562	1·02711	1·02587	
270	,, 3				50	18·1	21·7	,,	24	1·02533	1·02690	1·02629	
271	,, 3				100	15·6	21·3	,,	18	1·02506	1·02658	1·02657	
272	,, 3				200	12·4	21·5	,,	15	1·02484	1·02614	1·02580	
273	,, 3				300	9·0	21·0	,,	8	1·02436	1·02578	1·02708	
274	,, 3				400	6·0	21·5	,,	0·5	1·02412	1·02562	1·02728	
279	,, 6	131	29 35	28 9	100	16·1	18·5	,,	27	1·02565	1·02637	1·02624	
280	,, 6				200	12·0	18·5	,,	22	1·02538	1·02609	1·02671	
281	,, 6				300	9·2	18·6	,,	15	1·02490	1·02572	1·02694	
282	,, 6				400	5·7	18·7	,,	10	1·02472	1·02548	1·02717	
283	,, 6				1000	2·8	18·7	,,	16	1·02504	1·02580	1·02778	
288	,, 10	132	35 25	23 40	100	12·9	15·9	,,	35	1·02615	1·02622	1·02679	
289	,, 10				200	10·0	15·6	,,	28·5	1·02560	1·02581	1·02690	
290	,, 10				300	6·6	16·0	,,	21·5	1·02542	1·02552	1·02710	
291	,, 10				400	4·4	15·8	,,	22	1·02545	1·02551	1·02734	
301	,, 20	136	36 43	7 13	100	11·2	13·9	,,	27	1·02633	1·02598	1·02686	Tristan d'Acunha to Cape of Good Hope.
302	,, 20				200	9·5	12·9	,,	34	1·02615	1·02560	1·02697	
303	,, 20				300	6·2	13·9	,,	29	1·02589	1·02554	1·02717	
304	,, 20				400	4·2	13·8	,,	28	1·02584	1·02547	1·02733	
			S.	E.									
308	,, 23	137	35 59	1 34	100	13·1	13·2	,,	41	1·02653	1·02605	1·02657	
309	,, 23				200	11·0	13·2	,,	39	1·02645	1·02595	1·02687	
310	,, 23				300	7·0	13·4	,,	32·5	1·02615	1·02569	1·02722	
311	,, 23				400	4·7	13·0	,,	31·5	1·02610	1·02556	1·02736	
322	,, 28	140a	34 20	18 28	25	16·8	15·6	,,	36·5	1·02624	1·02625	1·02597	
323	,, 28				50	14·7	15·3	,,	36·0	1·02622	1·02616	1·02635	
	1876.		S.	W.									
1447	Jan. 22	314a	51 24	61 46	25	8·5	11·5	,,	23·5	1·02566	1·02483	1·02615	Magellan Strait to Falkland Islands.
1448	,, 22				50	7·7	11·8	,,	22·5	1·02559	1·02482	1·02626	
1453	Feb. 8	317	48 37	55 17	25	5·7	10·4	,,	34·5	1·02627	1·02525	1·02694	Falkland Islands to Monte Video.
1454	,, 8				50	4·4	9·9	,,	35	1·02631	1·02520	1·02703	
1455	,, 8				100	4·0	10·0	,,	35	1·02631	1·02522	1·02710	
1456	,, 8				200	3·7	10·1	,,	35	1·02630	1·02529	1·02713	
1457	,, 8				300	3·3	10·1	,,	35	1·02630	1·02523	1·02717	
1458	,, 8				400	3·0	10·1	,,	37·5	1·02645	1·02538	1·02735	
1463	,, 11	318	42 32	56 29	25	13·7	16·8	,,	14	1·02498	1·02526	1·02566	
1464	,, 11				50	6·2	16·3	,,	18·5	1·02497	1·02514	1·02677	
1465	,, 11				100	2·5	15·9	,,	14·5	1·02503	1·02511	1·02711	
1466	,, 11				200	1·9	16·1	,,	13·5	1·02497	1·02509	1·02714	
1467	,, 11				300	1·9	16·2	,,	13	1·02493	1·02508	1·02713	
1468	,, 11				400	1·9	16·2	,,	15	1·02504	1·02519	1·02724	
1469	,, 11				800	1·9	16·1	,,	24·5	1·02556	1·02563	1·02773	

VI. *Water from Intermediate Depths in the South Atlantic*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1876.		S. ° ′	W. ° ′									
1476	Feb. 14	320	37 17	53 52	25	15·5	17·1	00 V.	14·5	1·02499	1·02534	1·02536	Falkland Islands to Monte Video.
1477	" 14				50	7·8	16·9	"	7	1·02458	1·02488	1·02630	
1478	" 14				100	6·1	16·5	"	20·5	1·02534	1·02562	1·02727	
1479	" 14				200	4·1	16·8	"	15	1·02503	1·02531	1·02714	
1480	" 14				400	3·5	17·0	"	14·5	1·02500	1·02533	1·02725	
1487	" 28	323	35 39	50 47	25	21·9	23·1	"	13·5	1·02475	1·02671	1·02508	Monte Video to Tristan d'Acunha Islands.
1488	" 28				50	20·8	22·9	"	17	1·02494	1·02684	1·02552	
1489	" 28				100	18·6	22·9	"	12·5	1·02471	1·02661	1·02587	
1490	" 28				200	14·2	22·9	"	5	1·02428	1·02618	1·02645	
1491	" 28				300	9·7	23·0	00 IV.	94	1·02388	1·02579	1·02693	
1492	" 28				400	5·5	22·0	00 V.	8·5	1·02450	1·02643	1·02819	
1493	" 28				800	2·8	23·1	"	11	1·02461	1·02657	1·02861	
1498	Mar. 1	...	36 0	47 50	20	21·5	22·3	"	18·5	1·02503	1·02677	1·02525	
1500	" 2	325	36 44	46 16	25	21·0	22·2	"	13·5	1·02475	1·02674	1·02536	
1501	" 2				50	20·2	22·4	"	20	1·02513	1·02689	1·02573	
1502	" 2				100	16·8	22·6	"	15	1·02485	1·02667	1·02636	
1503	" 2				200	10·4	22·6	"	9	1·02452	1·02634	1·02680	
1504	" 2				300	7·2	22·7	"	18	1·02490	1·02675	1·02829	
1505	" 2				400	4·7	22·9	00 IV.	95·5	1·02385	1·02583	1·02763	
1506	" 2				800	2·9	22·8	"	87	1·02350	1·02525	1·02782	
1515	" 7	329	37 31	36 7	200	7·2	19·6	00 V.	10·5	1·02470	1·02569	1·02719	
1516	" 7				400	3·8	19·4	"	5·5	1·02441	1·02535	1·02724	
1517	" 7				2000	1·7	19·4	"	14	1·02490	1·02584	1·02790	
1522	" 9	331	37 47	30 20	25	16·7	20·1	"	15·5	1·02494	1·02600	1·02580	
1523	" 9				50	14·4	20·0	"	18	1·02506	1·02613	1·02643	
1524	" 9				100	12·7	20·7	"	14·5	1·02488	1·02616	1·02676	
1525	" 9				200	10·5	17·8	"	21·5	1·02536	1·02589	1·02689	
1526	" 9				300	6·3	19·8	"	5·5	1·02441	1·02545	1·02707	
1527	" 9				400	4·2	17·7	"	13	1·02490	1·02540	1·02726	
1528	" 9				800	2·8	18·0	00 IV. + 0·2g.	90·5	1·02508	1·02566	1·02764	
1531	" 10	332	37 29	27 31	800	2·9	17·7	00 V.	15·5	1·02502	1·02552	1·02749	
1532	" 10				1400	2·9	17·9	00 IV. + 0·2g.	95·5	1·02536	1·02591	1·02788	
1537	" 13	333	35 36	21 12	25	18·5	22·9	00 V.	4	1·02424	1·02612	1·02584	
1538	" 13				50	14·0	22·4	"	8	1·02446	1·02620	1·02653	
1539	" 13				100	12·8	22·4	"	8	1·02446	1·02620	1·02678	
1540	" 13				200	8·0	22·5	00 IV.	97	1·02404	1·02581	1·02721	
1541	" 13				300	5·5	23·5	"	88	1·02353	1·02558	1·02739	
1542	" 13				400	4·4	22·6	"	90	1·02366	1·02546	1·02729	
1543	" 13				800	2·9	22·4	"	95·5	1·02397	1·02571	1·02768	
1546	" 14	334	35 45	18 31	800	2·9	22·6	"	95·5	1·02396	1·02574	1·02773	
1550	" 16	335	32 24	13 5	25	21·0	23·2	00 V.	9	1·02451	1·02650	1·02512	Tristan d'Acunha Islands to Ascension.
1551	" 16				50	17·8	22·8	"	10	1·02457	1·02645	1·02591	
1552	" 16				100	15·2	23·0	"	7	1·02440	1·02633	1·02641	
1553	" 16				200	11·9	22·9	"	4	1·02424	1·02612	1·02687	
1554	" 16				300	8·9	22·8	00 IV.	93	1·02383	1·02568	1·02694	
1555	" 16				400	6·1	21·0	"	83·5	1·02338	1·02603	1·02767	
1556	" 16				800	2·8	22·8	00 V.	9	1·02451	1·02638	1·02843	
1560	" 18	336	27 54	13 13	25	21·6	24·2	"	8	1·02442	1·02670	1·02532	
1561	" 18				50	18·3	23·8	"	7	1·02437	1·02653	1·02587	
1562	" 18				100	15·4	23·9	00 IV.	90	1·02413	1·02632	1·02656	
1563	" 18				200	11·1	24·1	"	92	1·02374	1·02596	1·02686	
1564	" 18				300	7·8	24·0	"	91·5	1·02370	1·02589	1·02731	
1565	" 18				400	5·4	24·2	"	85·5	1·02339	1·02561	1·02734	
1566	" 18				800	3·3	24·3	"	80	1·02357	1·02555	1·02779	
1569	" 19	337	24 33	13 36	25	22·2	24·9	00 V.	11·5	1·02459	1·02707	1·02536	
1570	" 19				50	20·1	24·8	"	3	1·02413	1·02656	1·02545	
1571	" 19				100	17·2	24·8	00 IV.	90	1·02419	1·02649	1·02611	

VI. *Water from Intermediate Depths in the South Atlantic*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
1575	1876. Mar. 21	338	21 15	14 2	25	24·1	24·9	00 V.	14	1·02472	1·02720	1·02495	Tristan d'Acunha Islands to Ascension.
1576	„ 21				50	21·9	23·7	00 IV. + 0·2g.	90·5	1·02491	1·02704	1·02541	
1577	„ 21				100	17·2	24·9	00 V.	4	1·02418	1·02666	1·02628	
1578	„ 21				200	9·9	25·0	00 IV.	88	1·02346	1·02594	1·02705	
1579	„ 21				300	6·1	25·0	00 V.	0	1·02396	1·02647	1·02815	
1580	„ 21				400	3·8	25·0	00 IV.	98	1·02403	1·02654	1·02848	
1583	„ 23	339	17 26	13 52	25	23·8	24·9	00 V.	13	1·02467	1·02715	1·02499	
1584	„ 23				50	21·1	25·2	„	8	1·02440	1·02697	1·02557	
1585	„ 23				100	15·4	25·1	00 IV.	95	1·02385	1·02639	1·02643	
1586	„ 23				200	9·4	24·9	„	86	1·02337	1·02582	1·02701	
1587	„ 23				300	6·1	24·9	„	82	1·02314	1·02559	1·02724	
1588	„ 23				400	4·8	25·1	„	81	1·02309	1·02560	1·02744	
1591	„ 24	340	14 33	13 42	25	24·4	25·3	00 V.	13·5	1·02470	1·02730	1·02496	
1592	„ 24				50	22·4	25·1	„	13·5	1·02471	1·02725	1·02549	
1593	„ 24				100	14·9	24·8	00 IV.	95·5	1·02390	1·02635	1·02650	
1594	„ 24				200	8·8	24·9	00 V.	10	1·02483	1·02731	1·02869	
1595	„ 24				300	5·5	24·9	00 IV.	85	1·02330	1·02575	1·02746	
1596	„ 24				400	4·4	24·9	„	95·5	1·02389	1·02637	1·02825	
1597	„ 24				800	3·8	25·0	„	82	1·02314	1·02562	1·02751	
1600	„ 25	341	12 16	13 44	25	25·2	26·4	00 V.	4	1·02418	1·02706	1·02449	
1601	„ 25				50	21·9	26·1	„	7	1·02431	1·02715	1·02552	
1602	„ 25				115	12·6	26·0	00 IV.	85	1·02328	1·02606	1·02668	
1603	„ 25				200	8·3	25·9	„	84	1·02323	1·02598	1·02733	
1604	„ 25				300	5·9	25·9	„	87·5	1·02342	1·02617	1·02784	
1605	„ 25				400	4·6	26·0	„	76·5	1·02282	1·02560	1·02741	
1606	„ 25				800	2·8	26·0	„	77	1·02285	1·02563	1·02752	
1609	„ 26	342	9 43	13 51	25	26·3	26·6	00 V.	3	1·02408	1·02708	1·02418	
1610	„ 26				50	21·9	26·6	00 IV.	86	1·02388	1·02688	1·02525	
1611	„ 26				100	12·4	26·3	„	82	1·02312	1·02599	1·02665	
1612	„ 26				200	8·8	26·4	„	84	1·02322	1·02612	1·02740	
1613	„ 26				300	6·9	26·4	„	82	1·02312	1·02602	1·02756	
1614	„ 26				400	5·6	26·4	„	75·5	1·02274	1·02564	1·02732	
1615	„ 26				900	3·5	26·4	„	79·5	1·02299	1·02589	1·02781	
1621	April 4	345	5 45	14 25	25	27·1	27·7	„	85·5	1·02326	1·02659	1·02344	Ascension to Cape Verde Islands.
1622	„ 4				50	22·0	28·0	„	87	1·02332	1·02675	1·02510	
1623	„ 4				100	11·5	27·6	„	75	1·02269	1·02596	1·02679	
1624	„ 4				200	8·3	27·6	„	71	1·02248	1·02575	1·02710	
1625	„ 4				300	6·5	27·6	„	69	1·02237	1·02564	1·02723	
1626	„ 4				400	5·5	27·7	„	69	1·02237	1·02567	1·02738	
1627	„ 4				1525	3·1	27·8	„	70·5	1·02244	1·02577	1·02773	
1631	„ 6	346	2 42	14 41	25	21·9	27·8	„	80	1·02296	1·02633	1·02470	
1632	„ 6				50	13·6	27·9	„	76	1·02274	1·02614	1·02656	
1633	„ 6				100	12·9	27·8	„	77	1·02281	1·02618	1·02675	
1634	„ 6				200	9·3	27·8	„	75	1·02269	1·02602	1·02722	
1635	„ 6				300	6·3	27·7	„	69·5	1·02240	1·02570	1·02732	
1636	„ 6				400	4·9	27·8	„	66·5	1·02223	1·02556	1·02734	
1637	„ 6				800	4·0	27·9	„	73	1·02258	1·02594	1·02782	
1638	„ 6				1875	2·5	27·9	„	73	1·02256	1·02591	1·02791	
1641	„ 7	347	0 15	14 25	25	24·4	27·8	„	88·5	1·02343	1·02664	1·02430	
1642	„ 7				50	18·4	27·3	„	93	1·02369	1·02690	1·02621	
1643	„ 7				100	14·4	27·0	„	80·5	1·02300	1·02609	1·02634	
1644	„ 7				300	6·7	26·9	„	73	1·02260	1·02565	1·02722	
1645	„ 7				1500	3·3	27·0	„	78	1·02288	1·02595	1·02789	

VII. *Surface Water of the Southern Part of the Indian Ocean.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D.	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1873.		S.	E.									
325	Dec. 18	...	33° 20′	18° 40′	Surface.	19°·3	20°·4	00 V.	24·5	1·02544	1·02665	1·02579	Cape of Good Hope to Kerguelen Island.
†*327	,, 19	143	36 48	19 24	,,	22·8	23·4	,,	9	1·02452	1·02657	1·02470	
334	,, 20	...	38 6	19 53	,,	22·2	23·0	,,	7	1·02442	1·02635	1·02468	
335	,, 20	...	38 37	20 27	,,	19·4	20·8	,,	20	1·02520	1·02652	1·02557	
336	,, 21	...	40 24	22 45	,,	16·0	17·7	,,	29·5	1·02579	1·02630	1·02622	
337	,, 21	...	40 57	24 3	,,	15·6	17·3	,,	31	1·02589	1·02630	1·02632	
338	,, 22	...	42 21	27 58	,,	12·2	14·0	,,	36	1·02620	1·02593	1·02650	
339	,, 23	...	44 31	31 15	,,	7·8	9·2	,,	39	1·02656	1·02534	1·02677	
340	,, 23	...	45 11	32 24	,,	6·9	9·6	,,	37	1·02644	1·02529	1·02682	
†*341	,, 24	144	45 57	34 39	,,	6·1	7·0	,,	39	1·02661	1·02516	1·02680	
347	,, 25	...	46 28	36 43	,,	5·5	8·8	,,	35	1·02635	1·02507	1·02680	
348	,, 25	...	46 42	37 20	,,	4·3	8·7	,,	35·5	1·02638	1·02509	1·02692	
349	,, 27	145a	46 41	38 10	,,	5·3	7·3	,,	39·5	1·02664	1·02515	1·02690	
350	,, 28	...	46 47	40 13	,,	5·0	10·0	,,	34	1·02627	1·02518	1·02695	
351	,, 28	...	46 47	41 50	,,	6·1	7·3	,,	39	1·02655	1·02506	1·02671	
*352	,, 29	146	46 46	45 31	,,	6·1	10·0	,,	33	1·02621	1·02512	1·02675	
†*354	,, 30	147	46 16	48 27	,,	5·0	9·8	,,	35	1·02627	1·02515	1·02692	
360	,, 31	...	46 8	48 40	,,	5·8	7·5	,,	36·5	1·02647	1·02501	1·02669	
361	,, 31	...	46 24	50 27	,,	5·3	10·1	,,	31·5	1·02613	1·02506	1·02680	
	1874.												
362	Jan. 1	...	46 40	50 43	,,	5·5	6·8	,,	38·5	1·02659	1·02508	1·02676	
363	,, 2	...	46 41	51 12	,,	4·5	9·1	,,	32	1·02618	1·02495	1·02702	
364	,, 3	148a	46 53	51 52	,,	5·0	9·4	,,	33	1·02623	1·02504	1·02683	
365	,, 4	...	47 8	56 22	,,	6·0	6·3	,,	37	1·02654	1·02492	1·02658	
366	,, 5	...	47 41	61 38	,,	4·7	6·3	,,	40	1·02670	1·02508	1·02690	
367	,, 6	...	48 32	66 50	,,	3·9	6·2	,,	39·5	1·02660	1·02497	1·02687	
368	,, 8	...	48 50	69 48	,,	4·3	5·5	,,	41	1·02671	1·02500	1·02686	At Kerguelen.
369	,, 27	...	48 46	69 50	,,	5·4	7·0	,,	44	1·02690	1·02537	1·02712	
370	Feb. 2	...	52 22	71 28	,,	3·0	10·6	,,	32	1·02614	1·02515	1·02711	Kerguelen Island to Heard Island.
371	,, 3	...	52 24	72 11	,,	3·2	8·9	,,	37	1·02646	1·02520	1·02717	
372	,, 4	...	52 29	71 34	,,	3·3	4·4	,,	41	1·02679	1·02496	1·02691	
373	,, 5	...	53 11	71 48	,,	2·8	6·0	,,	38·5	1·02661	1·02495	1·02695	
374	,, 7	...	53 17	73 15	,,	2·8	7·9	,,	38·5	1·02658	1·02515	1·02710	Heard Island to the Antarctic Circle.
375	,, 8	...	55 28	74 37	,,	1·7	7·9	,,	37	1·02649	1·02508	1·02717	
376	,, 9	...	58 2	75 57	,,	1·1	2·9	,,	44·5	1·02703	1·02506	1·02718	
377	,, 10	...	60 12	77 34	,,	1·1	3·7	,,	39·5	1·02672	1·02482	1·02693	
*379	,, 11	152	60 52	80 20	,,	1·4	3·1	,,	45·5	1·02708	1·02512	1·02721	
380	,, 12	...	62 22	80 4	,,	1·1	3·1	,,	40·5	1·02681	1·02485	1·02696	
381	,, 12	...	63 0	80 0	,,	1·1	8·0	,,	33·5	1·02630	1·02490	1·02703	
382	,, 13	...	64 2	79 55	,,	0·7	2·7	,,	40·5	1·02682	1·02483	1·02697	
*384	,, 14	153	65 42	79 49	,,	−1·1	1·0	,,	29	1·02624	1·02413	1·02652	
385	,, 15	...	66 4	78 24	,,	−0·7	3·0	,,	40	1·02678	1·02481	1·02701	
386	,, 16	...	66 29	78 18	,,	−0·7	5·3	,,	28·5	1·02611	1·02437	1·02658	
387	,, 17	...	65 10	78 42	,,	0·7	3·1	,,	41	1·02684	1·02488	1·02702	The Antarctic Circle to Melbourne.
388	,, 17	...	64 57	79 30	,,	0·5	3·3	,,	42	1·02607	1·02413	1·02628	
389	,, 18	...	64 52	83 12	,,	−1·7	0·3	,,	29	1·02627	1·02413	1·02634	
390	,, 19	...	65 0	86 3	,,	0	2·5	,,	36	1·02658	1·02458	1·02672	
396	,, 20	...	64 1	87 41	,,	0·4	2·8	,,	40	1·02678	1·02480	1·02695	
398	,, 21	...	63 30	89 10	,,	0·3	1·4	,,	44	1·02708	1·02495	1·02720	
399	,, 22	...	63 30	90 47	,,	0·8	2·7	,,	43·5	1·02699	1·02500	1·02713	
400	,, 25	...	63 49	94 51	,,	−0·3	0·9	,,	43·5	1·02703	1·02492	1·02709	
†*401	,, 26	156	62 26	95 44	,,	0·6	2·5	,,	45	1·02708	1·02508	1·02721	
407	,, 27	...	61 30	97 56	,,	1·1	6·2	,,	41	1·02675	1·02512	1·02724	
408	,, 28	...	59 20	100 14	,,	1·4	5·8	,,	41	1·02676	1·02508	1·02718	
409	Mar. 1	...	57 39	102 36	,,	1·7	5·9	,,	41	1·02676	1·02509	1·02717	
410	,, 2	...	55 40	105 31	,,	3·2	4·5	,,	41·5	1·02683	1·02501	1·02697	
†*411	,, 3	157	53 55	108 35	,,	2·9	5·3	,,	42	1·02683	1·02509	1·02708	

VII. *Surface Water of the Southern Part of the Indian Ocean*—continued.

Number of Sample.	Date.		Corresponding Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (Distilled Water at 4° C. = 1.)			
				Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D	T	t		R	S_t	$S_{15·56}$	S_T	
	1874.			S.	E.									
415	Mar.	4	...	53° 13′	109° 23′	Surface.	4°·3	6°·6	00 V.	40	1·02569	1·02511	1·02686	The Antarctic Circle to Melbourne.
416	„	5	...	52 14	112 25	„	4·2	5·6	„	42	1·02582	1·02512	1·02697	
417	„	6	...	50 54	118 3	„	7·2	9·2	„	36	1·02640	1·02518	1·02668	
†*418	„	7	158	50 1	123 4	„	7·2	9·1	„	37	1·02645	1·02522	1·02672	
424	„	8	...	49 26	126 43	„	9·2	10·5	„	37	1·02642	1·02542	1·02664	
425	„	9	...	48 34	129 58	„	10·3	10·9	„	40·5	1·02659	1·02566	1·02670	
426	„	9	...	48 12	130 7	„	10·7	11·8	„	39	1·02648	1·02572	1·02670	
*427	„	10	159	47 23	130 32	„	10·6	11·4	„	39	1·02650	1·02566	1·02665	
429	„	11	...	46 50	129 43	„	11·2	12·7	„	34·5	1·02621	1·02561	1·02648	
430	„	11	...	46 37	129 56	„	11·2	12·5	„	36·5	1·02633	1·02569	1·02657	
431	„	12	...	45 1	131 45	„	11·2	12·6	„	37·5	1·02638	1·02580	1·02663	
432	„	12	...	44 7	132 34	„	12·5	13·6	„	36	1·02627	1·02585	1·02650	
†*433	„	13	160	42 42	134 10	„	12·8	13·1	„	35	1·02623	1·02570	1·02627	
440	„	14	...	41 20	136 38	„	14·2	14·8	„	33	1·02608	1·02591	1·02621	
441	„	14	...	40 53	137 43	„	14·7	15·2	„	34	1·02613	1·02603	1·02623	
442	„	15	...	39 45	140 40	„	15·7	16·3	„	34	1·02609	1·02625	1·02622	
443	„	16	...	39 24	142 19	„	15·7	16·6	„	33	1·02607	1·02631	1·02623	
444	Apr.	1	...	38 15	145 0	„	17·8	19·2	„	12	1·02480	1·02568	1·02518	Melbourne towards Sydney.
445	„	2	...	39 8	146 44	„	17·2	18·4	„	22·5	1·02563	1·02632	1·02593	
446	„	3	...	38 20	148 37	„	18·9	19·1	„	24·9	1·02549	1·02636	1·02556	
447	„	3	...	37 36	150 0	„	18·4	18·7	„	23	1·02542	1·02618	1·02551	

VIII. *Bottom Water of the Southern Part of the Indian Ocean.*

	1873.													
336	Dec.	18	142	35 4	18 37	150	8·3	20·1	00 V.	24	1·02545	1·02658	1·02796	Cape of Good Hope to Kerguelen Is.
†*338	„	19	143	36 48	19 24	1900	2·0	21·1	„	10·5	1·02468	1·02607	1·02811	
†*340	„	24	144	45 57	34 39	1570	2·1	9·1	00 IV. + 0·5g.	77·5	1·02648	1·02525	1·02729	
*353	„	29	146	46 46	45 31	1375	2·0	9·0	00 V.	47	1·02680	1·02555	1·02759	
†*358	„	30	147	46 16	48 27	1600	1·2	8·7	„	43	1·02679	1·02550	1·02759	
	1874.													
*378	Feb.	11	152	60 52	80 20	1260	...	4·8	„	52	1·02740	1·02561	...	Heard Island to Antarctic Circle.
*382	„	14	153	65 42	79 49	1675	...	7·8	„	49	1·02716	1·02567	...	
†395	„	19	154	64 37	85 49	1800	...	8·0	00 IV. + 0·4g.	92	1·02680	1·02529	...	The Antarctic Circle to Melbourne.
†*406	„	26	156	62 26	95 44	1975	...	3·9	00 V.	45	1·02703	1·02515	...	
†*414	Mar.	3	157	53 55	108 35	1950	0	6·0	00 IV. + 0·5g.	90	1·02727	1·02561	1·02776	
†*423	„	7	158	50 1	123 4	1800	0·6	10·2	00 V.	40	1·02659	1·02554	1·02766	
*428	„	10	159	47 25	130 32	2150	1·2	13·6	„	32	1·02606	1·02564	1·02773	
†*439	„	13	160	42 42	134 10	2600	1·1	13·4	„	34	1·02616	1·02579	1·02780	

IX. *Water from Intermediate Depths in the Southern Part of the Indian Ocean.*

	1873.													
328	Dec.	19	143	36 48	19 24	50	15·3	21·0	00 V.	15	1·02491	1·02629	1·02635	Cape of Good Hope to Kerguelen Is.
329	„	19				100	11·4	21·5	„	10·5	1·02466	1·02615	1·02700	
330	„	19				200	7·9	20·9	„	9	1·02460	1·02598	1·02734	
331	„	19				300	6·1	20·1	„	8·5	1·02480	1·02572	1·02737	
332	„	19				400	4·9	20·8	„	7	1·02448	1·02579	1·02757	

IX. *Water at Intermediate Depths in the Southern Part of the Indian Ocean*—continued.

Number of Sample.	Date.	Corresponding Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (Distilled Water at 4° C.=1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at 4° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_4	
			S.	E.									
	1873.		° ′	° ′		°	°						
342	Dec. 24	144	45 57	34 39	100	5·3	8·4	00 V.	37	1·02655	1·02524	1·02698	Cape of Good Hope to Kerguelen Is.
343	,, 24				200	3·6	8·7	,,	40	1·02662	1·02528	1·02724	
344	,, 24				300	3·3	8·0	,,	39·5	1·02658	1·02532	1·02726	
345	,, 24				400	3·2	9·3	,,	39·5	1·02657	1·02537	1·02732	
355	,, 30	147	46 16	48 27	100	3·0	8·7	,,	33	1·02641	1·02512	1·02700	
356	,, 30				200	2·5	8·2	,,	41·5	1·02672	1·02535	1·02733	
357	,, 30				300	2·6	8·3	,,	41	1·02669	1·02534	1·02734	
358	,, 30				400	2·4	8·5	,,	41	1·02668	1·02536	1·02737	
	1874.												
391	Feb. 19	154	64 37	85 49	50	−1·5	3·9	,,	48·5	1·02722	1·02534	1·02759	The Antarctic Circle towards Melbourne.
392	,, 19				140	−1·5	2·8	,,	52	1·02745	1·02547	1·02766	
393	,, 19				300	1·0	2·9	,,	54	1·02755	1·02556	1·02769	
394	,, 19				400	1·0	3·0	,,	54	1·02753	1·02562	1·02773	
402	,, 26	156	62 26	95 44	100	0	3·9	,,	53·5	1·02749	1·02561	1·02776	
403	,, 26				200	1·1	4·0	,,	54	1·02753	1·02565	1·02775	
404	,, 26				300	...	3·9	,,	54	1·02752	1·02565	....	
405	,, 26				400	...	4·4	,,	53·5	1·02738	1·02555	....	
412	Mar. 3	157	53 55	108 35	50	2·5	6·8	,,	39	1·02663	1·02507	1·02707	
413	,, 3				100	0·2	8·0	,,	46	1·02703	1·02537	1·02751	
419	,, 7	158	50 1	123 4	50	6·9	10·3	,,	34	1·02629	1·02522	1·02670	
420	,, 7				100	6·3	10·3	,,	38	1·02648	1·02544	1·02700	
421	,, 7				200	5·2	10·6	,,	38	1·02647	1·02548	1·02723	
422	,, 7				315	4·0	10·4	,,	38	1·02648	1·02546	1·02734	
434	,, 13	160	42 42	134 10	50	11·0	13·8	,,	23·5	1·02613	1·02570	1·02668	
435	,, 13				100	9·2	13·7	,,	23	1·02605	1·02565	1·02687	
436	,, 13				200	8·7	13·5	,,	24	1·02617	1·02573	1·02702	
437	,, 13				300	8·4	13·5	,,	22·5	1·02604	1·02560	1·02694	
438	,, 13				400	7·2	13·7	,,	30·5	1·02597	1·02557	1·02707	

X. *The Surface Water of the South Pacific Ocean.*

*448	Apr. 4	163	36 57	150 34	Surface.	22·2	21·0	00 V.	19	1·02514	1·02652	1·02480	Melbourne to Sydney.
450	,, 5	...	35 54	150 16	,,	21·2	21·8	00 IV.	87	1·02352	1·02510	1·02370	
451	June 12	163A	33 55	151 25	,,	19·7	19·9	00 V.	22·5	1·02536	1·02644	1·02541	From Sydney, N.S.W., to Wellington, New Zealand.
452	,, 12	164	34 8	152 0	,,	20·2	20·0	,,	19	1·02515	1·02630	1·02518	
453	,, 13	164B	34 13	151 38	,,	20·5	19·6	,,	22·5	1·02536	1·02636	1·02512	
454	,, 15	...	34 6	155 12	,,	17·1	17·2	,,	32·5	1·02600	1·02641	1·02605	
†455	,, 16	164C	34 27	154 57	,,	17·5	17·9	,,	31	1·02589	1·02644	1·02600	
†*460	,, 17	165	34 50	155 28	,,	18·0	18·6	,,	27	1·02564	1·02638	1·02579	
463	,, 18	...	34 53	156 38	,,	18·0	18·2	,,	28	1·02571	1·02637	1·02580	
465	,, 19	...	36 30	157 55	,,	17·3	17·4	,,	32	1·02594	1·02637	1·02596	
471	,, 20	...	37 2	160 48	,,	15·6	16·5	,,	37	1·02625	1·02647	1·02646	
472	,, 21	...	37 58	163 35	,,	15·3	16·9	,,	34·5	1·02596	1·02616	1·02626	
474	,, 22	...	38 41	166 9	,,	14·5	15·5	,,	33	1·02616	1·02614	1·02638	
*476	,, 23	166	38 50	169 20	,,	14·7	16·0	,,	33	1·02615	1·02625	1·02644	
478	,, 24	...	39 38	171 58	,,	14·6	15·2	,,	36·5	1·02625	1·02617	1·02639	
479	,, 25	...	40 46	173 55	,,	13·0	13·8	,,	37	1·02633	1·02596	1·02649	
480	,, 26	...	40 41	173 52	,,	12·2	12·7	,,	43	1·02668	1·02608	1·02674	
481	,, 27	...	41 12	174 35	,,	10·7	12·5	,,	41	1·02657	1·02593	1·02691	
482	July 7	...	41 29	174 55	,,	11·1	12·2	,,	39	1·02648	1·02581	1·02669	Wellington to Tongatabu.
483	,, 7	...	41 30	175 50	,,	11·4	13·5	,,	36·5	1·02630	1·02580	1·02671	
*484	,, 8	168	40 28	177 43	,,	14·0	13·2	,,	37·5	1·02630	1·02622	1·02654	
486	,, 9	...	39 18	178 30	,,	14·0	14·7	,,	40	1·02646	1·02627	1·02681	
487	,, 9	...	38 22	178 53	,,	14·7	15·3	,,	33	1·02649	1·02643	1·02682	
488	,, 10	...	37 13	179 45	,,	15·0	16·1	,,	36·5	1·02623	1·02626	1·02649	

X. *The Surface Water of the South Pacific Ocean*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (Distilled Water at 4° C. = 1.)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1874.		S. ° ′	W. ° ′		°	°						
493	July 11	....	36 4	178 21	Surface.	14·4	15·4	00 V.	36	1·02622	1·02618	1·02644	From Wellington, New Zealand, to Tongatabu.
494	,, 11	....	35 58	178 48	,,	14·5	15·4	,,	34·5	1·02614	1·02610	1·02635	
495	,, 12	....	34 0	178 8	,,	16·9	17·2	,,	32	1·02596	1·02634	1·02603	
496	,, 13	....	31 47	177 34	,,	17·6	17·7	,,	29	1·02577	1·02628	1·02580	
497	,, 13	....	31 23	177 48	,,	17·8	18·7	,,	29·5	1·02578	1·02655	1·02601	
498	,, 13	....	31 3	178 3	,,	18·0	18·7	,,	26·5	1·02561	1·02638	1·02579	
†499	,, 14	170A	29 45	178 11	,,	18·4	19·3	,,	25	1·02552	1·02644	1·02576	
504	,, 15	....	28 25	177 33	,,	19·4	22·8 20·5	,,	17 27·5	1·02497 1·02561	1·02655 1·02685	1·02591	
505	,, 16	....	26 48	175 0	,,	21·7	22·2	,,	12	1·02471	1·02642	1·02485	
506	,, 16	....	26 7	174 0	,,	21·7	22·7	,,	9	1·02454	1·02639	1·02482	
†*507	,, 17	171A	25 5	172 56	,,	22·2	22·8	,,	9	1·02454	1·02642	1·02472	
512	,, 18	....	23 18	173 26	,,	21·9	22·4	,,	13·5	1·02479	1·02655	1·02492	
513	,, 18	....	22 33	173 58	,,	22·3	22·9	,,	9	1·02453	1·02643	1·02469	
514	,, 22	....	20 56	175 30	,,	23·6	23·9	,,	4	1·02421	1·02640	1·02439	Tongatabu to Fiji Islands.
515	,, 23	....	20 9	174 47	,,	24·5	23·4	,,	8	1·02447	1·02652	1·02416	
516	,, 23	....	19 55	178 35	,,	23·9	24·5	,,	2·5	1·02413	1·02649	1·02430	
			S.	E.									
517	,, 24	....	19 11	179 40	,,	24·7	25·1	00 IV.	95	1·02388	1·02642	1·02400	
518	,, 25	....	19 7	178 18	,,	24·7	25·1	,,	97	1·02398	1·02652	1·02410	
519	,, 28	....	18 4	178 56	,,	25·0	25·8	,,	97	1·02399	1·02659	1·02408	
520	Aug. 11	....	19 10	177 38	,,	25·8	26·5	,,	90	1·02356	1·02652	1·02377	Fiji Islands to Cape York, Australia.
†*521	,, 12	175	19 2	177 10	,,	25·8	26·2	,,	90·5	1·02360	1·02647	1·02387	
525	,, 13	....	19 1	175 53	,,	25·4	26·1	,,	88·5	1·02348	1·02632	1·02369	
526	,, 14	....	18 56	174 57	,,	25·7	26·8	,,	87	1·02339	1·02645	1·02377	
*527	,, 15	176	18 30	173 52	,,	25·3	25·4	,,	92·5	1·02373	1·02636	1·02376	
528	,, 15	....	18 29	173 40	,,	25·5	26·0	,,	89	1·02351	1·02632	1·02366	
530	,, 16	....	18 8	171 51	,,	26·1	26·9	,,	80·5	1·02304	1·02609	1·02329	
531	,, 16	....	17 54	171 24	,,	26·7	27·0	,,	82·5	1·02313	1·02625	1·02322	
532	,, 17	....	17 25	169 5	,,	25·1	25·9	,,	90	1·02358	1·02636	1·02382	
533	,, 17	....	17 20	168 30	,,	25·3	26·0	,,	88·5	1·02349	1·02630	1·02370	
534	,, 18	....	16 50	168 0	,,	25·8	26·5	,,	85	1.02328	1·02624	1·02350	
535	,, 19	....	16 51	165 45	,,	26·1	26·4	,,	85	1·02328	1·02621	1·02339	
539	,, 20	....	16 32	163 12	,,	25·9	26·2	,,	95	1·02385	1·02672	1·02394	
540	,, 20	....	16 24	162 34	,,	25·4	26·3	,,	87	1·02340	1·02630	1·02367	
541	,, 21	....	16 2	161 3	,,	25·5	26·1	,,	88·5	1·02348	1·02632	1·02366	
547	,, 21	....	15 57	160 42	,,	25·8	26·1	,,	89	1·02352	1·02636	1·02361	
548	,, 22	....	15 28	159 15	,,	26·1	26·0	,,	89·5	1·02355	1·02636	1·02357	
549	,, 22	....	15 9	158 19	,,	25·9	26·4	,,	87·5	1·02342	1·02635	1·02357	
550	,, 23	....	14 44	155 53	,,	26·1	26·4	,,	87·5	1·02342	1.02635	1·02351	
551	,, 24	....	14 4	153 33	,,	26·6	27·3	,,	79	1·02298	1·02611	1·02314	
*557	,, 25	181	13 50	151 49	,,	26·7	26·5	,,	89·5	1·02353	1·02649	1·02348	
559	,, 26	....	13 30	150 53	,,	26·1	26·4	,,	86·5	1·02336	1·02629	1·02345	
*560	,, 27	182	13 6	148 37	,,	25·8	26·1	,,	86	1·02335	1·02619	1·02344	
†*562	,, 28	183	12 42	146 46	,,	25·5	26·0	,,	88·5	1·02349	1·02630	1·02364	
*568	,, 29	184	12 8	145 10	,,	25·3	26·1	,,	88	1·02346	1·02630	1·02373	
570	,, 30	....	11 37	144 8	,,	25·3	25·8	,,	89·5	1·02356	1·02631	1·02371	
571	,, 31	....	11 52	143 35	,,	25·3	25·3	,,	93·5	1·02379	1·02639	1·02379	
572	Sept. 1	....	11 37	142 59	,,	25·0	25·0	,,	98·5	1.02407	1·02658	1·02407	
	1875.												
†701	Feb. 21	....	0 4	138 22	,,	27·3	27·0	,,	61·5	1·02198	1·02507	1·02191	Meangis Islands to Admiralty Islands.
706	,, 21	....	0 5	138 22	,,	28·0	28·3	,,	57	1·02169	1·02518	1·02179	
†*707	,, 22	217	0 30	138 55	,,	28·3	28·1	,,	58	1·02175	1·02516	1·02169	
718	,, 22	....	0 45	139 8	,,	30·8	29·9	,,	55	1·02154	1·02554	1·02119	
719	,, 23	....	1 38	140 11	,,	27·8	27·2	,,	42	1·02090	1·02405	1·02071	
720	,, 25	....	2 14	141 20	,,	28·3	28·4	,,	65	1·02213	1·02565	1·02217	
721	,, 26	....	2 2	142 19	,,	28·8	28·8	,,	64	1·02206	1·02571	1·02206	
722	,, 27	....	1 58	143 21	,,	28·6	28·5	,,	66	1·02218	1·02573	1·02216	
723	,, 28	....	2 30	143 55	,,	28·8	28·3	,,	68	1·02230	1·02576	1·02213	

X. *Surface Water of the South Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
						D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1875.			S.	E.									
724	Mar.	1	...	2° 30′	144° 7′	Surface.	28°·8	29°·2	00 IV.	59·5	1·02186	1·02564	1·02199	Manngle Islands to Admiralty Islands.
733	,,	2	...	1 52	154 24	,,	28·8	28·2	,,	67	1·02224	1·02570	1·02204	
734	,,	3	...	1 53	146 36	,,	28·4	28·2	,,	66	1·02219	1·02565	1·02213	
735	,,	10	219	1 54	146 40	,,	28·9	28·7	,,	64·5	1·02209	1·02571	1·02203	Admiralty Islands to Japan.
†*736	,,	11	220	0 42	147 0	,,	28·9	27·8	,,	71	1·02247	1·02580	1·02212	
				S.	W.									
†*1118	Sept.	6	271	0 33	151 34	,,	25·9	25·9	,,	94·5	1·02383	1·02661	1·02383	Sandwich Islands to Tahiti.
1126	,,	7	...	2 33	152 34	,,	25·5	25·9	,,	91	1·02364	1·02642	1·02376	
†*1127	,,	8	272	3 48	152 56	,,	26·1	26·0	,,	92	1·02369	1·02650	1·02366	
1137	,,	9	...	5 7	152 56	,,	26·4	26·2	,,	89	1·02351	1·02638	1·02346	
1139	,,	10	...	6 26	152 26	,,	26·7	26·6	,,	90	1·02356	1·02656	1·02352	
*1140	,,	11	274	7 25	152 15	,,	26·8	26·6	,,	90	1·02356	1·02656	1·02350	
1142	,,	12	...	8 30	151 55	,,	26·7	26·8	,,	80	1·02300	1·02587	1·02297	
†*1143	,,	14	275	11 20	150 30	,,	26·7	26·6	,,	94	1·02378	1·02678	1·02375	
1146	,,	15	...	12 30	150 0	,,	26·4	26·5	,,	94·5	1·02380	1·02676	1·02383	
†*1147	,,	16	276	13 28	149 30	,,	26·7	26·1	,,	92	1·02344	1·02628	1·02326	
†*1158	,,	18	278	17 12	149 48	,,	26·4	25·8	00 V.	5	1·02421	1·02696	1·02403	
1166	Oct.	3	...	17 28	149 41	,,	25·5	25·4	,,	10	1·02451	1·02714	1·02448	Tahiti to Valparaiso.
†*1167	,,	4	280	18 40	149 52	,,	25·1	24·8	,,	12	1·02462	1·02707	1·02453	
1176	,,	5	...	21 10	150 11	,,	24·2	24·7	,,	10	1·02433	1·02695	1·02457	
†*1177	,,	6	281	22 21	150 17	,,	23·6	24·0	,,	9	1·02443	1·02670	1·02460	
†*1187	,,	7	282	23 46	149 59	,,	22·9	22·8	,,	18	1·02502	1·02676	1·02486	
1190	,,	8	...	24 46	147 58	,,	21·9	21·9	,,	19	1·02512	1·02658	1·02495	
†*1191	,,	9	283	26 9	145 17	,,	20·3	20·8	,,	17	1·02501	1·02633	1·02514	
1200	,,	10	...	27 39	142 47	,,	20·4	20·2	,,	18·5	1·02511	1·02630	1·02514	
†*1201	,,	11	284	28 22	141 22	,,	20·0	21·2	,,	15	1·02488	1·02631	1·02520	
1211	,,	12	...	29 25	140 23	,,	19·5	20·6	,,	21·5	1·02527	1·02654	1·02556	
1212	,,	13	...	30 50	139 13	,,	18·9	20·3	,,	18	1·02508	1·02627	1·02545	
†*1218	,,	14	285	32 36	137 43	,,	18·3	18·4	,,	25	1·02553	1·02621	1·02558	
1222	,,	15	...	33 10	135 6	,,	16·7	16·9	,,	26	1·02562	1·02592	1·02565	
†*1223	,,	16	286	33 29	133 22	,,	17·2	18·2	,,	23·5	1·02545	1·02608	1·02571	
1233	,,	17	...	34 3	131 35	,,	15·5	15·9	,,	26·5	1·02567	1·02575	1·02580	
1234	,,	18	...	36 15	132 22	,,	14·7	15·2	,,	31	1·02595	1·02587	1·02605	
†*1235	,,	19	287	36 32	132 52	,,	14·3	15·5	,,	30	1·02588	1·02586	1·02613	
†*1243	,,	21	288	40 3	132 58	,,	12·5	14·1	,,	30	1·02592	1·02561	1·02625	
1246	,,	22	...	40 3	131 32	,,	12·8	13·2	,,	31·5	1·02604	1·02554	1·02611	
†*1247	,,	23	289	39 41	131 23	,,	12·5	13·5	,,	27	1·02577	1·02533	1·02597	
†*1257	,,	25	290	39 16	124 7	,,	11·4	12·5	,,	30	1·02597	1·02533	1·02615	
1260	,,	26	...	39 12	120 40	,,	11·7	12·2	,,	30·5	1·02601	1·02532	1·02611	
†*1261	,,	27	291	39 13	118 49	,,	11·7	13·2	,,	30·5	1·02598	1·02548	1·02629	
1271	,,	28	...	38 56	116 8	,,	11·9	12·2	,,	30	1·02598	1·02529	1·02604	
*1272	,,	29	292	38 43	112 31	,,	11·8	12·1	,,	31	1·02603	1·02532	1·02600	
1275	,,	30	...	38 43	111 5	,,	12·1	13·1	,,	30	1·02595	1·02543	1·02614	
1276	,,	31	...	38 48	107 24	,,	12·5	13·0	,,	27	1·02579	1·02525	1·02591	
†*1277	Nov.	1	293	39 4	105 5	,,	12·1	13·4	,,	25	1·02568	1·02522	1·02595	
1287	,,	2	—	39 10	101 12	,,	12·5	13·8	,,	23·5	1·02558	1·02521	1·02585	
1288	,,	3	...	39 15	98 26	,,	14·2	15·7	,,	17	1·02516	1·02519	1·02542	
1297	,,	4	...	38 37	96 27	,,	13·3	15·9	,,	18	1·02522	1·02530	1·02577	
†*1298	,,	5	295	38 7	94 4	,,	14·7	16·2	,,	18	1·02521	1·02536	1·02554	
1301	,,	6	...	37 55	93 56	,,	14·7	15·7	,,	18	1·02522	1·02525	1·02545	
1302	,,	7	...	37 25	93 36	,,	15·5	16·0	,,	19	1·02528	1·02533	1·02539	
1303	,,	8	...	37 53	90 33	,,	15·0	15·5	,,	20·5	1·02537	1·02535	1·02548	
†*1304	,,	9	296	38 6	88 2	,,	15·4	15·6	,,	20	1·02535	1·02536	1·02538	
1314	,,	10	...	38 19	84 25	,,	13·6	14·2	,,	23·5	1·02556	1·02529	1·02570	
†*1315	,,	11	297	37 29	83 7	,,	13·9	14·7	,,	24·5	1·02561	1·02542	1·02577	
1325	,,	12	...	35 56	81 27	,,	15·3	15·1	,,	22·5	1·02549	1·02539	1·02545	
1326	,,	15	...	33 54	76 22	,,	14·8	15·2	,,	20	1·02538	1·02528	1·02545	
1327	,,	16	...	33 47	75 32	,,	14·7	15·2	,,	22·5	1·02549	1·02541	1·02560	
†*1328	,,	17	298	34 7	73 56	,,	15·0	15·5	,,	20	1·02535	1·02533	1·02546	

X. *Surface Water of the South Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
				Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1875.			S. ° ′	W. ° ′									
1338	Nov.	18	...	34 9	72 36	Surface.	14·4	14·7	00 V.	23	1·02553	1·02534	1·02559	Tahiti to Valparaiso.
1339	,,	18	...	34 9	72 32	,,	14·3	14·9	,,	25·5	1·02566	1·02551	1·02578	
1340	Dec.	11	...	33 0	71 56	,,	16·1	16·6	,,	18	1·02520	1·02544	1·02532	Valparaiso to Strait of Magellan.
1341	,,	12	...	32 33	74 17	,,	17·2	16·7	,,	14	1·02497	1·02523	1·02485	
1342	,,	13	...	33 29	74 24	,,	16·9	17·4	,,	13	1·02490	1·02533	1·02504	
†*1343	,,	14	299	33 31	74 43	,,	16·7	17·1	,,	13·5	1·02494	1·02529	1·02505	
1351	,,	15	...	33 13	76 44	,,	17·2	17·8	,,	12	1·02483	1·02536	1·02503	
†1352	,,	16	...	32 56	77 6	,,	17·5	19·1	,,	7	1·02451	1·02537	1·02494	
†*1354	,,	17	300	33 42	78 18	,,	16·9	17·5	,,	11	1·02481	1·02526	1·02497	
1364	,,	18	...	34 21	79 11	,,	16·5	16·9	,,	14·5	1·02500	1·02530	1·02511	
1365	,,	19	...	35 18	81 49	,,	16·1	16·4	,,	20	1·02532	1·02551	1·02540	
1366	,,	20	...	36 17	83 50	,,	15·5	15·7	,,	10·5	1·02531	1·02534	1·02537	
1367	,,	21	...	36 58	83 40	,,	15·5	15·8	,,	10·5	1·02531	1·02537	1·02537	
†1368	,,	22	301	37 29	84 2	,,	15·3	15·4	,,	21·5	1·02543	1·02539	1·02545	
1374	,,	23	...	38 59	83 53	,,	14·2	14·4	,,	21	1·02542	1·02517	1·02546	
1375	,,	24	...	39 41	86 33	,,	13·9	14·0	,,	23	1·02555	1·02522	1·02557	
1376	,,	25	...	40 35	89 25	,,	14·2	14·3	,,	23	1·02554	1·02527	1·02555	
1377	,,	26	...	41 8	87 40	,,	13·9	14·3	,,	23	1·02554	1·02527	1·02561	
1378	,,	27	...	42 19	84 47	,,	12·7	13·2	,,	24	1·02563	1·02513	1·02573	
†*1379	,,	28	302	42 43	82 11	,,	12·8	13·3	,,	27	1·02579	1·02531	1·02589	
1389	,,	29	...	43 15	80 0	,,	12·5	12·6	,,	26·5	1·02578	1·02516	1·02580	
†*1390	,,	30	303	45 31	78 9	,,	12·7	13·0	,,	23	1·02558	1·02504	1·02544	
1398	,,	31	304	46 53½	75 12	,,	14·0	14·1	00 IV.	78	1·02326	1·02265	1·02327	
	1876.													
1399	Jan.	1	...	47 39	74 49	,,	13·0	13·1	,,	73·5	1·02203	1·02251	1·02305	

XI. *The Bottom Water of the South Pacific.*

Number of Sample.	Date.		Distinguishing Number of Station.	Latitude.	Longitude.	Depth D	T	t	Number of the Instrument.	Reading R	S_t	$S_{15\cdot56}$	S_T	
	1874.			S.	E.									
*449	April	4	163	36 57	150 34	2200	1·4	18·3	00 V.	21·5	1·02536	1·02601	1·02809	Melbourne to Sydney.
†*462	June	17	165	34 50	155 28	2600	1·4	18·0	00 IV. + 0·2 g	99	1·02555	1·02813	1·02821	Sydney to Wellington.
473	,,	21	165b	37 53	163 18	1975	1·5	16·7	00 IV. + 0·3 g	95	1·02599	1·02825	1·02832	
475	,,	22	165c	38 36	166 39	1100	2·4	15·7	00 V.	30·5	1·02591	1·02594	1·02795	
*477	,,	23	166	38 50	169 20	275	10·4	19·5	00 IV. + 0·025 g	97	1·02570	1·02668	1·02772	
*485	July	8	168	40 28	177 43	1100	2·9	15·1	00 V.	30·5	1·02594	1·02584	1·02781	Wellington to Tongatabu.
†492	,,	10	169	37 34	179 22	700	4·4	16·8	,,	26·5	1·02566	1·02594	1·02777	
				S.	W.									
†*511	,,	17	171a	25 5	172 56	2900	1·3	22·0	,,	10	1·02461	1·02826	1·02841	
				S.	E.									
†*524	Aug.	12	175	19 2	177 10	1350	2·2	23·6	,,	4	1·02423	1·02633	1·02842	Tongatabu to Cape York.
*529	,,	15	176	18 30	173 52	1450	2·2	26·0	00 IV.	87	1·02340	1·02621	1·02829	
†546	,,	21	179	15 58	160 48	2325	2·2	26·1	,,	82	1·02313	1·02594	1·02797	
†556	,,	24	180	14 7	153 43	2450	2·2	26·7	,,	80·5	1·02302	1·02661	1·02804	
*558	,,	25	181	13 50	151 49	2440	2·1	24·1	,,	92	1·02360	1·02591	1·02795	
*561	,,	27	182	13 6	148 37	2275	2·1	25·9	,,	81	1·02309	1·02584	1·02788	
†*567	,,	28	183	12 42	146 40	1700	2·2	27·1	,,	77	1·02283	1·02595	1·02798	
*569	,,	29	184	12 8	145 10	1400	2·2	25·6	,,	88	1·02347	1·02613	1·02816	
	1875.													
*†717	Feb.	22	217	0 39	138 55	2000	1·8	28·4	,,	70·5	1·02243	1·02595	1·02801	Meangis Islands to Admiralty Islands.
†732	Mar.	1	218	2 33	144 4	1070	2·4	26·9	,,	74	1·02267	1·02572	1·02773	

XI. *Bottom Water of the South Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at* 4° C. = 1.)			
				Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at *t*° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D	T	*t*		R	S_t	$S_{15·56}$	S_T	
	1875.			S. ° ′	E. ° ′		°	°						
†*738	Mar.	11	220	0 42	147 0	1100	2·3	28·0	00 IV.	66	1·02220	1·02560	1·02762	Admiralty Islands to Japan.
				S.	W.									
†*1125	Sept.	6	271	0 33	151 34	2425	1·7	26·0	,,	81·5	1·02309	1·02587	1·02793	Sandwich Islands to Tahiti.
†*1136	,,	8	272	3 48	152 56	2600	1·7	25·9	,,	96	1·02356	1·02636	1·02848	
†*1145	,,	14	275	11 20	150 30	2610	1·7	26·4	,,	82	1·02312	1·02602	1·02808	
†*1155	,,	19	276	13 28	149 30	2350	1·7	25·1	,,	87	1·02342	1·02593	1·02799	
†1157	,,	17	277	15 51	149 41	2325	1·7	24·7	,,	86·5	1·02341	1·02581	1·02787	
†*1165	,,	18	278	17 12	149 43	1525	2·5	24·6	,,	84	1·02328	1·02565	1·02765	
†*1175	Oct.	4	280	18 40	149 52	1940	1·8	24·5	,,	96	1·02394	1·02630	1·02842	Tahiti to Valparaiso.
†*1186	,,	6	281	22 21	150 17	2385	1·6	23·9	,,	98·5	1·02409	1·02628	1·02841	
†*1189	,,	7	282	23 46	149 59	2450	1·7	22·2	,,	98·5	1·02413	1·02582	1·02788	
†*1199	,,	9	283	26 9	145 17	2075	1·9	20·8	00 V.	8	1·02432	1·02583	1·02788	
†*1210	,,	11	284	28 22	141 22	1985	1·7	21·9	,,	8·5	1·02452	1·02615	1·02827	
†*1221	,,	14	285	32 36	137 43	2375	1·7	17·8	,,	19	1·02522	1·02575	1·02781	
†*1232	,,	16	286	33 29	133 22	2335	1·5	15·9	,,	25·5	1·02562	1·02570	1·02777	
†*1242	,,	19	287	36 32	132 52	2400	1·5	14·4	,,	29·5	1·02589	1·02564	1·02771	
†*1245	,,	21	288	40 3	132 58	2600	1·5	14·1	,,	30·5	1·02595	1·02564	1·02771	
†*1256	,,	23	289	39 41	131 23	2550	1·5	12·9	,,	34·5	1·02621	1·02565	1·02772	
†*1259	,,	25	290	39 16	124 7	2300	1·6	13·5	,,	29	1·02590	1·02546	1·02753	
†*1270	,,	27	291	39 13	118 49	2250	1·4	13·5	,,	30	1·02594	1·02550	1·02758	
†*1274	,,	29	292	38 43	112 31	1600	1·8	13·1	,,	33	1·02611	1·02559	1·02765	
†*1286	Nov.	1	293	39 4	105 5	2025	1·3	15·6	,,	27	1·02572	1·02573	1·02782	
†*1300	,,	5	295	38 7	94 4	1500	1·8	16·4	,,	22	1·02543	1·02562	1·02768	
†*1313	,,	9	296	38 6	88 2	1825	1·8	16·0	,,	20	1·02534	1·02544	1·02750	
†*1324	,,	11	297	37 29	83 7	1775	1·9	14·8	,,	28·5	1·02582	1·02565	1·02770	
†*1350	Dec.	14	299	33 31	74 43	2160	1·8	18·7	00 IV. +0·2g.	88	1·02491	1·02567	1·02773	Valparaiso to Magellan Strait.
†*1363	,,	17	300	33 42	78 18	1375	1·6	17·6	,,	88	1·02495	1·02543	1·02748	
†*1388	,,	28	302	42 43	82 11	1450	2·0	13·8	00 V.	31	1·02599	1·02562	1·02766	
†*1397	,,	30	303	45 31	78 9	1325	2·2	13·9	,,	30·5	1·02598	1·02563	1·02766	

XII. *Water from Intermediate Depths in the South Pacific.*

	1874.			S.	E.									
456	June	16	164B	34 27	154 57	50	16·4	17·3	00 V.	32	1·02595	1·02636	1·02617	Sydney, N.S.W. to Wellington, N.Z.
457	,,	16				100	11·4	16·6	,,	33	1·02603	1·02627	1·02713	
458	,,	16				200	9·0	16·0	,,	28·5	1·02580	1·02590	1·02715	
459	,,	16				300	7·3	15·5	,,	28	1·02578	1·02576	1·02725	
461	,,	17	165	34 50	155 28	50	13·9	17·6	,,	29	1·02578	1·02628	1·02661	
464	,,	18	...	34 42	156 19	5	15·0	18·1	00 IV. +0·2g.	95	1·02595	1·02656	1·02597	
466	,,	19	165A	36 41	158 29	5	17·0	16·9	00 V.	33·5	1·02605	1·02636	1·02603	
467	,,	19				100	13·2	15·7	,,	32·5	1·02603	1·02606	1·02656	
468	,,	19				150	11·8	15·7	,,	32·5	1·02603	1·02606	1·02683	
469	,,	19				300	8·2	15·7	,,	26	1·02568	1·02571	1·02706	
470	,,	19				400	6·5	15·8	,,	30	1·02621	1·02627	1·02786	
489	July	10	169	37 34	179 22	50	13·7	16·5	,,	30	1·02587	1·02608	1·02648	Wellington to Fiji Islands.
490	,,	10				100	12·9	16·2	,,	30	1·02587	1·02602	1·02658	
491	,,	10				200	10·0	16·1	,,	25	1·02561	1·02573	1·02682	
				S.	W.									
500	,,	14	170A	29 45	178 11	100	15·8	20·1	,,	20	1·02522	1·02635	1·02629	
501	,,	14				200	11·7	20·5	,,	14	1·02488	1·02611	1·02690	
502	,,	14				300	9·4	20·5	,,	7·5	1·02452	1·02575	1·02694	
503	,,	14				400	7·6	20·3	,,	8	1·02456	1·02573	1·02718	

XII. *Water from Intermediate Depths in the South Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Reduced to its Value at 15°56 C.	Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1874.		S.	W.									
508	July 17	171a	25 5	172 56	100	19·8	22·2	00 V.	13	1·02456	1·02635	1·02530	Wellington to Fiji Islands.
509	,, 17				200	15·1	21·8	,,	14·5	1·02456	1·02646	1·02656	
510	,, 17				400	6·7	21·9	,,	5·5	1·02440	1·02576	1·02733	
			S.	E.									
522	Aug. 12	175	19 2	177 10	100	21·5	25·3	00 IV.	98	1·02404	1·02664	1·02512	Fiji Islands to Cape York.
523	,, 12				200	16·0	24·8	,,	97·5	1·02402	1·02647	1·02637	
536	,, 19	178	16 47	165 20	50	24·4	25·7	,,	89	1·02353	1·02625	1·02391	
537	,, 19				100	21·9	25·6	,,	98	1·02404	1·02673	1·02516	
538	,, 19				200	13·6	25·7	,,	91	1·02364	1·02636	1·02672	
542	,, 21	179	15 58	160 48	100	21·7	26·0	,,	95	1·02386	1·02667	1·02510	
543	,, 21				200	13·0	26·2	,,	85·5	1·02332	1·02619	1·02674	
544	,, 21				300	7·3	25·9	,,	86·5	1·02339	1·02614	1·02763	
545	,, 21				400	5·3	25·9	,,	82·5	1·02316	1·02591	1·02765	
552	,, 24	180	14 7	153 43	100	22·7	26·3	,,	93·5	1·02386	1·02676	1·02491	
553	,, 24				200	11·9	26·6	,,	81	1·02307	1·02603	1·02678	
554	,, 24				300	7·3	26·6	,,	81	1·02307	1·02603	1·02749	
555	,, 24				400	5·3	26·6	,,	85	1·02330	1·02630	1·02808	
562	,, 28	183	12 42	146 46	100	20·8	26·8	,,	91	1·02337	1·02643	1·02511	
564	,, 28				200	12·5	27·0	,,	77·5	1·02286	1·02595	1·02659	
565	,, 28				300	7·2	27·1	,,	73	1·02268	1·02580	1·02730	
566	,, 28				400	5·1	26·9	,,	78·5	1·02291	1·02596	1·02772	
	1875.												
702	Feb. 21	...	0 4	138 22	10	28·3	27·1	,,	68·5	1·02235	1·02547	1·02198	Meangis Islands to Admiralty Islands.
703	,, 21				20	28·3	27·7	,,	71	1·02247	1·02577	1·02228	
704	,, 21				30	28·3	27·4	,,	72	1·02247	1·02568	1·02219	
705	,, 21				40	28·3	28·3	,,	70	1·02240	1·02589	1·02240	
708	,, 22	217	0 39	138 55	10	28·3	27·4	,,	69·5	1·02240	1·02561	1·02212	
709	,, 22				15	28·3	28·1	,,	66	1·02219	1·02562	1·02213	
710	,, 22				20	28·3	28·0	,,	67	1·02225	1·02565	1·02216	
711	,, 22				40	28·3	27·5	,,	72	1·02254	1·02578	1·02229	
712	,, 22				50	28·0	27·8	,,	77	1·02281	1·02618	1·02275	
713	,, 22				100	23·3	27·4	,,	84	1·02320	1·02644	1·02442	
714	,, 22				200	9·8	28·4	,,	67·5	1·02231	1·02637	1·02751	
715	,, 22				300	7·3	28·4	,,	65	1·02213	1·02565	1·02714	
716	,, 22				400	5·8	26·7	00 III. + 0·6g.	96	1·02265	1·02564	1·02782	
725	Mar. 1	218	2 33	144 4	10	28·4	28·5	00 IV.	68·5	1·02204	1·02559	1·02207	
726	,, 1				20	28·3	26·5	,,	76	1·02270	1·02572	1·02223	
727	,, 1				50	27·5	27·2	,,	80	1·02299	1·02617	1·02290	
728	,, 1				100	22·7	27·1	,,	85	1·02327	1·02642	1·02457	
729	,, 1				200	10·0	27·2	,,	73	1·02260	1·02575	1·02684	
730	,, 1				300	7·5	27·0	,,	71	1·02249	1·02558	1·02707	
731	,, 1				400	5·8	27·1	,,	69·5	1·02242	1·02554	1·02722	
737	,, 11	220	0 42	147 0	350	7·0	28·1	,,	64	1·02268	1·02551	1·02704	Admiralty Islands to Japan
			S.	W.									
1119	Sept. 6	271	0 33	151 34	25	24·5	25·7	,,	89	1·02353	1·02625	1·02389	Sandwich Islands to Tahiti.
1120	,, 6				50	24·5	25·7	,,	91·5	1·02366	1·02638	1·02402	
1121	,, 6				100	15·2	25·6	,,	89	1·02353	1·02622	1·02630	
1122	,, 6				200	10·5	25·6	,,	83·5	1·02322	1·02588	1·02688	
1122a	,, 6				400	6·1	26·4	,,	77·5	1·02287	1·02577	1·02742	
1123	,, 6				800	3·4	26·5	,,	79·5	1·02298	1·02591	1·02784	
1124	,, 6				1975	1·8	26·8	,,	79	1·02298	1·02594	1·02800	
1128	,, 8	272	3 48	152 56	25	25·7	26·2	,,	86	1·02334	1·02621	1·02349	
1129	,, 8				50	25·6	26·2	,,	86	1·02334	1·02621	1·02352	
1130	,, 8				100	17·5	25·9	,,	87	1·02340	1·02615	1·02570	
1131	,, 8				200	9·5	25·9	,,	79·5	1·02300	1·02575	1·02692	
1132	,, 8				300	7·0	26·2	,,	80	1·02301	1·02583	1·02738	
1133	,, 8				400	5·7	26·3	,,	74·5	1·02270	1·02557	1·02726	
1134	,, 8				800	2·9	26·3	,,	74·5	1·02270	1·02557	1·02754	
1135	,, 8				2600	1·7	25·9	,,	77	1·02286	1·02561	1·02767	

XII. *Water from Intermediate Depths in the South Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1875.		S.	W.									
1138	Sept. 9	273	5° 11′	152° 56′	1900	1°·8	26°·5	00 IV.	88	1·02344	1·02640	1·02852	Sandwich Islands to Tahiti
1141	„ 11	274	7 25	152 15	2275	1·8	26·4	„	70	1·02279	1·02569	1·02775	
1144	„ 14	275	11 20	150 30	2125	1·8	26·4	„	79	1·02295	1·02585	1·02791	
1148	„ 16	276	13 28	149 30	25	26·6	25·3	00 V.	2·5	1·02409	1·02669	1·02388	
1149	„ 16				50	25·8	25·2	„	4·5	1·02421	1·02678	1·02403	
1150	„ 16				100	23·2	25·2	„	6·5	1·02432	1·02689	1·02490	
1151	„ 16				200	12·4	25·1	00 IV.	88·5	1·02323	1·02574	1·02640	
1152	„ 16				300	7·1	25·3	„	80	1·02303	1·02557	1·02709	
1153	„ 16				400	5·5	25·2	„	79	1·02298	1·02552	1·02723	
1154	„ 16				800	3·2	25·1	„	82·5	1·02317	1·02568	1·02763	
1156	„ 17	277	15 51	149 41	1850	1·8	24·8	„	86	1·02337	1·02580	1·02786	
1159	„ 18	278	17 12	149 43	25	25·0	24·5	00 V.	11	1·02458	1·02694	1·02443	
1160	„ 18				50	25·0	24·6	„	11	1·02458	1·02697	1·02446	
1161	„ 18				100	21·8	24·5	„	8	1·02442	1·02678	1·02518	
1162	„ 18				200	15·1	24·6	00 IV.	89	1·02350	1·02593	1·02603	
1163	„ 18				400	5·9	24·6	„	81	1·02311	1·02548	1·02715	
1164	„ 18				1025	2·5	24·5	„	83	1·02322	1·02556	1·02756	
1168	Oct. 4	280	18 40	149 52	25	25·0	24·7	00 IV. + 0·1g.	97	1·02459	1·02701	1·02450	Tahiti to Valparaiso
1169	„ 4				50	24·5	24·6	00 V.	7	1·02435	1·02674	1·02433	
1170	„ 4				100	22·8	24·6	„	9	1·02447	1·02686	1·02498	
1171	„ 4				200	14·4	24·6	00 IV.	92·5	1·02375	1·02612	1·02637	
1172	„ 4				300	7·2	24·6	„	82	1·02317	1·02554	1·02704	
1173	„ 4				400	5·4	24·7	„	80·5	1·02308	1·02548	1·02721	
1174	„ 4				1550	2·1	24·6	„	84·5	1·02330	1·02567	1·02771	
1178	„ 6	281	22 21	150 17	25	23·5	22·3	00 V.	16	1·02451	1·02665	1·02458	
1179	„ 6				50	23·0	22·4	„	16	1·02451	1·02667	1·02474	
1180	„ 6				100	20·5	22·6	„	11	1·02463	1·02645	1·02521	
1181	„ 6				200	13·4	22·6	„	3	1·02420	1·02600	1·02646	
1182	„ 6				300	7·5	22·6	00 IV.	92	1·02375	1·02558	1·02704	
1183	„ 6				400	5·7	22·6	„	90	1·02367	1·02547	1·02716	
1184	„ 6				800	3·0	22·5	„	93·5	1·02387	1·02564	1·02761	
1185	„ 6				1900	1·8	24·1	„	86	1·02339	1·02561	1·02767	
1188	„ 7	282	23 46	149 59	2000	1·8	22·5	„	91	1·02372	1·02549	1·02756	
1192	„ 9	283	26 9	145 17	25	20·7	20·3	00 V.	17	1·02513	1·02632	1·02502	
1193	„ 9				50	20·0	20·4	„	16	1·02497	1·02617	1·02508	
1194	„ 9				65	19·5	20·4	„	16	1·02497	1·02617	1·02521	
1195	„ 9				100	18·1	20·4	„	17	1·02502	1·02622	1·02562	
1196	„ 9				200	12·7	20·5	„	11·5	1·02472	1·02595	1·02655	
1197	„ 9				300	7·4	20·4	„	6	1·02441	1·02561	1·02709	
1198	„ 9				400	5·7	20·5	00 IV.	98	1·02415	1·02538	1·02707	
1202	„ 11	284	28 22	141 22	25	19·7	21·7	00 V.	11·5	1·02468	1·02625	1·02522	
1203	„ 11				50	19·2	21·9	„	11	1·02465	1·02628	1·02538	
1204	„ 11				100	17·3	21·6	„	12	1·02471	1·02623	1·02583	
1205	„ 11				200	12·5	21·8	„	7	1·02443	1·02601	1·02665	
1206	„ 11				300	7·7	21·6	00 IV.	95·5	1·02399	1·02551	1·02695	
1207	„ 11				400	5·3	21·9	„	93	1·02385	1·02546	1·02729	
1208	„ 11				500	4·4	22·3	„	94·5	1·02392	1·02564	1·02747	
1209	„ 11				1975	1·6	21·9	„	98·5	1·02415	1·02576	1·02782	
1214	„ 14	285	32 36	137 43	25	17·7	17·7	00 V.	24	1·02550	1·02600	1·02550	
1215	„ 14				50	17·4	17·8	„	25·5	1·02556	1·02609	1·02566	
1216	„ 14				100	16·5	17·7	„	24	1·02550	1·02600	1·02579	
1217	„ 14				200	11·3	17·8	„	20	1·02528	1·02581	1·02667	
1218	„ 14				300	7·3	17·8	„	14·5	1·02497	1·02550	1·02699	
1219	„ 14				400	6·0	17·8	„	14	1·02493	1·02546	1·02712	
1220	„ 14				800	3·2	17·3	00 IV. + 0·2g.	91	1·02513	1·02553	1·02748	
1224	„ 16	286	33 29	133 22	25	17·0	15·7	00 V.	33	1·02599	1·02602	1·02569	
1225	„ 16				50	15·2	15·9	„	31·5	1·02595	1·02603	1·02611	
1226	„ 16				100	15·2	15·8	„	31	1·02593	1·02599	1·02607	

XII. *Water from Intermediate Depths in the South Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)		
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.
					D	T	t		R	S_t	$S_{15·56}$	S_T
	1875.		S. ° ′	W. ° ′		°	°					
1227	Oct. 16	286	32 29	133 22	200	9·4	15·8	00 V.	24·5	1·02557	1·02563	1·02682
1228	,, 16				300	6·9	15·7	,,	21·5	1·02542	1·02545	1·02699
1229	,, 16				400	5·8	15·9	,,	21·5	1·02542	1·02548	1·02716
1230	,, 16				800	3·4	15·7	,,	22·5	1·02533	1·02536	1·02729
1231	,, 16				2290	1·8	16·0	00 IV. + 0·3g.	87·5	1·02560	1·02570	1·02776
1236	,, 19	287	36 32	132 52	25	14·1	14·5	00 V.	28·5	1·02583	1·02560	1·02591
1237	,, 19				50	13·2	14·5	,,	28·5	1·02583	1·02560	1·02610
1238	,, 19				100	12·9	14·6	,,	28	1·02580	1·02559	1·02615
1239	,, 19				200	7·8	14·5	,,	25·5	1·02567	1·02544	1·02686
1240	,, 19				400	5·6	14·5	,,	25	1·02564	1·02541	1·02711
1241	,, 19				1925	1·7	14·4	00 IV. + 0·3g.	89	1·02573	1·02548	1·02754
1244	,, 21	288	40 3	132 58	2125	1·7	14·4	,,	94	1·02598	1·02573	1·02779
1248	,, 23	289	39 41	131 23	25	12·2	12·9	00 V.	28·5	1·02594	1·02528	1·02607
1249	,, 23				50	9·5	12·8	,,	28	1·02585	1·02527	1·02644
1250	,, 23				100	9·0	13·0	,,	29	1·02590	1·02530	1·02661
1251	,, 23				200	7·5	12·9	,,	28·5	1·02594	1·02538	1·02684
1252	,, 23				300	6·2	13·2	,,	29	1·02589	1·02539	1·02702
1253	,, 23				400	5·1	13·1	,,	29·5	1·02593	1·02541	1·02717
1254	,, 23				800	2·8	12·3	,,	31	1·02603	1·02536	1·02734
1255	,, 23				2075	1·6	12·5	,,	34	1·02618	1·02554	1·02761
1258	,, 25	290	39 16	124 7	1850	1·7	13·8	,,	26	1·02571	1·02534	1·02740
1262	,, 27	291	39 13	118 49	25	11·2	13·0	00 IV. + 0·3g.	89	1·02577	1·02523	1·02611
1263	,, 27				50	10·4	13·0	00 V.	26·5	1·02577	1·02523	1·02625
1264	,, 27				100	8·7	13·1	,,	28·5	1·02588	1·02536	1·02635
1265	,, 27				200	6·9	13·6	,,	28	1·02560	1·02516	1·02670
1266	,, 27				300	6·1	13·1	,,	28·5	1·02588	1·02536	1·02701
1267	,, 27				400	5·2	13·1	,,	28	1·02585	1·02533	1·02708
1268	,, 27				800	3·6	13·1	,,	26·5	1·02598	1·02546	1·02748
1269	,, 27				1775	1·7	13·2	00 IV. + 0·3g.	91	1·02588	1·02538	1·02744
1273	,, 29	292	38 43	112 31	1600	1·8	13·1	00 V.	28	1·02584	1·02532	1·02738
1278	Nov. 1	293	39 4	105 5	25	11·6	15·1	,,	19·5	1·02533	1·02523	1·02604
1279	,, 1				50	10·9	15·0	,,	19	1·02530	1·02517	1·02610
1280	,, 1				100	9·0	15·1	,,	21	1·02541	1·02531	1·02656
1281	,, 1				200	6·7	15·2	,,	22	1·02546	1·02538	1·02695
1282	,, 1				300	6·1	15·2	,,	22	1·02546	1·02538	1·02703
1283	,, 1				400	5·4	15·2	,,	19·5	1·02533	1·02525	1·02698
1284	,, 1				800	3·5	15·3	,,	23·5	1·02554	1·02548	1·02749
1285	,, 1				1550	2·1	15·4	,,	26	1·02567	1·02563	1·02767
1289	,, 3	294	39 22	98 46	25	12·8	16·2	,,	16	1·02510	1·02525	1·02588
1290	,, 3				50	11·4	15·9	,,	16	1·02511	1·02519	1·02605
1291	,, 3				100	9·0	15·9	,,	19	1·02528	1·02536	1·02661
1292	,, 3				200	6·7	16·0	,,	21	1·02538	1·02548	1·02705
1293	,, 3				300	5·7	15·9	,,	20	1·02534	1·02542	1·02711
1294	,, 3				400	4·9	16·5	,,	17·5	1·02517	1·02538	1·02716
1295	,, 3				800	3·2	16·4	,,	20·5	1·02535	1·02554	1·02749
1296	,, 3				1775	1·7	17·2	00 IV. + 0·2g.	95·5	1·02539	1·02577	1·02783
1299	,, 5	295	38 7	94 4	1000	2·7	16·3	00 V.	22·5	1·02546	1·02569	1·02762
1305	,, 9	296	38 6	88 2	25	13·8	15·7	,,	18	1·02522	1·02523	1·02562
1306	,, 9				50	12·5	16·1	00 IV. + 0·3g.	70·5	1·02515	1·02527	1·02591
1307	,, 9				100	10·0	15·7	00 V.	17	1·02517	1·02520	1·02629
1308	,, 9				200	6·5	15·9	,,	19	1·02528	1·02536	1·02695
1309	,, 9				300	5·4	15·8	,,	19·5	1·02531	1·02537	1·02710
1310	,, 9				400	4·9	15·8	,,	18·5	1·02524	1·02530	1·02708
1311	,, 9				800	3·6	16·2	,,	21·5	1·02541	1·02556	1·02747
1312	,, 9				1350	2·4	17·4	00 IV. + 0·15g.	96	1·02509	1·02552	1·02753

Tahiti to Valparaiso.

XII. *Water from Intermediate Depths in the South Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1875.		S.	W.									
			° ′	° ′									
1316	Nov. 11	297	37 29	83 7	25	13·0	14·7	00 V.	23·5	1·02556	1·02529	1·02583	Tahiti to Valparaiso.
1317	,, 11				50	12·0	14·4	,,	22·5	1·02551	1·02526	1·02599	
1318	,, 11				100	10·0	14·4	,,	21	1·02543	1·02518	1·02627	
1319	,, 11				200	6·9	14·9	00 IV. + 0·2g.	85·5	1·02551	1·02536	1·02690	
1320	,, 11				300	5·5	14·5	00 V.	23·5	1·02556	1·02533	1·02704	
1321	,, 11				400	4·7	14·6	,,	23	1·02553	1·02532	1·02712	
1322	,, 11				800	2·6	14·7	,,	24	1·02558	1·02539	1·02739	
1323	,, 11				1300	2·3	14·8	,,	26·5	1·02571	1·02554	1·02756	
1329	,, 17	298	34 7	73 56	25	13·2	17·1	00 IV. + 0·2g.	87	1·02491	1·02526	1·02576	
1330	,, 17				50	11·4	16·9	00 V.	13	1·02492	1·02522	1·02606	
1331	,, 17				100	9·8	17·1	,,	16·5	1·02511	1·02546	1·02658	
1332	,, 17				200	7·3	17·2	,,	15	1·02502	1·02540	1·02689	
1333	,, 17				300	5·5	17·2	,,	13	1·02491	1·02529	1·02700	
1334	,, 17				400	4·6	17·2	,,	15	1·02502	1·02540	1·02721	
1335	,, 17				800	3·2	17·4	,,	15	1·02501	1·02544	1·02739	
1336	,, 17				1725	1·9	17·2	,,	15	1·02502	1·02540	1·02745	
1344	Dec. 14	299	33 31	74 43	25	15·0	17·8	,,	12·5	1·02486	1·02539	1·02552	Valparaiso to Strait of Magellan.
1345	,, 14				50	11·7	17·9	,,	10·5	1·02475	1·02530	1·02609	
1346	,, 14				100	9·5	17·8	,,	12·5	1·02486	1·02539	1·02656	
1347	,, 14				200	6·9	17·9	,,	13·5	1·02492	1·02547	1·02701	
1348	,, 14				300	5·4	18·4	00 IV. + 0·2g.	85·5	1·02477	1·02545	1·02718	
1349	,, 14				400	4·8	18·0	00 V.	12·5	1·02485	1·02543	1·02722	
1353	,, 16	...	32 50	77 6	10	16·7	18·5	,,	7	1·02453	1·02524	1·02498	
1355	,, 17	300	33 42	78 18	25	14·3	17·3	,,	9	1·02469	1·02509	1·02536	
1356	,, 17				50	12·0	17·4	,,	9	1·02469	1·02512	1·02585	
1357	,, 17				100	9·7	17·3	,,	11	1·02480	1·02520	1·02634	
1358	,, 17				200	6·7	17·3	,,	15	1·02501	1·02541	1·02698	
1359	,, 17				300	5·2	17·3	,,	14	1·02495	1·02535	1·02710	
1360	,, 17				400	4·5	17·4	,,	13	1·02489	1·02532	1·02714	
1361	,, 17				800	3·0	17·3	,,	17	1·02512	1·02552	1·02749	
1362	,, 17				1350	2·6	17·4	,,	18·5	1·02520	1·02563	1·02767	
1369	,, 22	301	37 29	84 2	25	14·1	14·4	,,	21·5	1·02546	1·02521	1·02552	
1370	,, 22				50	12·5	14·5	,,	21	1·02542	1·02519	1·02575	
1371	,, 22				100	10·3	14·4	,,	21	1·02542	1·02517	1·02621	
1372	,, 22				200	6·8	14·5	,,	23	1·02544	1·02521	1·02677	
1373	,, 22				300	5·5	14·5	,,	23	1·02544	1·02521	1·02692	
1380	,, 28	302	42 43	82 11	25	11·4	13·9	,,	20	1·02539	1·02504	1·02588	
1381	,, 28				50	9·7	14·5	,,	20	1·02537	1·02514	1·02628	
1382	,, 28				100	7·7	13·7	,,	24	1·02562	1·02523	1·02666	
1383	,, 28				200	5·8	14·3	,,	25	1·02565	1·02538	1·02706	
1384	,, 28				300	5·0	14·1	,,	25	1·02565	1·02534	1·02711	
1385	,, 28				400	4·5	14·3	,,	24·5	1·02562	1·02535	1·02717	
1386	,, 28				800	2·7	14·0	,,	29·5	1·02590	1·02557	1·02756	
1387	,, 28				950	2·4	14·2	,,	30	1·02593	1·02564	1·02765	
1391	,, 30	303	45 31	78 9	25	10·8	14·1	,,	20	1·02540	1·02509	1·02604	
1392	,, 30				50	9·2	14·2	,,	20·5	1·02542	1·02518	1·02635	
1393	,, 30				100	7·2	14·3	,,	23	1·02544	1·02517	1·02667	
1394	,, 30				200	4·9	13·5	,,	27	1·02579	1·02535	1·02713	
1395	,, 30				400	4·3	14·2	,,	24	1·02562	1·02533	1·02717	
1396	,, 30				850	2·6	14·2	,,	28·5	1·02586	1·02557	1·02757	

XIII. *Surface Water of the North Pacific.*

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained. D	Temperature (Centigrade) of Water. At the Depth D. T	Temperature (Centigrade) of Water. During Observation. t	Hydrometer. Number of the Instrument.	Hydrometer. Reading. R	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C. S_t	Specific Gravity. Reduced to its Value at 15°·56 C. $S_{15·56}$	Specific Gravity. Reduced to its Value at T° C. S_T	
	1875.		N.	E.									
679	Feb. 9	...	5° 33′	125° 28′	Surface.	26°·7	27°·1	60 IV.	70	1·02244	1·02556	1·02256	Meangis Islands to Admiralty Islands.
*680	,, 10	214	4 33	127 6	,,	28·9	28·9	,,	70·5	1·02246	1·02551	1·02246	
*682	,, 10	214	4 33	127 6	,,	28·9	27·7	,,	66	1·02221	1·02551	1·02248	
683	,, 11	...	4 33	128 50	,,	27·4	27·4	,,	71	1·02251	1·02572	1·02251	
684	,, 11	...	4 28	129 30	,,	27·8	27·6	,,	76·5	1·02278	1·02605	1·02275	
†*685	,, 12	215	4 19	130 15	,,	27·8	27·6	,,	75	1·02270	1·02597	1·02264	
692	,, 13	...	4 19	130 47	,,	27·2	26·9	,,	73	1·02261	1·02566	1·02251	
693	,, 14	...	3 37	132 37	,,	27·6	27·7	,,	72	1·02253	1·02583	1·02256	
694	,, 15	...	3 17	133 33	,,	27·8	27·8	,,	75	1·02270	1·02603	1·02270	
*695	,, 16	216a	2 56	134 11	,,	28·2	28·3	,,	66·5	1·02221	1·02570	1·02224	
698	,, 17	...	2 46	134 51	,,	28·3	28·1	,,	71	1·02246	1·02589	1·02241	
699	,, 18	...	1 38	135 47	,,	28·2	28·1	,,	74	1·02263	1·02606	1·02260	
700	,, 19	...	1 3	137 10	,,	27·8	28·0	,,	65	1·02214	1·02554	1·02220	
739	Mar. 12	...	0 4	147 44	,,	28·6	28·5	,,	73	1·02257	1·02616	1·02254	Admiralty Islands to Japan.
740	,, 12	...	0 22	148 10	,,	28·9	28·5	,,	74	1·02263	1·02622	1·02248	
741	,, 13	...	0 40	148 50	,,	28·9	28·8	,,	73	1·02256	1·02624	1·02253	
749	,, 14	...	0 49	147 58	,,	28·2	28·5	,,	77	1·02278	1·02637	1·02284	
750	,, 15	...	1 33	147 6	,,	28·4	28·3	,,	78	1·02284	1·02637	1·02281	
751	,, 16	...	2 20	146 16	,,	28·3	28·3	,,	77·5	1·02281	1·02634	1·02281	
759	,, 17	...	3 21	145 35	,,	28·6	28·4	,,	72	1·02250	1·02602	1·02244	
†760	,, 18	...	4 21	145 18	,,	28·4	28·5	,,	69	1·02235	1·02584	1·02232	
†761	,, 18	...	4 21	145 18	,,	28·7	28·8	,,	68	1·02228	1·02593	1·02231	
†*768	,, 19	223	5 31	145 13	,,	27·8	27·9	,,	73	1·02259	1·02595	1·02263	
772	,, 20	...	6 33	145 5	,,	27·2	27·9	,,	71	1·02248	1·02566	1·02248	
†*773	,, 21	224	7 45	144 20	,,	27·3	26·9	,,	76·5	1·02280	1·02585	1·02266	
782	,, 22	...	9 24	143 55	,,	27·1	27·1	,,	75	1·02272	1·02584	1·02272	
783	,, 22	...	10 19	143 35	,,	26·9	26·7	,,	73·5	1·02264	1·02563	1·02257	
†*784	,, 23	225	11 24	143 16	,,	26·8	26·8	,,	74	1·02266	1·02568	1·02266	
792	,, 24	...	12 51	142 40	,,	26·5	26·8	,,	74	1·02266	1·02568	1·02275	
†793	,, 25	226	14 44	142 13	,,	26·1	26·1	,,	82	1·02314	1·02595	1·02314	
800	,, 26	...	16 21	141 44	,,	26·2	26·5	,,	76	1·02279	1·02572	1·02289	
801	,, 27	...	17 34	141 21	,,	26·2	26·4	,,	76·5	1·02282	1·02573	1·02289	
808	,, 28	...	18 26	141 11	,,	27·1	27·3	,,	73·5	1·02262	1·02580	1·02269	
†809	,, 29	228	19 24	141 13	,,	26·8	26·9	,,	76	1·02277	1·02582	1·02281	
816	,, 30	...	20 12	140 59	,,	26·1	26·4	,,	82	1·02312	1·02602	1·02321	
817	,, 31	...	21 17	140 40	,,	25·8	26·1	,,	84·5	1·02333	1·02614	1·02342	
†818	April 1	229	22 1	140 27	,,	25·8	26·0	,,	85	1·02335	1·02613	1·02341	
825	,, 2	...	22 39	139 24	,,	25·0	25·4	,,	86	1·02336	1·02596	1·02350	
826	,, 3	...	24 47	138 34	,,	21·8	22·6	60 IV. 60 V.	98 1·5	1·02411 1·02410	1·02590	1·02432	
827	,, 4	...	25 33	137 57	,,	20·5	21·1	60 V.	8	1·02452	1·02591	1·02471	
†828	,, 5	230	26 29	137 57	,,	20·3	21·5	,,	9	1·02456	1·02606	1·02489	
835	,, 6	...	27 10	137 59	,,	21·1	21·5	,,	9	1·02439	1·02589	1·02450	
836	,, 7	...	28 23	137 45	,,	20·8	20·8	,,	8·5	1·02455	1·02586	1·02455	
837	,, 8	...	30 15	137 4	,,	20·8	20·6	,,	6	1·02441	1·02566	1·02436	
†*838	,, 9	231	31 8	137 8	,,	17·8	18·8	,,	9	1·02463	1·02541	1·02488	
846	,, 10	...	32 55	138 15	,,	20·1	20·0	,,	11·5	1·02474	1·02583	1·02476	
847	May 12	232	35 11	139 28	,,	17·9	17·4	,,	14	1·02496	1·02539	1·02485	Off South Coast of Japan.
848	,, 13	...	34 20	137 47	,,	18·3	18·7	,,	19	1·02519	1·02595	1·02531	
849	,, 15	...	34 15	135 0	,,	16·4	16·7	60 IV.	99	1·02434	1·02460	1·02441	
856	June 2	...	34 17	135 0	,,	18·4	19·2	,,	87	1·02360	1·02448	1·02380	
857	,, 2	...	33 53	135 2	,,	20·3	19·4	60 V.	8	1·02456	1·02550	1·02434	
858	,, 3	234	32 31	135 39	,,	20·5	20·1	60 IV. 60 V.	99·5 4	1·02426 1·02423	1·02541	1·02410	
859	,, 4	...	33 40	137 26	,,	20·8	21·0	60 IV.	99	1·02421	1·02557	1·02426	
*861	,, 5	236	34 58	139 29	,,	19·2	19·3	60 V.	10	1·02469	1·02560	1·02472	
*862	,, 17	237	34 37	140 32	,,	22·8	23·1	60 IV.	92	1·02376	1·02570	1·02385	Japan to Sandwich Islands.
†*866	,, 19	239	35 18	147 9	,,	21·2	21·8	,,	99	1·02419	1·02577	1·02436	

XIII. *Surface Water of the North Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (*Distilled Water at 4° C. = 1.*) Observed at *t*° C.	Specific Gravity. Reduced to its Value at 15°56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	*t*		R	S_t	$S_{15 \cdot 56}$	S_T	
	1875.		N. ° ′	E. ° ′		°	°						
872	June 20	...	35 35	150 50	Surface.	21·0	21·6	00 V.	6	1·02439	1·02591	1·02455	Japan to the Sandwich Islands.
†873	,, 21	240	35 20	153 39	,,	18·2	19·1	,,	10	1·02470	1·02556	1·02493	
880	,, 22	...	35 26	156 29	,,	20·0	21·0	,,	5·5	1·02438	1·02574	1·02465	
†*881	,, 23	241	35 41	157 42	,,	20·7	21·0	,,	5·5	1·02438	1·02574	1·02447	
*889	,, 24	242	35 29	161 52	,,	20·3	21·1	,,	7	1·02451	1·02590	1·02473	
891	,, 25	...	35 22	164 33	,,	20·3	21·0	,,	5	1·02435	1·02571	1·02454	
†892	,, 26	243	35 24	166 35	,,	21·7	22·4	00 IV.	94	1·02388	1·02562	1·02407	
898	,, 27	...	35 22	168 17	,,	21·1	21·2	00 IV. 00 V.	100 4	1·02426 1·02426	1·02567	1·02428	
†*899	,, 28	244	35 22	169 53	,,	21·4	21·3	00 IV. 00 V.	99·5 3·5	1·02421 1·02424	1·02566	1·02419	
908	,, 29	...	35 49	171 46	,,	21·1	21·8	00 IV.	99	1·02419	1·02571	1·02432	
916	,, 29	...	35 55	171 54	,,	21·7	22·7	,,	93	1·02383	1·02566	1·02411	
*911	,, 30	245	36 23	174 31	,,	20·5	21·3	,,	96·5	1·02404	1·02556	1·02423	
913	July 1	...	38 8	176 17	,,	22·3	23·2	,,	88	1·02353	1·02550	1·02353	
†*914	,, 2	246	36 10	178 0	,,	22·8	24·3	,,	86	1·02329	1·02567	1·02382	
			N.	W.									
*922	,, 3	247	35 49	179 57	,,	22·8	22·6	,,	95	1·02394	1·02574	1·02389	
923	,, 4	...	36 42	179 50	,,	22·9	22·9	,,	93	1·02383	1·02571	1·02383	
926	,, 4 ,, *bis*	...	36 59	178 56	,,	21·9	21·9	,,	96·5	1·02403	1·02564	1·02403	
†927	,, 5	248	37 41	177 4	,,	20·7	21·8	,,	98·5	1·02415	1·02573	1·02445	
935	,, 6	...	38 9	175 0	,,	19·3	20·2	00 V.	6	1·02442	1·02556	1·02465	
*939	,, 7	249	37 59	171 48	,,	18·4	21·0	00 IV.	96	1·02404	1·02540	1·02472	
938	,, 8	...	37 48	169 11	,,	17·2	20·0	00 V.	5·5	1·02438	1·02547	1·02509	
939*	,, 9	...	37 49	166 36	,,	18·0	19·0	,,	9·5	1·02467	1·02556	1·02492	
949	,, 10	...	37 35	163 46	,,	17·9	18·9	,,	5	1·02441	1·02522	1·02467	
954	,, 11	...	37 42	161 28	,,	18·2	19·6	,,	8	1·02446	1·02529	1·02466	
†*955	,, 12	252	37 52	160 17	,,	18·3	19·5	,,	5	1·02439	1·02535	1·02470	
965	,, 13	...	37 55	158 23	,,	19·2	19·1	,,	4	1·02436	1·02523	1·02434	
†*975	,, 14	253	38 9	156 25	,,	19·8	21·2	00 IV.	94·5	1·02395	1·02536	1·02434	
976	,, 15	...	37 26	155 22	,,	20·6	20·9	,,	93·5	1·02391	1·02524	1·02400	
977	,, 16	...	37 8	154 52	,,	21·7	21·7	,,	87	1·02351	1·02506	1·02351	
†*978	,, 17	254	35 13	154 43	,,	22·2	23·2	,,	91·5	1·02373	1·02570	1·02401	
988	,, 18	...	34 46	154 59	,,	23·3	23·3	,,	88·5	1·02356	1·02555	1·02356	
989	,, 19	...	32 21	154 37	,,	23·3	23·0	,,	93·5	1·02411	1·02602	1·02403	
990	,, 20	...	30 51	154 23	,,	23·9	24·0	,,	97·5	1·02404	1·02626	1·02412	
†*993	,, 21	256	30 22	154 56	,,	23·3	25·0	,,	94·5	1·02385	1·02636	1·02434	
1003	,, 22	...	29 5	154 43	,,	24·0	24·3	,,	95·5	1·02392	1·02620	1·02402	
1004	,, 23	...	27 40	154 55	,,	24·4	24·4	,,	93·5	1·02380	1·02611	1·02380	
1011	,, 24	...	26 24	155 8	,,	25·0	24·8	,,	88	1·02348	1·02591	1·02342	
1014	,, 25	...	24 31	155 34	,,	24·5	24·9	,,	89	1·02355	1·02600	1·02367	
†*1015	,, 26	259	23 3	156 6	,,	25·0	25·0	,,	84	1·02326	1·02574	1·02326	
1025	,, 27	...	21 7	157 30	,,	24·7	24·8	,,	83	1·02322	1·02565	1·02326	
1027	Aug. 11	...	21 12	157 53	,,	25·8	25·8	,,	85·5	1·02332	1·02604	1·02332	Sandwich Islands to Tahiti.
†*1028	,, 12	261	20 18	157 14	,,	25·8	25·3	,,	84·5	1·02329	1·02586	1·02314	
1036	,, 13	...	20 18	155 53	,,	25·5	25·7	,,	81·5	1·02311	1·02580	1·02317	
†*1037	,, 20	262	19 12	154 14	,,	25·3	25·2	,,	85	1·02331	1·02585	1·02329	
†*1046	,, 21	263	17 33	153 36	,,	25·3	25·5	,,	85	1·02330	1·02593	1·02336	
1052	,, 22	...	16 0	153 3	,,	25·0	24·9	,,	82	1·02315	1·02560	1·02312	
1053	,, 22	...	15 14	152 49	,,	25·3	25·3	,,	80	1·02307	1·02564	1·02307	
†*1054	,, 23	264	14 19	152 37	,,	25·3	25·6	,,	80·5	1·02306	1·02572	1·02315	
1064	,, 24	...	13 7	151 50	,,	25·7	25·8	,,	82·5	1·02315	1·02587	1·02318	
†*1063	,, 25	265	12 42	152 1	,,	26·2	26·4	,,	75	1·02274	1·02564	1·02280	
1068	,, 26	...	11 11	152 2	,,	26·7	26·6	,,	77·5	1·02286	1·02592	1·02283	
1077	,, 27	...	10 25	152 6	,,	27·2	26·7	,,	73	1·02261	1·02560	1·02244	
†*1078	,, 28	267	9 28	150 49	,,	26·7	27·4	,,	56·5	1·02169	1·02490	1·02191	
1085	,, 29	...	8 15	149 51	,,	26·9	27·1	,,	69	1·02239	1·02551	1·02245	
†*1089	,, 30	268	7 35	149 49	,,	27·2	27·4	,,	71	1·02249	1·02570	1·02255	
1097	,, 31	...	7 26	149 22	,,	26·8	25·6	,,	60	1·02209	1·02475	1·02171	

XIII. *Surface Water of the North Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity (*Distilled Water at 4° C. = 1.*) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1875.		N. ° ′	W. ° ′		°	°						
1098	Sept. 1	...	7 0	147 20	Surface.	27·5	27·5	00 IV.	73·5	1·02261	1·02585	1·02261	Sandwich Ids. to Tahiti.
+*1099	„ 2	269	5 54	147 2	„	27·3	27·9	„	72·5	1·02255	1·02591	1·02273	
1107	„ 3	...	3 55	148 5	„	28·4	28·5	„	82	1·02311	1·02604	1·02314	
+*1108	„ 4	270	2 34	149 9	„	26·4	26·2	„	86	1·02334	1·02621	1·02328	
1117	„ 8	...	0 34	150 40	„	25·3	25·1	„	95·5	1·02390	1·02644	1·02384	
XIV. *Bottom Water of the North Pacific.*													
	1875.		N.	E.									
*681	Feb. 10	214	4 33	127 6	500	5·4	27·7	00 IV.	68	1·02232	1·02562	1·02735	Moluccas Id. to Ad'lty Ids.
+*691	„ 12	215	4 19	130 15	2550	1·9	27·0	„	73·5	1·02263	1·02572	1·02777	
+*691a	„ 12					1·9	26·6	„	73	1·02262	1·02559	1·02764	
+*691b	„ 12					1·9	26·9	„	72	1·02255	1·02560	1·02765	
696	„ 16	216	2 46	133 58	1675	1·9	27·9	„	71·5	1·02249	1·02585	1·02790	
*697	„ 16	216a	2 56	134 11	2000	1·9	27·7	„	69	1·02237	1·02567	1·02772	
+759	Mar. 16	222	2 15	146 16	2450	1·8	28·8	„	62	1·02195	1·02580	1·02766	Ad'lty Ids. to Japan.
+*771	„ 19	223	5 31	145 13	2325	1·9	27·5	„	73	1·02254	1·02578	1·02783	
+*781	„ 21	224	7 45	144 20	1850	1·9	27·1	„	72	1·02255	1·02567	1·02772	
+*791	„ 23	225	11 24	143 16	4475	1·8	26·4	„	78	1·02289	1·02579	1·02785	
+*845	April 6	231	31 6	137 8	2250	1·8	19·0	00 V.	15	1·02490	1·02579	1·02785	
858	June 4	235	34 7	138 0	565	3·4	20·5	„	5	1·02437	1·02560	1·02753	Off the S. Coast of Japan.
*862	„ 5	236	34 58	139 29	775	3·1	19·0	„	9	1·02463	1·02546	1·02742	
*864	„ 17	237	34 37	140 32	1875	1·8	23·4	00 IV.	88	1·02353	1·02555	1·02761	Japan to the Sandwich Islands.
865	„ 18	238	35 18	144 8	3950	1·7	23·3	„	89	1·02359	1·02558	1·02764	
+*871	„ 19	239	35 18	147 9	3625	1·7	23·1	„	92·5	1·02378	1·02572	1·02778	
+*884	„ 23	241	35 41	157 42	2300	1·7	22·5	„	92·5	1·02381	1·02558	1·02764	
*890	„ 24	242	35 29	161 52	2575	1·7	22·7	„	92	1·02377	1·02560	1·02766	
+*907	„ 28	244	35 22	169 53	2900	1·8	22·7	„	94	1·02388	1·02571	1·02777	
*912	„ 30	245	36 23	174 31	2775	1·6	23·2	„	88·5	1·02356	1·02553	1·02760	
+*922	July 2	246	36 10	178 0	2050	1·7	23·0	„	93	1·02381	1·02572	1·02778	
			N.	W.									
*924	„ 3	247	35 49	179 57	2500	1·6	22·4	„	95	1·02394	1·02568	1·02774	
*937	„ 7	249	37 59	171 48	3000	1·5	21·0	„	96·5	1·02406	1·02542	1·02748	
+948	„ 9	250	37 49	166 47	3050	1·7	20·4	00 V.	7	1·02448	1·02568	1·02774	
*953	„ 10	251	37 37	163 26	2950	1·7	19·4	„	12	1·02478	1·02572	1·02778	
+*964	„ 12	252	37 52	160 17	2740	1·8	19·5	„	10·5	1·02471	1·02567	1·02773	
+974	„ 14	253	38 9	156 25	3125	1·7	21·6	00 IV. + 0·1g.	87·5	1·02417	1·02569	1·02775	
+*987	„ 17	254	35 13	154 43	3025	1·7	23·3	00 IV.	84·5	1·02334	1·02533	1·02739	
+993	„ 19	255	32 28	154 33	2850	1·7	24·1	„	87·5	1·02347	1·02569	1·02775	
+*1002	„ 21	256	30 22	154 56	2950	1·8	25·0	„	92·5	1·02317	1·02565	1·02771	
+1010	„ 23	257	27 33	154 55	2875	1·6	24·3	„	88·5	1·02353	1·02581	1·02788	
1012	„ 24	258	26 11	155 12	2775	1·8	25·3	„	73	1·02266	1·02525	1·02731	
1013	„ 24	258	26 11	155 12	2775	1·8	25·3	„	74	1·02271	1·02528		
+*1024	„ 26	259	23 3	156 6	2225	1·6	25·2	„	83·5	1·02323	1·02577	1·02784	
*1026	„ 27	260	21 11	157 25	310	6·7	22·9	„	88	1·02354	1·02542	1·02659	
+*1035	Aug. 12	261	20 18	157 14	2050	1·8	25·3	„	83	1·02320	1·02577	0·02783	Sandwich Ids. towards Tahiti.
+*1045	„ 20	262	19 12	154 14	2875	1·8	25·4	„	82	1·02315	1·02569	1·02775	
+*1051	„ 21	263	17 33	153 36	2650	1·7	25·3	„	77	1·02287	1·02544	1·02750	
+*1063	„ 23	264	14 19	152 37	3000	1·8	26·1	„	83	1·02313	1·02594	1·02800	
+*1067	„ 25	265	12 42	152 1	2900	1·7	26·6	„	71·5	1·02253	1·02551	1·02757	
+1076	„ 26	266	11 7	152 3	2750	1·7	26·8	„	76	1·02277	1·02579	1·02785	
+*1087	„ 28	267	9 28	150 49	2700	1·7	27·7	„	70	1·02242	1·02572	1·02778	

XIV. *Bottom Water of the North Pacific*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
	1875.		N.	W.									
†*1096	Aug. 30	268	7° 35′	149° 49′	2900	1°·5	25°·7	00 IV.	79·5	1·02300	1·02569	1·02776	Sandwich Ids. towards Tahiti.
†*1108	Sept. 2	269	3 54	147 2	2550	1·8	26·7	,,	75	1·02272	1·02571	1·02777	
†*1118	,, 4	270	2 34	149 9	2925	1·4	25·8	,,	80·5	1·02306	1·02578	1·02786	

XV. *Intermediate Waters of the North Pacific.*

	1875.		N.	E.									
686	Feb. 12	215	4 19	150 15	50	23·6	26·9	00 IV.	78	1·02288	1·02593	1·02385	Meangis Island to Admiralty Ids.
687	,, 12				100	20·0	26·9	,,	83·5	1·02318	1·02627	1·02516	
688	,, 12				150	15·6	26·8	,,	77	1·02282	1·02584	1·02583	
689	,, 12				200	12·2	26·7	,,	76·5	1·02280	1·02579	1·02648	
690	,, 12				400	6·2	26·8	,,	72·5	1·02254	1·02549	1·02722	
742	Mar. 13	221	0 49	148 41	10	28·2	28·9	,,	68	1·02228	1·02596	1·02347	Admiralty Islands to Japan.
743	,, 13				20	28·2	29·1	,,	68	1·02228	1·02602	1·02256	
744	,, 13				50	27·6	28·5	,,	73	1·02257	1·02616	1·02289	
745	,, 13				100	21·8	28·4	,,	75	1·02269	1·02625	1·02465	
746	,, 13				200	10·0	28·2	,,	67·5	1·02228	1·02571	1·02633	
747	,, 13				300	9·9	28·3	,,	65	1·02213	1·02562	1·02687	
748	,, 13				350	7·9	28·4	,,	65	1·02213	1·02565	1·02706	
752	,, 16	222	2 15	146 16	50	27·8	28·6	00 III. + 0·05	97	1·02266	1·02628	1·02291	
753	,, 16				70	27·0	28·6	00 IV.	71	1·02244	1·02603	1·02270	
754	,, 16				100	26·1	28·5	,,	72	1·02250	1·02605	1·02324	
755	,, 16				200	9·2	28·5	,,	88	1·02238	1·02583	1·02705	
756	,, 16				300	7·5	28·6	,,	62	1·02201	1·02560	1·02708	
757	,, 16				380	6·5	28·5	,,	64	1·02206	1·02561	1·02720	
762	,, 18	—	4 21	145 18	10	28·7	28·5	,,	69	1·02235	1·02590	1·02228	
764	,, 19	223	5 31	145 13	10	27·8	28·0	,,	71	1·02247	1·02587	1·02260	
765	,, 19				20	27·6	27·4	,,	72	1·02254	1·02575	1·02248	
766	,, 19				50	27·6	27·5	,,	74	1·02265	1·02580	1·02262	
767	,, 19				100	21·6	27·6	,,	70	1·02242	1·02549	1·02417	
768	,, 19				200	8·7	27·5	,,	70	1·02242	1·02566	1·02685	
769	,, 19				300	7·7	27·5	,,	68	1·02232	1·02556	1·02700	
770	,, 19				400	6·8	27·6	,,	69·5	1·02240	1·02567	1·02723	
774	,, 21	224	7 45	144 20	10	27·5	27·4	,,	70	1·02243	1·02564	1·02240	
775	,, 21				25	27·2	27·2	,,	69	1·02229	1·02553	1·02238	
776	,, 21				50	26·4	27·5	,,	70·5	1·02245	1·02568	1·02279	
777	,, 21				100	17·3	27·0	,,	72	1·02255	1·02584	1·02524	
778	,, 21				200	9·0	27·1	,,	70	1·02244	1·02556	1·02681	
779	,, 21				300	7·6	27·1	,,	70	1·02244	1·02559	1·02701	
780	,, 21				400	6·3	27·2	,,	69·5	1·02241	1·02556	1·02718	
785	,, 23	225	11 24	143 16	20	26·7	26·8	,,	73·5	1·02263	1·02565	1·02286	
786	,, 23				50	26·7	26·5	,,	75	1·02273	1·02566	1·02267	
787	,, 23				100	19·4	26·5	,,	78	1·02293	1·02582	1·02433	
788	,, 23				200	9·5	26·5	,,	71	1·02251	1·02544	1·02661	
789	,, 23				300	6·2	26·6	,,	73	1·02263	1·02559	1·02722	
790	,, 23				400	5·1	26·6	,,	73	1·02263	1·02559	1·02735	
794	,, 25	226	14 44	142 13	25	26·0	27·6	,,	69	1·02237	1·02570	1·02292	
795	,, 25				50	25·6	26·2	,,	79	1·02290	1·02580	1·02308	
796	,, 25				100	21·8	26·1	,,	83	1·02318	1·02599	1·02441	
797	,, 25				200	11·5	26·1	,,	75	1·02273	1·02556	1·02639	
798	,, 25				300	7·2	26·0	,,	72·5	1·02261	1·02539	1·02688	
799	,, 25				400	5·4	26·1	,,	72	1·02258	1·02539	1·02712	
802	,, 27	227	17 29	141 21	25	25·9	26·0	,,	79	1·02296	1·02574	1·02299	
803	,, 27				50	25·7	26·3	,,	77·5	1·02288	1·02575	1·02306	

XV. *Water from Intermediate Depths in the North Pacific*—continued.

Number of Sample.	Date.	Distinguishable Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1875.		N. ° ′	E. ° ′		°	°						
804	Mar. 27	227	17 29	141 21	100	22·9	26·3	00 IV.	83	1·02318	1·02605	1·02417	Admiralty Islands to Japan.
805	" 27				200	13·9	26·2	"	81	1·02307	1·02591	1·02628	
806	" 27				300	7·9	26·4	"	76	1·02246	1·02536	1·02677	
807	" 27				400	5·5	26·4	"	72·5	1·02260	1·02550	1·02721	
810	" 29	228	19 24	141 13	25	26·1	26·2	"	80	1·02302	1·02586	1·02305	
811	" 29				50	25·2	26·7	"	79	1·02293	1·02592	1·02338	
812	" 29				100	21·9	26·5	"	78·5	1·02291	1·02584	1·02423	
813	" 29				200	14·4	26·5	"	75	1·02273	1·02566	1·02591	
814	" 29				300	8·7	26·4	"	71	1·02252	1·02542	1·02671	
815	" 29				400	5·9	26·4	"	69	1·02240	1·02530	1·02697	
819	April 1	229	22 1	140 27	25	24·2	26·8	"	78	1·02288	1·02590	1·02365	
820	" 1				50	22·9	25·0	"	87·5	1·02340	1·02594	1·02408	
821	" 1				100	20·5	25·4	"	83	1·02320	1·02580	1·02457	
822	" 1				200	15·8	25·1	"	80	1·02304	1·02555	1·02549	
823	" 1				300	11·1	24·6	"	73·5	1·02270	1·02507	1·02597	
824	" 1				400	6·8	25·1	"	75	1·02277	1·02528	1·02684	
829	" 5	230	26 29	137 57	25	19·4	22·2	00 IV. 00 V.	98 1	1·02411 1·02408	1·02582	1·02488	
830	" 5				50	18·9	22·5	00 IV. 00 V.	96 0	1·02400 1·02405	1·02579	1·02498	
831	" 5				100	17·7	22·2	00 IV. 00 V.	98 2·5	1·02411 1·02418	1·02583	1·02533	
832	" 5				200	15·4	22·1	00 IV.	95	1·02395	1·02561	1·02565	
833	" 5				300	10·3	22·1	"	93	1·02385	1·02551	1·02655	
834	" 5				400	6·1	22·4	"	89	1·02362	1·02509	1·02674	
839	" 9	231	31 8	137 8	25	16·7	18·9	00 V.	13	1·02485	1·02566	1·02540	
840	" 9				50	15·5	18·9	"	12	1·02481	1·02562	1·02564	
841	" 9				100	13·2	19·1	"	10	1·02479	1·02565	1·02615	
842	" 9				200	8·3	19·2	"	8	1·02458	1·02546	1·02681	
843	" 9				300	4·8	19·1	"	8	1·02458	1·02544	1·02723	
844	" 9				400	3·4	19·1	"	9	1·02463	1·02549	1·02742	
867	June 19	239	35 18	147 9	50	17·8	21·6	"	5	1·02433	1·02585	1·02533	Japan to Sandwich Islands.
868	" 19				100	16·8	23·1	00 IV.	93	1·02381	1·02575	1·02547	
869	" 19				200	12·8	23·1	"	90	1·02366	1·02560	1·02618	
870	" 19				400	5·3	23·1	"	84	1·02332	1·02526	1·02700	
874	" 21	240	35 20	153 39	25	14·0	21·2	"	98·5	1·02417	1·02558	1·02591	
875	" 21				50	11·3	20·9	"	97	1·02411	1·02544	1·02630	
876	" 21				100	7·7	22·1	"	90	1·02369	1·02535	1·02679	
877	" 21				200	4·5	21·9	"	83·5	1·02343	1·02504	1·02686	
878	" 21				300	4·2	22·0	"	88	1·02357	1·02520	1·02706	
879	" 21				400	3·4	22·0	"	85	1·02341	1·02504	1·02697	
882	" 23	241	35 41	157 42	50	16·9	21·0	00 V.	5·5	1·02438	1·02574	1·02544	
883	" 23				100	15·2	20·4	"	7·0	1·02447	1·02567	1·02575	
884	" 23				200	10·4	22·3	00 IV.	96	1·02401	1·02573	1·02675	
885	" 23				300	5·8	22·4	"	96	1·02401	1·02575	1·02743	
886	" 23				400	4·3	21·7	00 V.	2·5	1·02420	1·02575	1·02759	
887	" 23				600	2·5	22·3	00 IV.	94	1·02389	1·02561	1·02761	
893	" 26	243	35 24	166 35	50	15·8	20·5	00 V.	7	1·02447	1·02570	1·02564	
894	" 26				100	14·6	22·6	00 IV.	91·5	1·02374	1·02559	1·02580	
895	" 26				200	11·9	22·9	"	89·5	1·02364	1·02552	1·02627	
896	" 26				300	7·2	22·8	"	85·5	1·02340	1·02525	1·02675	
897	" 26				400	4·7	22·0	"	88	1·02354	1·02549	1·02722	
900	" 28	244	35 22	169 53	25	16·1	21·4	"	98·5	1·02416	1·02563	1·02551	
901	" 28				50	15·1	22·8	"	91·5	1·02374	1·02559	1·02569	
902	" 28				100	13·4	22·5	"	91·5	1·02375	1·02552	1·02599	
903	" 28				200	9·9	22·8	"	87	1·02349	1·02534	1·02645	
904	" 28				300	6·2	22·7	"	84·5	1·02336	1·02519	1·02682	
905	" 28				400	4·7	22·7	"	85	1·02338	1·02521	1·02701	
906	" 28				600	3·3	22·7	"	85	1·02338	1·02521	1·02715	

XV. *Water from Intermediate Depths in the North Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity (*Distilled Water at 4° C. = 1.*)		
				Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.
						D	T	t		R	S_t	$S_{15·56}$	S_T
	1875.			N. ° '	E. ° '		°	°					
915	July	2				25	16·4	22·8	60 IV.	92	1·02378	1·02565	1·02544
916	,,	2				50	14·7	23·1	,,	91·5	1·02374	1·02568	1·02587
917	,,	2				100	13·9	22·6	,,	93	1·02382	1·02563	1·02598
918	,,	2	246	36 10	178 0	200	11·7	23·0	,,	88	1·02353	1·02544	1·02628
919	,,	2				300	8·3	23·0	,,	88	1·02353	1·02544	1·02679
920	,,	2				400	5·4	22·7	,,	88	1·02344	1·02527	1·02700
921	,,	2				1000	2·4	23·1	,,	85	1·02337	1·02531	1·02732
				N.	W.								
928	,,	5				25	14·8	22·9	,,	89	1·02360	1·02548	1·02585
929	,,	5				50	12·5	22·8	,,	90	1·02367	1·02547	1·02611
930	,,	5				100	10·9	22·9	,,	85	1·02349	1·02537	1·02630
931	,,	5	248	37 41	177 4	200	8·0	22·9	,,	85	1·02337	1·02523	1·02665
932	,,	5				300	5·5	22·9	,,	84	1·02332	1·02520	1·02691
933	,,	5				400	4·2	22·8	,,	85	1·02337	1·02522	1·02708
934	,,	5				2475	1·8	22·8	,,	84	1·02332	1·02517	1·02723
941	,,	9				25	14·7	20·1	,,	99·5	1·02425	1·02557	1·02556
942	,,	9				50	12·8	19·1	,,	87·5	1·02365	1·02449	1·02507
943	,,	9				100	11·7	20·7	,,	97	1·02411	1·02530	1·02618
944	,,	9	250	37 49	166 47	200	9·5	20·6	,,	98	1·02417	1·02542	1·02659
945	,,	9				300	7·4	20·6	,,	95·5	1·02403	1·02528	1·02676
946	,,	9				400	5·9	21·5	,,	92	1·02381	1·02531	1·02698
947	,,	9				2800	1·8	20·7	,,	97	1·02411	1·02529	1·02745
950	,,	10				50	12·9	19·2	60 V.	8	1·02446	1·02528	1·02584
951	,,	10	251	37 37	163 26	100	11·4	19·4	,,	5·5	1·02442	1·02536	1·02620
952	,,	10				2350	1·8	19·4	,,	7	1·02450	1·02544	1·02750
956	,,	12				25	12·8	19·0	,,	2·5	1·02428	1·02511	1·02569
957	,,	12				75	11·4	19·0	,,	4·5	1·02439	1·02522	1·02606
958	,,	12				130	9·8	19·1	,,	6	1·02446	1·02532	1·02644
959	,,	12	252	37 52	160 17	225	7·2	19·1	,,	5	1·02441	1·02527	1·02677
960	,,	12				300	5·7	19·0	,,	3	1·02431	1·02514	1·02683
961	,,	12				400	4·3	19·3	,,	2·5	1·02427	1·02518	1·02702
962	,,	12				850	2·2	19·1	,,	8·5	1·02465	1·02546	1·02749
963	,,	12				2340	1·6	19·1	,,	5	1·02441	1·02527	1·02733
966	,,	14				25	14·9	21·3	60 IV.	88·5	1·02360	1·02504	1·02519
967	,,	14				50	11·9	21·3	,,	88	1·02358	1·02502	1·02577
968	,,	14				100	10·2	21·2	,,	94	1·02383	1·02534	1·02629
969	,,	14	253	38 9	156 25	200	8·3	21·2	,,	91	1·02376	1·02517	1·02652
970	,,	14				300	4·9	21·2	,,	91	1·02376	1·02517	1·02695
971	,,	14				400	4·0	22·2	,,	90	1·02368	1·02537	1·02725
972	,,	14				800	2·4	22·7	,,	85·5	1·02341	1·02524	1·02725
973	,,	14				3000	1·8	21·8	,,	99·5	1·02426	1·02578	1·02784
979	,,	17				25	16·8	22·4	,,	90	1·02367	1·02567	1·02536
980	,,	17				50	13·8	22·8	,,	84·5	1·02335	1·02520	1·02555
981	,,	17				100	11·1	22·5	,,	89	1·02362	1·02539	1·02629
982	,,	17	254	35 13	154 43	200	8·2	22·7	,,	87	1·02349	1·02532	1·02669
983	,,	17				300	6·3	22·5	,,	86	1·02344	1·02521	1·02683
984	,,	17				400	4·8	23·5	,,	82	1·02320	1·02525	1·02704
985	,,	17				800	2·5	23·3	,,	88	1·02353	1·02552	1·02752
986	,,	17				2950	1·8	23·2	,,	87·5	1·02351	1·02548	1·02754
991	,,	19	255	32 28	154 33	2100	1·8	24·2	,,	81	1·02327	1·02552	1·02758
994	,,	21				25	21·1	24·8	,,	92	1·02371	1·02514	1·02375
995	,,	21				50	18·3	24·9	,,	87	1·02343	1·02538	1·02523
996	,,	21				100	13·1	24·6	,,	81	1·02310	1·02547	1·02558
997	,,	21	256	30 22	154 56	200	8·9	24·7	,,	77	1·02290	1·02530	1·02656
998	,,	21				300	6·0	24·5	,,	77	1·02291	1·02525	1·02691
999	,,	21				400	4·3	24·7	,,	75·5	1·02280	1·02520	1·02704
1000	,,	21				800	2·4	24·8	,,	77	1·02290	1·02533	1·02734
1001	,,	21				2875	1·8	25·0	,,	77	1·02289	1·02537	1·02743
1005	,,	23	257	27 33	154 55	25	21·8	24·1	,,	94	1·02385	1·02507	1·02449
1006	,,	23				50	18·2	24·1	,,	92·5	1·02376	1·02598	1·02533

Japan to the Sandwich Islands.

XV. *Water from Intermediate Depths in the North Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled Water at 4° C. = 1.*)			
				Latitude.	Longitude.		At the Depth T.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D	T	t		R	S_t	$S_{15·56}$	S_T	
	1875.			N.	W.									
				° ′	° ′		°	°						
1007	July	23	257	27 33	154 55	100	13·6	24·1	60 IV.	65	1·02335	1·02557	1·02599	Japan to the Sandwich Islands.
1008	,,	23				200	9·3	24·1	,,	80·5	1·02310	1·02532	1·02652	
1009	,,	23				2350	1·6	24·5	,,	80	1·02305	1·02539	1·02746	
1016	,,	26	259	23 3	156 6	25	24·2	25·0	,,	79·5	1·02302	1·02550	1·02325	
1017	,,	26				50	22·8	25·1	,,	83	1·02320	1·02571	1·02391	
1018	,,	26				100	18·0	24·7	,,	89	1·02332	1·02572	1·02514	
1019	,,	26				200	9·2	24·4	,,	73	1·02296	1·02527	1·02647	
1020	,,	26				300	6·0	24·4	,,	78·5	1·02298	1·02529	1·02695	
1021	,,	26				400	4·7	24·5	,,	78	1·02295	1·02529	1·02709	
1022	,,	26				500	3·0	25·1	,,	74	1·02272	1·02523	1·02720	
1023	,,	26				2150	1·6	25·3	,,	78	1·02293	1·02550	1·02757	
1029	Aug.	12	261	20 18	157 14	25	25·9	25·3	,,	80	1·02303	1·02566	1·02350	Sandwich Islands to Tahiti.
1030	,,	12				50	21·8	25·5	,,	83	1·02320	1·02583	1·02431	
1031	,,	12				100	15·0	25·3	,,	80	1·02303	1·02566	1·02579	
1032	,,	12				200	8·1	25·5	,,	73	1·02265	1·02528	1·02666	
1033	,,	12				300	5·9	25·5	,,	72·5	1·02262	1·02525	1·02692	
1034	,,	12				800	2·9	25·3	,,	74	1·02271	1·02528	1·02725	
1038	,,	20	262	19 12	154 14	25	25·0	25·1	,,	80·5	1·02306	1·02557	1·02309	
1039	,,	20				50	23·5	25·1	,,	80	1·02303	1·02554	1·02338	
1040	,,	20				100	16·4	25·1	,,	82	1·02315	1·02566	1·02547	
1041	,,	20				200	7·8	25·1	,,	73·5	1·02279	1·02530	1·02671	
1042	,,	20				300	6·7	25·1	,,	74	1·02271	1·02522	1·02679	
1043	,,	20				400	6·0	25·1	,,	75	1·02276	1·02527	1·02698	
1044	,,	20				800	3·0	25·1	,,	80	1·02303	1·02554	1·02751	
1047	,,	21	263	17 33	153 36	400	5·2	25·1	,,	77	1·02288	1·02539	1·02714	
1048	,,	21				1000	2·8	25·3	,,	77	1·02288	1·02549	1·02740	
1049	,,	21				2000	1·8	25·3	,,	75	1·02276	1·02533	1·02739	
1050	,,	21				2550	1·7	25·3	,,	75·5	1·02279	1·02536	1·02742	
1055	,,	22	264	14 19	152 37	25	25·2	26·1	,,	76	1·02275	1·02558	1·02302	
1056	,,	22				50	22·3	25·7	,,	78	1·02281	1·02550	1·02351	
1057	,,	22				100	12·3	25·5	,,	74·5	1·02273	1·02536	1·02603	
1058	,,	22				200	8·7	25·3	,,	79	1·02295	1·02561	1·02690	
1059	,,	22				300	6·9	25·5	,,	78·5	1·02295	1·02558	1·02712	
1060	,,	22				400	5·3	25·6	,,	78·5	1·02295	1·02561	1·02729	
1061	,,	22				800	3·3	25·7	,,	78·5	1·02295	1·02564	1·02758	
1062	,,	22				2550	1·8	26·0	,,	72	1·02252	1·02536	1·02742	
1066	,,	25	265	12 42	152 1	2425	1·8	26·5	,,	72	1·02257	1·02550	1·02756	
1069	,,	26	266	11 7	152 3	25	24·2	27·2	,,	73	1·02260	1·02575	1·02336	
1070	,,	26				50	18·1	26·7	,,	71	1·02251	1·02550	1·02490	
1071	,,	26				100	11·2	26·3	,,	78	1·02293	1·02577	1·02665	
1072	,,	26				200	9·0	26·3	,,	78	1·02290	1·02577	1·02702	
1073	,,	26				300	7·6	26·3	,,	76	1·02279	1·02566	1·02719	
1074	,,	26				400	5·5	26·4	,,	76·5	1·02282	1·02572	1·02743	
1075	,,	26				2275	1·8	27·2	,,	69·5	1·02240	1·02555	1·02761	
1079	,,	28	267	9 28	150 49	25	21·6	26·6	,,	72	1·02250	1·02552	1·02400	
1080	,,	28				50	13·3	26·5	,,	72·5	1·02250	1·02552	1·02600	
1081	,,	28				100	10·5	26·3	,,	78	1·02291	1·02578	1·02678	
1082	,,	28				200	8·8	26·3	,,	76	1·02280	1·02567	1·02695	
1083	,,	28				300	7·2	26·3	,,	75	1·02275	1·02562	1·02712	
1084	,,	28				400	5·8	26·9	,,	72	1·02255	1·02560	1·02738	
1085	,,	28				800	3·2	26·4	,,	78	1·02280	1·02570	1·02765	
1088	,,	28				2275	1·8	27·0	,,	69	1·02237	1·02564	1·02770	
1090	,,	30	268	7 35	149 49	25	26·3	25·9	,,	76·5	1·02281	1·02560	1·02272	
1091	,,	30				50	23·3	25·6	,,	81	1·02308	1·02575	1·02379	
1092	,,	30				100	10·2	26·5	,,	78	1·02287	1·02569	1·02671	
1093	,,	30				200	9·0	25·8	,,	78	1·02291	1·02563	1·02688	
1094	,,	30				300	7·7	25·8	,,	76·5	1·02282	1·02554	1·02698	
1095	,,	30				400	6·2	25·8	,,	76·5	1·02282	1·02554	1·02717	
1100	Sept.	2	269	5 54	147 2	25	25·5	26·7	,,	78	1·02278	1·02577	1·02314	
1101	,,	2				50	25·4	26·5	,,	78	1·02290	1·02583	1·02323	

XV. *Water from Intermediate Depths in the North Pacific*—continued.

Number of Sample.	Date.		Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (Distilled Water at 4° C. = 1.) Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
						D	T	t		R	S_t	$S_{15\cdot56}$	S_T	
	1875.			N.	W.									
1102	Sept.	2	269	5 54	147 2	100	15·3	26·4	60 IV.	75·5	1·02275	1·02565	1·02571	Sandwich Islands to Tahiti.
1103	,,	2				200	9·2	26·4	,,	74·5	1·02270	1·02560	1·02682	
1104	,,	2				400	6·5	26·5	,,	75·5	1·02275	1·02568	1·02727	
1105	,,	2				800	3·0	26·5	,,	80	1·02300	1·02593	1·02790	
1109	,,	4	270	2 34	149 9	25	25·2	26·0	,,	62	1·02213	1·02591	1·02337	
1110	,,	4				50	21·2	25·6	,,	86	1·02306	1·02572	1·02347	
1111	,,	4				100	17·1	25·7	,,	79	1·02298	1·02567	1·02532	
1112	,,	4				200	11·1	25·7	,,	80	1·02303	1·02572	1·02602	
1113	,,	4				300	9·0	25·6	,,	81	1·02309	1·02575	1·02700	
1114	,,	4				400	7·2	25·6	,,	80·5	1·02306	1·02572	1·02722	
1115	,,	4				2500	1·8	25·8	,,	80	1·02303	1·02573	1·02781	

XVI. *Surface Water—Miscellaneous Observations.*

	1874.			S.	E.		°	°						
573	Sept.	9	187	10 36	141 55	Surface.	25·4	26·2	60 IV.	88·5	1·02404	1·02691	1·02428	Arafura Sea.
574	,,	10	188	9 59	139 42	,,	25·8	26·7	,,	80	1·02300	1·02599	1·02327	
*575	,,	11	189	9 36	137 50	,,	26·1	26·8	,,	70·5	1·02248	1·02550	1·02269	
577	,,	11	...	9 27	137 26	,,	26·2	26·9	,,	71	1·02251	1·02556	1·02272	
578	,,	12	...	9 1	136 20	,,	26·2	26·7	,,	70	1·02246	1·02545	1·02261	
579	,,	13	...	8 18	135 7	,,	26·1	27·1	,,	70·5	1·02247	1·02550	1·02278	
580	,,	13	...	8 12	135 2	,,	26·7	27·0	,,	67	1·02228	1·02537	1·02238	
581	,,	14	...	7 13	134 18	,,	26·4	27·0	,,	62·5	1·02202	1·02538	1·02248	
582	,,	14	...	7 3	134 9	,,	26·9	27·1	,,	63	1·02207	1·02519	1·02213	
583	,,	15	—	6 36	133 54	,,	27·2	27·7	,,	57	1·02172	1·02505	1·02190	
584	,,	23	191	5 41	134 4½	,,	27·9	28·1	,,	52	1·02153	1·02496	1·02158	Banda Sea.
*585	,,	24	191A	5 26	133 19	,,	27·5	28·3	,,	68	1·02230	1·02579	1·02255	
587	,,	26	192	5 49	132 14	,,	27·8	29·0	,,	65·5	1·02214	1·02585	1·02252	
588	,,	27	—	5 46	132 0	,,	27·5	28·4	,,	69	1·02246	1·02598	1·02274	
589	,,	28	—	5 26	130 22	,,	28·6	30·7	,,	53	1·02147	1·02565	1·02207	
597	Oct.	1	...	4 15	129 46	,,	28·9	28·9	,,	63	1·02201	1·02569	1·02201	
*598	,,	3	195	4 21	129 7	,,	27·8	28·2	,,	71·5	1·02256	1·02602	1·02270	
600	,,	4	...	3 55	128 10	,,	27·8	28·2	,,	66·5	1·02223	1·02569	1·02236	
601	,,	11	...	3 16	127 21	,,	27·9	28·7	,,	70	1·02240	1·02602	1·02266	
602	,,	12	...	1 42	127 7	,,	27·9	28·7	,,	62	1·02196	1·02558	1·02223	Molucca Passage.
603	,,	12	...	1 27	127 7	,,	28·2	28·7	,,	62	1·02196	1·02558	1·02212	
*604	,,	13	196	0 48½	126 58½	,,	28·3	28·7	,,	62	1·02196	1·02558	1·02209	
				N.	E.									
*606	,,	14	197	0 41	126 37	,,	28·0	29·0	,,	54	1·02152	1·02523	1·02183	
608	,,	14	...	0 44	127 17	,,	28·3	28·2	,,	54·5	1·02157	1·02503	1·02154	
609	,,	17	...	0 55	127 0	,,	28·7	28·8	,,	48·5	1·02122	1·02487	1·02124	
610	,,	18	...	0 57	126 24	,,	28·6	29·0	,,	51	1·02138	1·02507	1·02148	
611	,,	19	...	1 54½	125 29	,,	28·6	28·4	,,	66	1·02220	1·02572	1·02228	
612	,,	19	...	2 6½	125 15	,,	28·3	28·3	,,	65	1·02214	1·02563	1·02214	Celebes Sea.
613	,,	19	...	2 7½	125 15	,,	28·4	28·5	,,	63	1·02197	1·02552	1·02200	
614	,,	19	...	2 15	125 9	,,	28·3	28·3	,,	63	1·02202	1·02567	1·02219	
†*615	,,	20	198	2 55	124 53	,,	29·4	29·6	,,	61	1·02192	1·02551	1·02167	
622	,,	21	...	4 4	124 22	,,	28·9	29·5	,,	56·5	1·02164	1·02554	1·02185	
†*623	,,	22	199	5 44	122 34	,,	28·3	29·0	,,	58	1·02174	1·02545	1·02196	
624	,,	22	...	5 47	122 33	,,	28·3	28·8	,,	51·5	1·02133	1·02503	1·02154	
625	,,	22	*	6 3	122 20	,,	29·4	29·6	,,	56	1·02162	1·02552	1·02168	
630	,,	28	...	6 49	122 28	,,	28·9	29·7	,,	52·5	1·02142	1·02536	1·02168	
	1875.													
672	Feb.	3	—	6 48	122 49	,,	27·6	27·4	,,	55·5	1·02164	1·02485	1·02159	

XVI. *Surface Water—Miscellaneous Observations*—continued.

Number of Sample.	Date.	Distinguishing Number of Station.	Position. Latitude.	Position. Longitude.	Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water. At the Depth D.	Temperature (Centigrade) of Water. During Observation.	Hydrometer. Number of the Instrument.	Hydrometer. Reading.	Specific Gravity. (*Distilled Water at 4° C. = 1.*) Observed at t° C.	Specific Gravity. Reduced to its Value at 15°·56 C.	Specific Gravity. Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15.56}$	S_T	
			N.	E.									
	1875.												
673	Feb. 7	...	6° 4′	123° 35′	Surface.	27°·8	27°·6	00 IV.	54	1·02155	1·02482	1·02149	Celebes Sea.
674	,, 8	...	5 45	123 59	,,	27·8	28·0	,,	50·5	1·02135	1·02475	1·02141	
	1874.												
631	Oct. 26	201	7 3	121 48	,,	28·3	28·7	,,	54	1·02153	1·02515	1·02167	Sulu Sea.
+*632	,, 27	202	8 22	121 55	,,	28·3	29·0	,,	47	1·02123	1·02494	1·02143	
637	,, 27	...	8 54	122 6	,,	28·6	29·0	,,	53	1·02146	1·02517	1·02159	
638	,, 28	...	10 20	122 16	,,	29·4	29·3	,,	38	1·02064	1·02445	1·02061	
639	,, 28	...	10 36	122 31	,,	29·4	29·4	,,	39	1·02070	1·02454	1·02070	
	1875.												
670	Jan. 28	...	7 53	121 42	,,	27·3	28·2	,,	67	1·02225	1·02571	1·02261	
	1874.												
640	Nov. 1	...	11 19	123 21	,,	28·9	29·1	,,	39	1·02076	1·02444	1·02076	Seas enclosed by the Philippine Islands.
641	,, 1	...	11 47	123 3	,,	28·9	29·2	,,	49	1·02124	1·02502	1·02132	
642	,, 2	204	12 28	122 15	,,	28·9	29·0	,,	53	1·02146	1·02517	1·02148	
644	,, 2	204A	12 46	122 10	,,	28·9	29·3	,,	52	1·02140	1·02521	1·02151	
645	,, 3	...	13 31	121 17	,,	28·6	28·2	,,	54	1·02154	1·02500	1·02142	
646	,, 3	...	13 36	120 54	,,	28·2	28·7	,,	48	1·02120	1·02482	1·02136	
	1875.												
+*661	Jan. 16	207	12 21	122 15	,,	26·7	26·7	,,	64·5	1·02214	1·02513	1·02214	
661a	,, 16	207	12 21	122 15	,,	26·7	26·9	,,	64	1·02212	1·02517	1·02219	
666	,, 17	...	11 40	123 17	,,	27·3	27·5	,,	61	1·02193	1·02517	1·02202	
667	,, 18	...	10 21	124 0	,,	27·2	27·6	,,	59	1·02182	1·02509	1·02194	
668	,, 26	...	9 10	124 25	,,	27·2	27·0	,,	64	1·02211	1·02520	1·02204	
669	,, 27	...	8 50	123 29	,,	26·7	26·4	,,	70	1·02245	1·02535	1·02235	
	1874.												
646a	Nov. 11	...	14 55	120 55	,,	27·0	27·6	,,	38·5	1·02061	1·02388	1·02079	China Sea.
647	,, 12	...	15 7	119 49	,,	28·3	28·9	,,	47	1·02113	1·02481	1·02132	
*648	,, 13	205	16 42	119 22	,,	27·8	28·4	,,	53·5	1·02150	1·02503	1·02170	
650	,, 14	...	18 15	118 0	,,	25·4	21·9	,,	89	1·02264	1·02525	1·02265	
651	,, 15	...	20 20	115 30	,,	25·3	21·8	,,	87	1·02258	1·02511	1·02248	
652	,, 16	...	21 50	114 12	,,	19·2	21·2	,,	72·5	1·02282	1·02423	1·02335	
653	Dec. 8	...	22 17	114 10	,,	19·1	20·4	,,	72	1·02284	1·02404	1·02318	
	1875.												
654	Jan. 7	...	20 16	115 41	,,	22·5	21·6	,,	95	1·02396	1·02554	1·02377	
*655	,, 8	206	17 54	117 14	,,	24·0	23·6	,,	83	1·02325	1·02538	1·02319	
657	,, 9	...	16 35	117 47	,,	25·0	25·4	,,	70	1·02249	1·02509	1·02261	
658	,, 10	...	15 29	119 27	,,	26·4	26·5	,,	61	1·02197	1·02490	1·02201	
659	,, 11	...	14 32	120 48	,,	26·4	27·1	,,	41	1·02085	1·02393	1·02103	
660	,, 15	...	13 42	120 40	,,	26·7	26·3	,,	58	1·02180	1·02470	1·02170	
850	May 26	...	34 28	134 1	,,	16·9	17·4	,,	68	1·02263	1·02306	1·02275	Inland Sea, Japan.
851	,, 26	...	34 24	133 54	,,	17·2	17·0	,,	70	1·02272	1·02320	1·02280	
852	,, 26	233B	34 18	133 35	,,	19·0	20·4	,,	66	1·02241	1·02361	1·02279	
853	,, 26	...	34 23	133 6	,,	20·0	18·2	,,	78	1·02313	1·02376	1·02268	
854	,, 28	...	34 23	133 6	,,	17·8	17·6	,,	81	1·02333	1·02381	1·02332	
855	,, 29	...	34 24	134 25	,,	17·6	18·1	,,	74	1·02293	1·02353	1·02310	
	1876.		S.	W.									
+*1401	Jan. 2	306	48 17	74 33	,,	13·9	14·4	00 III.	26	1·01546	1·01521	1·01557	Strait of Magellan and channels leading thereto from the Gulf of Peñas.
1406	,, 2	...	48 37	74 24	,,	6·7	12·7	00 I.	19	1·00540	1·00480	1·00636	
+1407	,, 4	...	48 55	74 10	,,	14·4	11·6	,,	50	1·00707	1·00626	1·00642	
+*1412	,, 4	307	49 24½	74 23½	,,	11·7	11·8	00 III.	32	1·01585	1·01508	1·01585	
1418	,, 5	...	49 39	74 28	,,	10·8	11·2	,,	14	1·01489	1·01401	1·01496	
+1419	,, 7	...	50 11	74 45	,,	10·5	11·7	00 IV.	57·5	1·02221	1·02142	1·02241	
1423	,, 8	...	50 10	74 41	,,	10·5	10·5	,,	57	1·02222	1·02122	1·02222	
1424	,, 8	...	50 17	74 46	,,	9·4	10·4	,,	74·5	1·02316	1·02214	1·02331	
*1425	,, 8	309	50 56	74 15	,,	10·3	10·4	,,	18	1·01998	1·01896	1·02000	
+*1428	,, 10	310	51 27½	74 3	,,	10·3	11·0	,,	17·5	1·02002	1·01910	1·02013	
1432	,, 11	...	52 44	73 48	,,	10·6	10·3	00 III.	97	1·01944	1·01840	1·01948	
+*1433	,, 11	311	52 45½	73 46	,,	10·9	10·6	00 IV.	17·5	1·02003	1·01904	1·02011	
1439	,, 13	...	53 30	72 43	,,	9·3	10·1	,,	63·5	1·02257	1·02150	1·02271	
1440	,, 13	312	53 37	70 56	,,	8·8	9·9	,,	79·5	1·02344	1·02233	1·02357	
1441	,, 20	...	52 23	69 4	,,	10·6	10·5	,,	89	1·02396	1·02303	1·02397	

XVII. *Bottom Water—Miscellaneous Observations.*

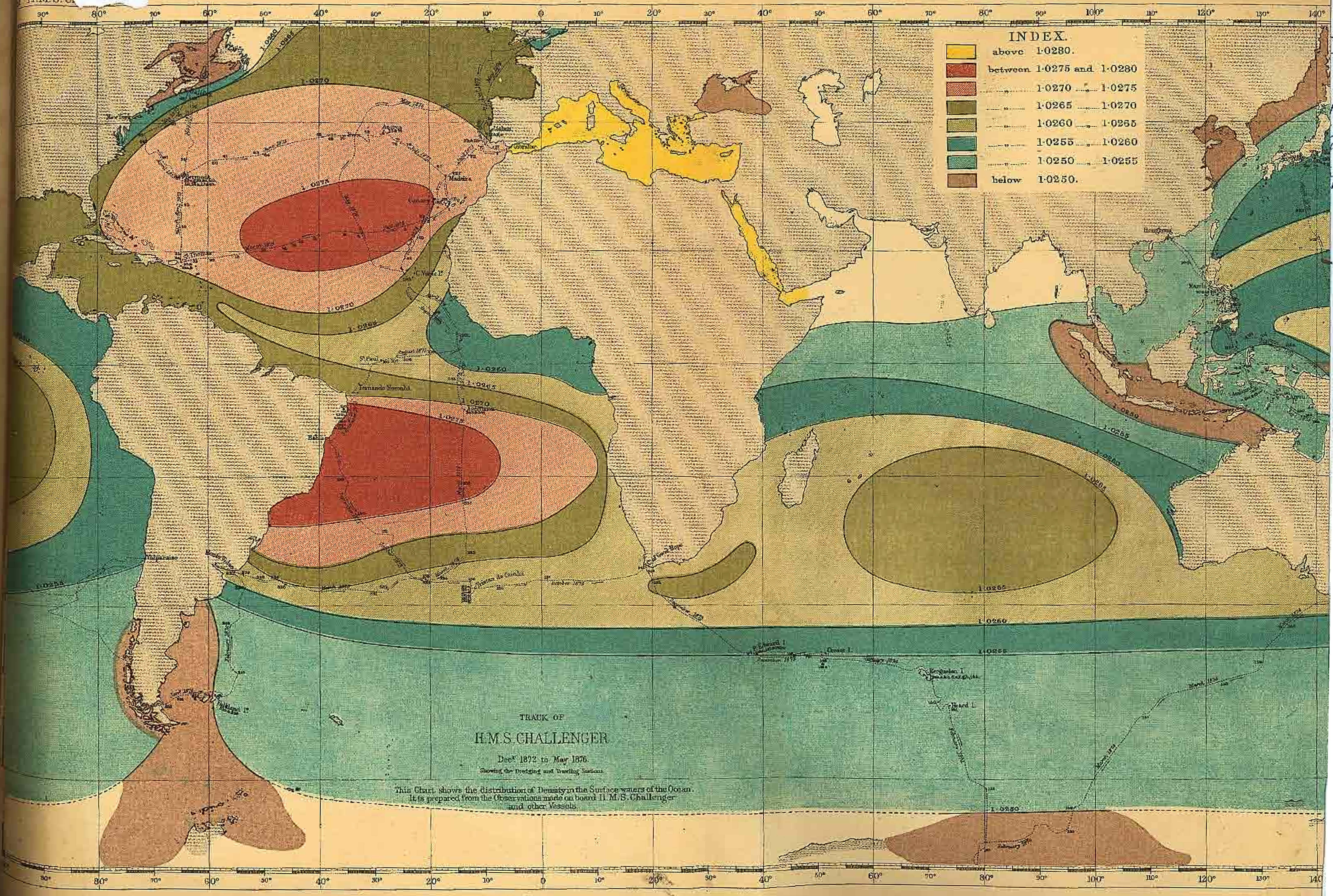
Number of Sample.	Date.	Distinguishing Number of Station.	Position		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (Distilled Water at 4° C. = 1.)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at 15°·56 C.	Reduced to its Value at T° C.	
					D	T	t		R	S_t	$S_{15·56}$	S_T	
			S.	E.									
*576	1874. Sept. 11	189	9° 36′	137° 50′	25	...	27·7	00 IV.	62	1·02100	1·02529	...	Arafura Sea.
*586	,, 24	191A	5 26	133 19	580	4·8	26·1	,,	79·5	1·02300	1·02581	1·02760	Banda Sea.
†596	,, 28	193	5 24	130 37½	2800	3·3	30·6	00 III. + 0·5 g	36	1·02137	1·02558	1·02752	
*599	Oct. 3	195	4 21	129 7	1425	3·3	27·6	00 IV.	69·5	1·02241	1·02568	1·02762	
*605	,, 13	196	0 48½	126 58½	825	3·7	27·7	,,	72	1·02254	1·02584	1·02783	Molucca Passage.
			N.	E.									
*607	,, 14	197	0 41	126 37	1200	2·2	27·8	,,	73	1·02260	1·02593	1·02796	
†*621	,, 20	198	2 55	124 53	2150	3·8	28·6	,,	67·5	1·02227	1·02586	1·02775	Celebes Sea.
†*629	,, 22	199	5 44	123 34	2600	3·7	29·6	,,	53	1·02145	1·02535	1·02725	
†675	1875. Feb. 8	213	5 47	124 1	2050	3·7	27·5	,,	70	1·02243	1·02567	1·02757	
†*636	1874. Oct. 27	202	8 32	121 55	2550	10·2	29·6	00 III. + 0·60 g	96	1·02165	1·02555	1·02659	Sulu Sea.
671	1875. Jan. 28	211	8 0	121 42	2225	10·3	28·1	00 IV.	63	1·02203	1·02546	1·02650	
643	1874. Nov. 2	204A	12 43	122 9	100	...	28·15	,,	67	1·02225	1·02569	...	Sea enclosed by the Philippine Ids.
†*665	1875. Jan. 16	207	12 21	122 15	700	10·9	28·8	,,	72	1·02255	1·02557	1·02650	
*649	1874. Nov. 13	205	16 42	119 22	1050	2·8	28·5	,,	66	1·02219	1·02574	1·02772	China Sea.
*656	1875. Jan. 8	206	17 54	117 14	2100	2·6	24·4	,,	85·5	1·02337	1·02568	1·02768	
	1876.		S.	W.									
1400	Jan. 1	305B	47 48	74 5	160	12·8	13·7	00 V.	23·5	1·02559	1·02519	1·02577	Strait of Magellan and passages leading thence from the Gulf of Peñas.
†1405	,, 2	306A	48 27	74 30	345	7·8	14·4	,,	20·5	1·02540	1·02518	1·02657	
†*1417	,, 4	307	49 24½	74 23½	140	7·9	11·6	,,	20	1·02548	1·02465	1·02606	
1427	,, 8	309A	50 56	74 14	140	8·1	9·4	,,	22·5	1·02565	1·02446	1·02584	
†*1431	,, 10	310	51 27½	74 3	400	8·1	11·0	,,	19·5	1·02543	1·02451	1·02589	
†*1438	,, 11	311	52 45½	73 46	245	7·8	11·5	,,	18·5	1·02537	1·02454	1·02596	

XVIII. *Miscellaneous Observations—Intermediate Results.*

	1874.		S.	E.									
590	Sept. 28	193	5 24	130 37½	50	25·5	28·7	00 IV.	68	1·02202	1·02564	1·02301	Banda Sea.
591	,, 28				100	18·9	28·6	,,	67	1·02224	1·02583	1·02502	
592	,, 28				200	10·1	31·0	,,	55	1·02152	1·02589	1·02696	
593	,, 28				300	7·8	30·5	,,	57	1·02164	1·02582	1·02724	
594	,, 28				400	6·4	30·4	00 III. + 0·5 g	91	1·02167	1·02582	1·02743	
595	,, 28				600	4·5	28·8	00 IV.	68	1·02220	1·02588	1·02751	
			N.	E.									
616	Oct. 20	198	2 55	124 53	50	25·1	28·6	,,	66	1·02219	1·02578	1·02327	Celebes Sea.
617	,, 20				100	18·2	28·6	,,	67·5	1·02227	1·02588	1·02521	
618	,, 20				200	9·5	28·5	,,	65	1·02213	1·02568	1·02685	
619	,, 20				400	5·5	28·5	,,	63·5	1·02205	1·02560	1·02731	
620	,, 20				800	3·9	28·8	00 III. + 0·6 g	93	1·02246	1·02604	1·02792	
626	,, 22	199	5 44	123 34	50	26·2	28·7	00 IV.	68	1·02229	1·02591	1·02307	
627	,, 22				100	17·7	29·2	,,	65	1·02211	1·02589	1·02530	
628	,, 22				200	9·0	28·7	,,	64	1·02208	1·02570	1·02695	

XVIII. *Miscellaneous Observations—Intermediate Results*—continued.

Number of Sample.	Date.	Challenger Number of Station.	Position.		Depth in Fathoms from which Sample was obtained.	Temperature (Centigrade) of Water.		Hydrometer.		Specific Gravity. (*Distilled* Water at 4° C. = 1.)			
			Latitude.	Longitude.		At the Depth D.	During Observation.	Number of the Instrument.	Reading.	Observed at t° C.	Reduced to its Value at		
											15°·56 C.	T° C.	
					D	T	t		R	S_t	$S_{15°·56}$	S_T	
			N.	E.									
	1875.		° ′	° ′		°	°						
676	Feb. 8	213	5 47	124 1	200	9·6	27·5	00 IV.	70	1·02243	1·02567	1·02682	Celebes Sea.
677	„ 8				100	18·3	27·6	„	70	1·02242	1·02569	1·02504	
678	„ 8				50	25·4	27·6	„	67	1·02236	1·02563	1·02293	
678a	„ 8				50	25·4	27·4	„	62	1·02200	1·02521	1·02261	
678b	„ 8				50	25·4	27·4	„	66·5	1·02224	1·02545	1·02285	
	1874.												
633	Oct. 27	202	8 32	121 55	50	23·4	28·2	„	64·5	1·02211	1·02557	1·02355	Sulu Sea.
634	„ 27				100	16·7	29·0	„	61	1·02191	1·02562	1·02536	
635	„ 27				200	11·1	29·1	„	47	1·02113	1·02487	1·02577	
	1875.												
662	Jan. 16	207	12 21	122 15	50	22·5	25·8	„	73	1·02264	1·02536	1·02359	Seas enclosed by Philippine Islands.
663	„ 16				100	14·7	26·6	„	71	1·02250	1·02540	1·02563	
664	„ 16				200	11·3	26·8	„	70·5	1·02247	1·02549	1·02635	
	1876.		S.	W.									
1402	Jan. 2	306a	48 27	74 30	100	7·9	13·3	00 V.	18·5	1·02531	1·02487	1·02628	Magellan Strait and passages leading thereto from the Gulf of Peñas.
1403	„ 2				200	7·8	13·3	„	22·5	1·02560	1·02519	1·02654	
1404	„ 2				300	7·8	14·3	„	18·5	1·02530	1·02503	1·02645	
1408	„ 4	...	48 55	74 19	2½	...	13·5	00 II.	13·5	1·00970	1·00926	...	
1409	„ 4				5	...	13·8	00 III.	92	1·01967	1·01870	...	
1410	„ 4				7	...	12·9	00 IV.	14·5	1·01984	1·01928	...	
1411	„ 4				10	...	12·5	„	78	1·02330	1·02266	...	
1412	„ 4				16	...	11·4	00 V.	6	1·02469	1·02385	...	
1414	„ 4	307	49 24½	74 23½	25	9·6	11·3	„	10	1·02491	1·02405	1·02520	
1415	„ 4				50	8·4	11·2	„	18·5	1·02538	1·02450	1·02584	
1416	„ 4				100	8·0	11·8	„	21	1·02550	1·02460	1·02609	
1420	„ 7	...	50 11	74 45	5	...	11·4	00 IV.	83	1·02358	1·02272	...	
1421	„ 7				10	...	11·0	00 V.	8	1·02453	1·02363	...	
1422	„ 7				22	...	11·1	„	17	1·02531	1·02441	...	
1426	„ 8	309	50 56	74 15	40	8·3	10·2	„	15	1·02522	1·02417	1·02552	
1429	„ 10	310	51 27½	74 3	25	9·1	10·8	00 IV.	91·5	1·02410	1·02315	1·02438	
1430	„ 10				200	8·1	11·0	00 V.	20·5	1·02550	1·02458	1·02596	
1434	„ 11	311	52 45½	73 46	25	9·0	12·0	00 IV.	90·5	1·02344	1·02271	1·02396	
1435	„ 11				50	8·4	11·7	00 V.	10	1·02491	1·02412	1·02546	
1436	„ 11				100	8·0	11·7	„	17·5	1·02531	1·02452	1·02592	
1437	„ 11				200	7·9	11·8	„	5·5	1·02463	1·02388	1·02529	



TRACK OF

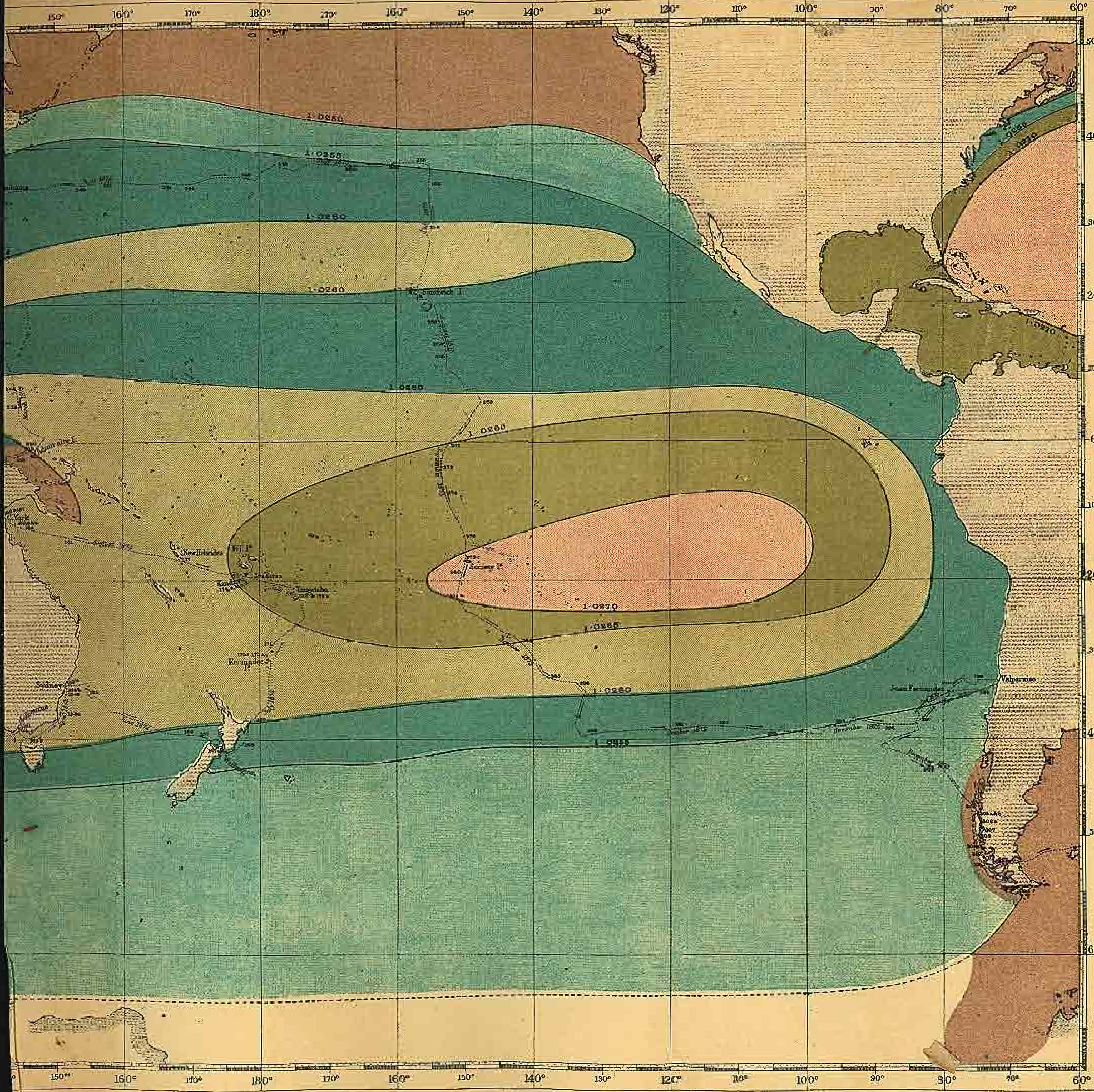
H.M.S. CHALLENGER

Decr. 1872 to May 1876.

Showing the Dredging and Trawling Stations.

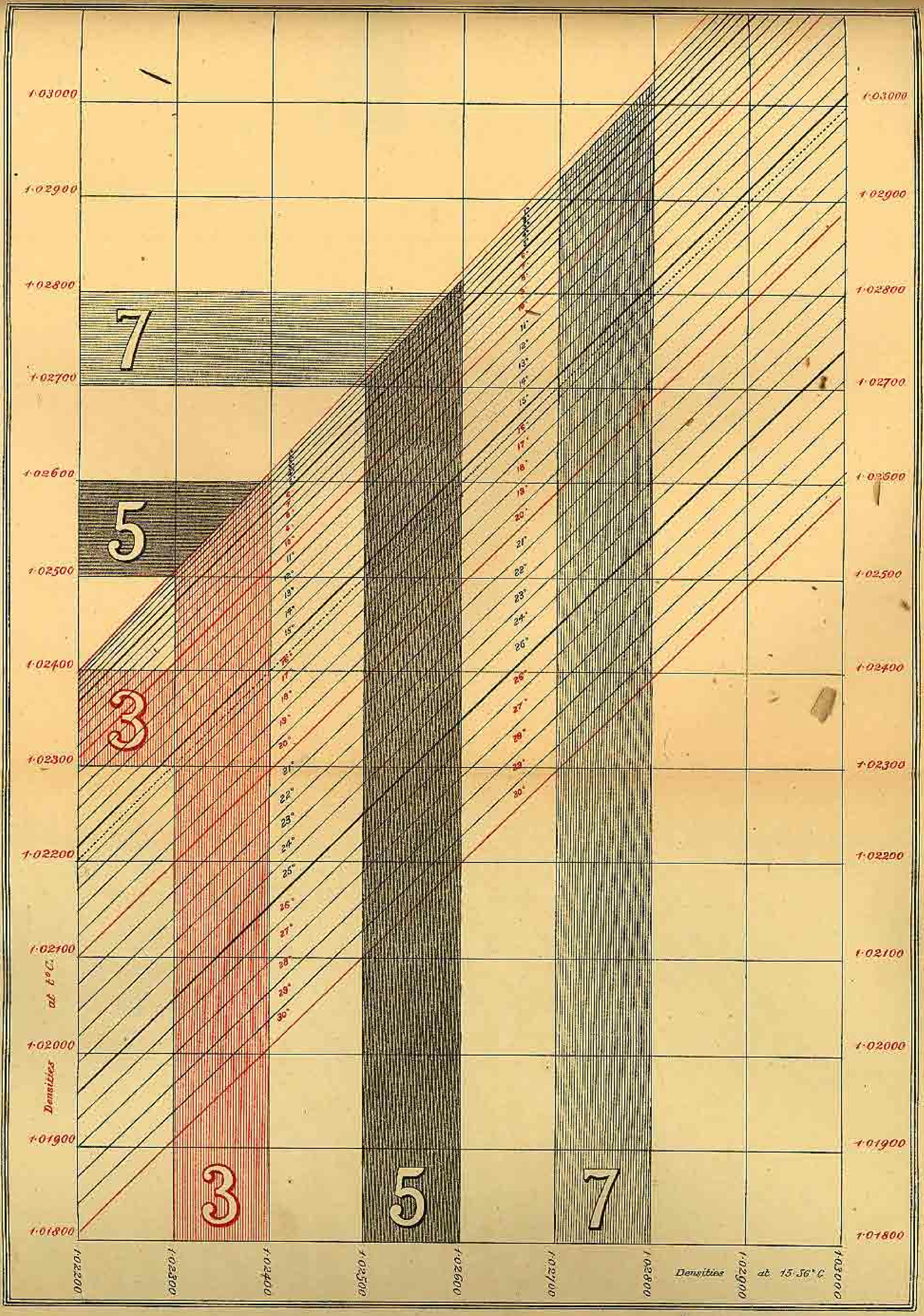
This Chart shows the distribution of Density in the Surface waters of the Ocean.
It is prepared from the Observations made on board H.M.S. Challenger
and other Vessels.

Specific Gravity of Sea Water.



Engraved by Malby & Sons.

DIAGRAM FOR CORRECTING SPECIFIC GRAVITY FOR TEMPERATURE.



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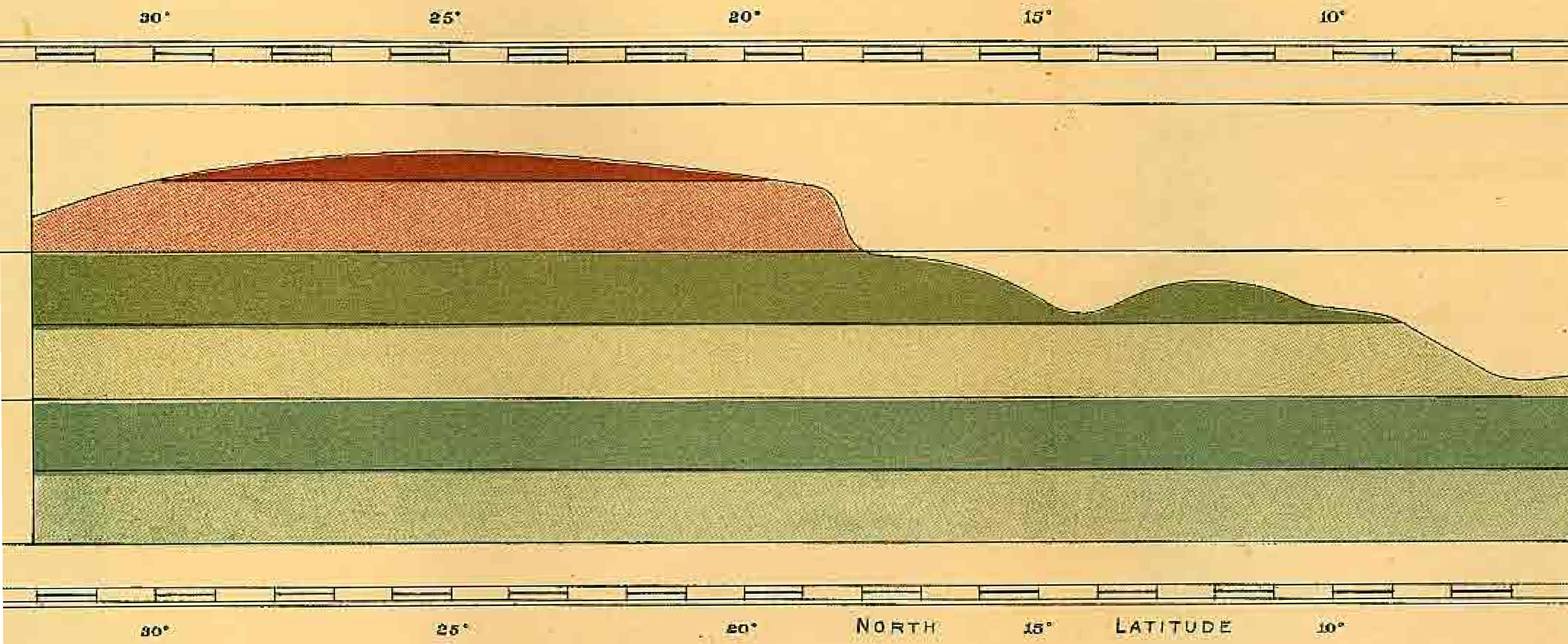
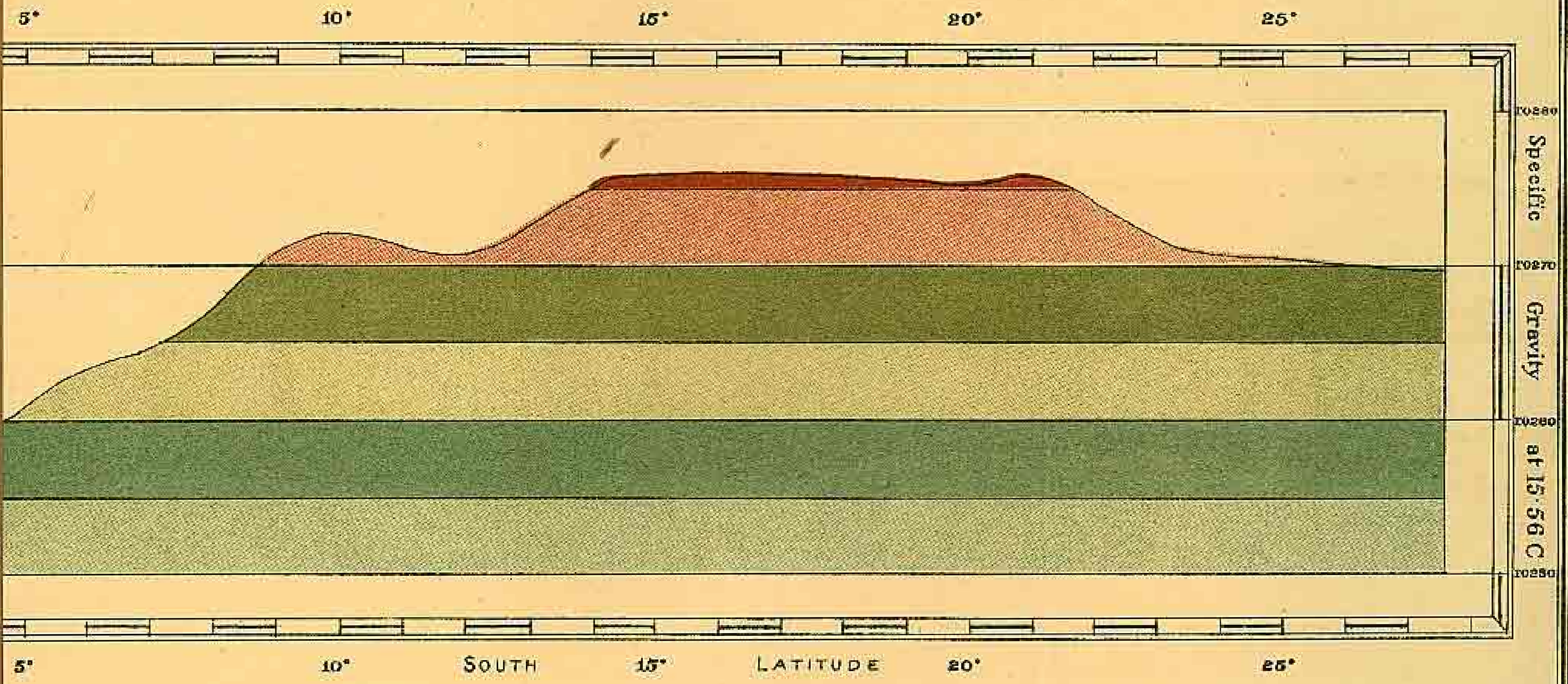


GRAPHIC REPRESENTATION

Specific Gravity of Sea Water. Diagram II.



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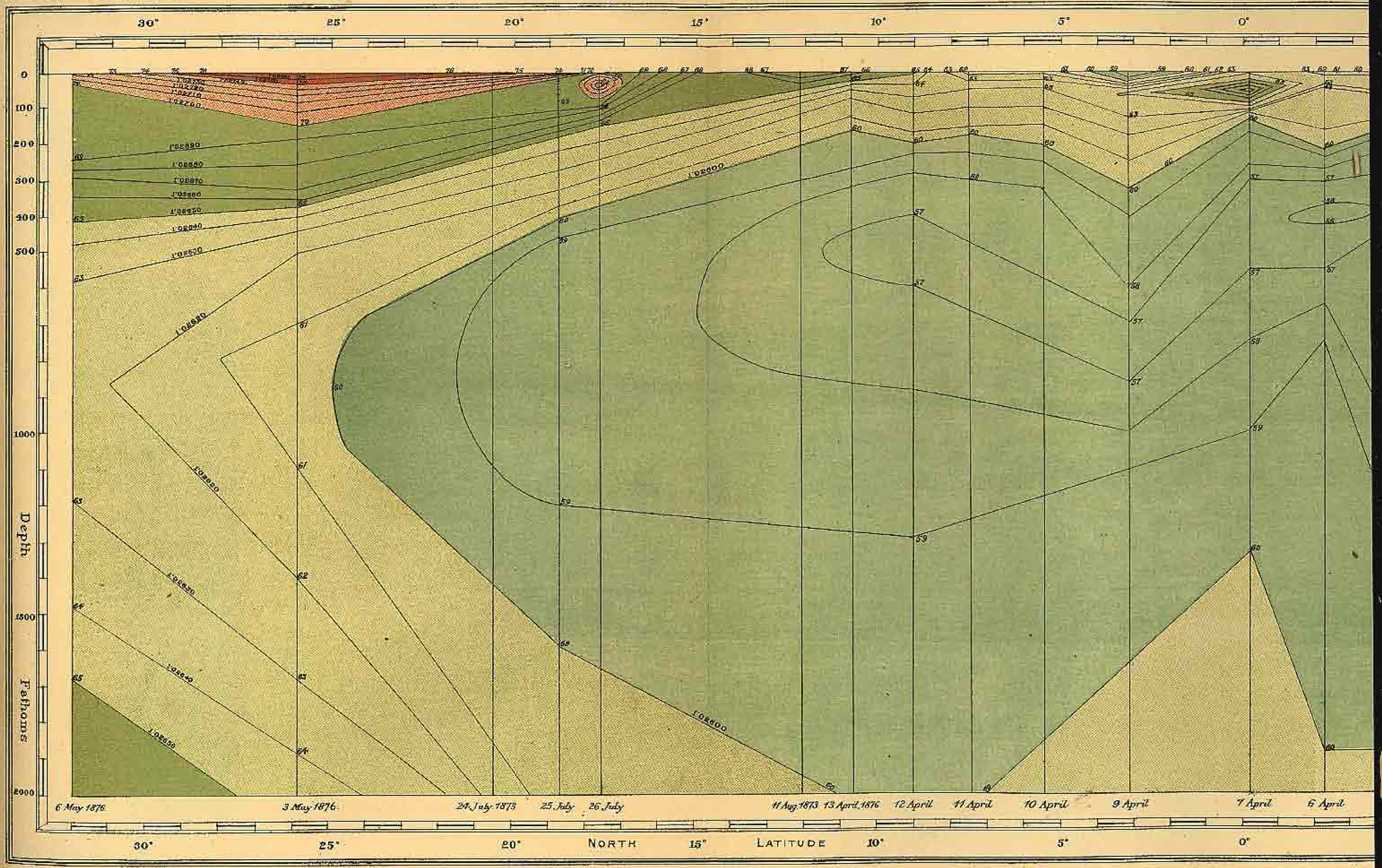
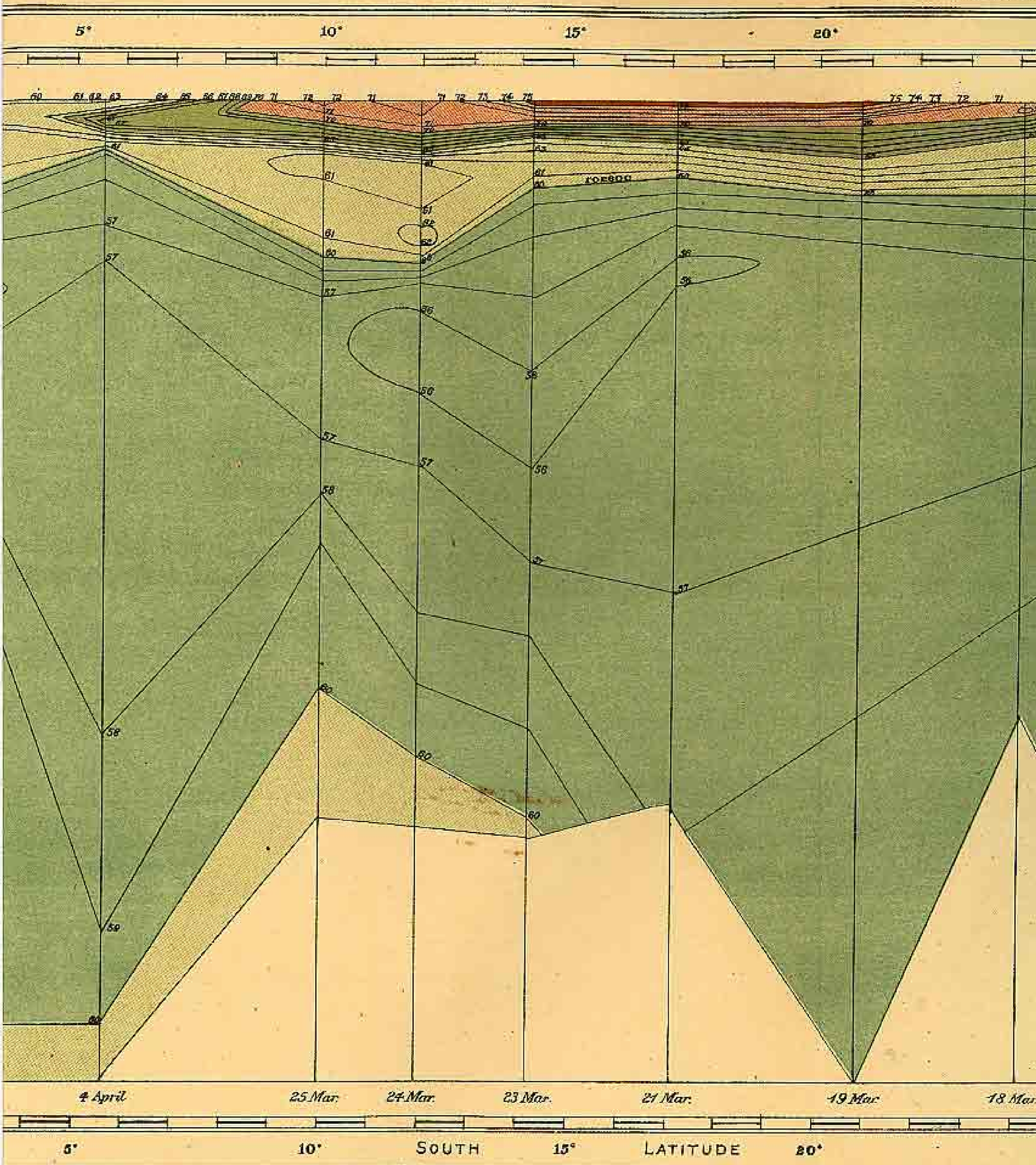


GRAPHIC REPRESENTATION OF THE BATHYMETRICAL DISTRIBUTION OF SPECIFIC GRAVIT

Specific



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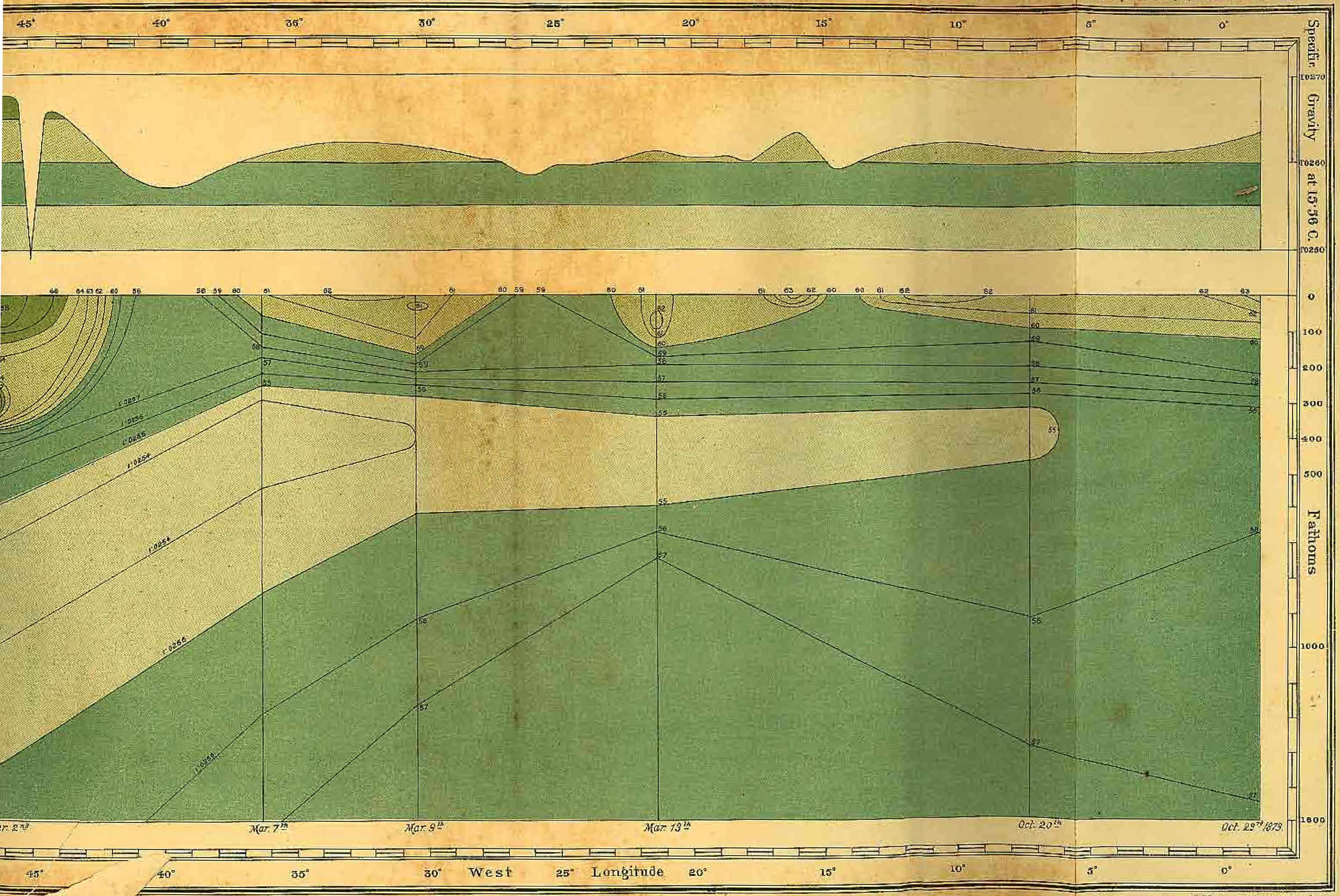
Specific Gravity of Ocean Water. Diagram IV.



GRAPHIC REPRESENTATION OF THE DISTRIBUTION OF SPECIFIC GRAVITY AT DIFFERENT LONGITUDES

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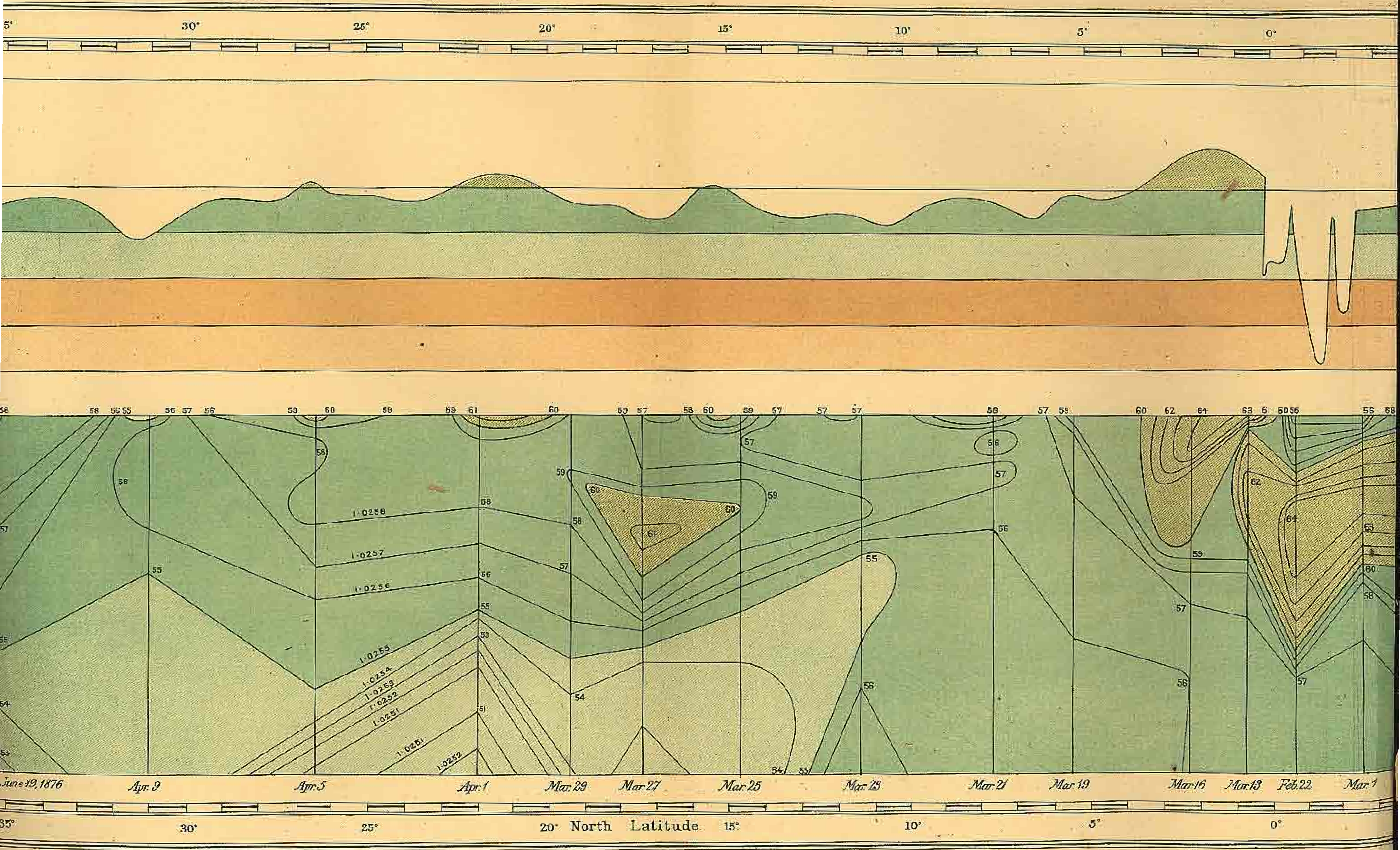
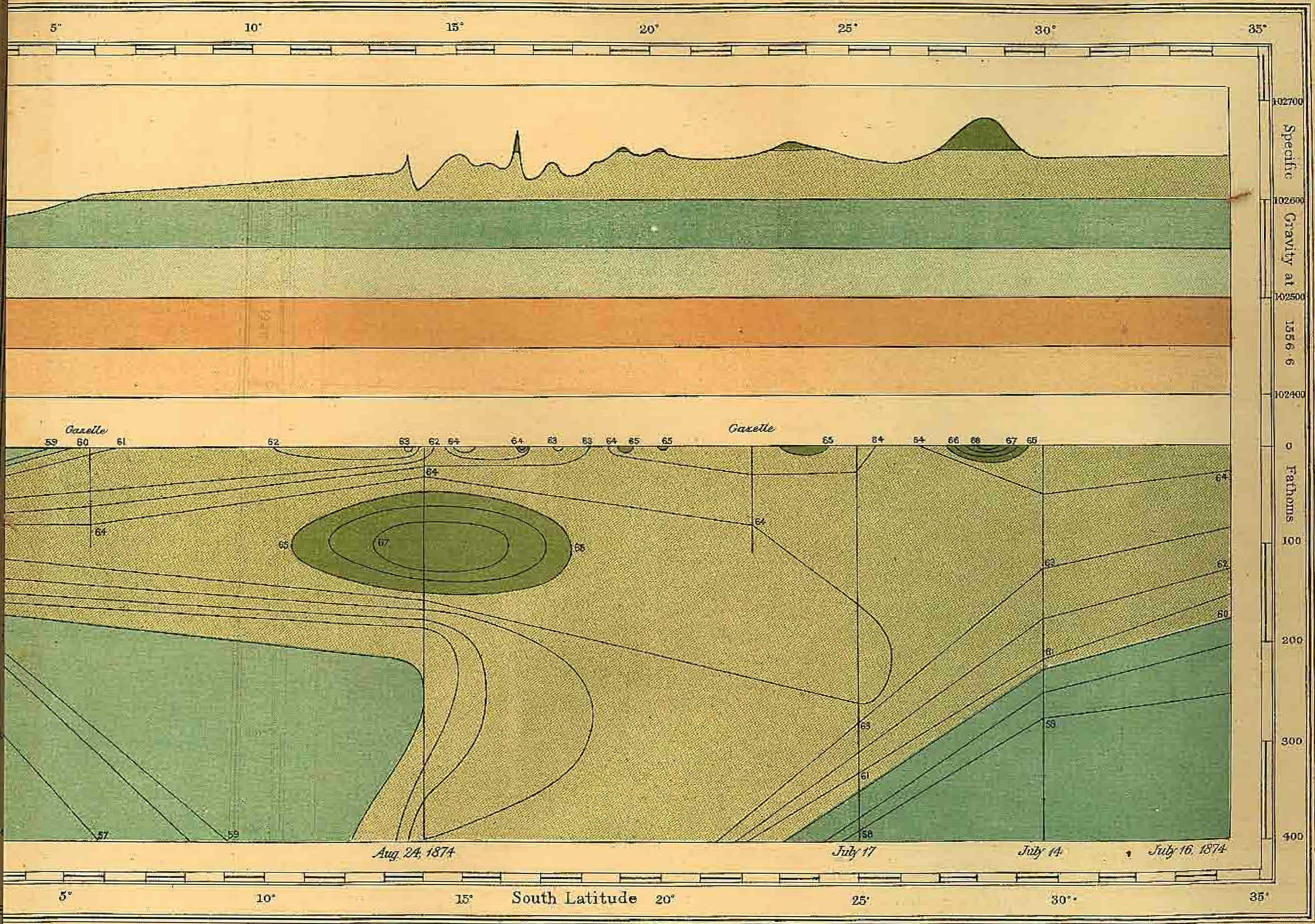
H.M.S "Challenger"

WESTERN PACIFIC



GRAPHIC REPRESENTATION OF THE DISTRIBUTION OF SPECIFIC GR

Specific Gravity of Ocean Water Diagram V



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RAVITY AT DIFFERENT LATITUDES

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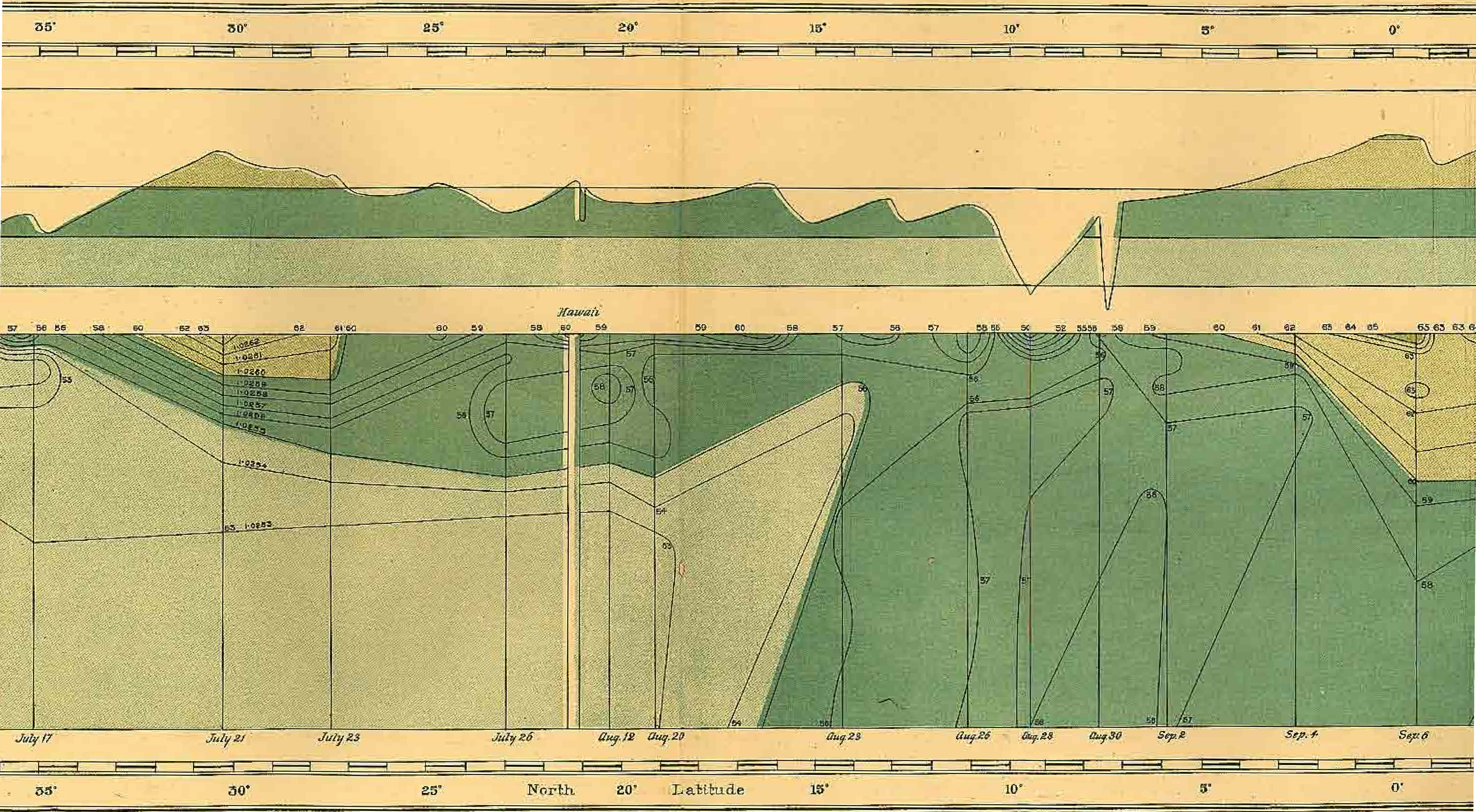

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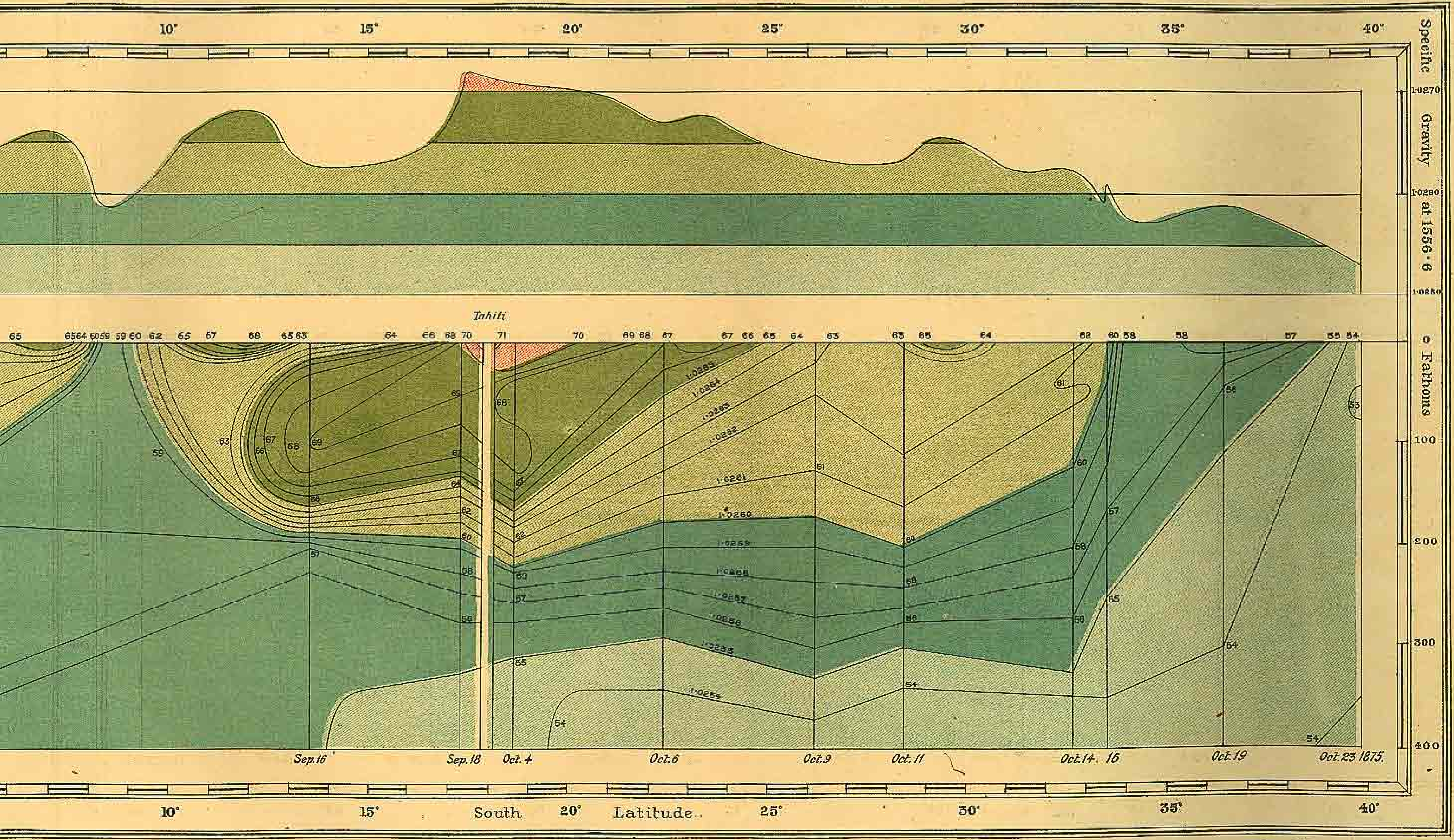

Y AT DIFFERENT LATITUDES.

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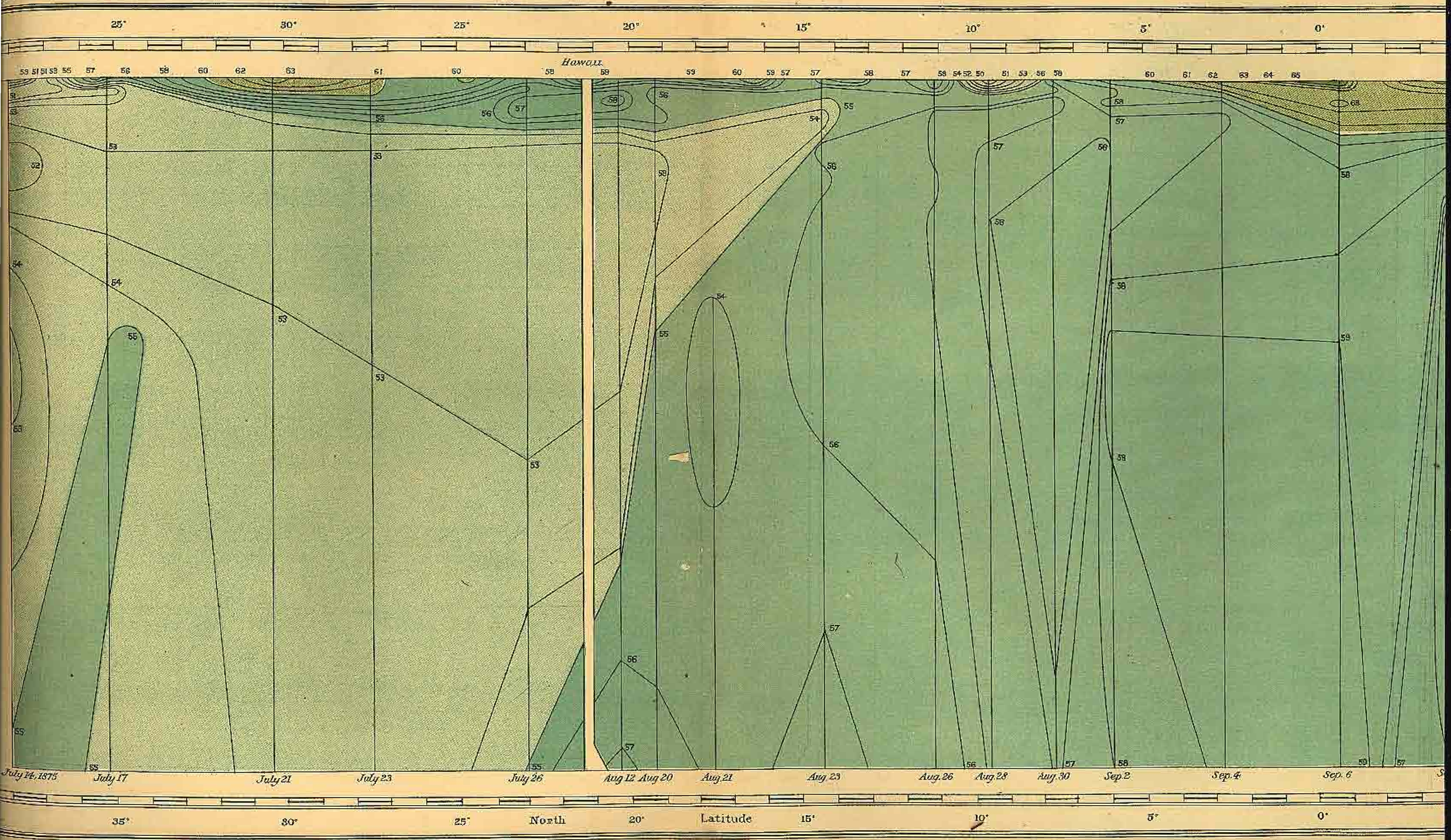
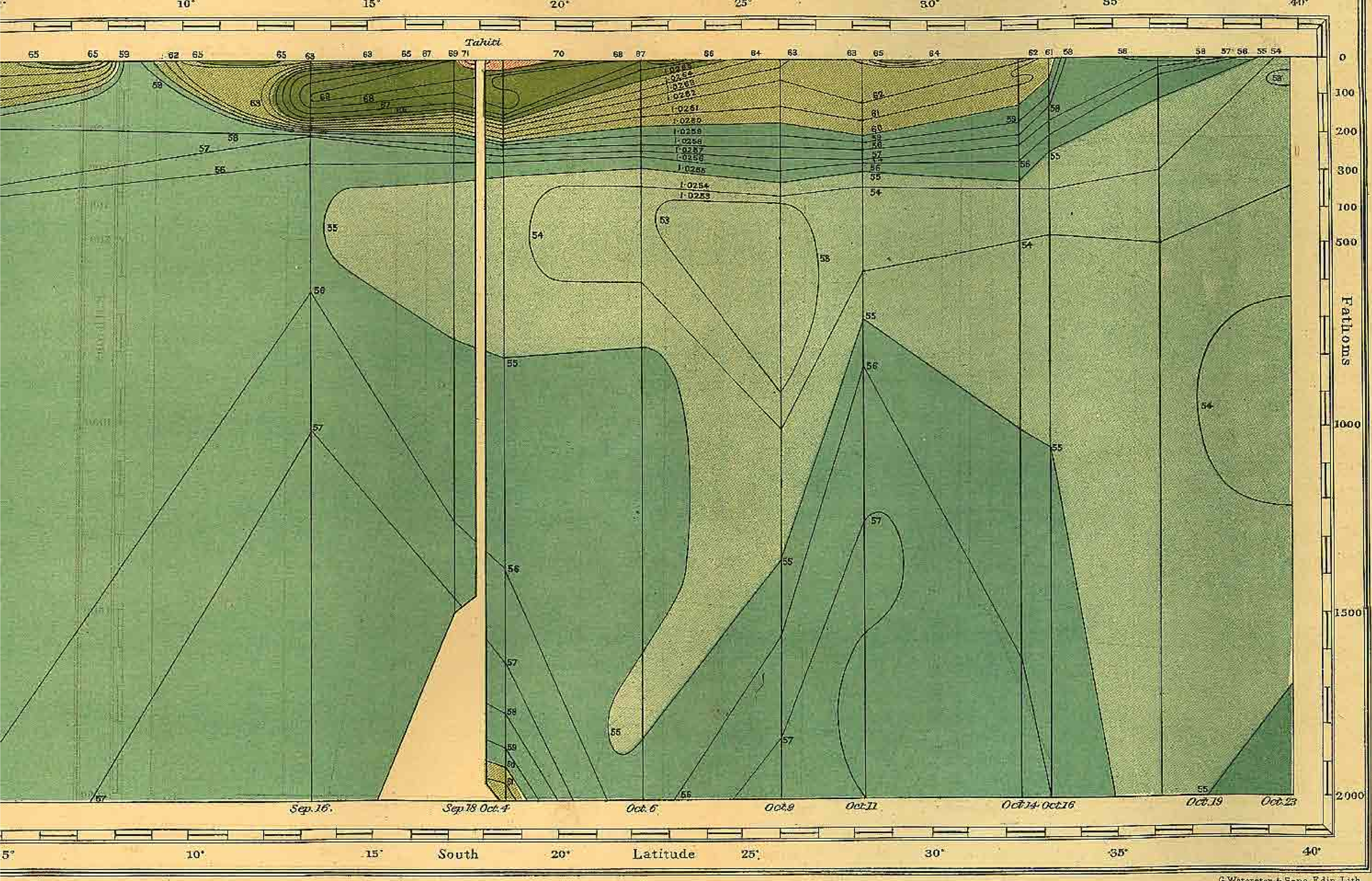
of H.M.S. "Challenger"

CENTRAL PACIF



GRAPHIC REPRESENTATION OF THE BATHYMETRICAL DISTRIBUTION OF SP



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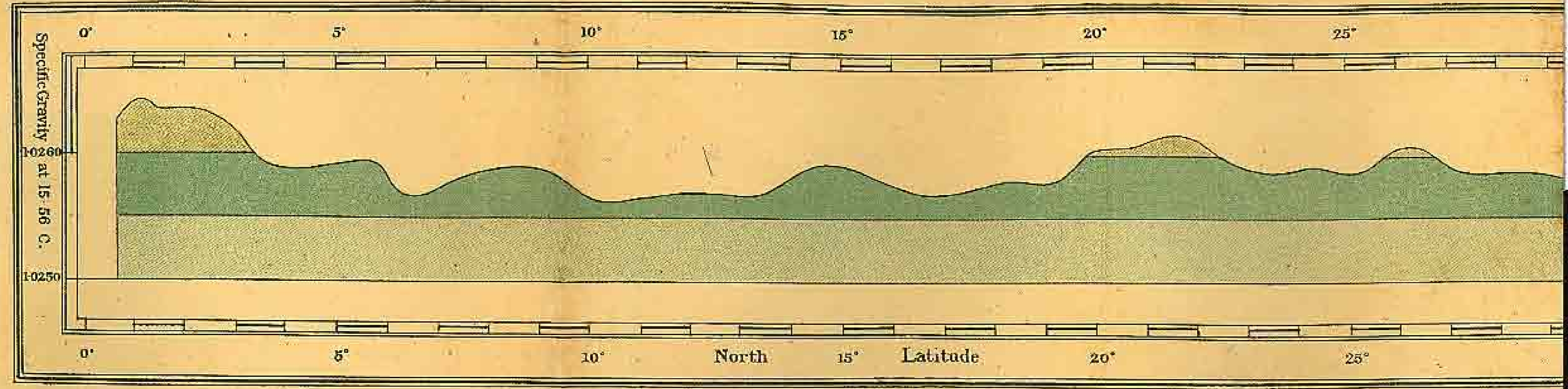
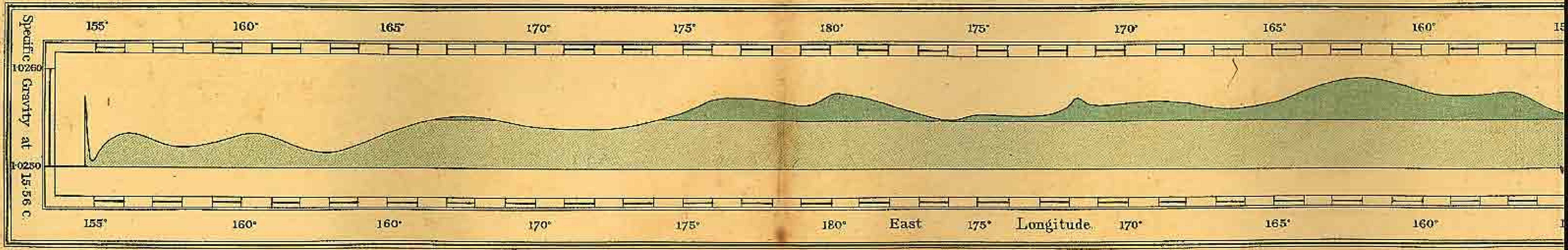
GRAVITY AT DIFFERENT LATITUDES.

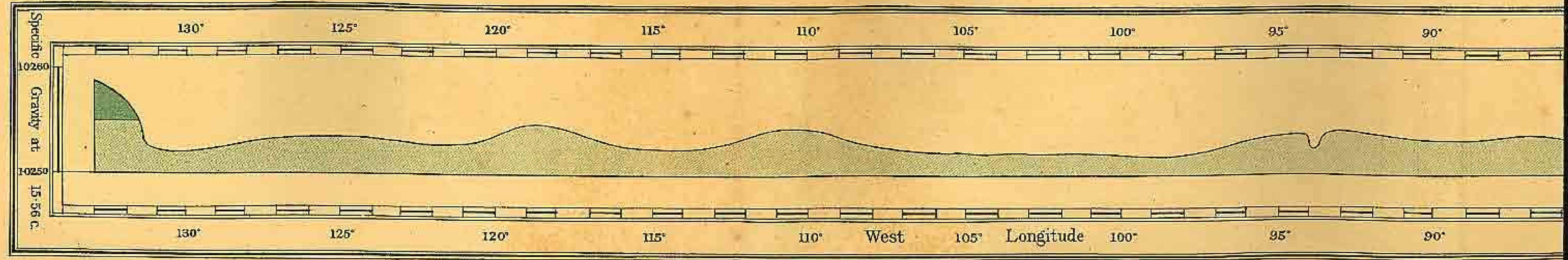
NORTH PACIFIC.



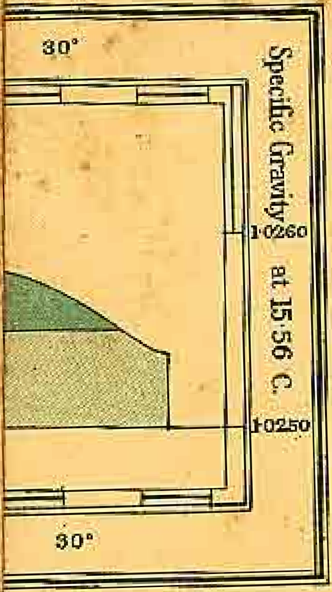
NORTH PACIFIC.

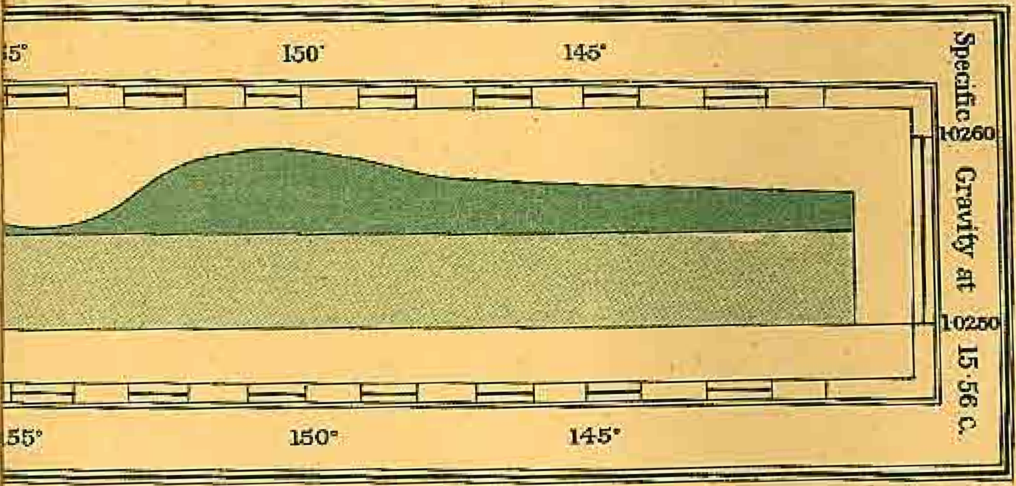


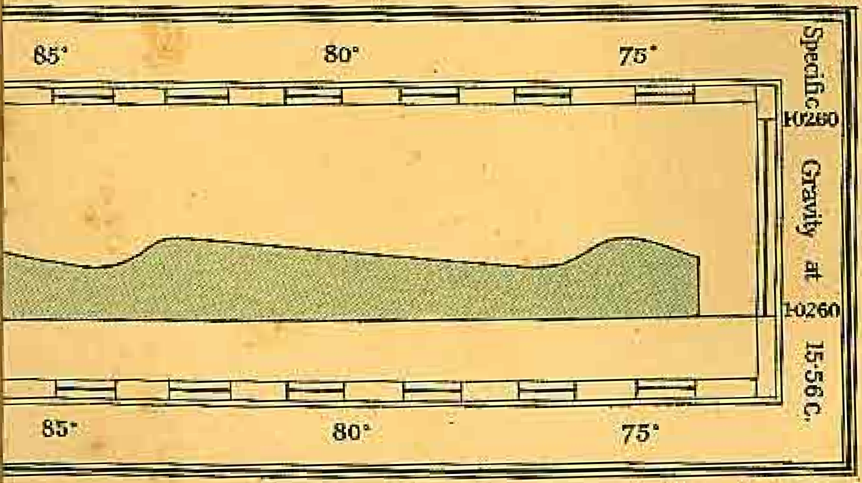
SOUTH PACIFIC.



GRAPHIC REPRESENTATION OF THE SPECIFIC GRAVITY OF SURFACE WATER IN THE PACIFIC OCEAN.







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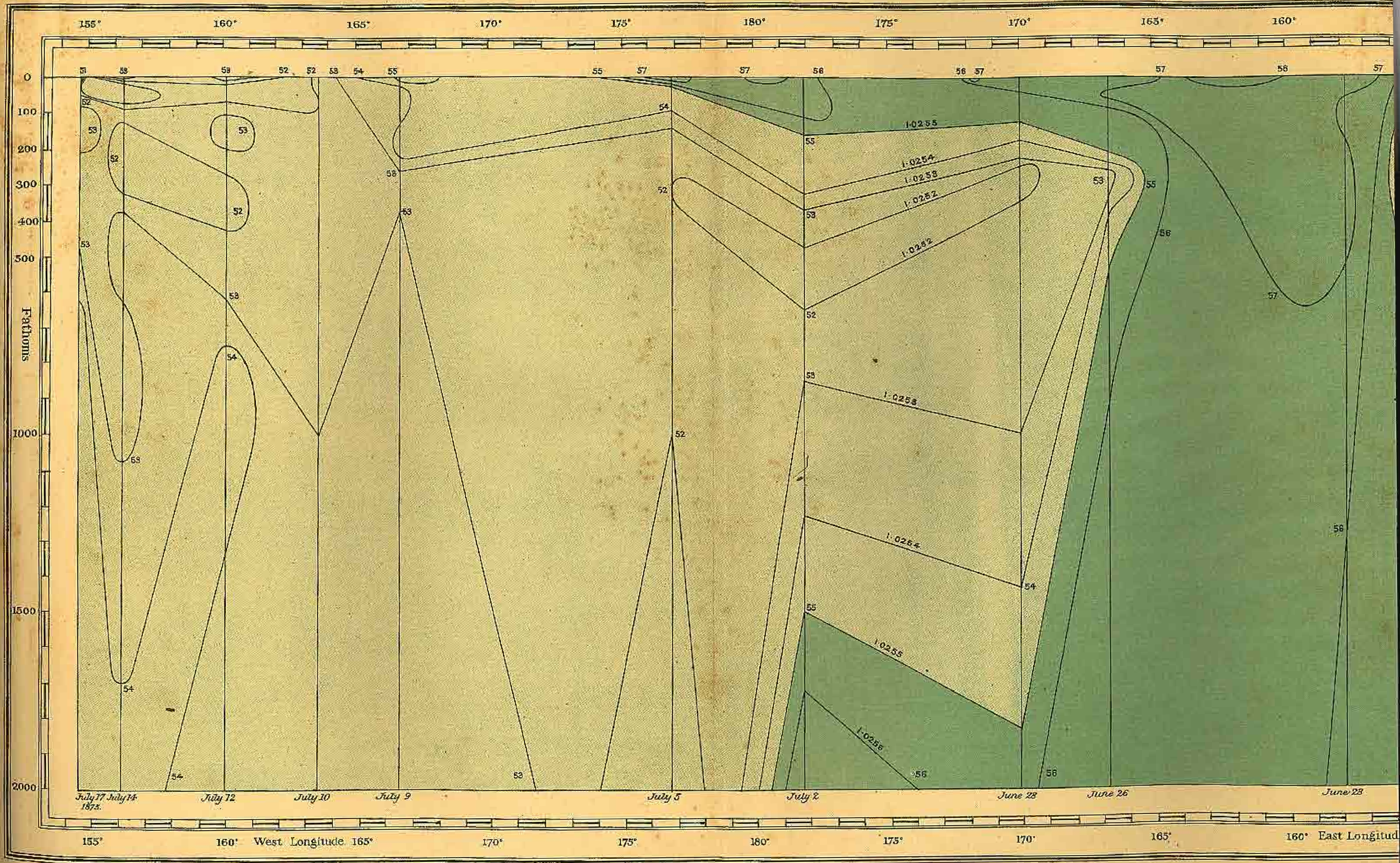
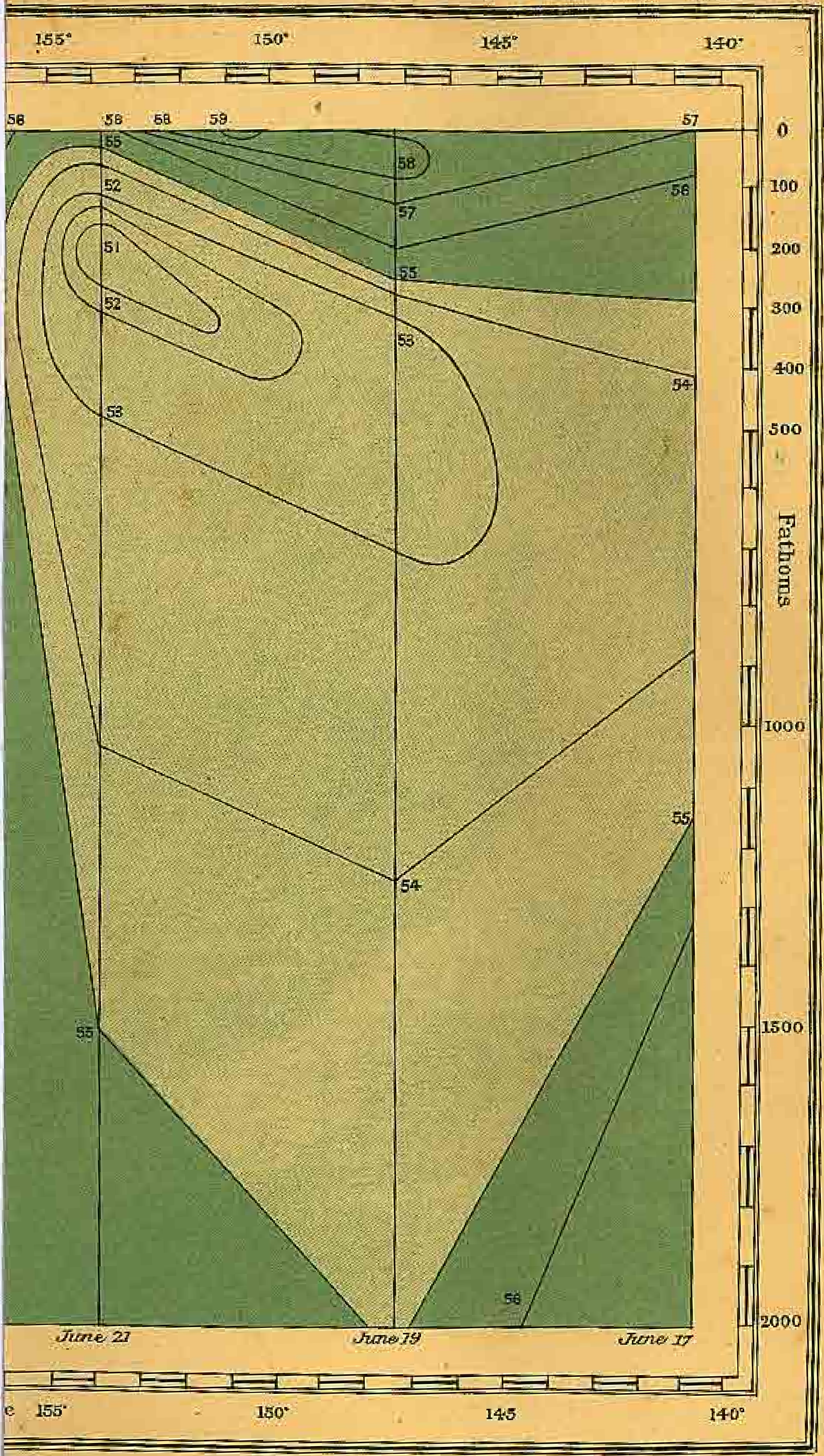
NORTH PACIFIC



GRAPHIC REPRESENTATION OF THE BATHYMETRICAL DISTRIBUTION OF SPECIFIC GRAVITY AT DIFFERENT LONGITUDE

Specific Gravity of Ocean Water. Diagram IX.



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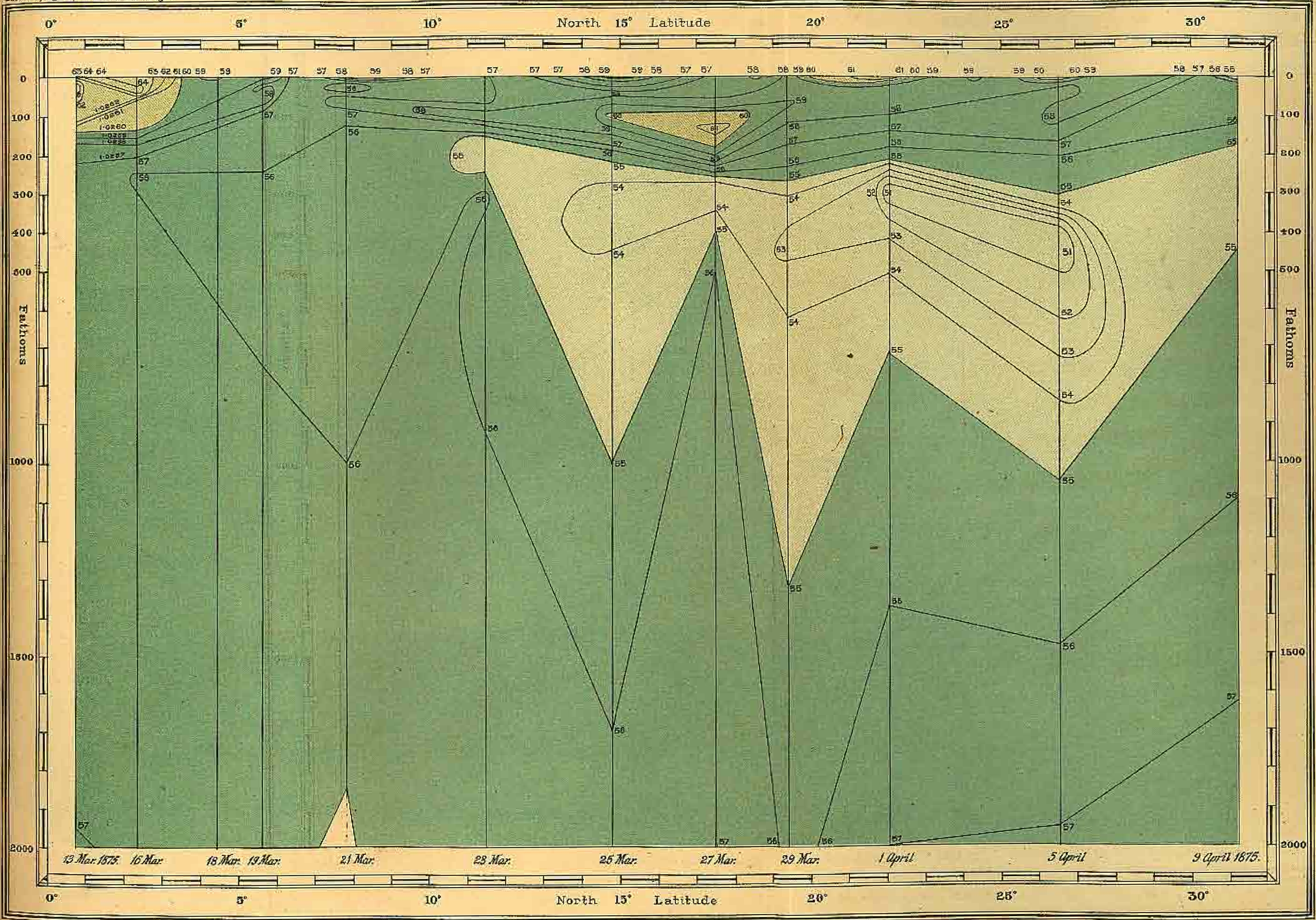
NORTH PACIFIC



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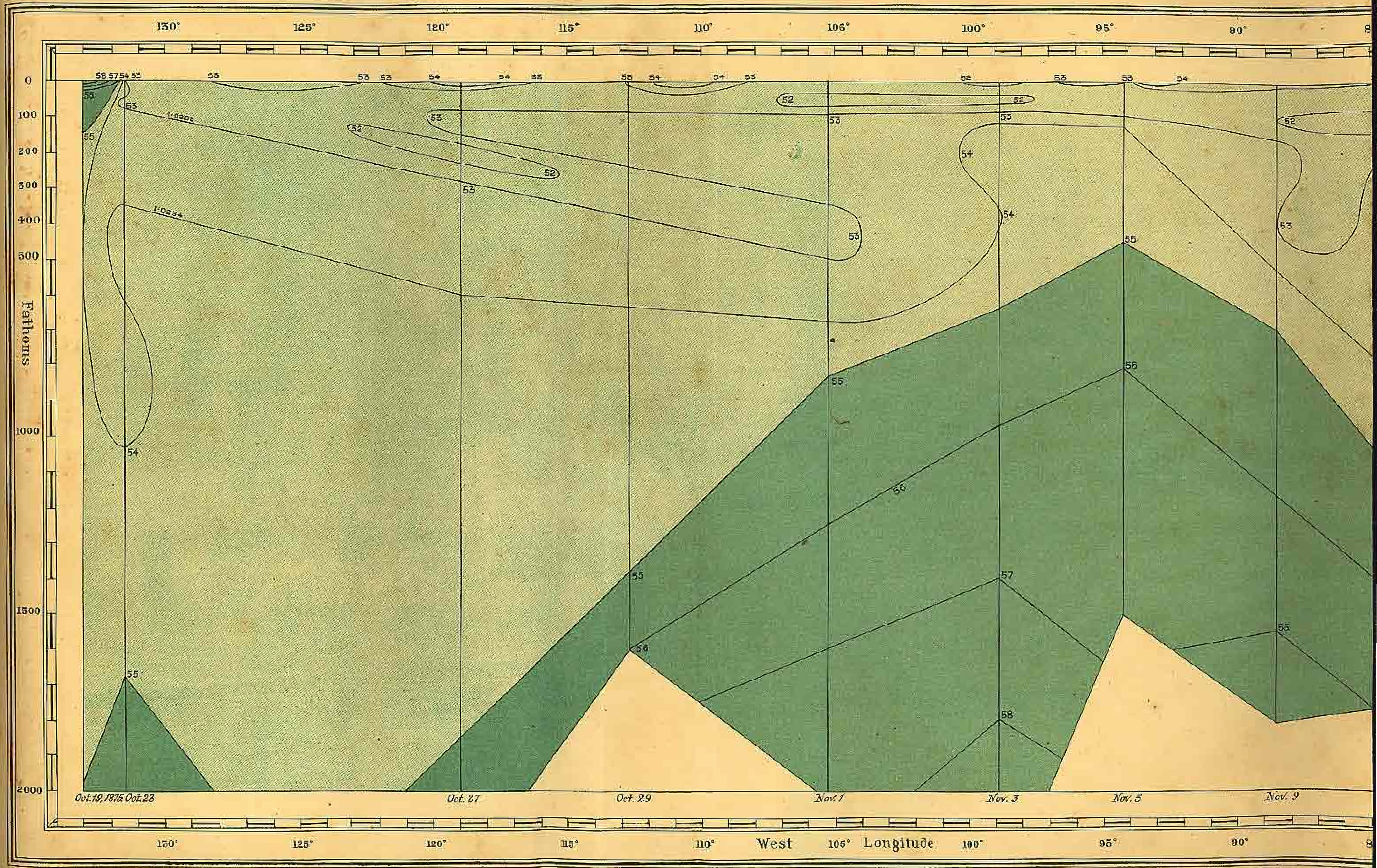
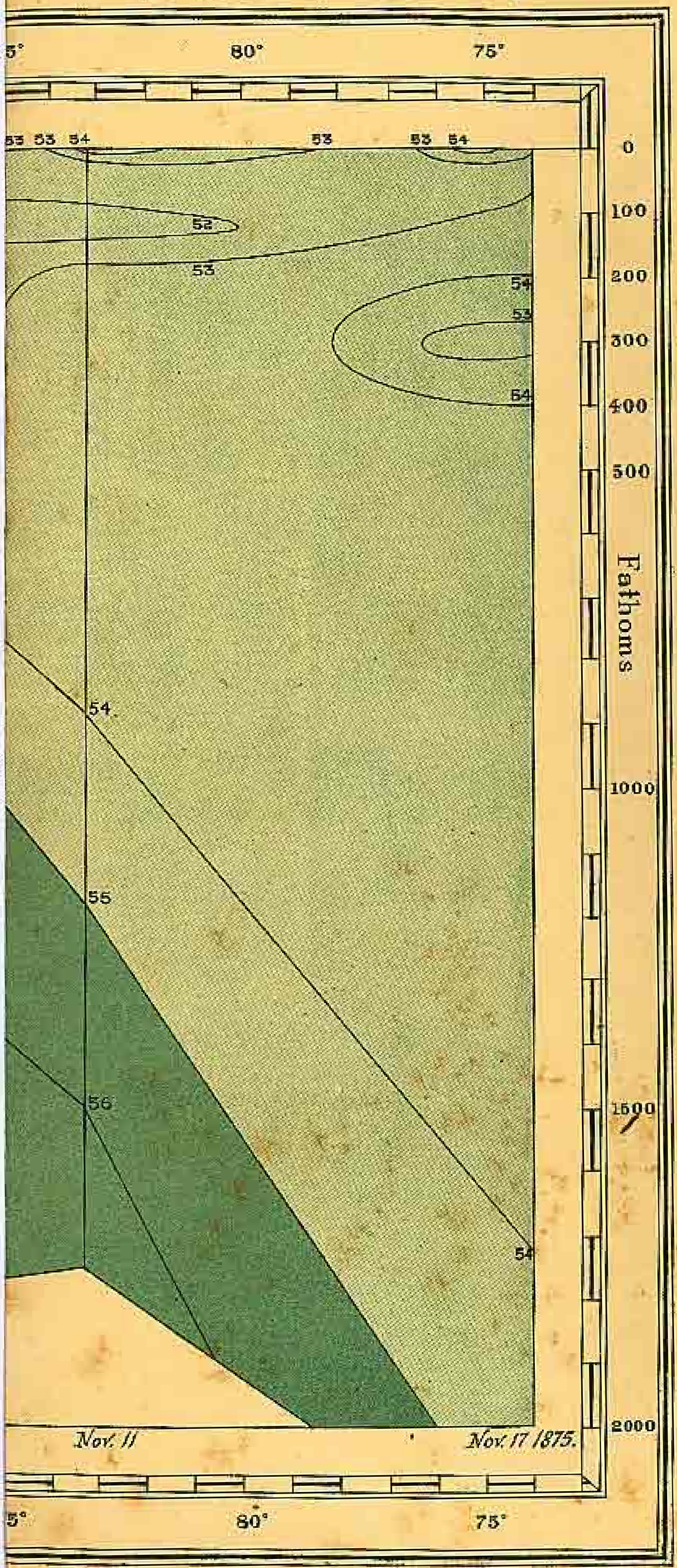
GRAPHIC REPRESENTATION OF THE BATHYMETRICAL DISTRIBUTION OF SPECIFIC GRAVITY AT DIFFERENT LATITUDES

SOUTH PACIFIC



GRAPHIC REPRESENTATION OF THE BATHYMETRICAL DISTRIBUTION OF SPECIFIC GRAVITY AT DIFFERENT LONGITUDES

Specific Gravity of Ocean Water. Diagram XI.



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THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on the Deep-Sea Temperature Observations obtained by the Officers of H.M.S. Challenger, during the years 1873–76.

It has been deemed advisable to publish, for the convenience of scientific men, the whole of the deep-sea observations of temperature made during the voyage of the Challenger. These are given in detail in the accompanying series of 263 plates, which show the latitude and longitude of the Station; the depth in fathoms of the bottom; the date when the serial temperatures were taken; the depth at which each temperature was taken; the No. of the thermometer; the temperature actually observed read to quarter degrees; the error of the thermometer; and the temperature corrected for instrumental error only.

These temperatures were plotted on the squares, as represented on each Plate, by Staff-Commander Tizard, R.N., simply as observed and corrected for instrumental errors, just as has been done in the case of the Challenger Meteorological Observations,[1] no attempt being made to correct even the most obvious errors of observation. Thus on Pl. XVIII. the temperature of 46°·2 at the depth of 700 fathoms, is plainly 5°·0 too high; and on Pl. XXII. the temperature 43°·0 at the depth of 450 fathoms is 10°·0 too low. These, however, are printed as recorded in the Observation Books, it being left to the specialist, who may have occasion to discuss the observations, to make for himself all such necessary corrections. A curve is then drawn through the observations as plotted *libera manu*, and on examining the curves on Pls. XVIII. and XXII., it will be found that allowance has been made for the errors of observation referred to above.

From these curves a new set of temperatures have been taken, which are printed on the line in the Plate named "Temperature from Curves." It is the last temperatures

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[1] Nar. Chall. Exp., vol. ii.

which have been used in constructing the diagrammatic sections of the ocean basins to illustrate the distribution of temperature with depth in different parts of the ocean. These diagrammatic sections will be published in Vol. I. of the NARRATIVE OF THE CRUISE.

The observations of the temperature of the surface of the sea, taken at least every two hours during the cruise, have been published *in extenso*, along with the meteorological observations.[1]

For convenience of reference, series of tables, arranged by Staff-Commander Tizard, R.N., are appended to the plates, in which the serial temperatures for the four different oceans have been grouped and averaged according to latitude. Miscellaneous temperatures are given in Table V.; in Table VI. the observations are summarised in 5° belts of latitude for each of the four oceans; and Table VII. includes all temperatures obtained between the depth of 1500 fathoms and the bottom.

In certain cases it was thought that the form of the curve would be more clearly shown if magnified ten times horizontally, and accordingly, in some diagrams, each larger division of the scale has been taken to represent 10 instead of 100 fathoms. Of this Pl. II. is an example; and in all cases where this has been done a stroke has been drawn through the last cipher of the numbers indicating the fathoms.

Where two curves are shown on the same plate, one of them (generally the longer one) represents the whole depth plotted in the usual manner, while the other represents the temperatures of the upper portion of the section plotted in a curve on the larger scale. The curves on Pl. X. are examples.

A Report on the COMPOSITION OF OCEAN-WATER, by Professor W. Dittmar, F.R.S.,[2] and a Report on the SPECIFIC GRAVITY OF OCEAN-WATER by Mr. J. Y. Buchanan[3] form Parts I. and II. of this volume; and a discussion of the meteorological observations and deep-sea temperatures and specific gravity in their bearings on ocean circulation is in course of preparation by Professor P. G. Tait and Mr. Alexander Buchan.

JOHN MURRAY.

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[1] Nar. Chall. Exp., vol. ii.

[2] Phys. Chem. Chall. Exp., part i.

[3] Phys. Chem. Chall. Exp., part ii.

ERRATA.

Pl. LXXX., *for* "Tristan d'Acuhna," *read* "Tristan da Cunha."

Pl. CCXXIV., *for* "Magalhaens," *read* "Magellans."

Pl. CCL., at end of footnote, *for* "corrected Thermometer," *read* "corrected Temperature."

15 January 1873.

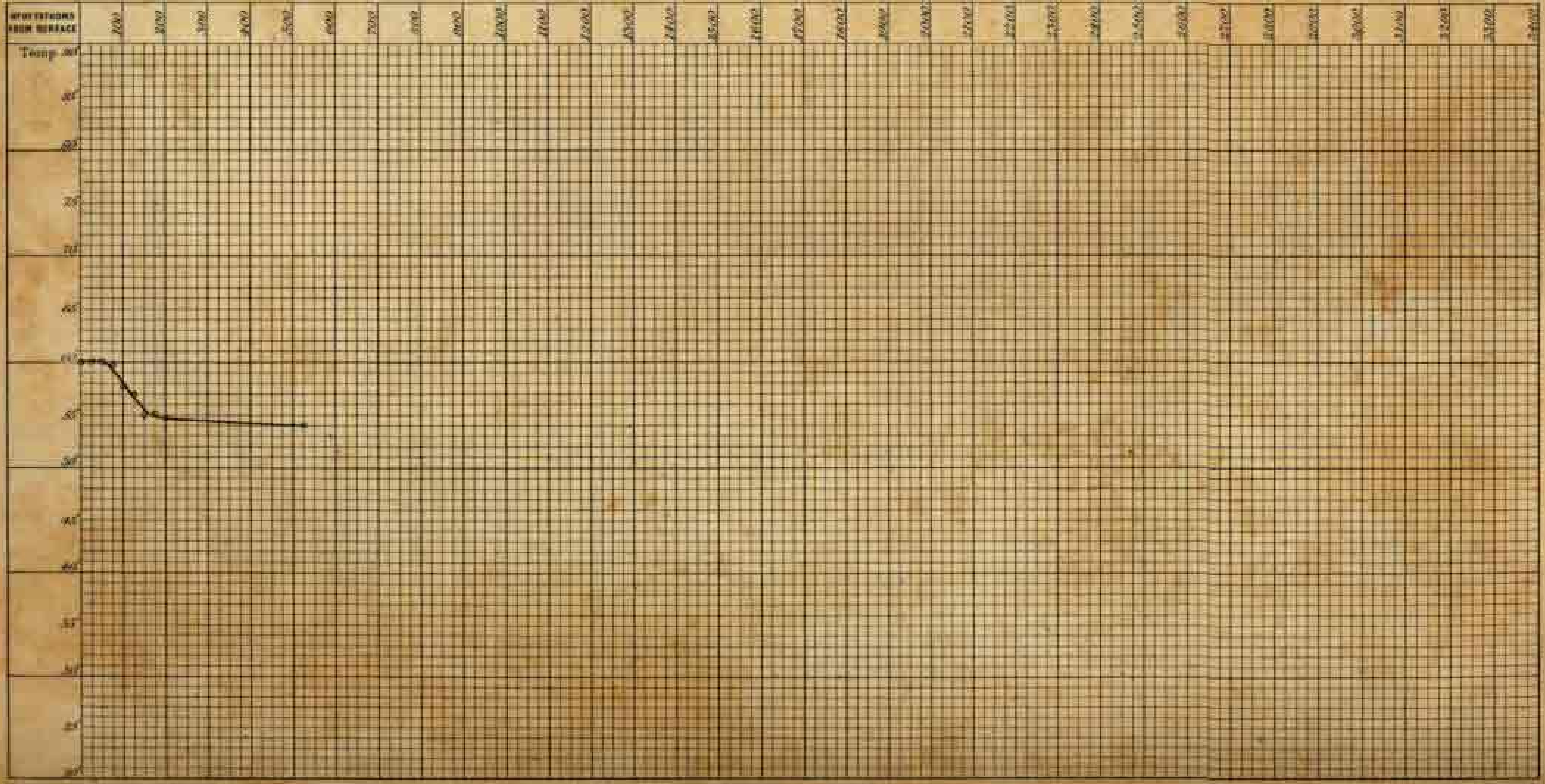
Nº of Sounding 16.
Station. II. k.

Depth 525 fathoms

Latitude 36° 58' 50" N
Longitude 9° 14' 20" W.

Nº of fathoms from surface	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225
Nº of thermometer			47			58		39			58		49			34		43			48	
Temperature shewn by thermometer	60.0		60.0			60.0		59.5			57.3		56.3			55.0		55.0			54.5	
Error of thermometer																						
Corrected temperature																						
Temperature from curve	60.0		60.0			60.0		59.9			57.3		56.3			55.3		54.8			54.5	

Nº of fathoms from surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº of thermometer																							19
Temperature shewn by thermometer																							54.0
Error of thermometer																							
Corrected temperature																							
Temperature from curve																							54.0



28 January 1873.

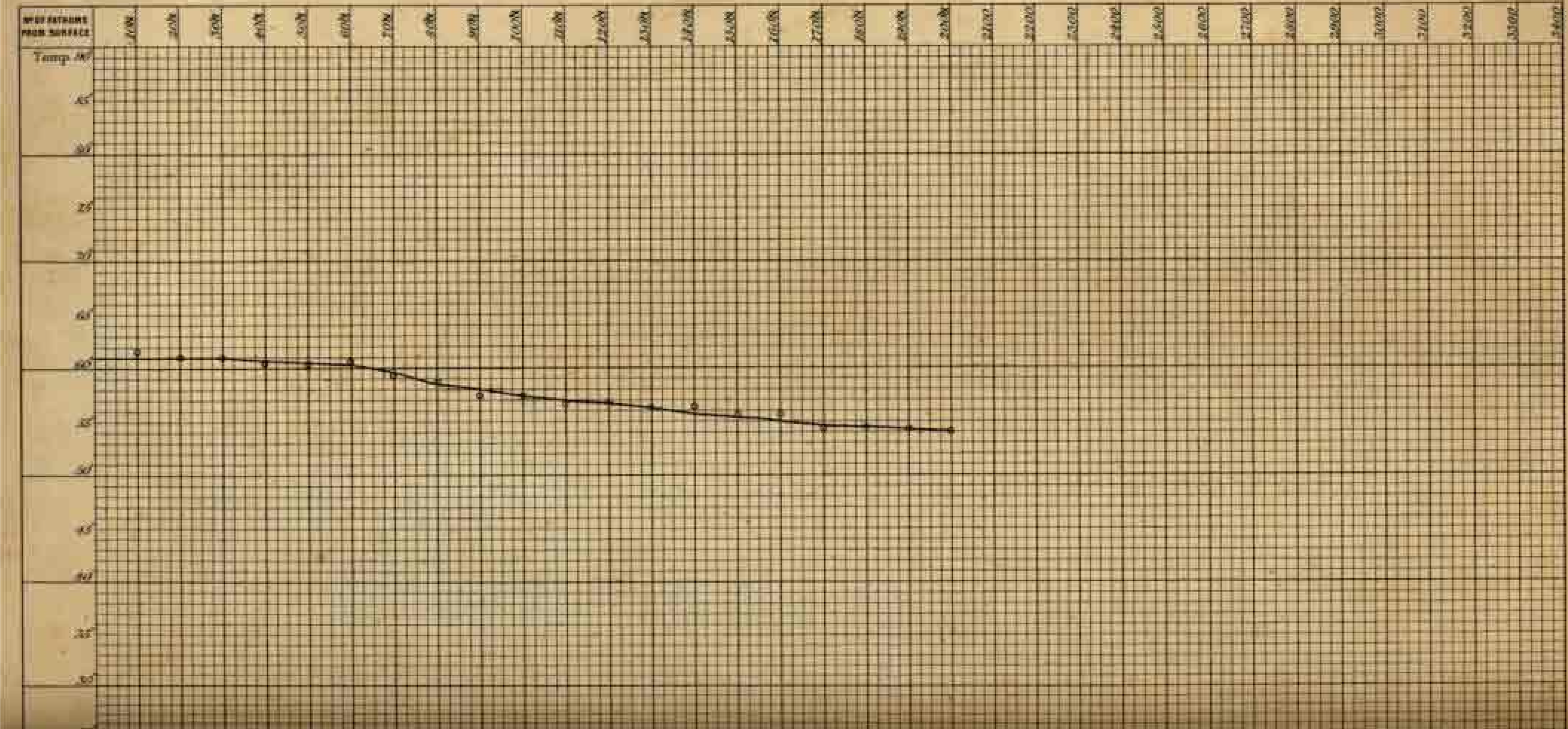
N° of Sounding 19.
Station V.

Depth 1090 fathoms.

Latitude 35° 47′ N.
Longitude 8° 23′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
N° OF THERMOMETER		34	39	32	37	46	31	40	43	35	34	30	34	40	43	35	42	38	46	37		
TEMPERATURE SHEWN BY THERMOMETER	61.0	61.5	61.0	61.0	60.5	60.5	60.3	59.5	58.8	57.9	57.5	57.0	56.8	56.2	56.1	55.2	55.8	54.4	54.4	54.0	54.1	
ERROR OF THERMOMETER																						
CORRECTED TEMPERATURE																						
TEMPERATURE FROM CURVE	61.0	61.0	61.0	60.9	60.7	60.5	60.3	59.6	58.7	57.9	57.4	57.0	56.8	56.2	55.7	55.2	54.9	54.6	54.3	54.2	54.0	

N° OF FATHOMS FROM SURFACE	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER																							
TEMPERATURE SHEWN BY THERMOMETER																							38.5
ERROR OF THERMOMETER																							
CORRECTED TEMPERATURE																							
TEMPERATURE FROM CURVE																							38.5



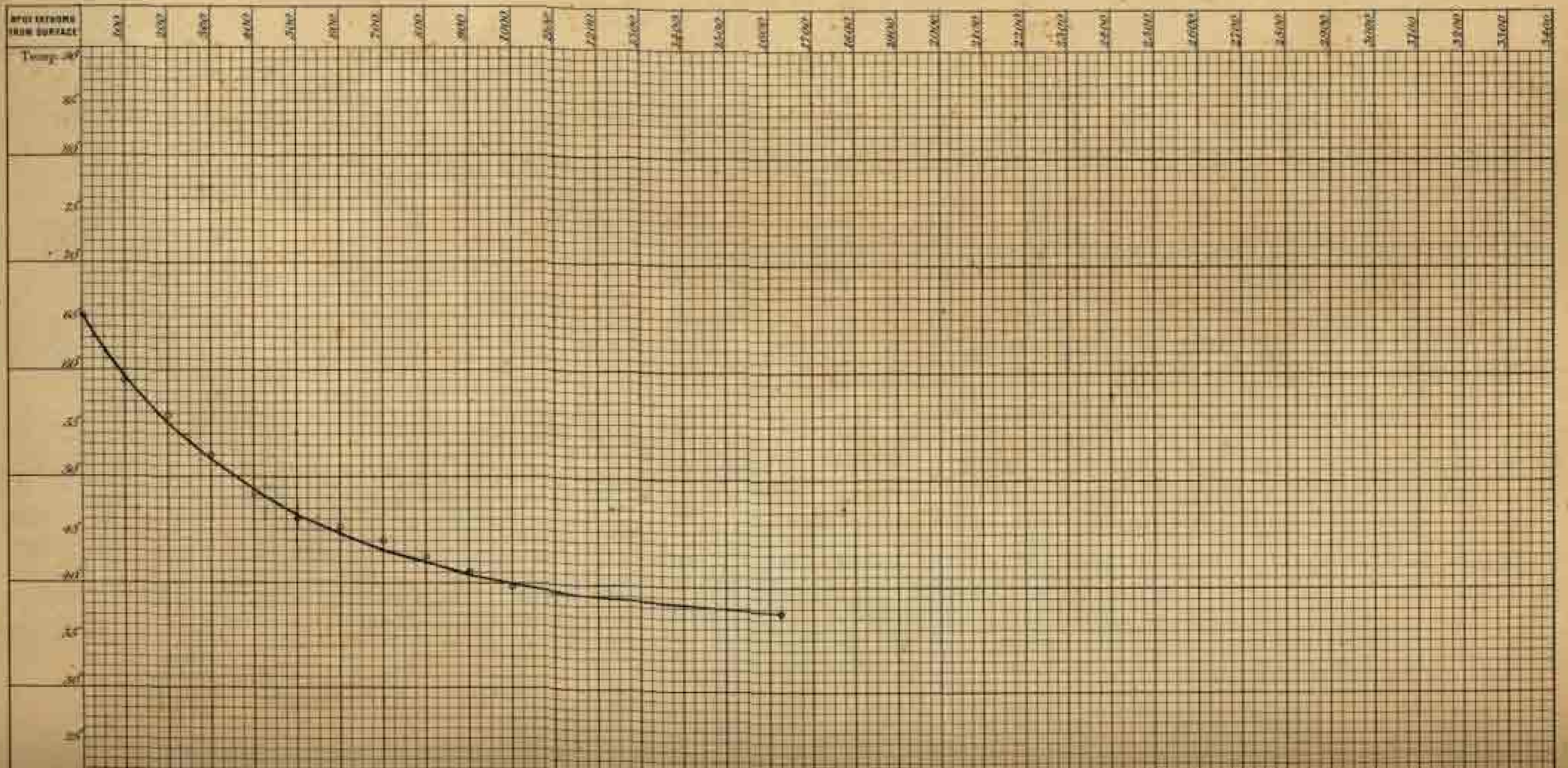
No. of Sounding 48.
Station VII. a.

11 February 1873.
Depth 1620 fathoms.

Latitude 27° 58′ N.
Longitude 17° 39′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. OF THERMOMETER											32									
TEMPERATURE SHEWN BY THERMOMETER	65.0										59.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	65.0										60.3									

No. OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	43				37	34	46	35	37	38	40	39													42
TEMPERATURE SHEWN BY THERMOMETER	55.8				51.8	48.5	46.0	45.2	44.0	42.5	41.0	39.8													37.5
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	55.0				51.8	48.4	46.3	44.7	43.0	41.9	40.8	40.0													37.5



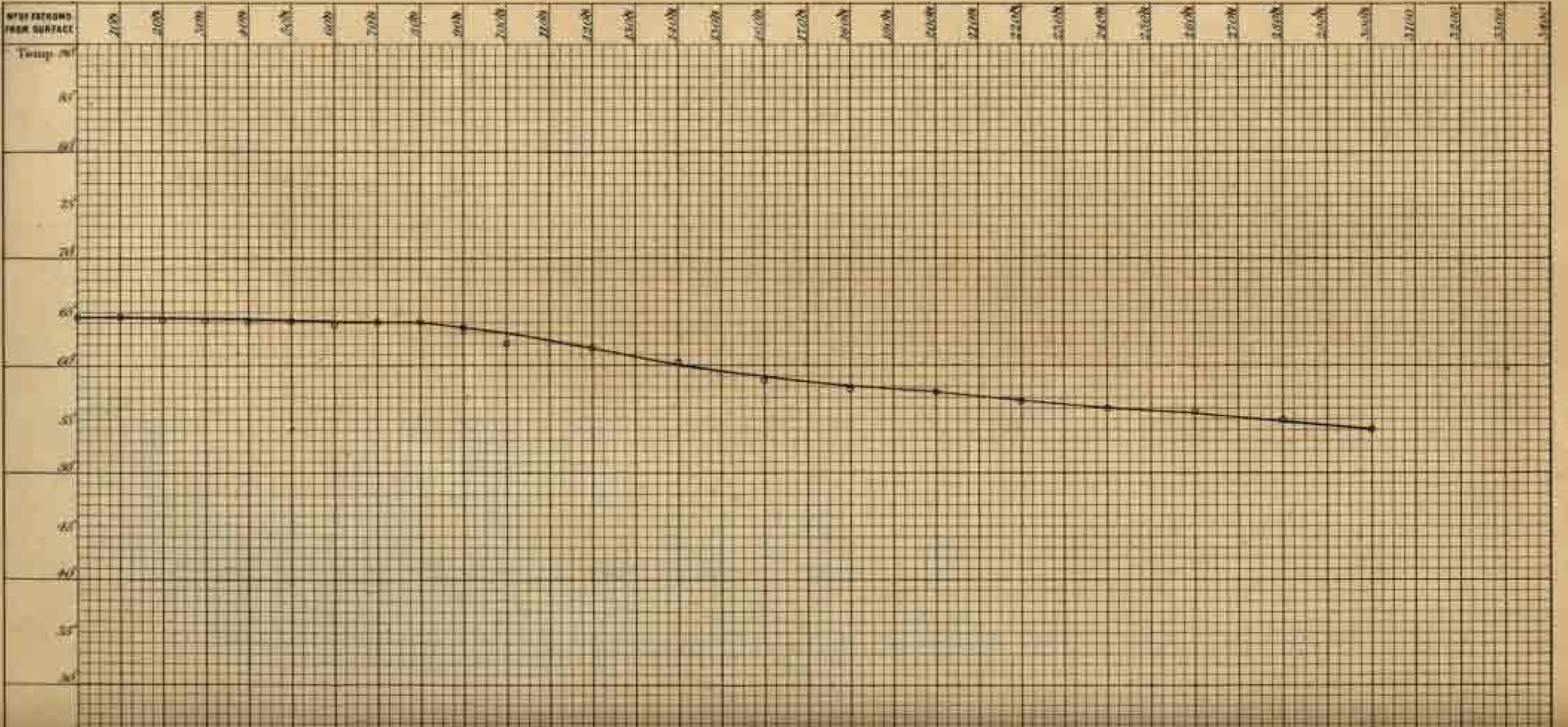
12 February 1873.

No. of Sounding 44.
Station VIII.

Depth 620 *fathoms.*

Latitude 28° 8' 15" N.
Longitude 17° 27' 0" W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	230	240	260	280	300	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER		34	34	32	45	40	43	37	46	47	40		49		43		37		46		40		39	34	38	39	47																		
TEMPERATURE SHEWN BY THERMOMETER	64.5	64.5	64.2	64.2	64.0	64.0	63.3	64.0	63.8	63.5	62.0		61.4		60.3		59.0		58.0		57.6		56.8	56.0	55.8	55.0	54.2																		
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	64.5	64.4	64.3	64.2	64.2	64.0	63.9	63.8	63.7	63.5	63.0		61.4		60.0		59.1		58.3		57.6		56.8	56.0	55.8	54.9	54.2																		



15 February 1873.

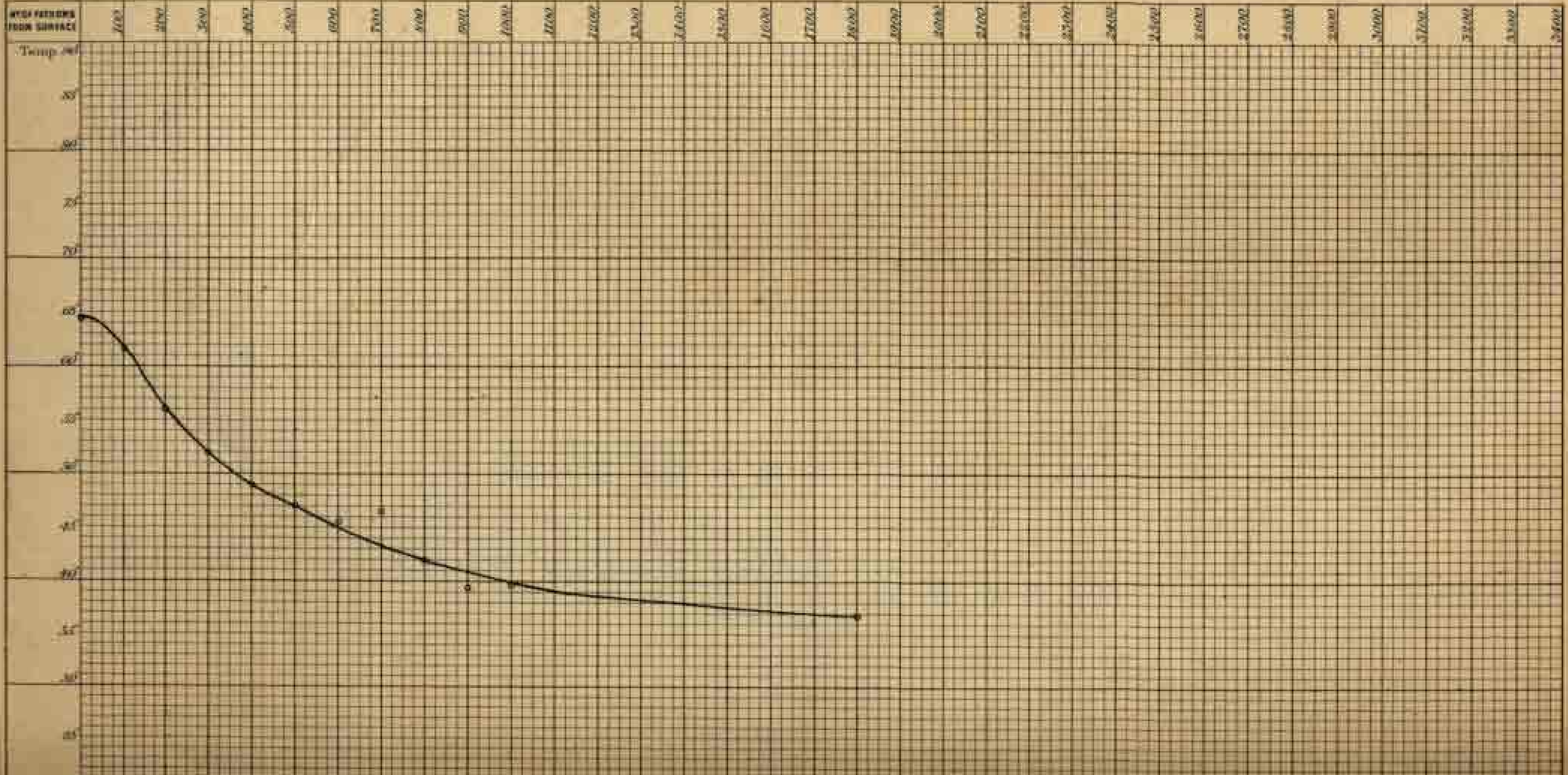
Nº of Sounding 45.
Station I.

Depth 1800 fathoms.

Latitude 27° 44' N.
Longitude 16° 56' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER											32										36
TEMPERATURE SHEWN BY THERMOMETER	64.4										61.8										55.8
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	64.4										61.8										56.0

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER				46	43	35	37	34	34	30	39													47 39
TEMPERATURE SHEWN BY THERMOMETER				51.8	49.0	46.8	45.1	46.5	41.8	39.3	39.8													36.8 36.8
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE				51.7	49.0	46.8	44.9	43.0	41.8	40.7	39.9													36.8



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

17 February 1873

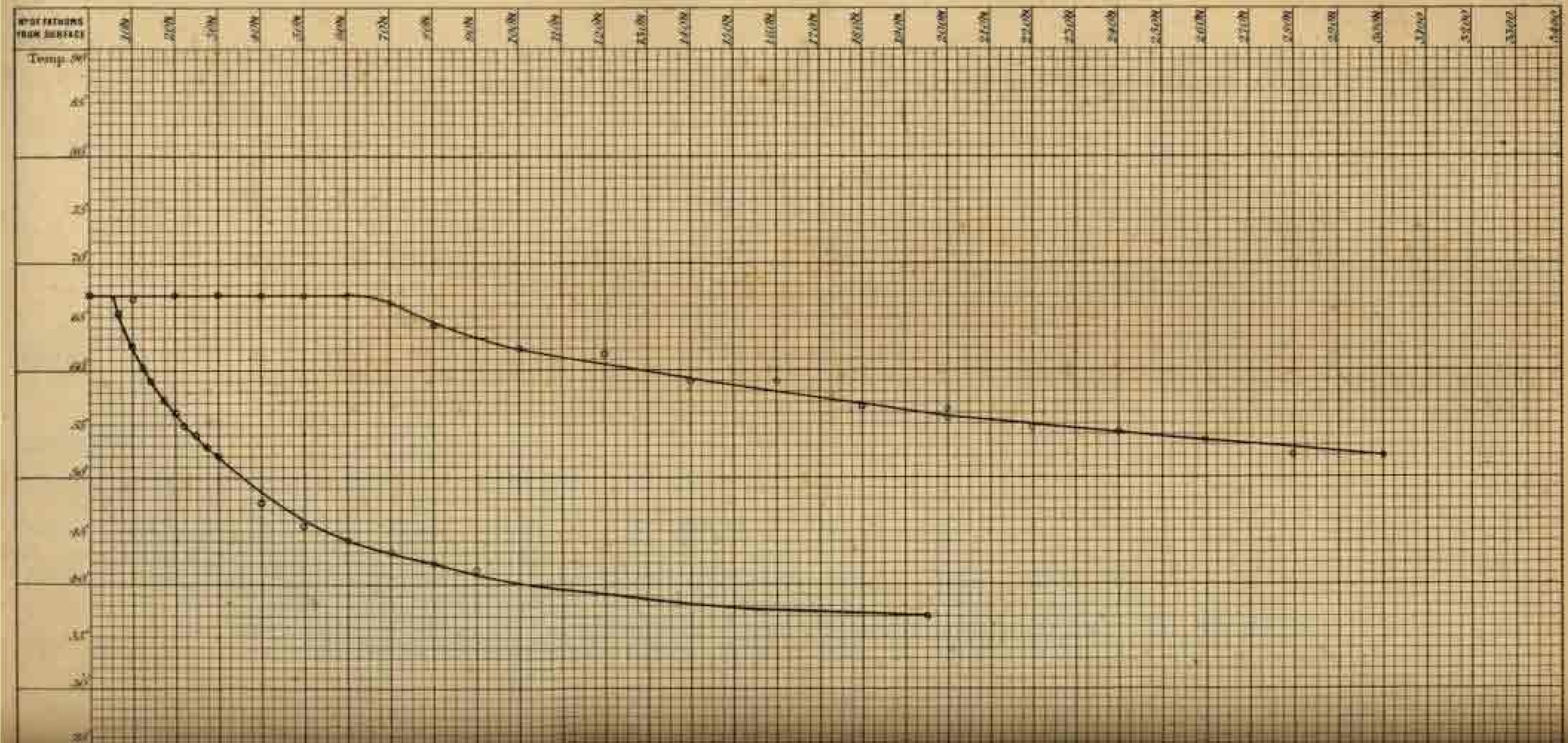
Nº of Sounding 46.
Station 2.

Depth 1945 fathoms

Latitude 25° 52′ N.
Longitude 19° 22′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER		36	42	39	50	46	57	34	37		30 40		37		46		34		32		48 39
TEMPERATURE SHEWN BY THERMOMETER	67.0	66.8	67.0	67.0	67.0	67.0	67.0	66.2	64.2		62.0 62.0		61.5		59.0		59.0		56.8		56.3 55.8
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	67.0	67.0	67.0	67.0	67.0	67.0	67.0	66.2	64.1	63.0	62.0		60.7		59.4		58.2		57.0		56.0

Nº OF FATHOMS FROM SURFACE	220	240	260	280	300	400	500	600	700	800	900	1000	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	39	40	36	51	37 37	34	54	39	45	48	35													40 49
TEMPERATURE SHEWN BY THERMOMETER	55.0	54.5	53.5	51.8	52.2 52.2	47.8	45.5	44.7	43.0	42.0	41.2													35.8 35.8
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	55.3	54.5	53.7	52.9	52.1	48.8	46.0	44.2	42.9	41.9	41.0													35.8



19 February 1873.

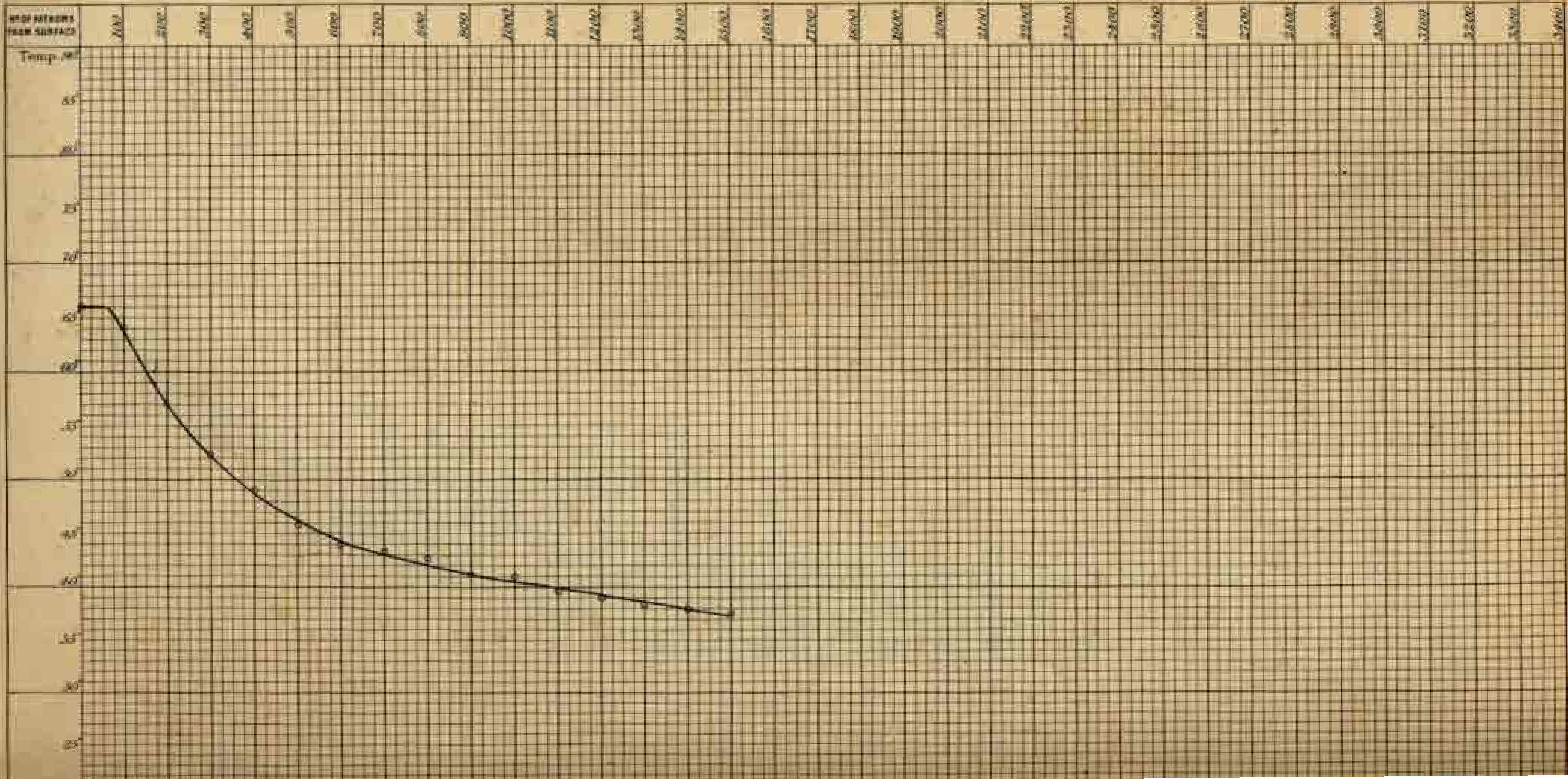
N.º of Sounding 48.
Station 4.

Depth 2220 fathoms

Latitude 25° 28′ N.
Longitude 20° 22′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº of thermometer											34										39			
Temperature shewn by thermometer	66.0										63.0										56.8			
Error of thermometer																								
Corrected temperature																								
Temperature from curve	66.0										63.0										56.8			

Nº of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	36	49	42	46	32	34	37	61	33	31	30	43	38								
Temperature shewn by thermometer	52.0	49.2	46.0	44.0	43.5	42.8	41.2	41.0	39.8	39.0	38.5	38.0	37.8								
Error of thermometer																					
Corrected temperature																					
Temperature from curve	51.0	49.0	46.3	44.3	43.0	42.0	41.2	40.5	39.9	39.1	38.7	38.1	37.3								



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

21 February 1873.

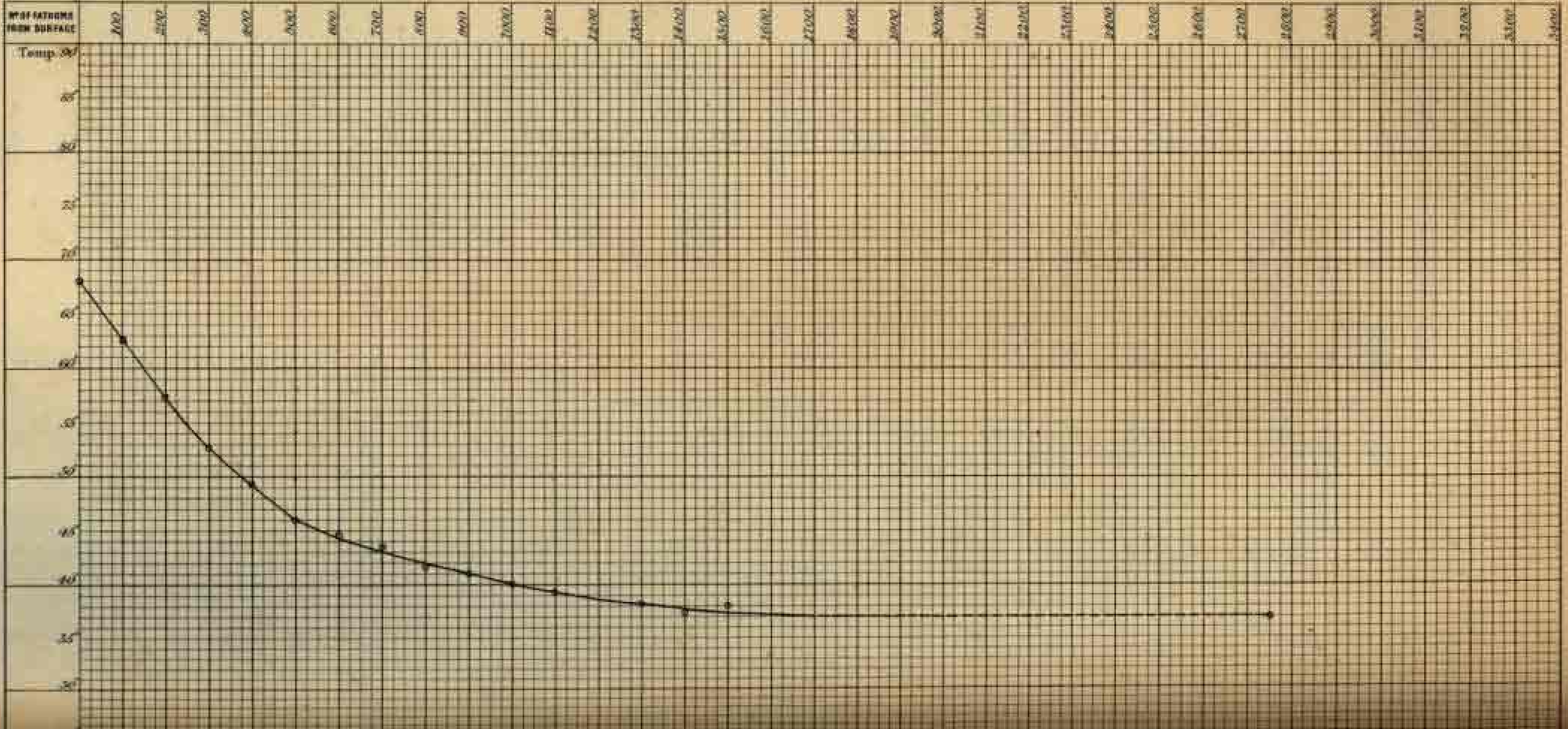
Nº of Sounding 49.
. . *Station* 5.

Depth 2740 *fathoms.*

Latitude 24° 20′ N.
Longitude 24° 28′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº OF THERMOMETER											46										48			
TEMPERATURE SHEWN BY THERMOMETER	68.0										62.6										57.2			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	68.0										62.6										57.2			

Nº OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	51	39	43	37	34	39	49	36	58	64	61	30	31								31
TEMPERATURE SHEWN BY THERMOMETER	52.5	49.0	46.2	44.8	43.6	42.0	41.0	40.0	39.2	38.5	38.0	37.6	38.0								37.0
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	52.5	49.0	46.3	44.7	43.2	42.2	41.0	40.0	39.2	38.7	38.2	37.8	37.5								37.0



25 February 1873.

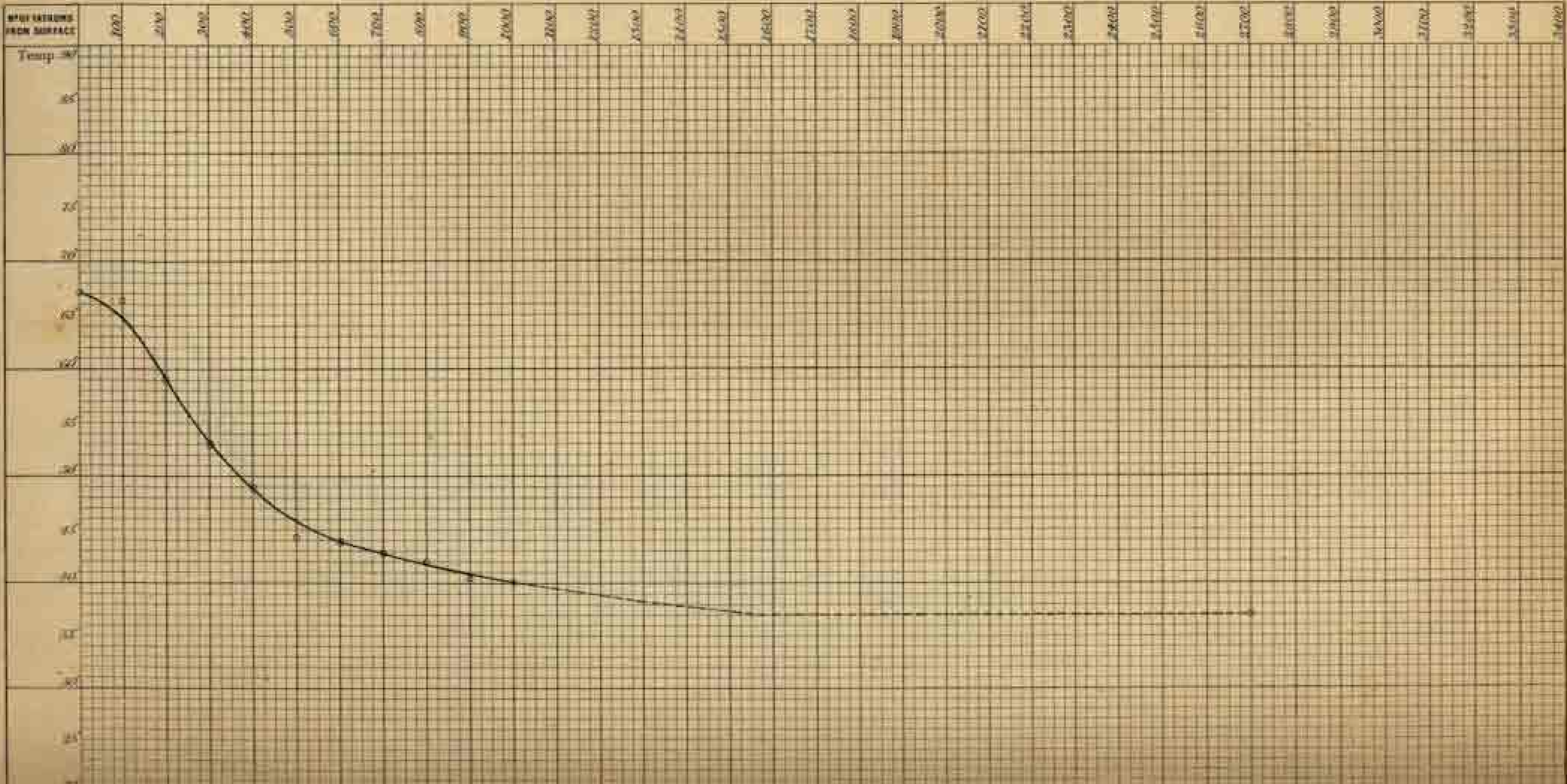
Nº of Sounding 52.
Station 8.

Depth 2700 fathoms

Latitude 23° 12′ N.
Longitude 32° 56′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER																				
TEMPERATURE SHEWN BY THERMOMETER	67.0										65.2									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	67.0										64.5									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	37				40	34	32	40	40	35	81	31													31
TEMPERATURE SHEWN BY THERMOMETER	59.0				53.0	49.0	44.2	43.8	42.5	41.3	40.3	40.0													37.0
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	59.0				53.4	49.0	46.0	44.0	42.5	41.8	40.8	40.0													37.0



SECTION: TENERIFFE TO SOMBRERO ISLAND, W.I.

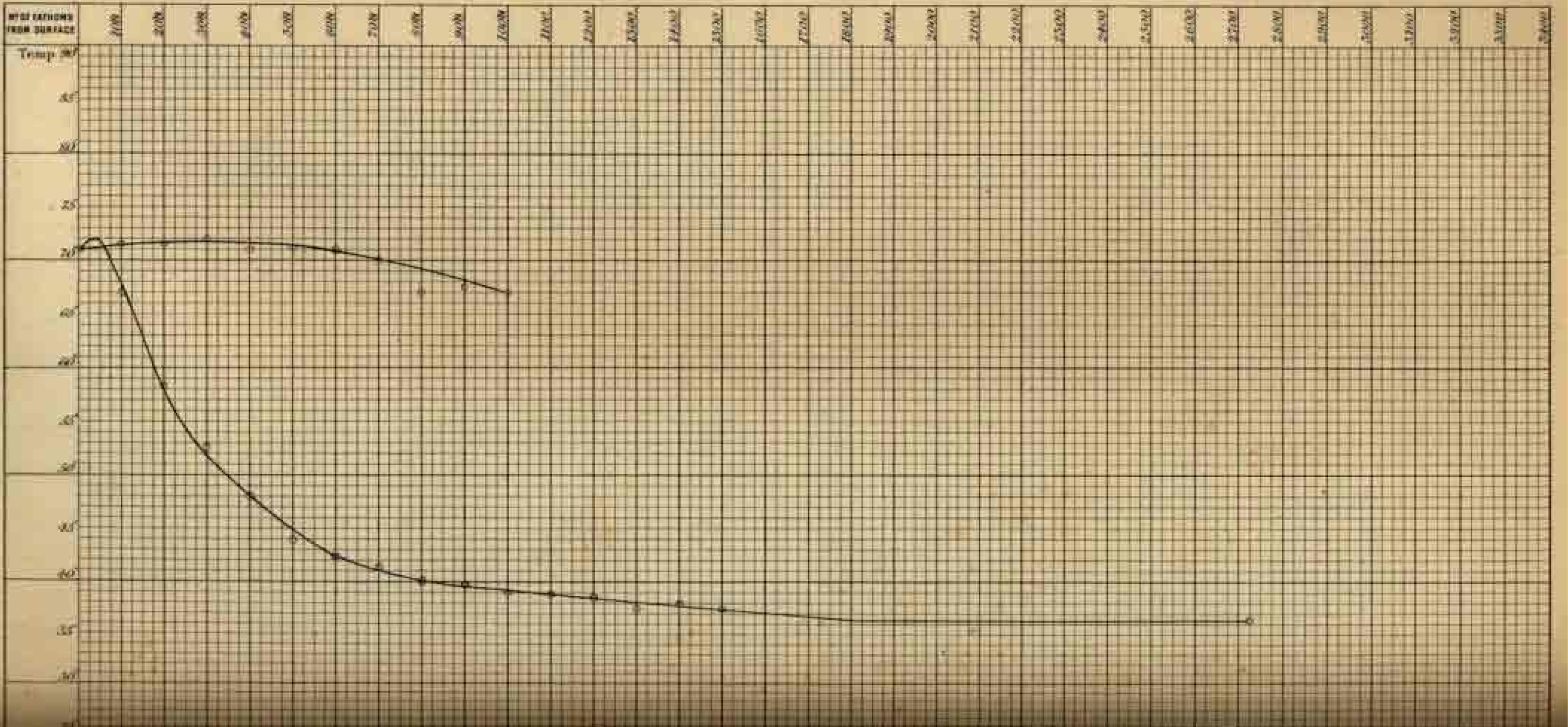
28 February 1873.

No. of Sounding 54.
Station 10.

Depth 2720 *fathoms.*

Latitude 23° 10′ N.
Longitude 38° 42′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER		46	39	49	36	30	33	64	61	31	37										49				36	30	64	46	53	34	31	54	58	48	61	27	35								39
TEMPERATURE SHEWN BY THERMOMETER	71.0	71.8	71.5	71.8	71.0	71.2	71.2	70.5	67.0	67.5	67.0										57.8				52.8	48.0	44.0	42.0	41.3	40.0	39.8	39.0	38.8	38.5	37.5	38.0	37.5								36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	71.0	71.8	71.8	71.3	71.6	71.4	71.2	70.5	69.3	68.4	67.0										58.0				52.5	48.0	44.5	42.2	40.8	40.0	39.6	39.2	38.9	38.6	38.4	37.9	37.6								36.5



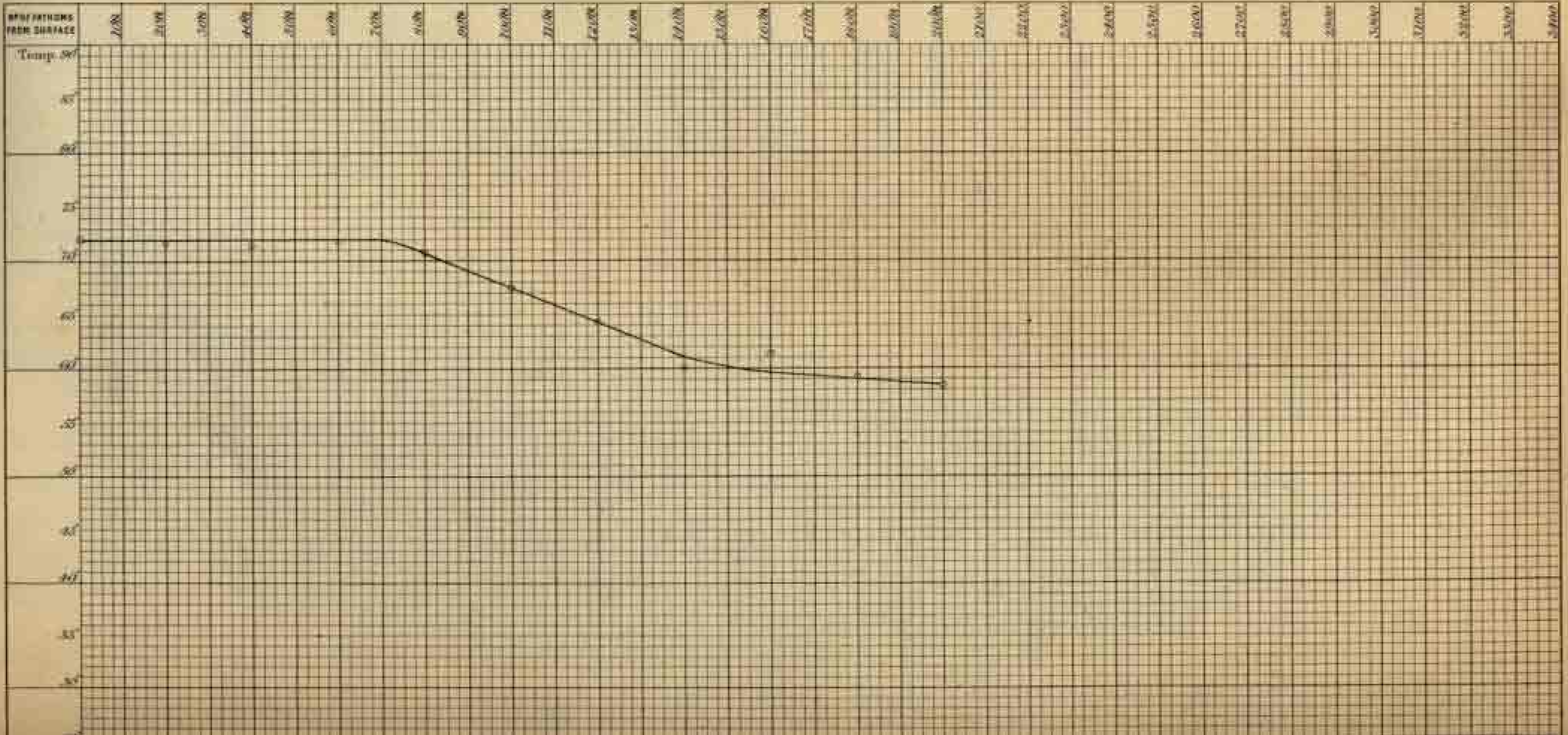
1 March 1873.

N.º of Sounding 55.
Station 11.

Depth 2575 fathoms.

Latitude 22° 45′ N.
Longitude 40° 37′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER			34		62		34		42		43		38		46		64		30		38																								39
TEMPERATURE SHEWN BY THERMOMETER	72.2		72.0		71.2		72.0		71.9		67.2		64.5		60.0		61.3		59.3		58.3																								36.3
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	71.9		72.1		72.0		72.0		71.9		67.0		64.1		61.3		59.8		59.2		58.6																								36.3



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

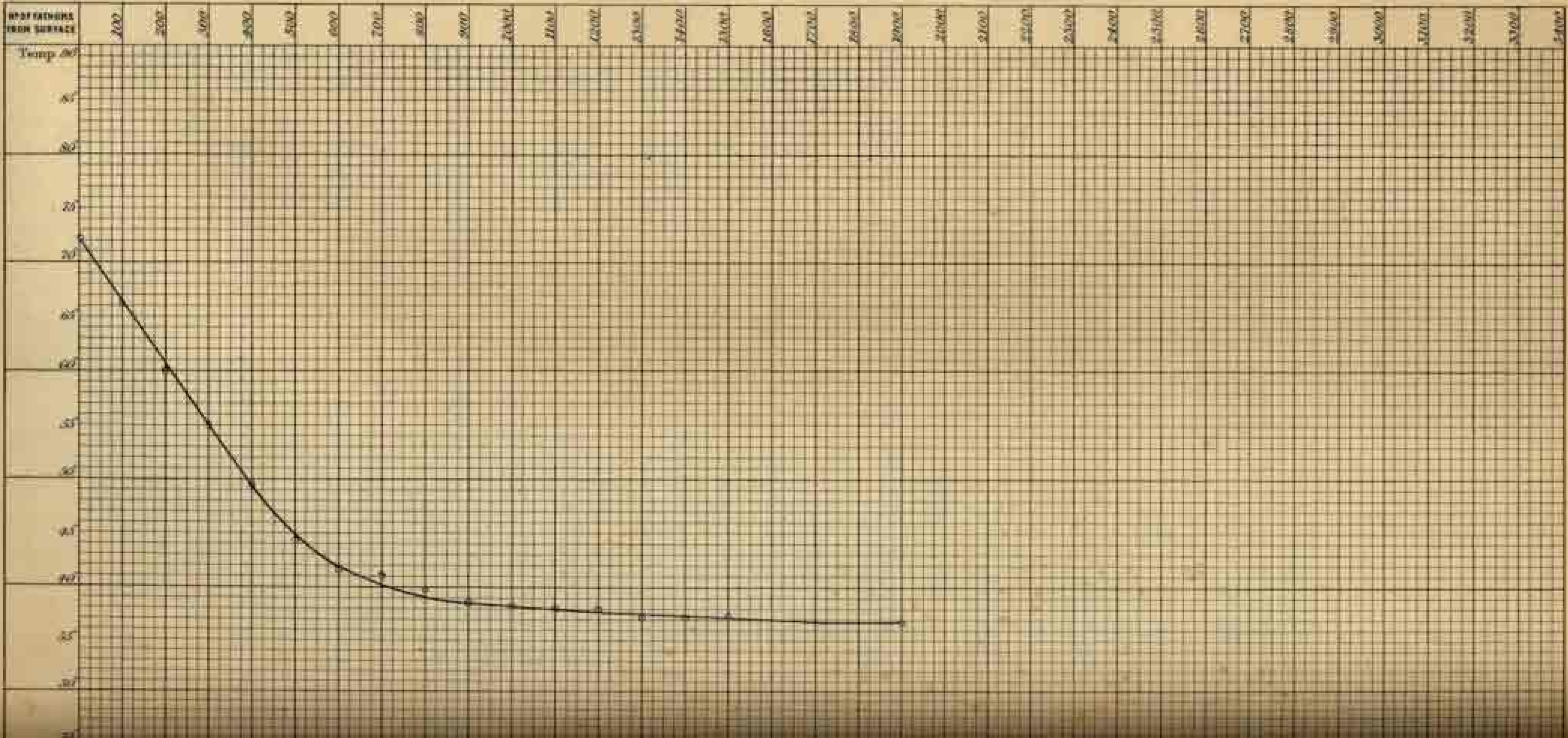
4 March 1873.

No. of Sounding 57.
Station 13.

Depth 1900 fathoms.

Latitude 21° 38′ N.
Longitude 44° 39′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER											61										39				34	46	34	54	53	35	43	42	37	34	64	30	46								34
TEMPERATURE SHEWN BY THERMOMETER	72.0										66.0										60.0				54.5	49.5	44.5	41.8	41.0	40.0	39.0	38.8	38.3	37.6	37.3	37.1	37.1								35.8
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	72.0										66.0										60.3				54.8	49.3	45.0	42.0	40.5	39.7	39.1	38.7	38.3	38.0	37.5	37.4	37.2								36.8



6 March 1873.

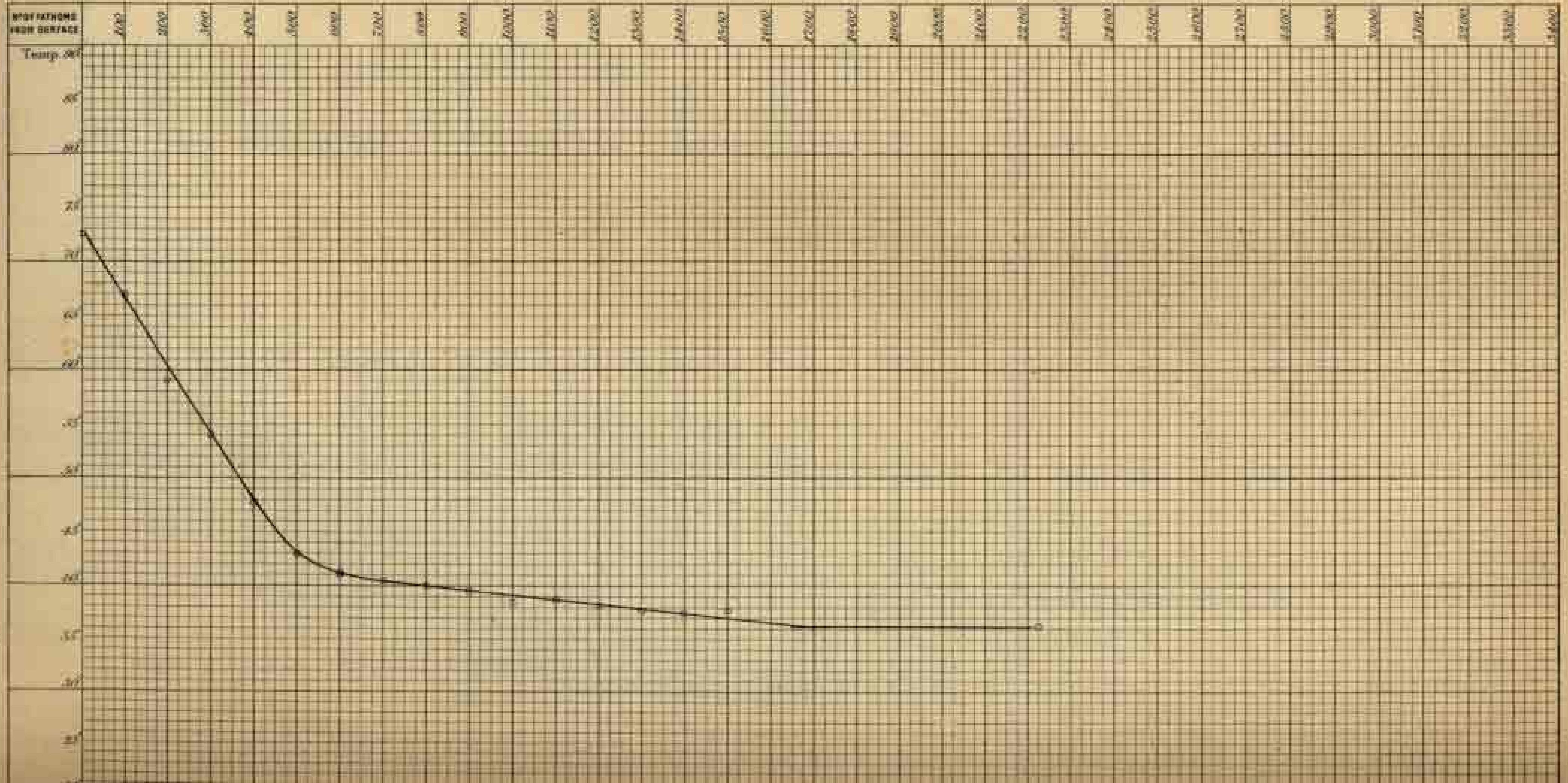
No. of Sounding 69.
Station 15.

Depth 2325 fathoms.

Latitude 20° 49′ N.
Longitude 48° 45′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
No. of thermometer											64										30	
Temperature shewn by thermometer	72.5										67.0										59.0	
Error of thermometer																						
Corrected temperature																						
Temperature from curve	72.5										66.5										60.3	

No. of fathoms from surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			42	34	34	46	58	30	31	61	33	37	38	49	47								39
Temperature shewn by thermometer			54.0	47.5	43.0	41.5	40.8	40.0	39.8	38.5	38.8	38.0	37.8	37.3	37.8								36.1
Error of thermometer																							
Corrected temperature																							
Temperature from curve			53.8	47.0	43.2	41.6	40.7	40.0	39.8	39.3	38.8	38.2	37.9	37.5	37.1								36.1



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

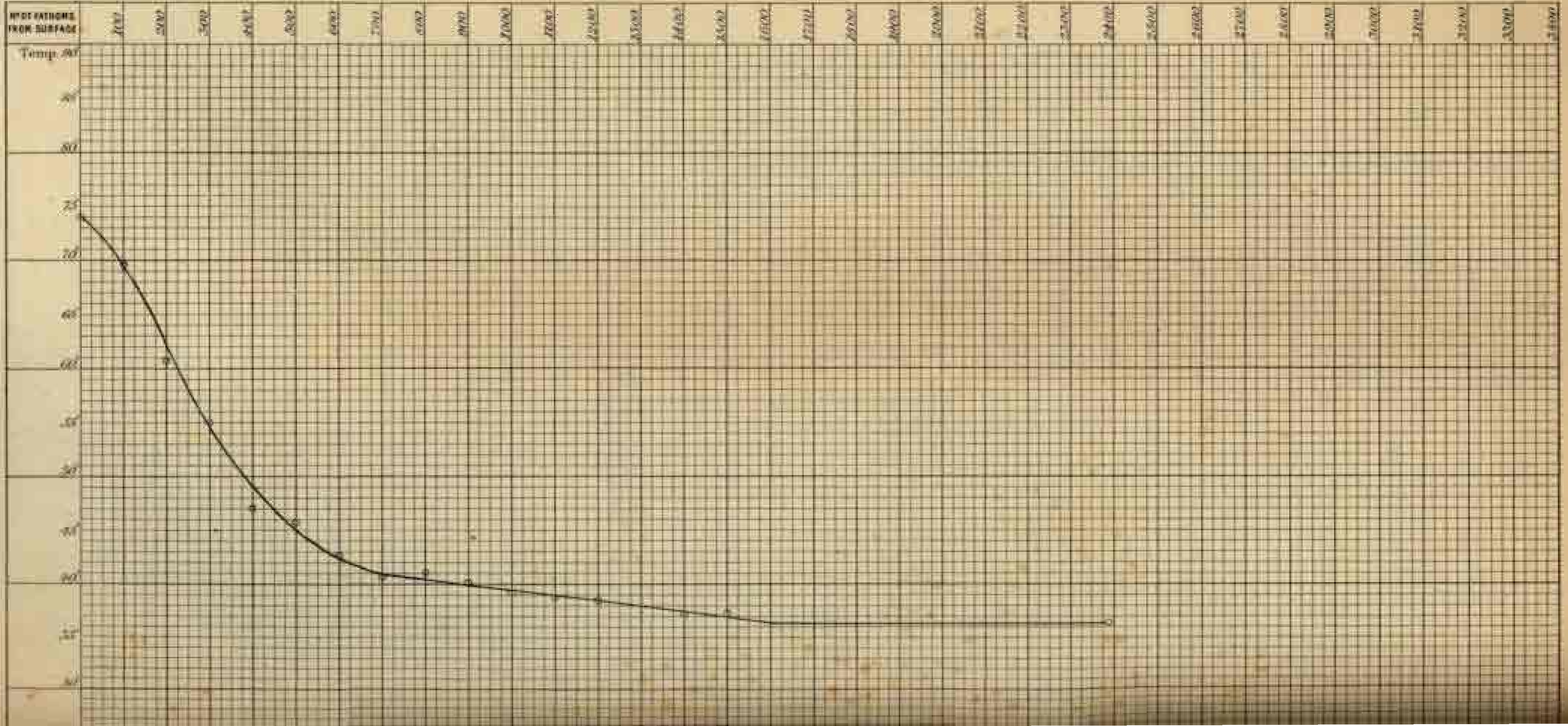
8 March 1873.

No. of Sounding 61.
Station 17.

Depth 2385 fathoms.

Latitude 20° 7′ N.
Longitude 52° 32′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER											77										39				53	39	38	47	38	37	34	33	64	43		46	43								39
TEMPERATURE SHEWN BY THERMOMETER	74.0										69.8										60.8				54.1	48.2	45.7	42.8	41.0	41.0	39.7	39.6	38.8	38.5		37.5	37.5								36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	74.0										69.7										60.0				54.1	48.5	44.7	42.3	41.2	40.4	39.7	39.4	39.0	38.5	38.0	37.5	37.1								36.5



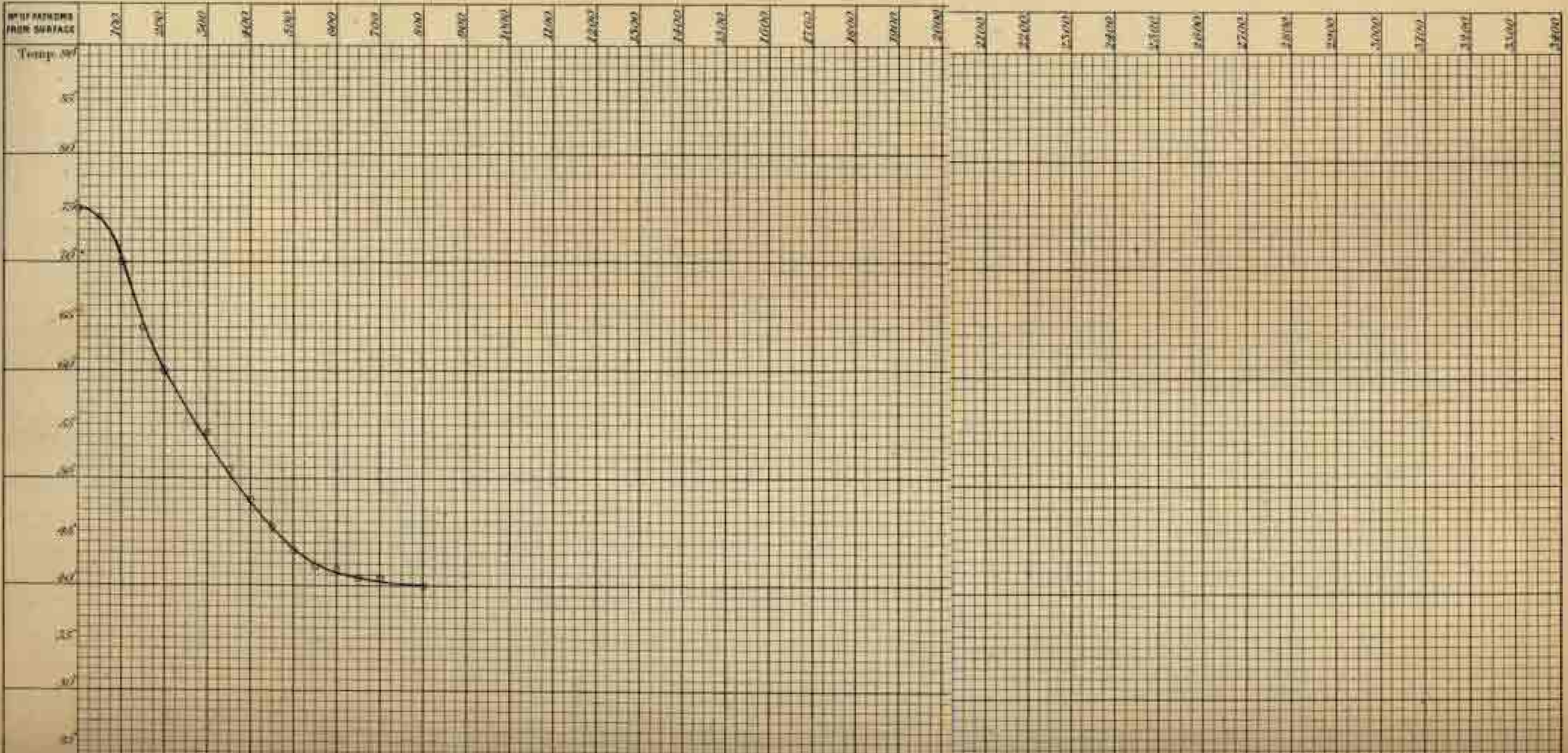
N° of Sounding 62.
Station 18

10 March 1873.
Depth 2650 Fathoms.

Latitude 19° 41′ N.
Longitude 55° 13′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER						54					48					37				
TEMPERATURE SHOWN BY THERMOMETER	74.0					73.5					70.0					64.0				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	74.0					73.1					69.3					64.3				

Nº OF FATHOMS FROM SURFACE	200	250	300	350	400	450	500	550	600	650	700	800	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	36	39	58	30	39	37	14	84	39	40	34	39													39
TEMPERATURE SHOWN BY THERMOMETER	59.8	56.2	54.1	50.8	47.8	45.0	43.3	41.2	41.5	40.5	40.6	40.0													36.0
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	60.0	57.2	53.5	50.5	47.2	45.0	43.0	41.3	41.2	40.7	40.4	40.0													36.0



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

12 March 1873.

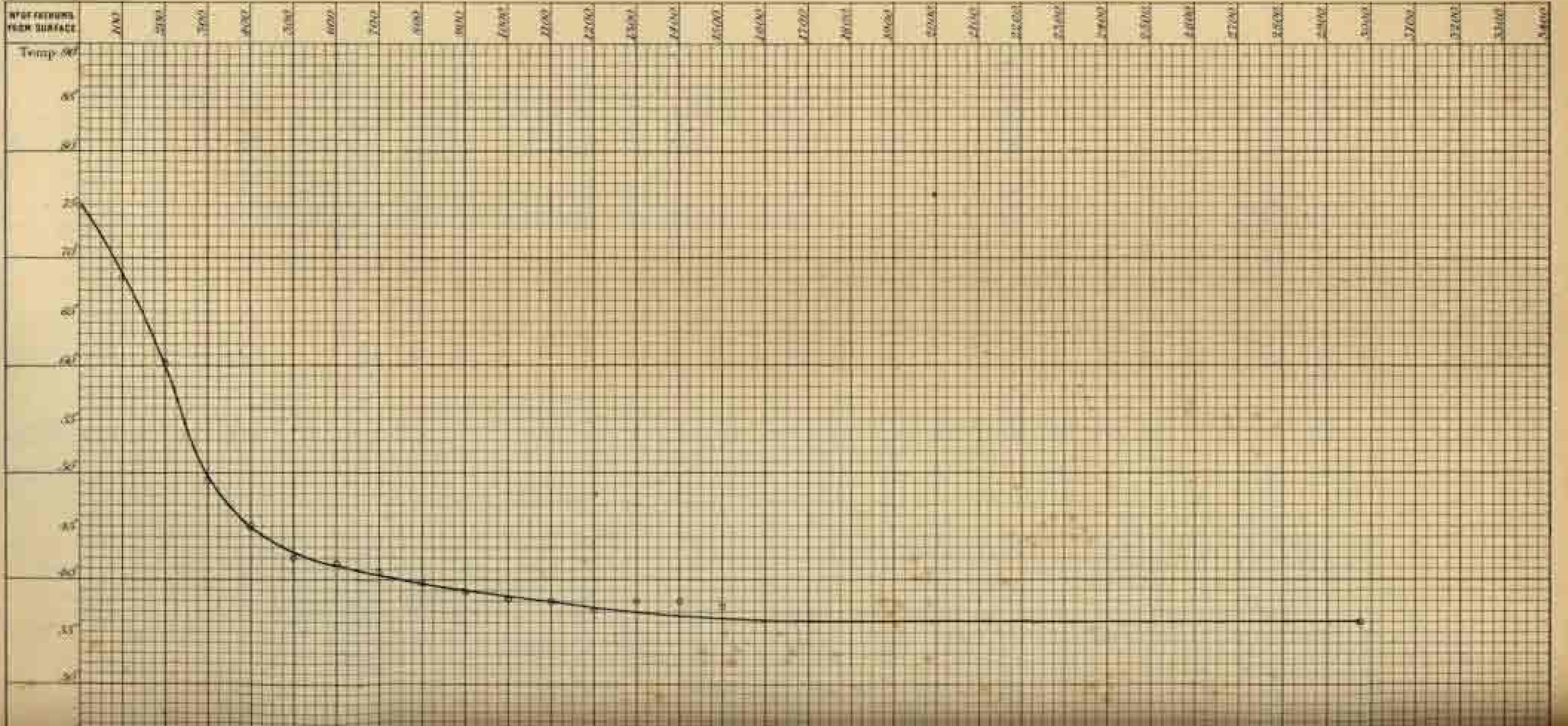
No. of Sounding 64.
Station 20.

Depth 2975 *fathoms.*

Latitude 18° 56′ N.
Longitude 59° 35′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
NO. OF THERMOMETER											38									
TEMPERATURE SHEWN BY THERMOMETER	75.0										68.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	75.0										68.5									

NO. OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER	64				54	31	55	58	40	43	47	58	30	36	17	48	41								39 39
TEMPERATURE SHEWN BY THERMOMETER	60.2				49.8	45.0	42.0	41.3	40.2	39.8	39.0	38.6	38.0	37.5	38.0	38.0	37.3								36.0 36.0
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	59.8				49.7	45.0	42.5	41.4	40.3	39.8	39.3	38.3	38.5	37.8	37.1	36.8	36.5								36.0



SECTION. TENERIFFE TO SOMBRERO ISLAND, W.I.

14 March 1873.

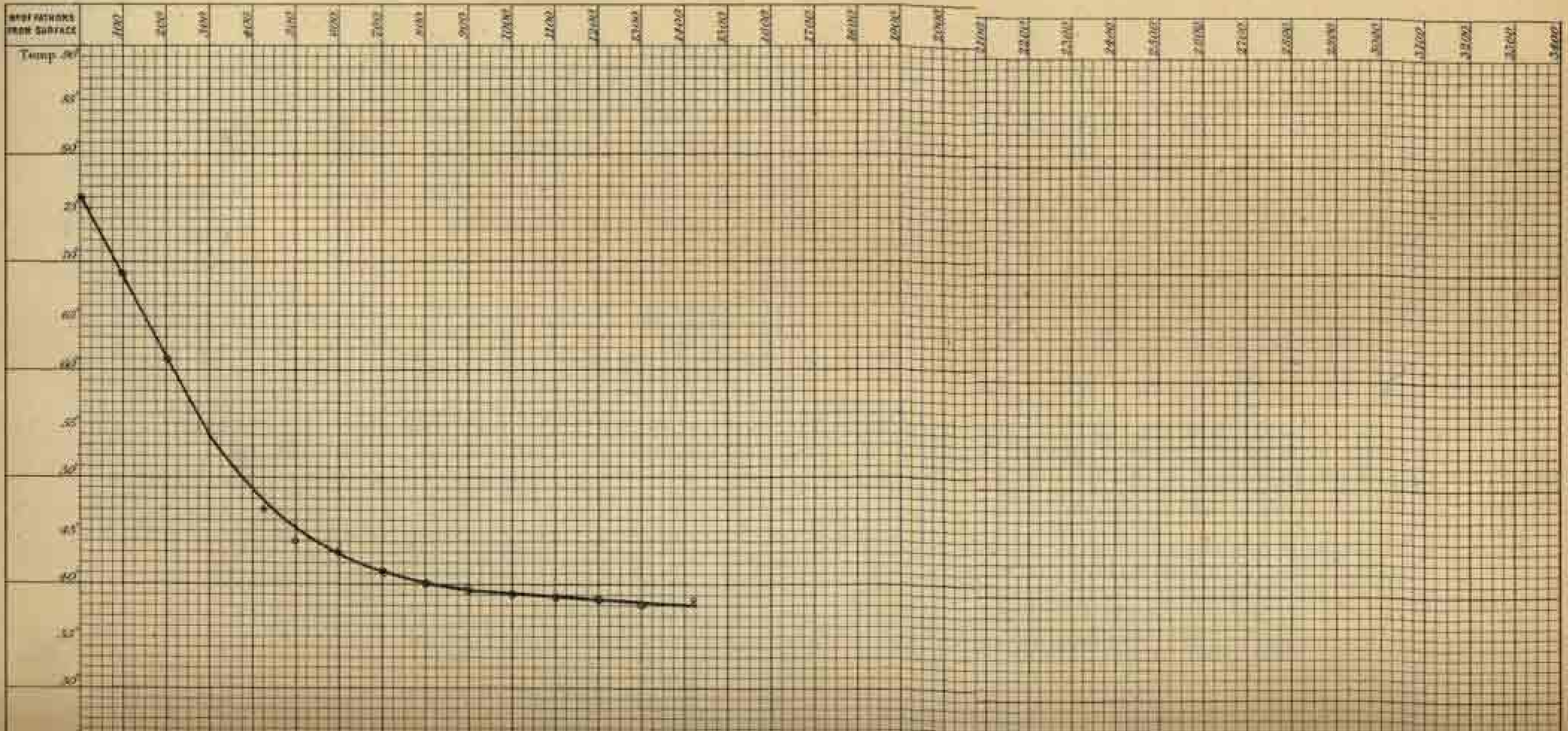
Nº of Sounding 66.
Station 22.

Depth 1420 fathoms.

Latitude 18° 40′ N.
Longitude 62° 56′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER											30									
TEMPERATURE SHEWN BY THERMOMETER	76.0										69.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	76.0										69.0									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	39				23	34	19	34	32	61	43	58	36	37	62										39 40
TEMPERATURE SHEWN BY THERMOMETER	61.2					48.0	44.2	43.0	41.2	38.8	39.6	39.1	38.8	38.5	38.2										38.2 38.5
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	61.3				54.7	48.9	45.7	43.0	41.2	40.0	39.7	39.2	39.0	38.7	38.4										38.0



SECTION. ST. THOMAS TO BERMUDA.

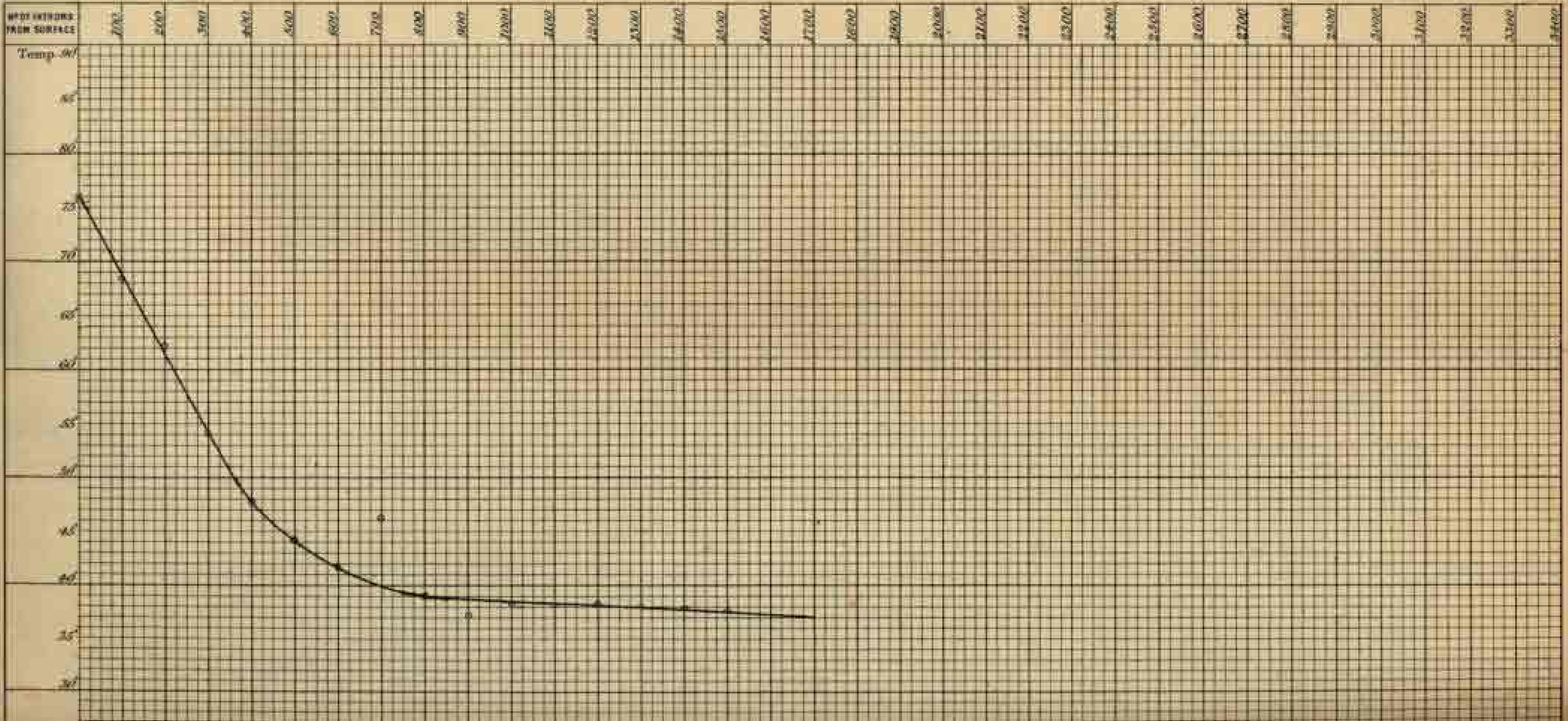
26 March 1873.

Nº of Sounding 72.
Station 25.

Depth. 3875 fathoms.

Latitude 19° 41′ N.
Longitude 65° 7′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
Nº OF THERMOMETER											37										34				64	53	58	34	64	31	61	34	37	58	34	53	45							
TEMPERATURE SHEWN BY THERMOMETER	76.0										68.5										62.2				54.0	47.4	43.8	41.5	46.2	39.6	37.9	38.4	38.2	38.1	38.0	37.8	37.5							
ERROR OF THERMOMETER																																												
CORRECTED TEMPERATURE																																												
TEMPERATURE FROM CURVE	76.0										68.8										62.5				54.0	47.4	43.8	41.5	40.0	39.0	38.7	38.5	38.3	38.1	37.9	37.7	37.5							



SECTION. ST. THOMAS TO BERMUDA.

28 March 1873.

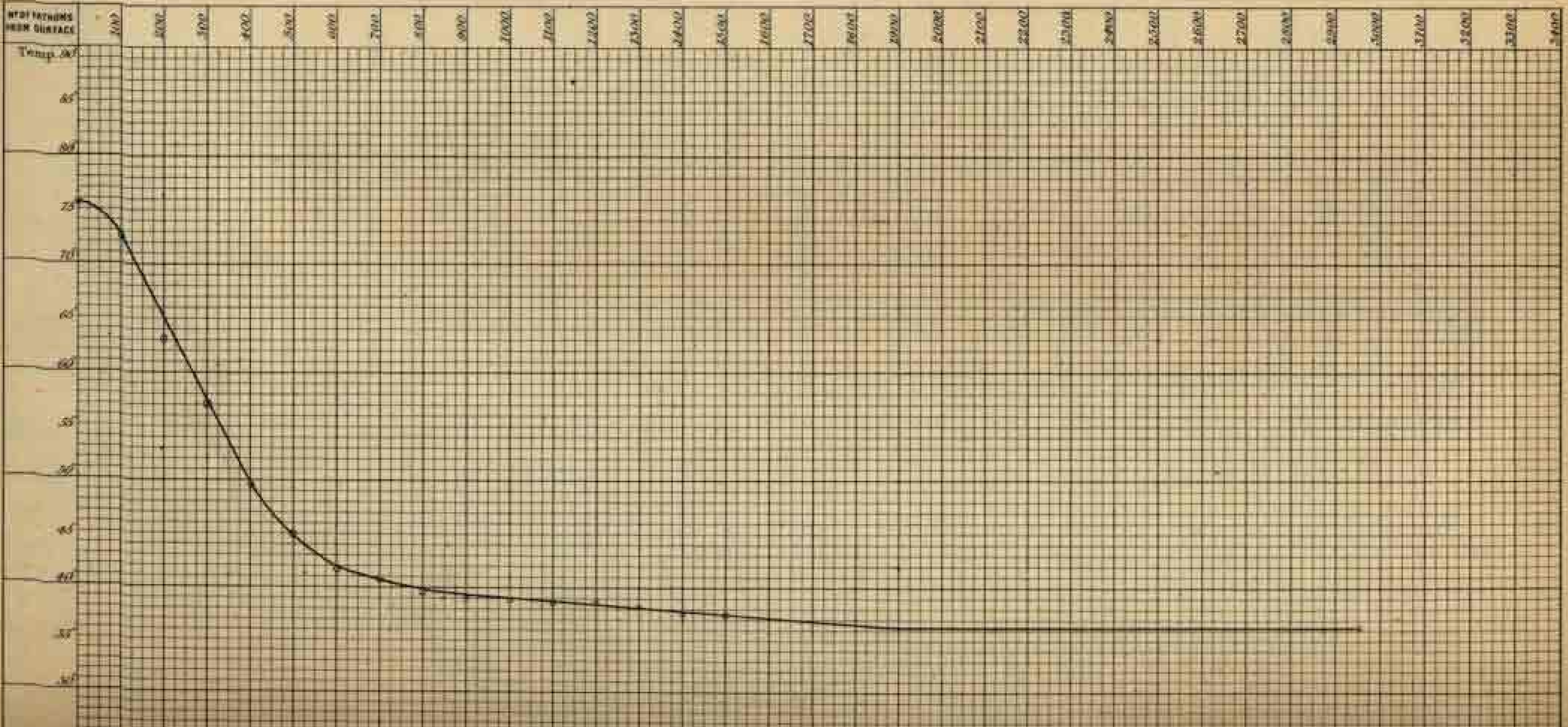
Nº of Sounding 74.
Station 27.

Depth 2960 fathoms.

Latitude 22° 49′ N.
Longitude 65° 19′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of thermometer											37									
Temperature shewn by thermometer	73.5										72.5									
Error of thermometer																				
Corrected temperature																				
Temperature from curve	73.5										72.5									

Nº of fathoms from surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	43				33	64	37	36	54	38	43	53	37	36	34	64	38								38
Temperature shewn by thermometer	63.0				56.8	49.5	45.0	41.8	40.8	39.8	39.0	39.0	38.6	38.6	38.2	37.6	37.5								36.2
Error of thermometer																									
Corrected temperature																									
Temperature from curve	64.7				57.0	49.7	45.0	42.3	40.8	40.0	39.4	39.0	38.7	38.4	38.1	37.8	37.5								36.2



SECTION. ST. THOMAS TO BERMUDA.

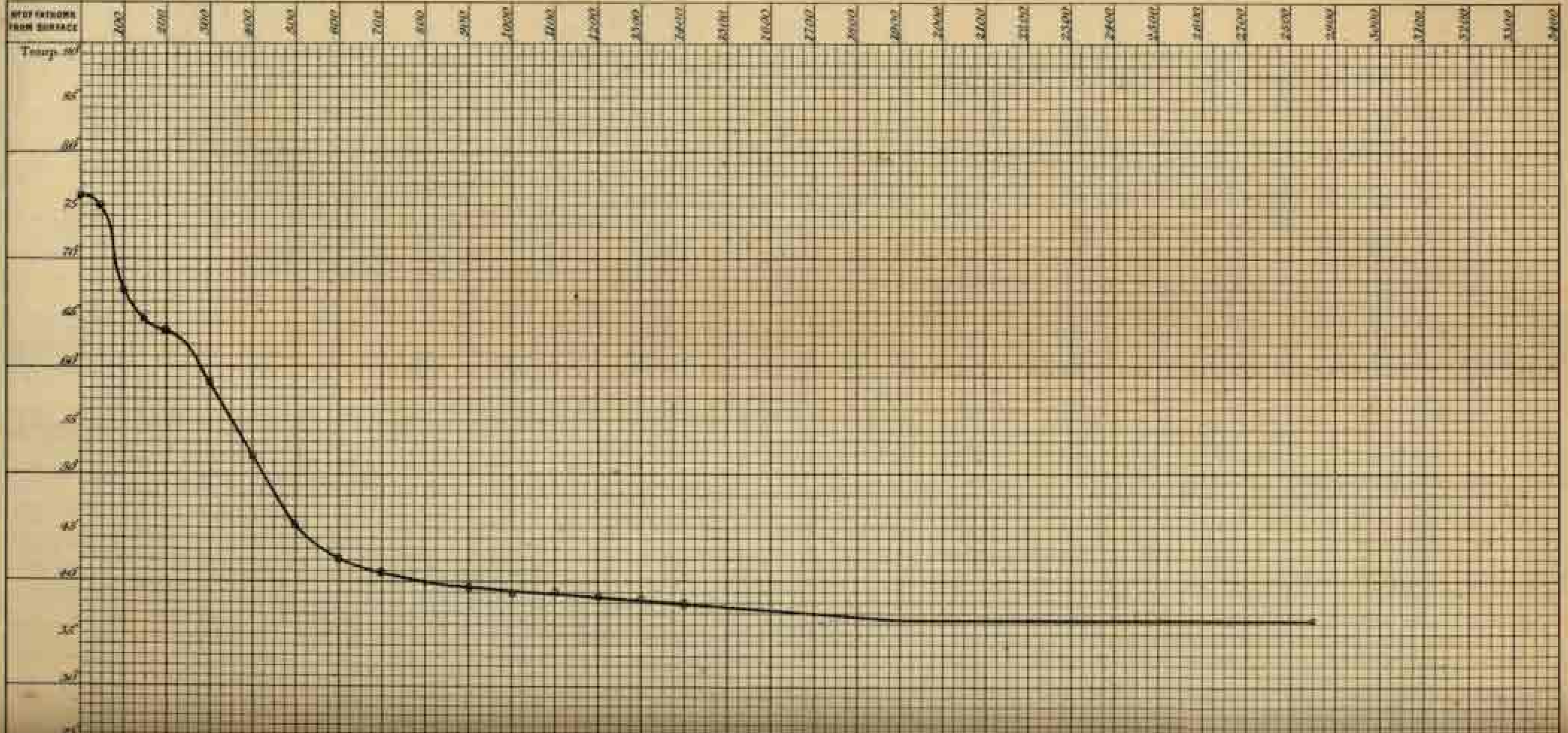
29 March 1873.

No. of Sounding 75.
Station 28.

Depth 2850 fathoms.

Latitude 24° 39′ N.
Longitude 65° 25′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER						54					35 34					37					43 39				33	54	36	37	43		54	36	33	43	58	37	64								43 39
TEMPERATURE SHEWN BY THERMOMETER	75.0					74.0					67.2 67.2					64.6					63.5 63.5				58.3	51.8	45.2	44.3	41.0		39.5	39.0	39.0	38.4	38.1	38.0	37.6								36.3 36.4
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	75.0					74.0					67.2					64.6					63.5				58.3	51.8	45.2	44.3	41.0	40.0	39.5	39.1	38.7	38.4	38.1	37.8	37.5								36.3



31 March 1873.

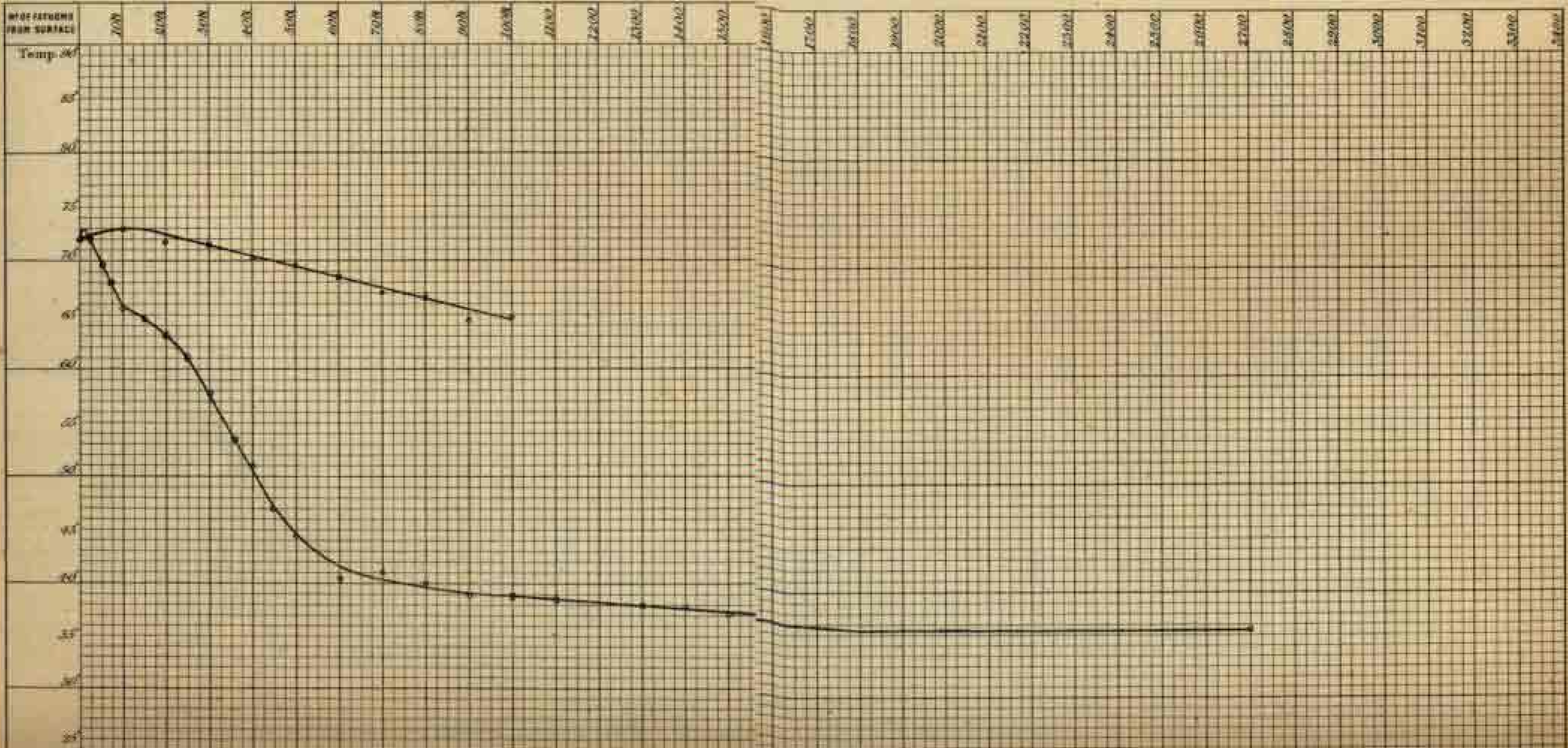
Nº of Sounding 76.
Station 29.

Depth 2700 fathoms.

Latitude 27° 49′ N.
Longitude 64° 59′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	200	250	300	350	400
Nº OF THERMOMETER		43	38	37	36	49	53	34	31	61	30					31	34	53	49	38	37
TEMPERATURE SHEWN BY THERMOMETER	72.0	73.0	71.8	71.4	70.2	69.5	68.5	67.2	66.6	64.5	64.3					63.8	62.8	61.2	58.0	54.6	51.4
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	72.0	73.0	71.3	71.4	70.2	69.4	68.4	67.4	66.4	65.3	64.3					63.8	62.8	62.2	58.0	54.5	50.9

Nº OF FATHOMS FROM SURFACE	450	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	38					43	51	49	31	34	53	36	64	37	37	43								43 37
TEMPERATURE SHEWN BY THERMOMETER	47.2					44.6	40.6	41.0	40.0	39.0	39.0	38.6	38.5	38.0	37.8	37.2								36.4 36.3
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	47.4					44.7	41.7	40.5	39.8	39.2	38.9	38.6	38.3	38.0	37.7	37.4								36.4



SECTION. BERMUDA TO NEW YORK.

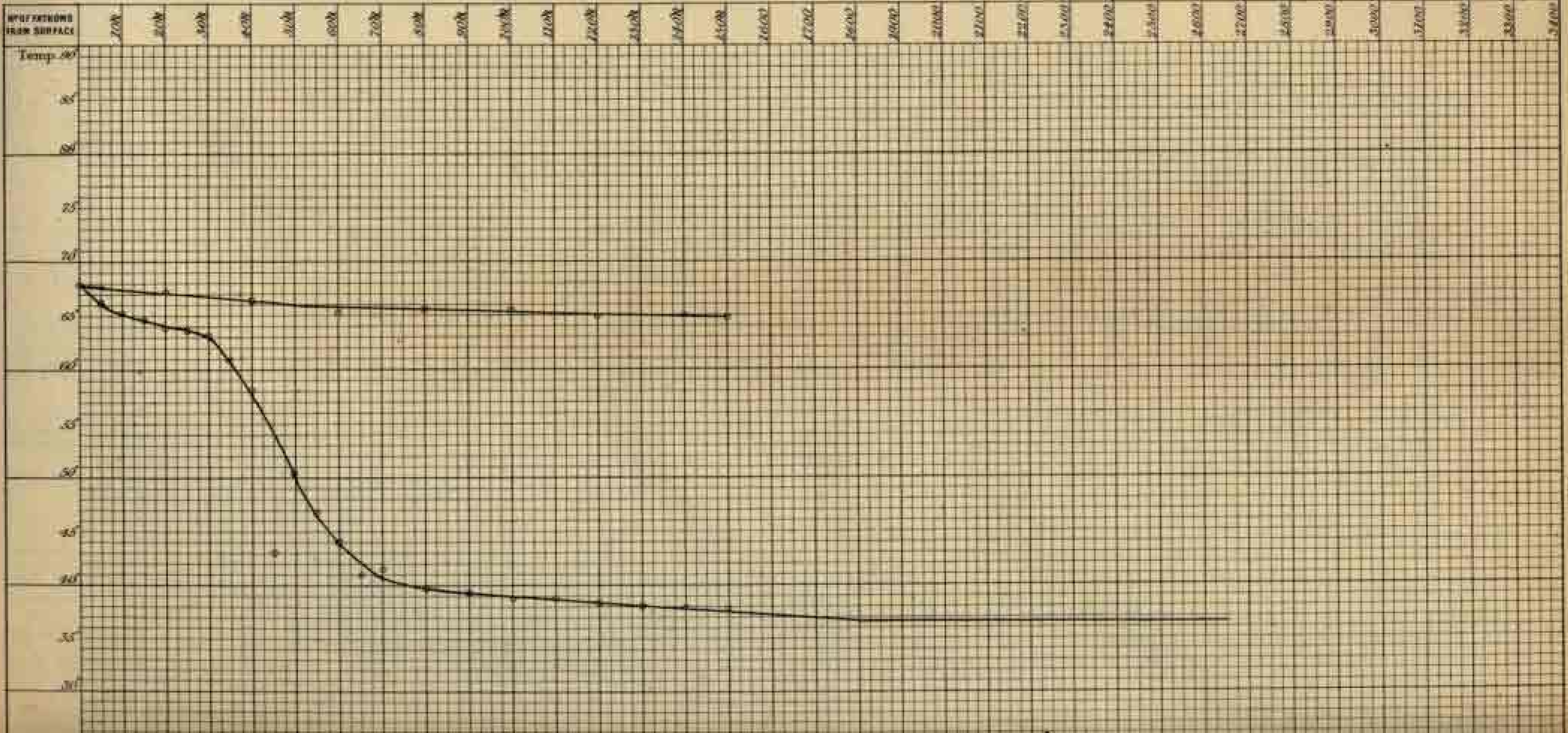
24 April 1873.

No. of Sounding 95.
Station 37.

Depth 2650 fathoms.

Latitude 32° 18' N.
Longitude 65° 33' W.

No. of fathoms from surface	No. of thermometer	Temperature shown by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		68.0			68.0
10					
20	37	67.2			67.2
30					
40	58	66.2			66.2
50					
60	61	65.3			65.7
70					
80	56	65.5			65.5
90					
100	43	65.5			65.3
110					
120	39	65.0			65.1
130					
140	64	65.0			64.9
150	64	64.8			64.8
200	56	64.0			64.3
250	49	63.8			63.8
300	58	63.2			63.2
350	39	61.0			61.0
400	53	58.0			57.7
450	52	43.0			54.3
500	37	50.4			50.4
550	37	46.8			46.8
600	34	43.9			43.9
650	61	41.0			42.0
500					
600					
700	43	41.5			41.0
800	64	39.8			39.8
900	43	39.3			39.3
1000	51	39.0			39.0
1100	31	38.9			38.7
1200	39	38.3			38.4
1300	37	38.2			38.1
1400	58	38.0			37.8
1500	34	37.8			37.3
1600					
1700					
1800					
1900					
2000					
Bottom	58	36.5			36.5



SECTION. BERMUDA TO NEW YORK.

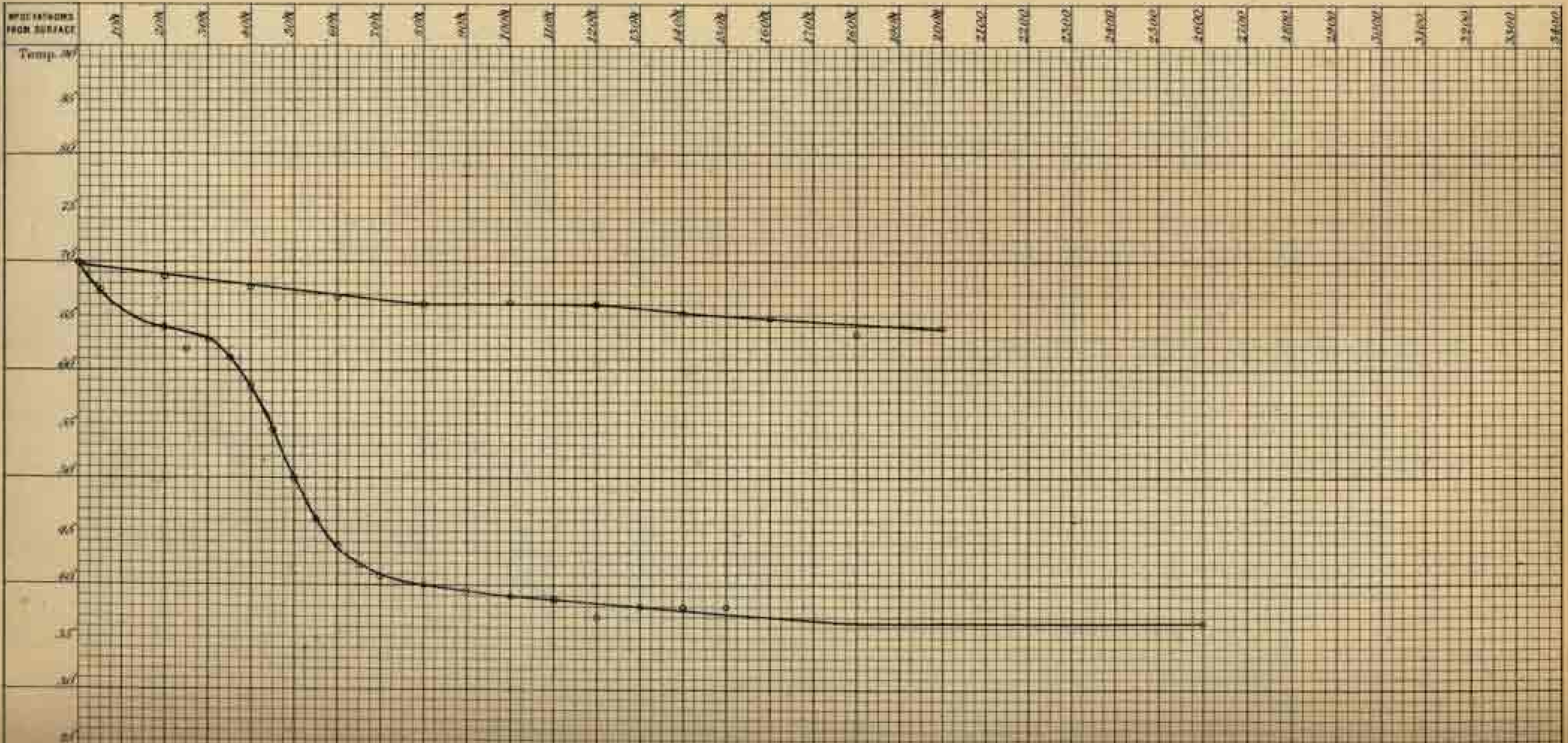
No. of Sounding 96.
Station 38.

20 April 1873.

Depth 2600 fathoms.

Latitude 33° 3′ N.
Longitude 66° 32′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	180	200	250	300	350	400	450	500	550	600	650	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			64		31		39		34		58		57		49		54	61	36	61	54	49	37	58	34	30	31	36	64	64	54	36	37	61	30	58	43								63
Temperature shewn by thermometer	70.0		68.8		68.0		66.8		66.2		66.2		66.0		65.4		64.9	63.2	64.0	62.0	63.0	61.2	58.3	54.5	50.0	46.2	43.8	41.9	40.8	40.0	39.6	39.1	38.9	36.9	38.2	38.0	38.0								36.5
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	70.0		69.0		68.0		67.1		66.2		66.0		66.0		65.4		64.8	64.2	63.7	63.5	63.0	61.3	58.5	54.7	50.0	46.0	43.6	42.0	41.1	40.0	39.6	39.2	38.8	38.4	38.0	37.7	37.4								36.5



SECTION. BERMUDA TO NEW YORK.

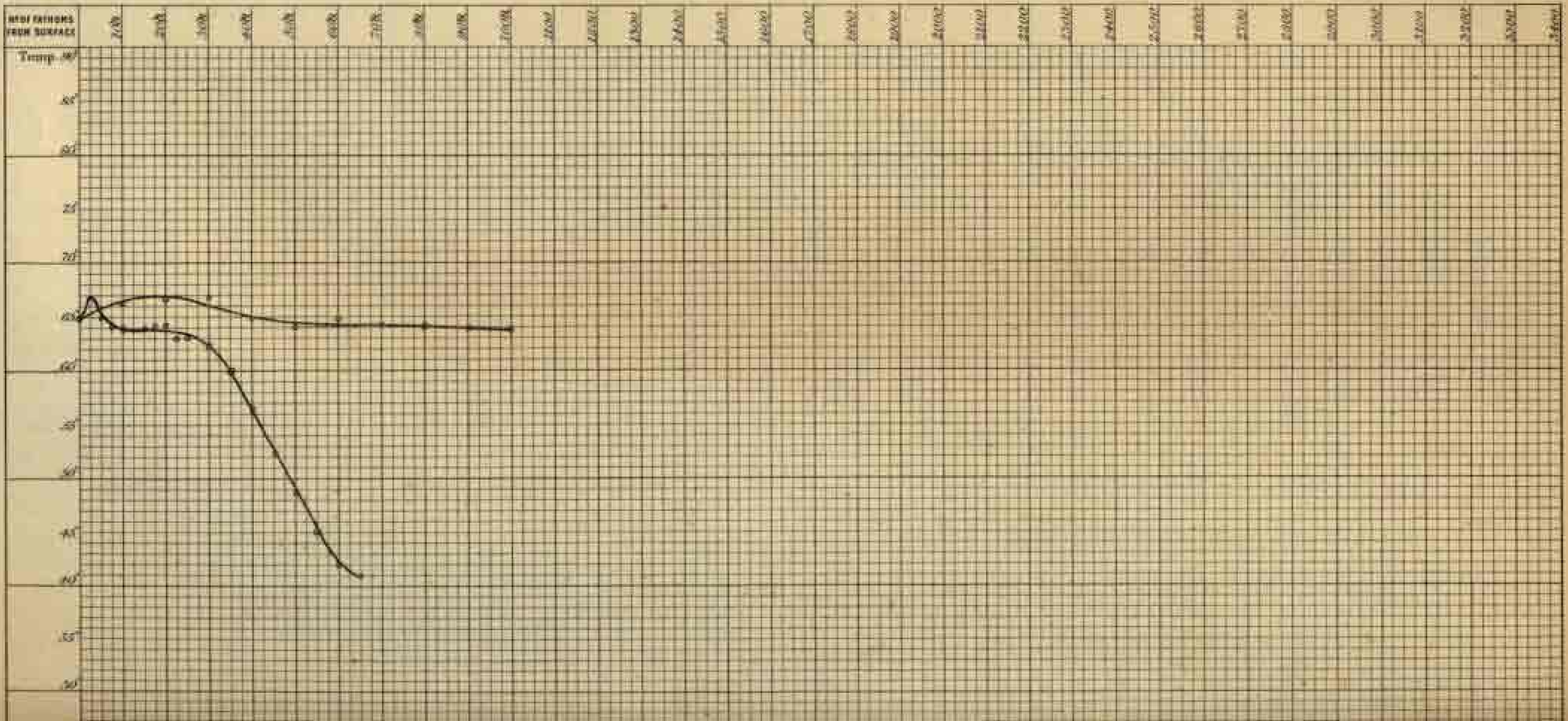
27 April 1873.

N° of Sounding 97.
Station 39.

Depth 2850 fathoms.

Latitude 34° 3' *N.*
Longitude 67° 32' *W.*

N° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	125	130	140	150	160	175	200	225	250	300	350	400	450	500	550	600	650	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER		43	34	30	36	31	37	38	64	49	34		34			37		64	49	36	34	43	30	36	64	31	37	54	49																43
TEMPERATURE SHEWN BY THERMOMETER	65.0	66.5	66.3	66.8	65.0	64.7	64.8	64.2	64.0	64.0	63.5		63.7			63.8		64.2	64.3	63.0	63.2	62.4	59.8	56.3	52.4	48.1	45.2	42.0	41.0																36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	65.0	66.5	67.0	66.2	65.2	64.7	64.0	64.1	64.0	63.9	63.8		63.8			63.8		63.8	63.7	63.5	63.3	62.5	60.0	56.5	52.5	48.7	45.0	42.8	41.0																36.5



29 April 1873.

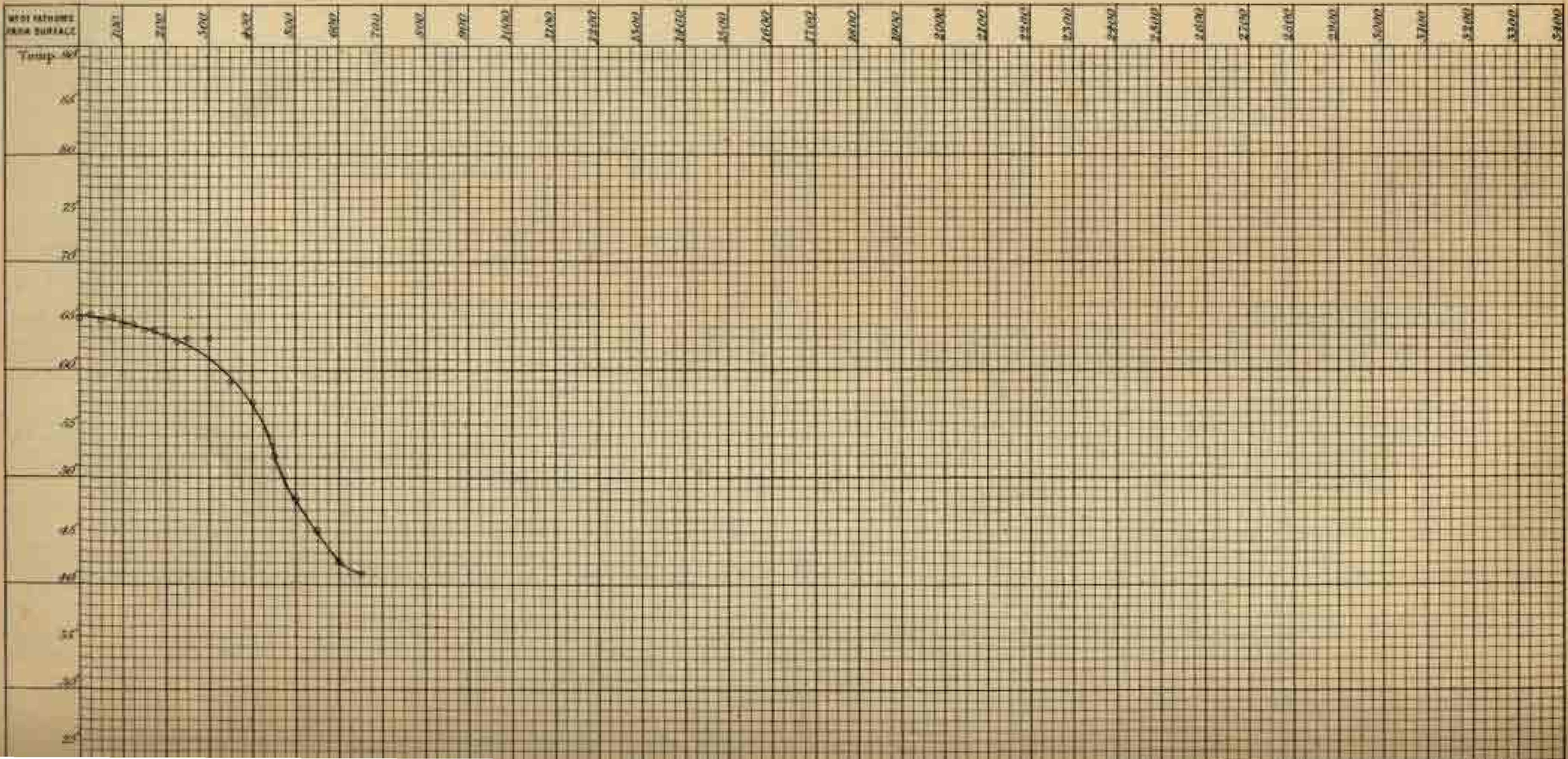
Nº of Sounding 99.
Station 41.

Depth None obtained.

Latitude 36° 5′ N.
Longitude 69° 54′ W.

Nº of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
Nº of thermometer			34			36		36			64 36		37			30		36		
Temperature shewn by thermometer	65.0		65.2			64.8		65.0			64.3 64.3		64.5			63.9		63.8		
Error of thermometer																				
Corrected temperature																				
Temperature from curve	65.0		64.9			64.8		64.7			64.5		64.3			64.1		63.8		

Nº of fathoms from surface	200	225	250	300	350	400	450	500	550	600	650	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	61	36	58	34	44	34	37	64	37	35	36														
Temperature shewn by thermometer	63.5	63.0	63.0	62.8	59.0	57.0	52.2	48.0	45.0	42.0	40.8														
Error of thermometer																									
Corrected temperature																									
Temperature from curve	63.5	63.1	62.6	61.2	59.3	56.0	52.2	48.0	45.0	42.0	40.8														



SECTION. BERMUDA TO NEW YORK.

30 April 1873.

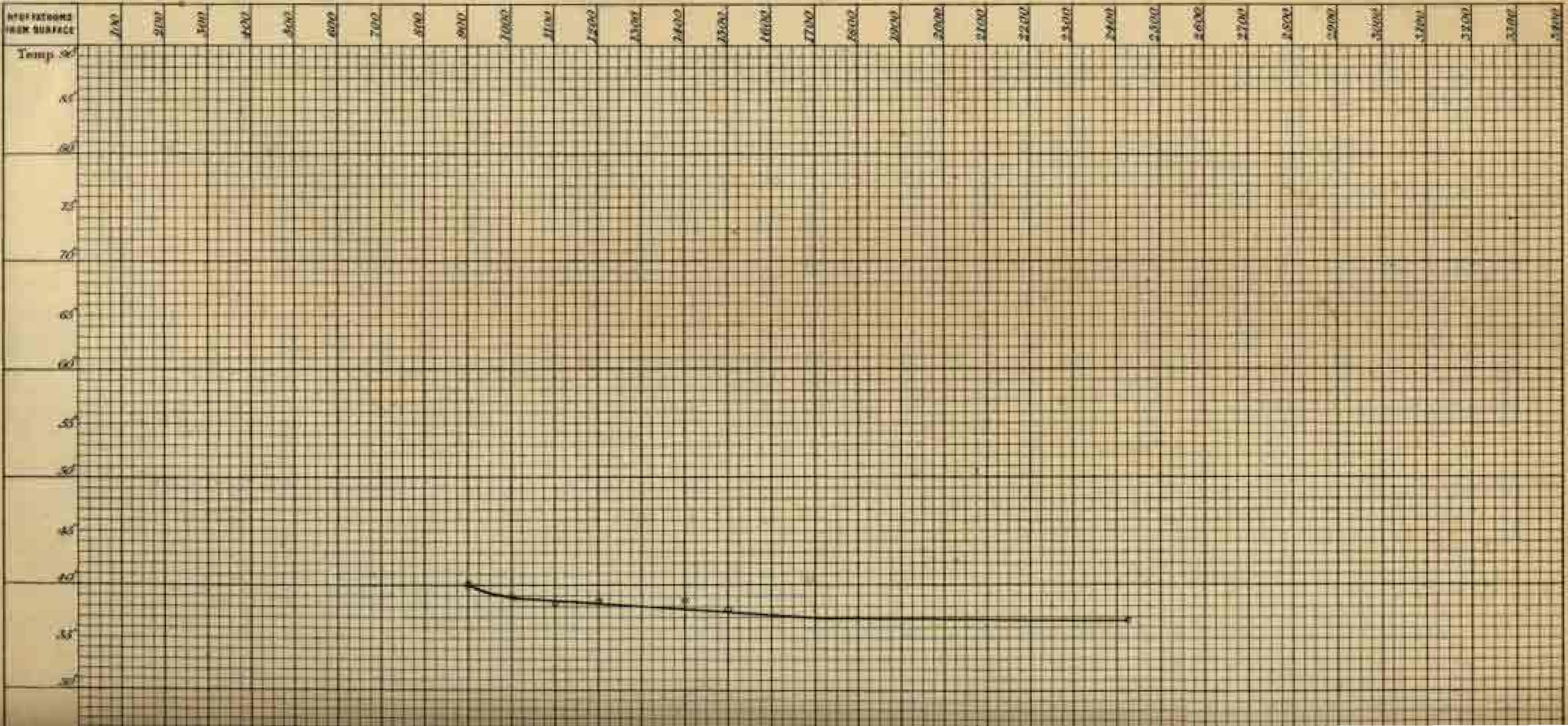
Nº of Sounding 100.
. . *Station* 42.

Depth 2425 fathoms.

Latitude 35° 58′ N.
Longitude 70° 35′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº of thermometer																								
Temperature shewn by thermometer	65.0																							
Error of thermometer																								
Corrected temperature																								
Temperature from curve	65.0																							

Nº of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer							54	37	45	56	53	58	56								38
Temperature shewn by thermometer							40.2	39.2	38.5	38.6		38.6	37.9								36.8
Error of thermometer																					
Corrected temperature																					
Temperature from curve							40.2	39.2	38.8	38.5	38.2	37.9	37.6								36.8



SECTION, BERMUDA TO NEW YORK.

1 May 1873.

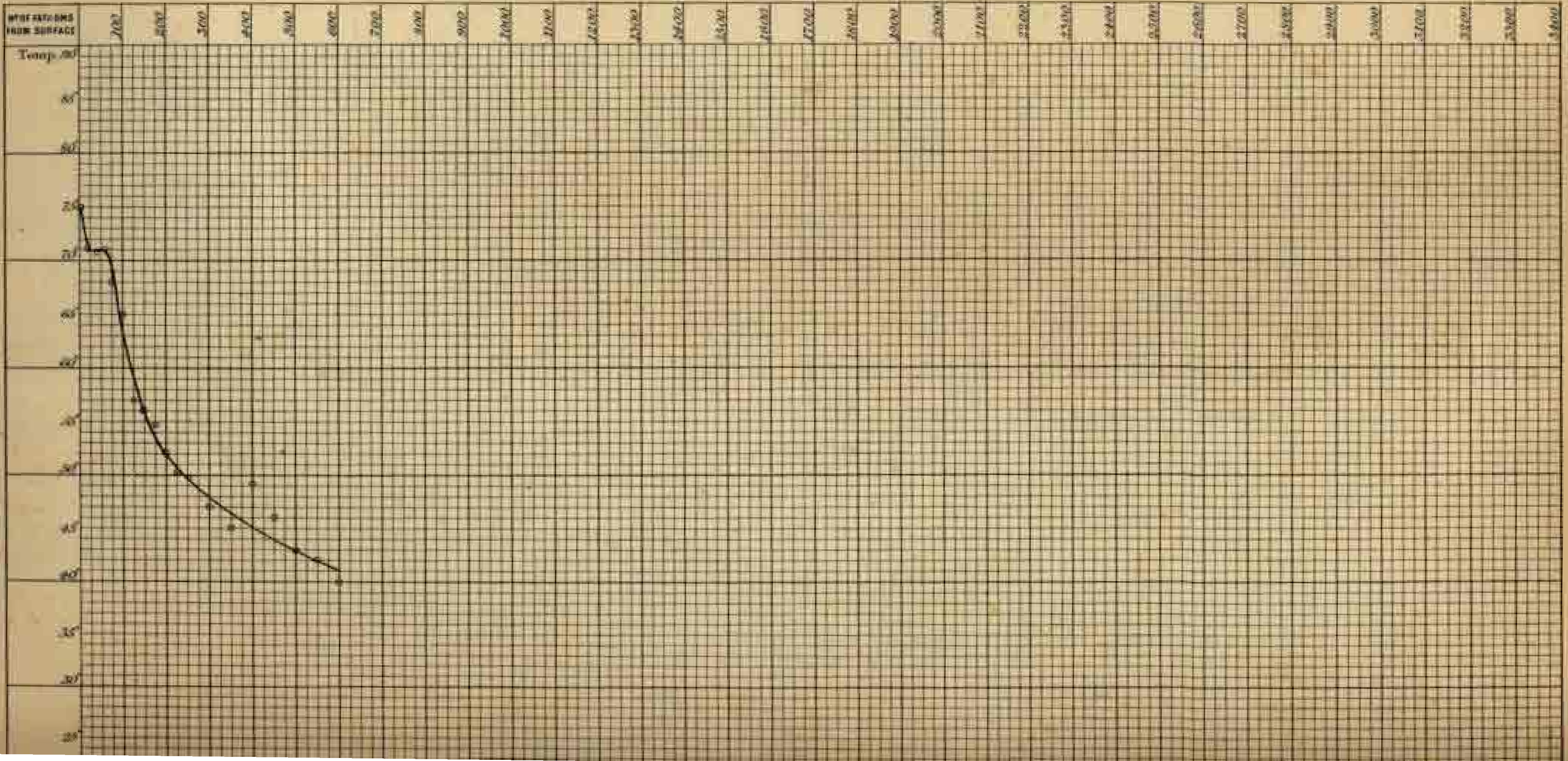
No. of Sounding 101.
Station 43.

Depth 2600 no Bottom.

Latitude 36° 23′ N.
Longitude 71° 48′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	125	130	140	150	160	175	180	190
No. of Thermometer			37		36		30		44		45		34			37		44		
Temperature shewn by Thermometer	75.0		71.2		70.8		71.0		68.0		65.0		57.0			56.0		54.9		
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	75.0		71.2		71.0		71.0		68.0		64.0		59.5			56.4		54.0		

No. of Fathoms from Surface	200	225	250	275	300	350	400	450	500	550	600	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2600		Bottom
No. of Thermometer	30	36	37		43	44	47	34	30	44	60												38		
Temperature shewn by Thermometer	52.2	50.4	49.8		47.0	45.0	49.2	46.0	42.8	42.0	40.0												36.8		
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	52.2	51.0	49.7		47.7	46.2	44.8	43.8	42.9	42.0	41.0												36.8		



SECTION. BERMUDA TO NEW YORK.

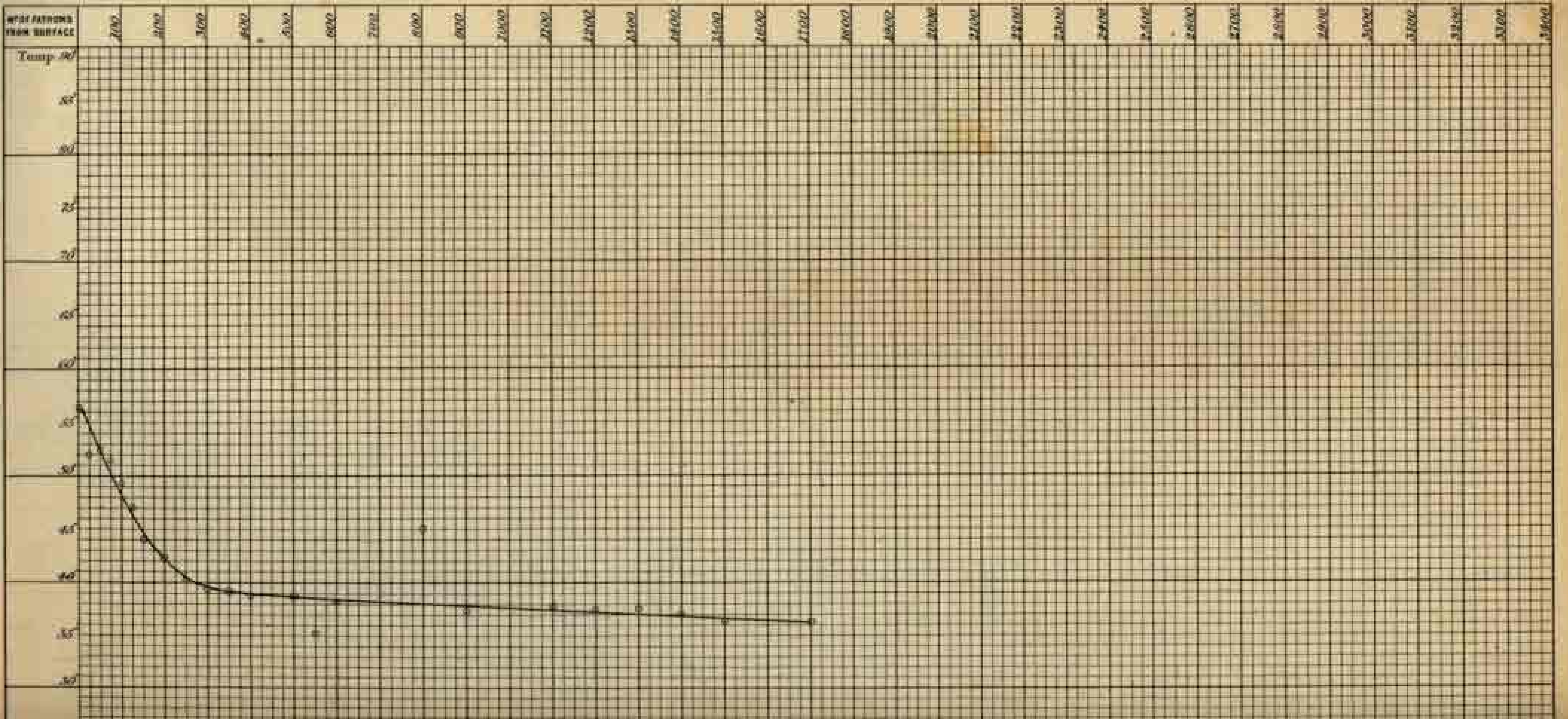
2 May 1873.

Nº of Sounding 102.
Station 44.

Depth 1700 fathoms.

Latitude 37° 25' N.
Longitude 71° 40' W.

Nº of fathoms from surface	Nº of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		56.5			56.5
10					
25	56	52.0			54.8
30					
40					
50	30	50.5			52.5
60					
75	54	51.4			50.4
80					
90					
100	56	49.4			48.0
110					
125	45	47.0			46.0
130					
140					
150	53	44.0			44.3
160					
175	54				42.9
180					
190					
200	56	42.0			42.0
225					
250	34	40.2			40.3
275					
300	34	39.5			39.5
350	36	39.3			39.4
400	30	39.0			39.0
450	53				38.8
500	37	38.0			38.7
550	45	38.0			38.5
600	36	38.5			38.4
700	34				38.2
800	54	45.0			38.0
900	45	37.5			37.8
1000	44				37.6
1100	36	37.8			37.4
1200	37	37.6			37.2
1300	50	37.6			37.0
1400	34	37.0			36.8
1500	36	36.5			36.6
1900					
2000					
Bottom	56	36.2			36.2



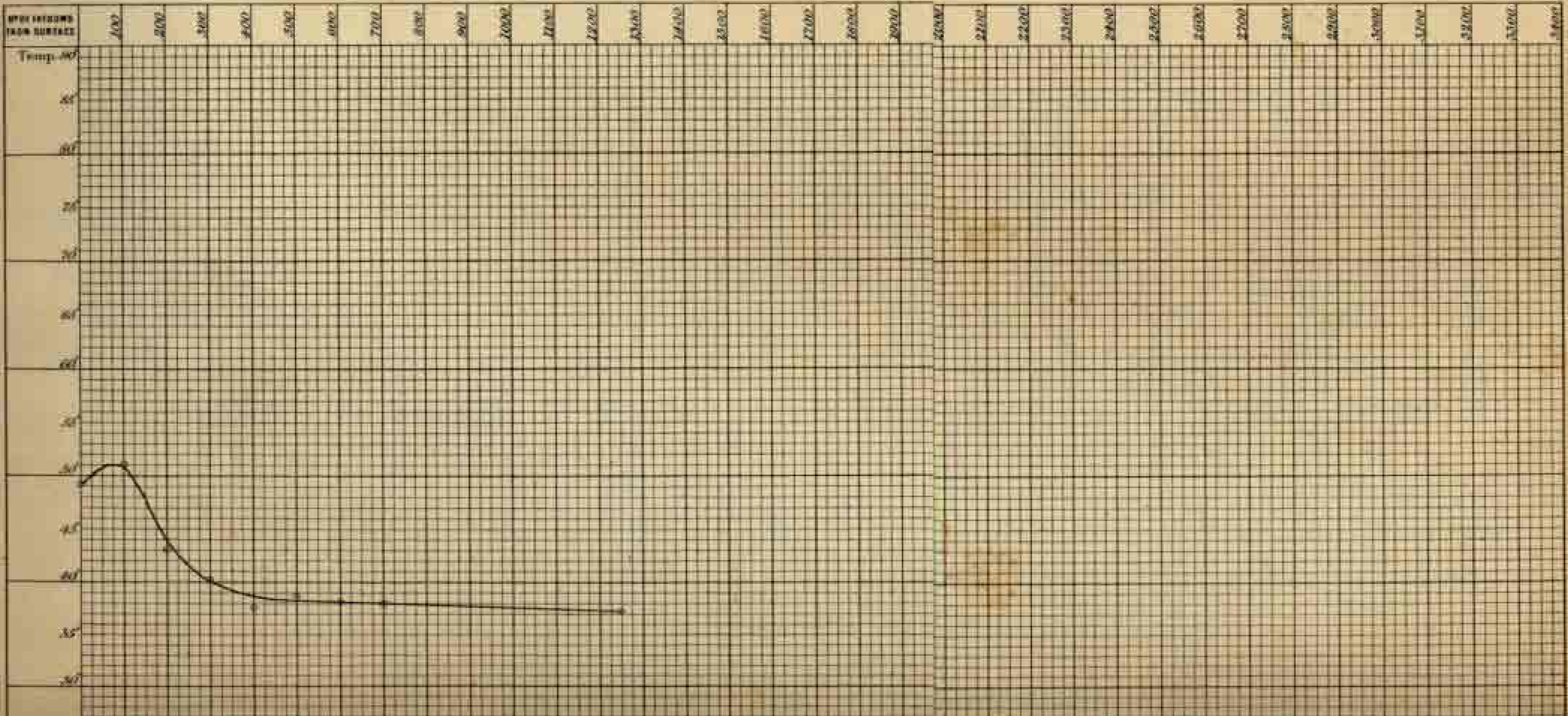
5 May 1873.

Nº of Sounding 103.
Station 45.

Depth 1240 *fathoms.*

Latitude 38° 34′ N.
Longitude 72° 10′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											36										49				50	53	37	45	34																41
TEMPERATURE SHEWN BY THERMOMETER	49.5										51.1										43.1				40.4	37.4	38.8	38.1	38.0																37.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	49.5										51.1										43.5				40.5	39.0	38.4	38.1	38.0																37.0



SECTION. HALIFAX TO BERMUDA.

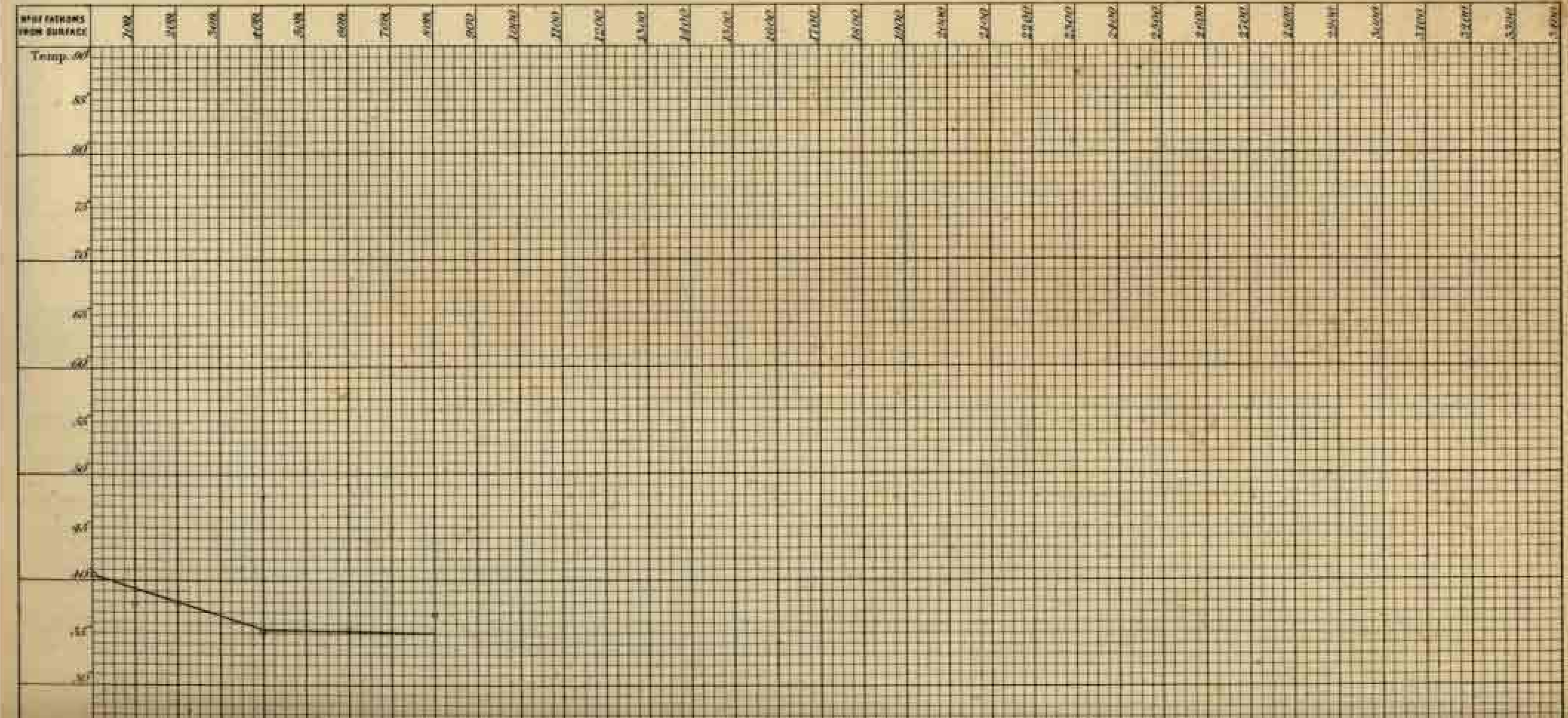
20 May 1873.

Nº of Sounding 107.
Station 49.

Depth. 83 fathoms.

Latitude 43° 3' N.
Longitude 63° 39' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																																													
TEMPERATURE SHEWN BY THERMOMETER	40·5		37·8		35·4		35·2																																						36·9
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	40·5		37·8		35·4		35·4																																						35·4



SECTION HALIFAX TO BERMUDA.

21 May 1873.

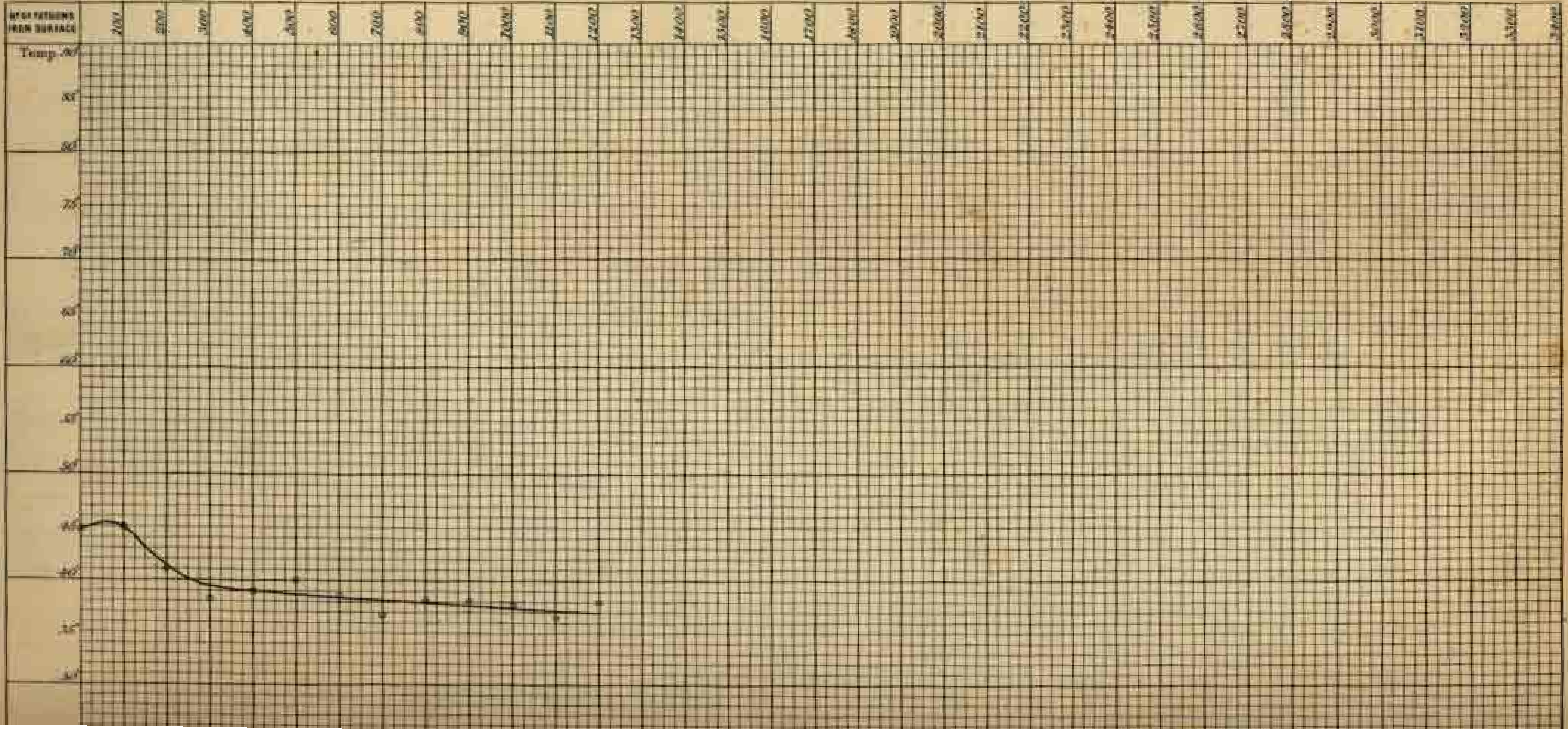
Nº of Sounding 108.
Station 50.

Depth 1250 *fathoms.*

Latitude 42° 8′ N.
Longitude 63° 39′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº OF THERMOMETER											37										49			
TEMPERATURE SHEWN BY THERMOMETER	45.0										45.2										41.0			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	45.0										45.2										41.3			

Nº OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	53	34	30	54	53	49	37	58	43	38											
TEMPERATURE SHEWN BY THERMOMETER	38.0	39.0	40.0	38.5	38.8	38.0	38.0	37.9	36.5	38.0											
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	39.5	39.0	38.7	38.4	38.2	37.8	37.6	37.4	37.2	37.0											



SECTION. HALIFAX TO BERMUDA.

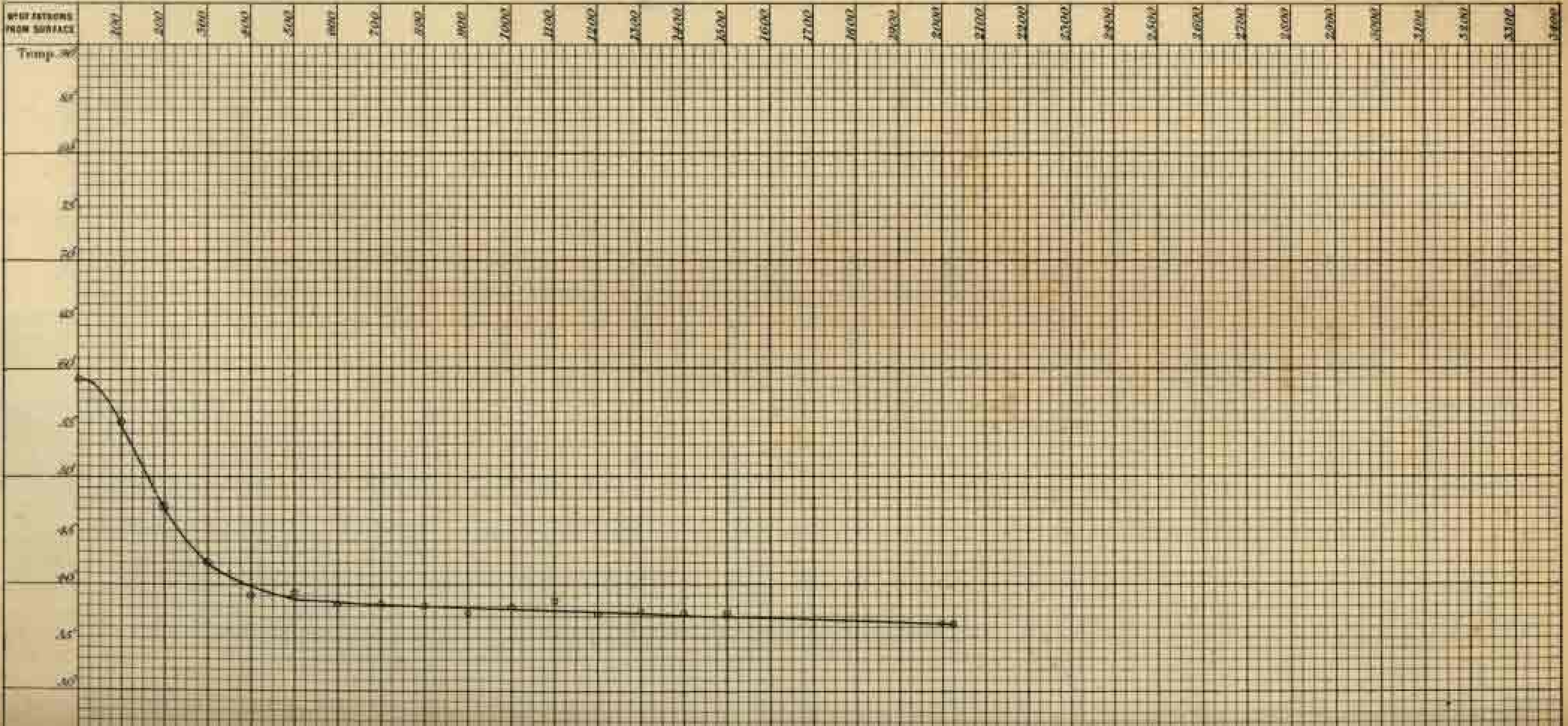
22 May 1873.

Nº of Sounding 109.
. . Station 51.

Depth 2020 fathoms

Latitude 41° 19' N.
Longitude 63° 12' W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer											37										56				45	33	56	43	56	37	64	34	56	45	56	37	64								48
Temperature shewn by thermometer	59.0										55.0										46.7				42.0	39.0	39.2	38.1	38.1	38.1	37.6	38.0	36.5	37.2	37.5	37.6	37.4								36.0
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	59.0										55.0										47.0				42.0	39.8	38.8	38.4	38.2	38.1	38.0	37.8	37.7	37.5	37.4	37.3	37.0								36.0



23 May 1873.

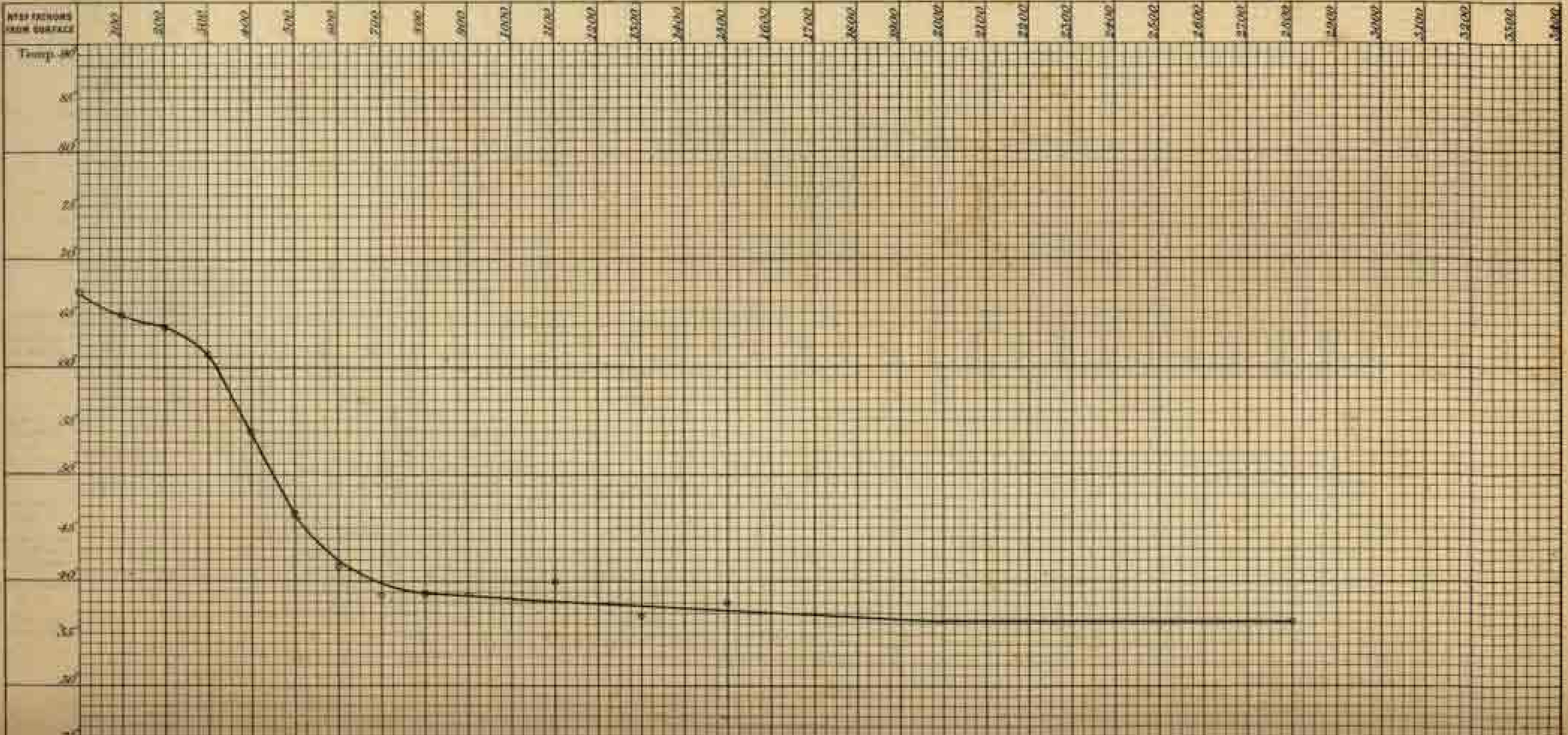
No. of Sounding 110.
Station 52.

Depth 2800 fathoms

Latitude 39° 44′ N.
Longitude 63° 22′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
No. of Thermometer											44										30			
Temperature shewn by Thermometer	67.2										64.8										63.7			
Error of Thermometer																								
Corrected Temperature																								
Temperature from Curve	67.0										64.8										63.8			

No. of Fathoms from Surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	34	38	37	36	64	45	43		30		64		36								43
Temperature shewn by Thermometer	61.4	53.5	46.8	41.4	38.3	39.0	38.8		40.0		36.7		38.0								36.2
Error of Thermometer																					
Corrected Temperature																					
Temperature from Curve	61.4	53.5	46.4	42.0	39.8	39.0	38.7		38.1		37.7		37.3								36.2



SECTION. HALIFAX TO BERMUDA.

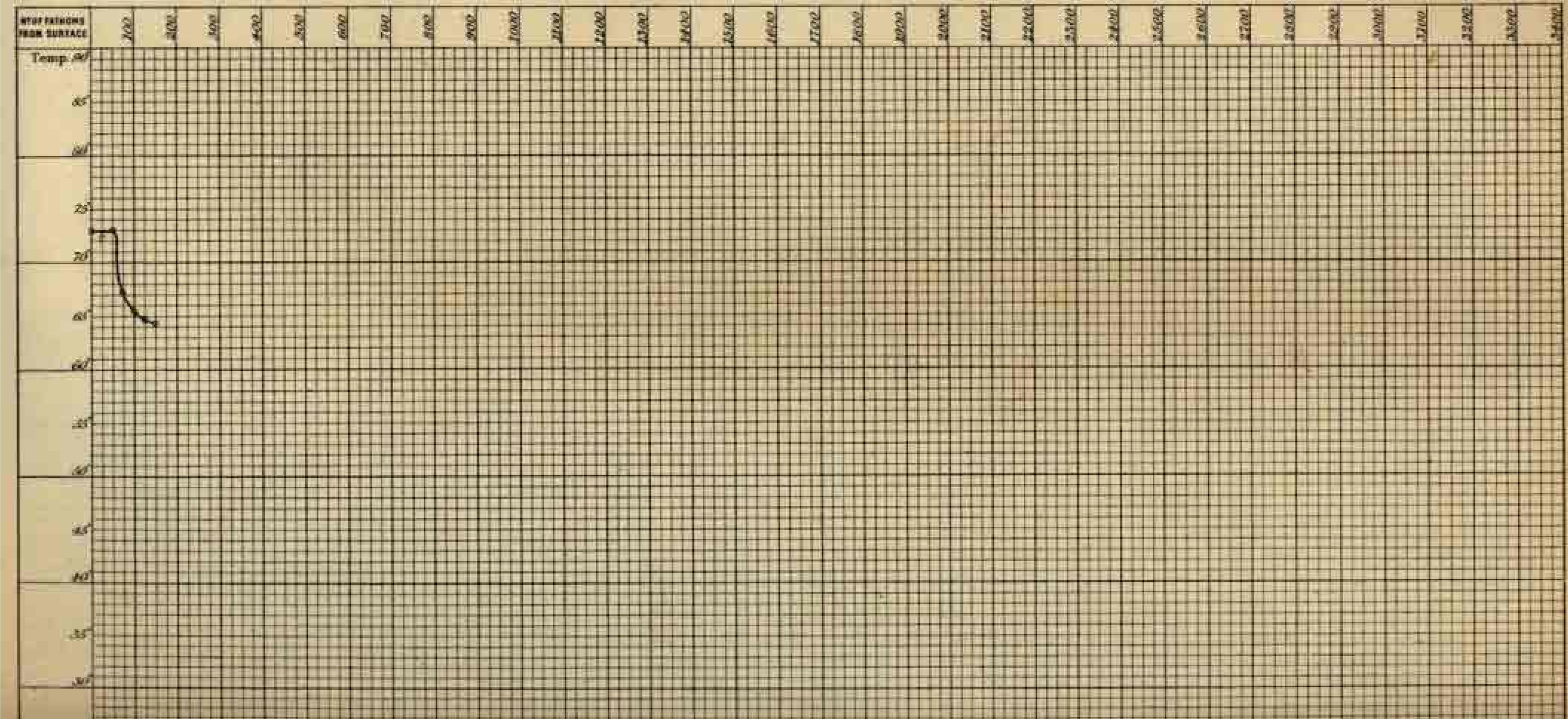
24 May 1873.

N° of Sounding 111.
Station 52 a.

Depth, None obtained.

Latitude 38° 16′ N.
Longitude 63° 17′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
N° OF THERMOMETER			36			45		36			45		36			45																												
TEMPERATURE SHOWN BY THERMOMETER	73.0		72.6			73.0		67.4			65.5		64.7			64.5																												
ERROR OF THERMOMETER																																												
CORRECTED TEMPERATURE																																												
TEMPERATURE FROM CURVE	73.0		73.0			73.0		67.4			65.5		64.7			64.5																												



SECTION. HALIFAX TO BERMUDA.

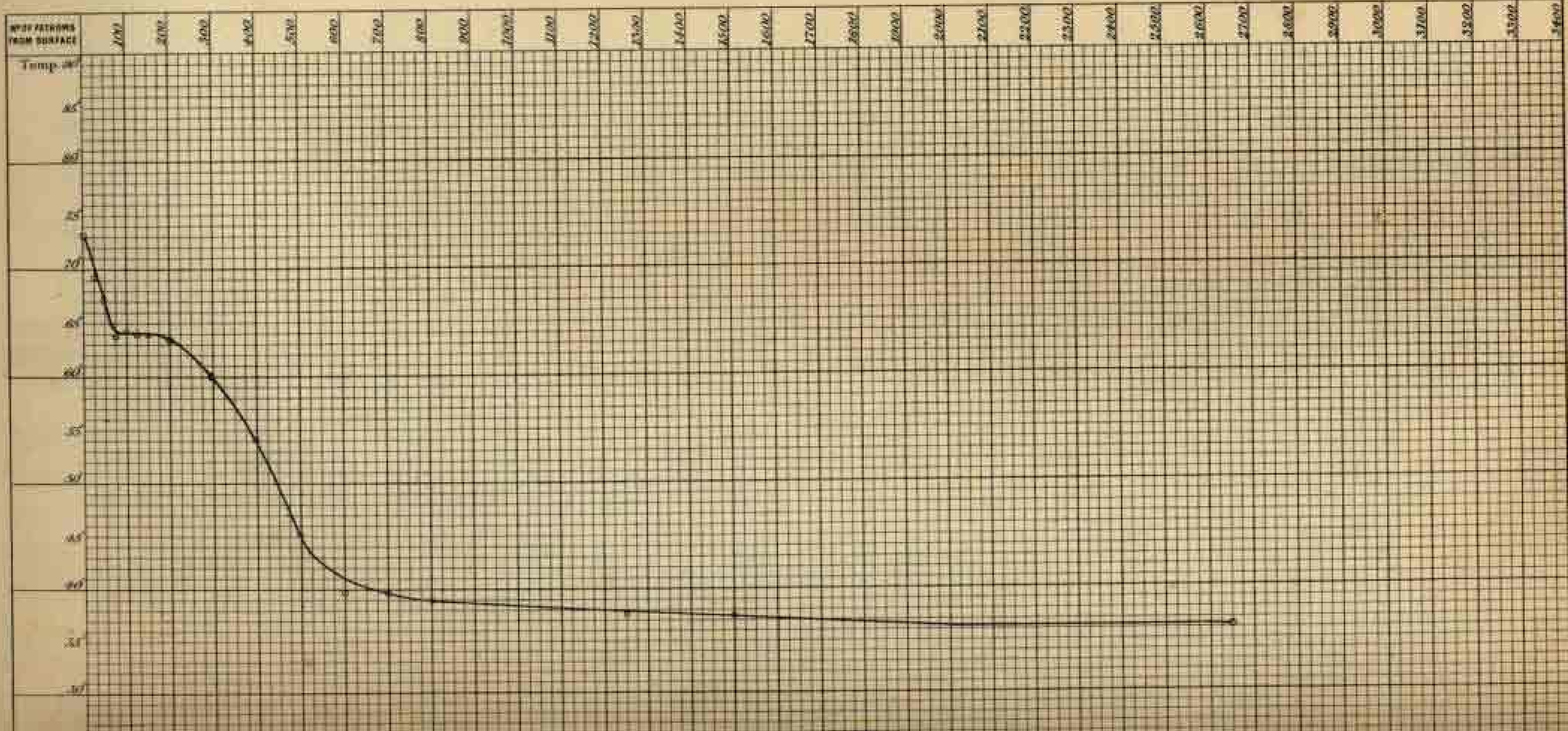
26 May 1873.

N.º of Sounding 112.
Station 53.

Depth 2650 fathoms.

Latitude 36° 30′ N.
Longitude 63° 40′ W.

N° of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
N° of thermometer			49			36		53			45					37					40				36	37	34	33	43	36				57			64								54
Temperature shewn by thermometer	72.0		69.4			66.2		65.8			64.2					64.0					63.6				60.2	54.2	45.2	39.8	39.8	39.2				37.6			37.6								36.3
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	72.0		69.5			66.2		64.0			64.0					64.0					63.6				60.2	54.0	45.2	41.2	39.8	39.4				37.9			37.3								36.3



SECTION. HALIFAX TO BERMUDA.

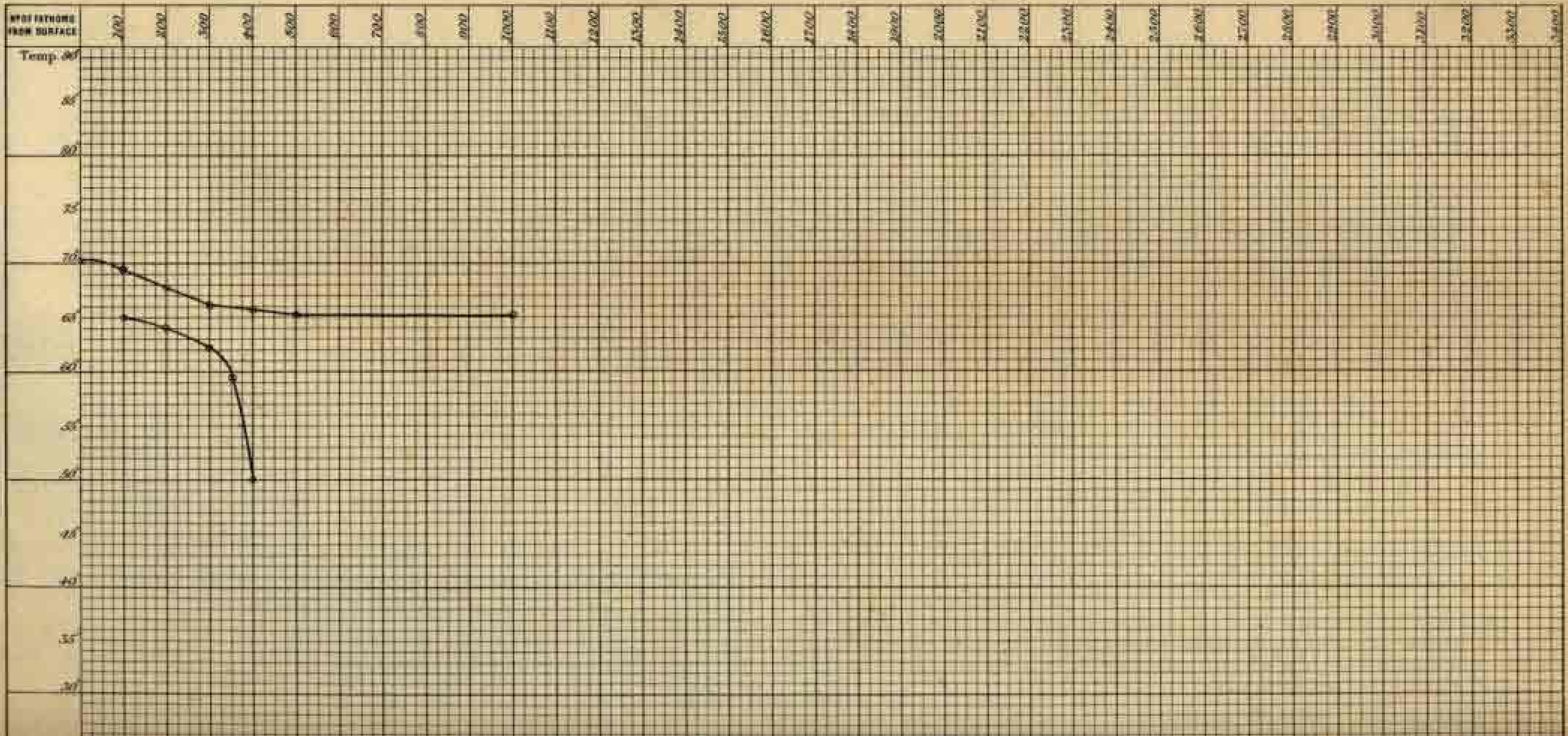
27 May 1873.

Nº of Sounding 113.
" " Station. 54.

Depth 2650 fathoms.

Latitude 34° 51′ N.
Longitude 63° 59′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	350	400	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		49	44	64	63	63					63										44				49	55	52																		
TEMPERATURE SHEWN BY THERMOMETER	70.5	69.8	68.2	66.2	65.8	65.2					65.2										63.9				61.8	59.5	49.8																		
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	70.5	69.8	68.2	66.2	65.8	65.2					65.0										63.9				61.8	59.5	49.8																		



SECTION. BERMUDA TO THE AZORES.

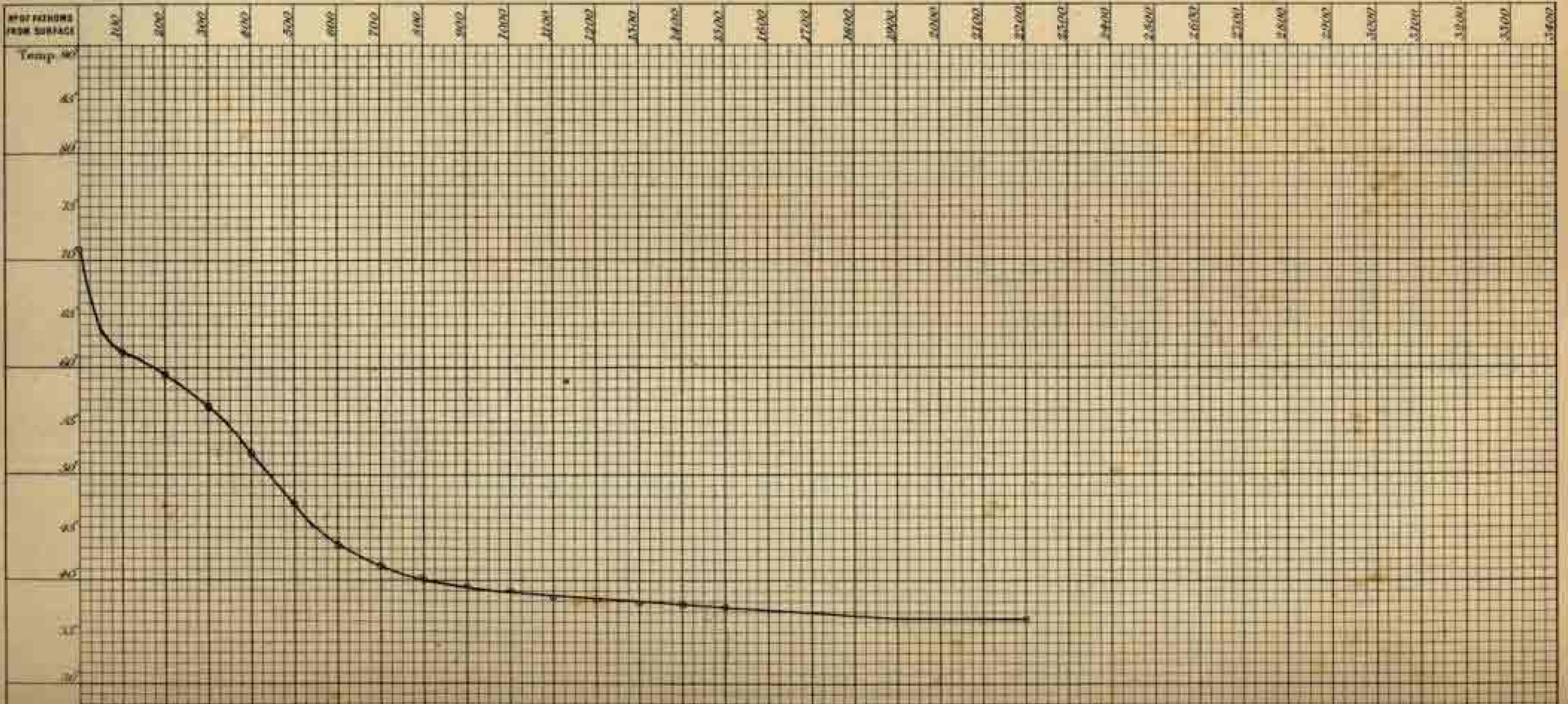
25 June 1873.

No. of Sounding 133.
Station 69.

Depth 2200 fathoms

Latitude 38° 23′ N.
Longitude 37° 21′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer											55										65				64	63	44	55	65	64	63	44	44	65	63	55	64								37
Temperature shewn by Thermometer	71.0										61.5										59.5				56.5	52.0	47.3	43.4	41.4	40.8	39.8	39.2	38.5	38.3	38.0	37.0	37.0								36.2
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	71.0										61.5										59.5				56.5	52.0	47.3	43.4	41.4	40.0	39.7	39.1	38.7	38.4	38.1	37.8	37.5								36.2



SECTION. ST. THOMAS TO BERMUDA.

30 May 1873.

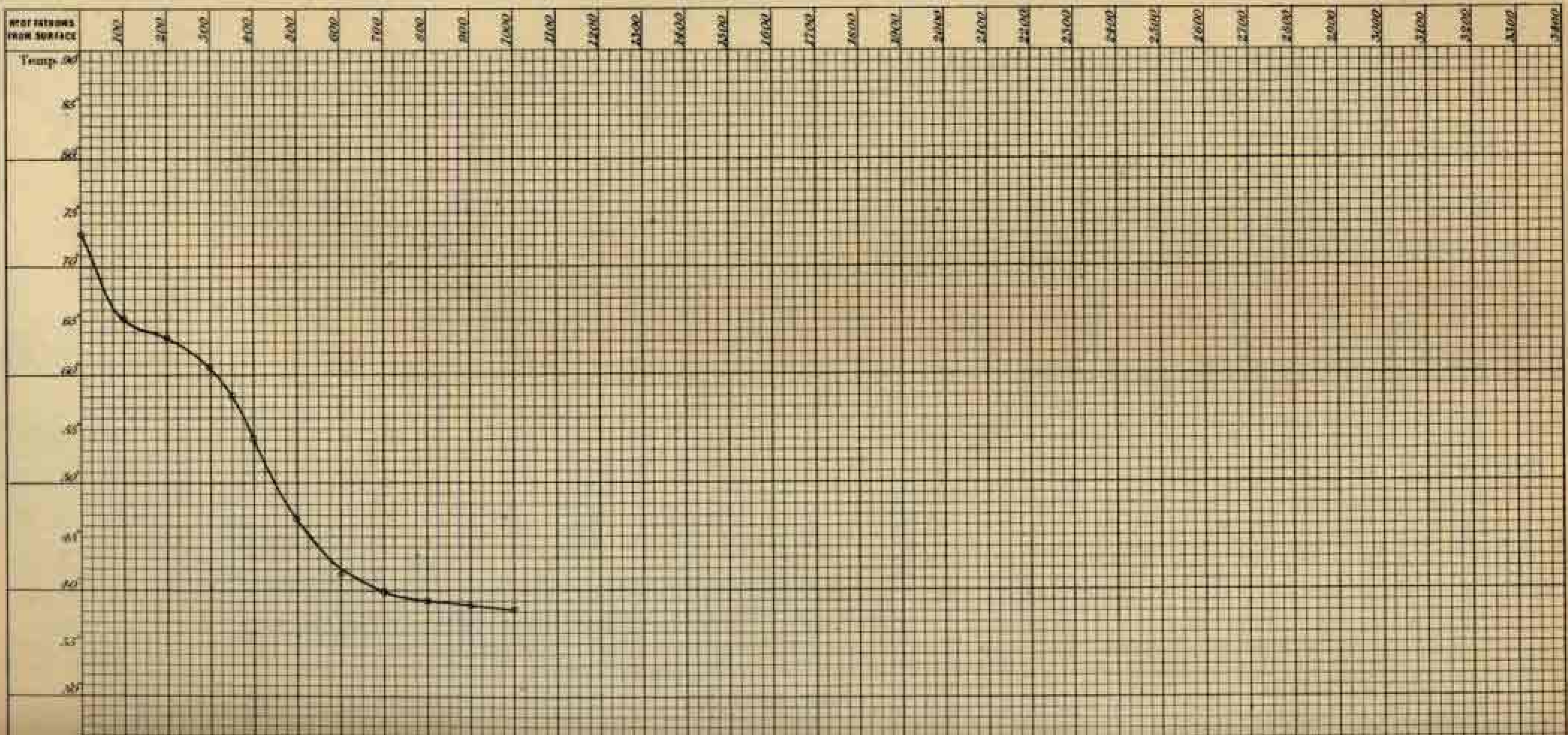
N.º of Sounding 121.
Station 57 b.

Depth 1575 fathoms.

Latitude 32° 9' 45" N.
Longitude, 65° 10' 50" W.

N.º OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
N.º OF THERMOMETER											49									
TEMPERATURE SHEWN BY THERMOMETER	73.0										65.2									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	73.0										65.2									

N.º OF FATHOMS FROM SURFACE	200	225	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
N.º OF THERMOMETER	44			64	55	65	63	49	64	55	65	63												
TEMPERATURE SHEWN BY THERMOMETER	63.6			60.8	58.0	54.0	46.8	41.6	40.0	39.7	38.8	38.0												
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	63.6			60.8	58.0	54.0	46.8	41.8	40.0	39.4	38.7	38.0												



SECTION. BERMUDA TO THE AZORES.

14 June 1873.

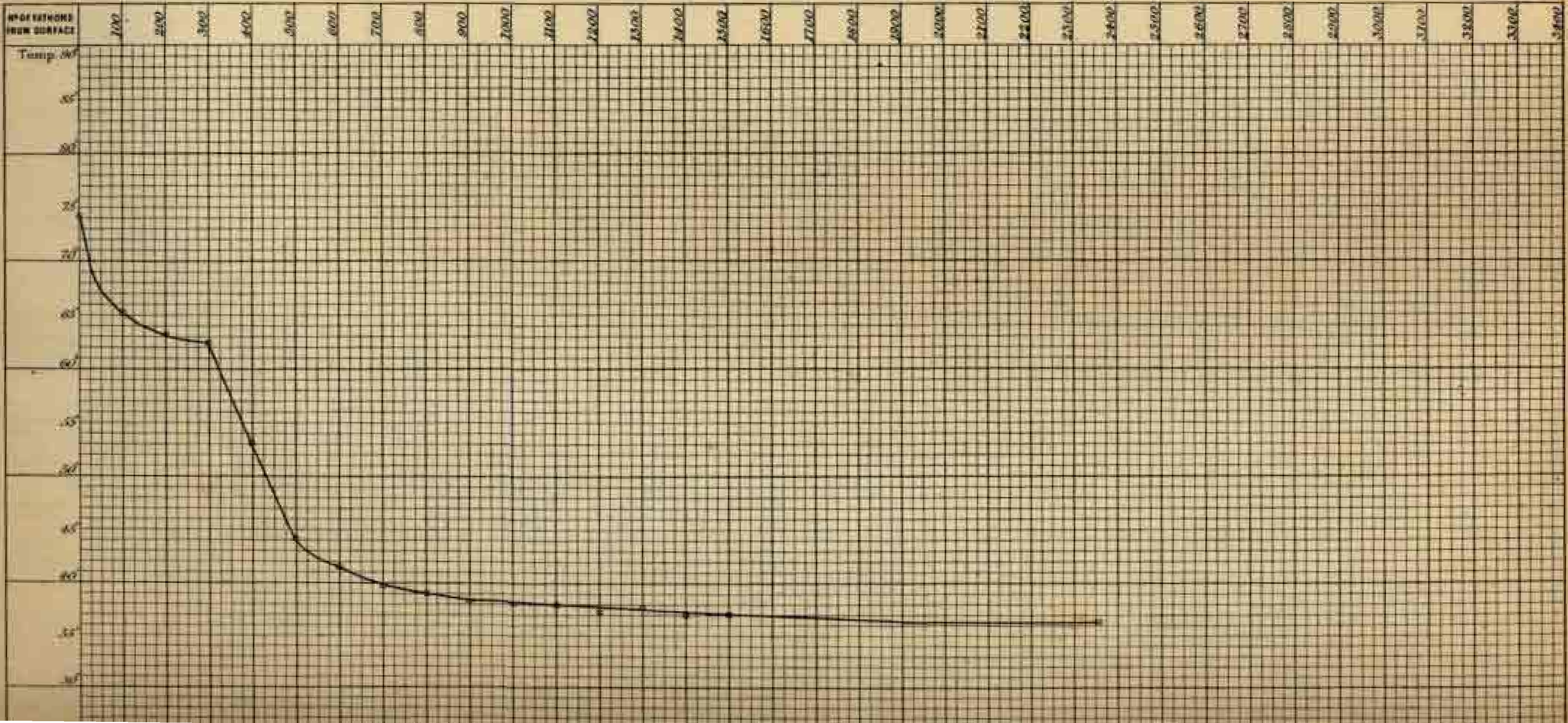
N.º of Sounding 123.
Station 59.

Depth 2360 fathoms.

Latitude 32° 54′ N.
Longitude 63° 22′ W.

Nº. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº. of thermometer											37										64			
Temperature shewn by thermometer	74.0										65.2										63.5			
Error of thermometer																								
Corrected temperature																								
Temperature from curve	74.0										65.2										63.5			

Nº. of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº. of thermometer	55	65	63	37	64	53	65	63	57	64	55	62	63								63
Temperature shewn by thermometer	62.6	54.2	46.9	41.8	39.8	39.2	38.5	38.2	38.0	37.5	37.8	37.0	37.2								36.3
Error of thermometer																					
Corrected temperature																					
Temperature from curve	62.6	54.2	46.2	41.8	39.8	39.2	38.5	38.3	38.1	37.9	37.7	37.5	37.3								36.3



SECTION. BERMUDA TO THE AZORES.

16 June 1873.

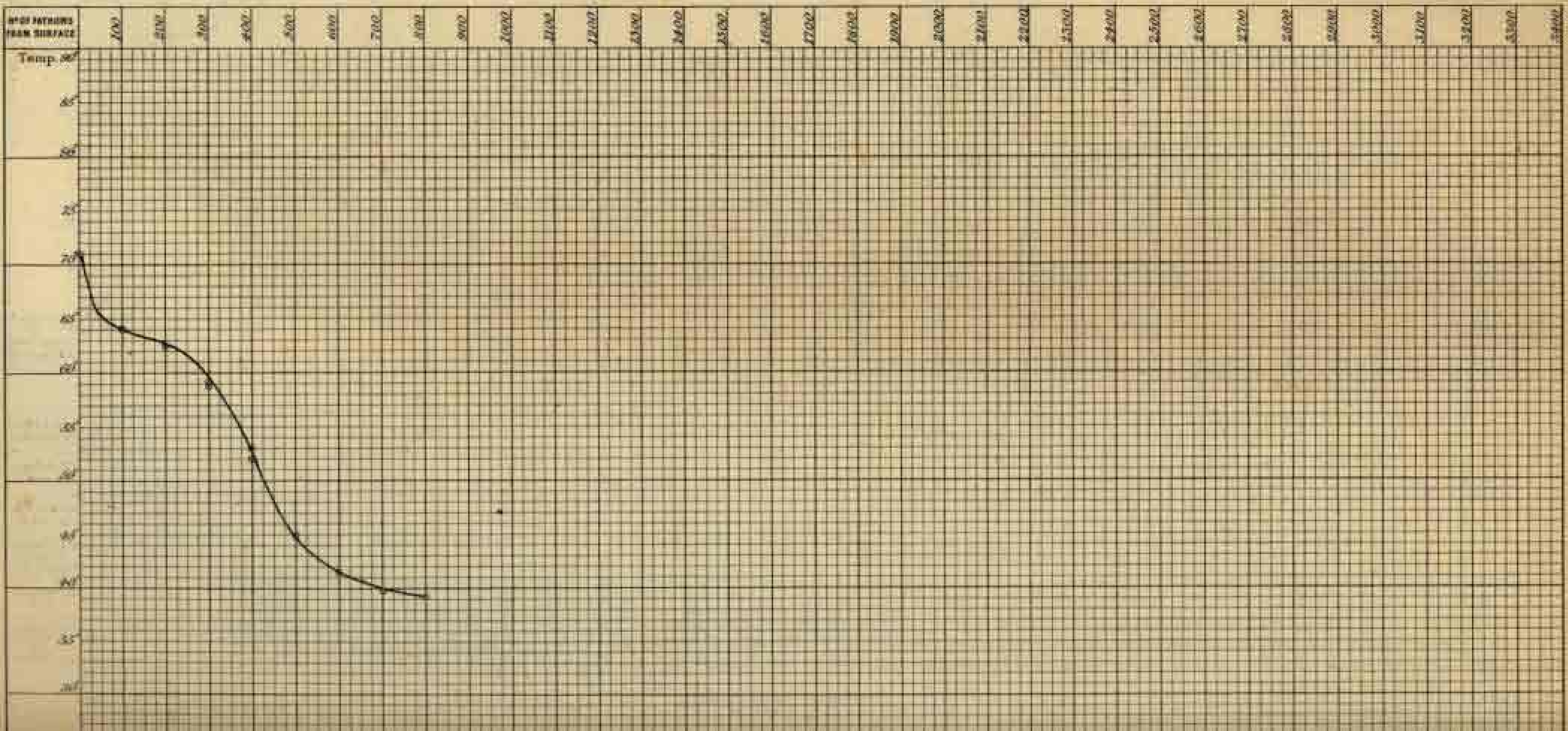
N.º of Sounding 124.
Station 60.

Depth 2575 fathoms.

Latitude 34° 28′ N.
Longitude 58° 56′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. OF THERMOMETER											55									
TEMPERATURE SHEWN BY THERMOMETER	71.5										64.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	71.5										64.2									

No. OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	63				30 57	55 64	65	63	57	84															64
TEMPERATURE SHEWN BY THERMOMETER	62.8				59.0 59.4	52.0 53.0	44.6	41.3	39.8	39.5															36.2
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	62.8				59.5	52.5	44.5	41.3	40.0	39.4															36.2



17 June 1873.

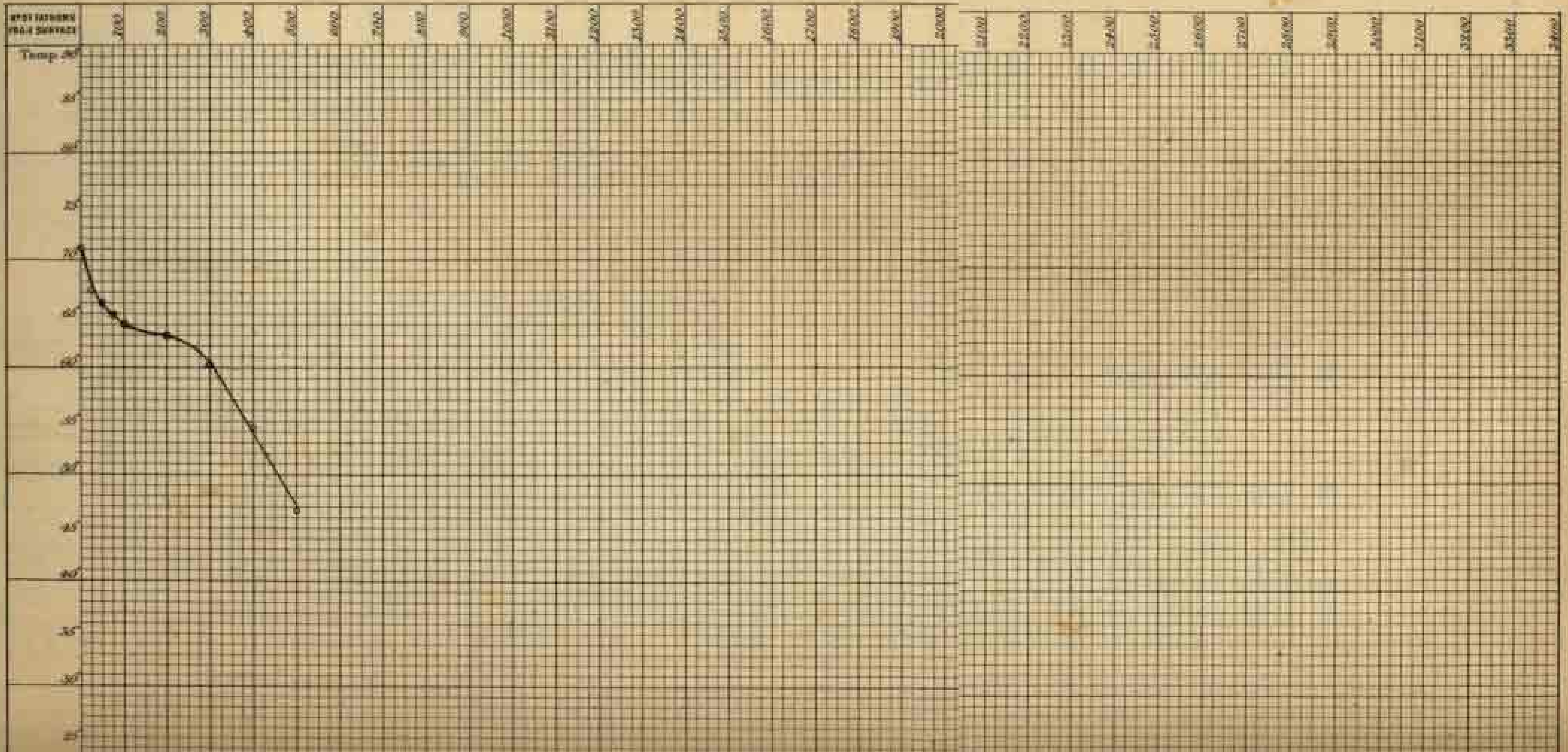
Nº of Sounding 125.
Station 61.

Depth 2850 fathoms.

Latitude 34° 54′ N.
Longitude 56° 38′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER			64			44		30			30									
TEMPERATURE SHOWN BY THERMOMETER	71.0		67.2			66.0		65.0			64.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	71.0		67.2			66.0		65.0			64.0									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
Nº OF THERMOMETER	44				69	83	64																	57
TEMPERATURE SHOWN BY THERMOMETER	63.0				60.0	53.8	46.																	36.2
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	63.0				60.2	53.5	46.																	36.2



SECTION. BERMUDA TO THE AZORES.

18 June 1873.

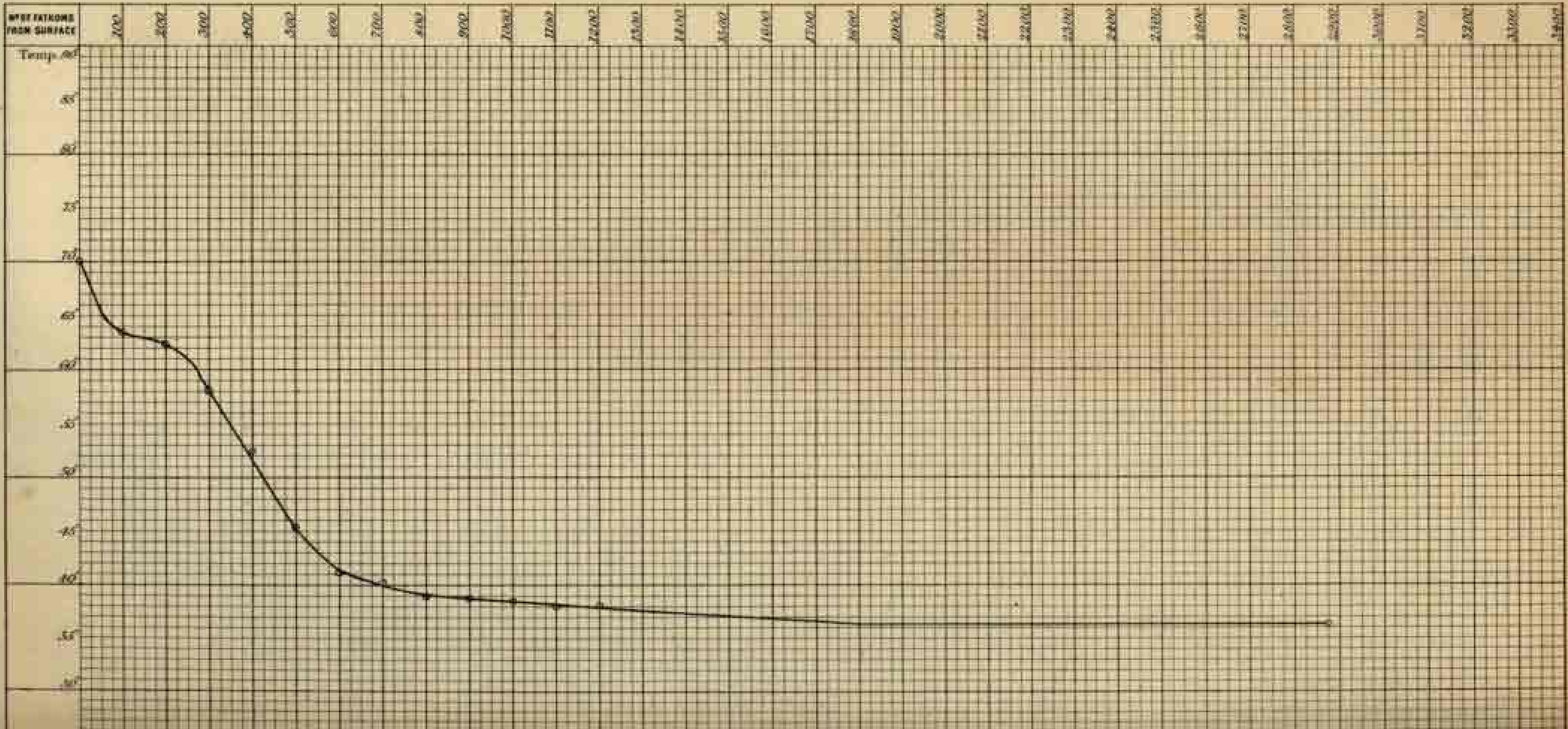
Nº of Sounding 126.
. . Station 62.

Depth 2875 fathoms.

Latitude 35° 7' N.
Longitude 52° 32' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER											44									
TEMPERATURE SHEWN BY THERMOMETER	70.0										63.4									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	70.0										63.4									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	30				65	70	49	64	49	57	63	65	55	64											64
TEMPERATURE SHEWN BY THERMOMETER	62.5				58.0	52.4	45.2	41.2	40.2	39.0	38.9	38.6	38.0	38.2											36.4
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	62.5				58.2	51.5	45.2	41.4	40.0	39.2	38.9	38.6	38.3	38.0											36.4



SECTION. BERMUDA TO THE AZORES

20 June 1873.

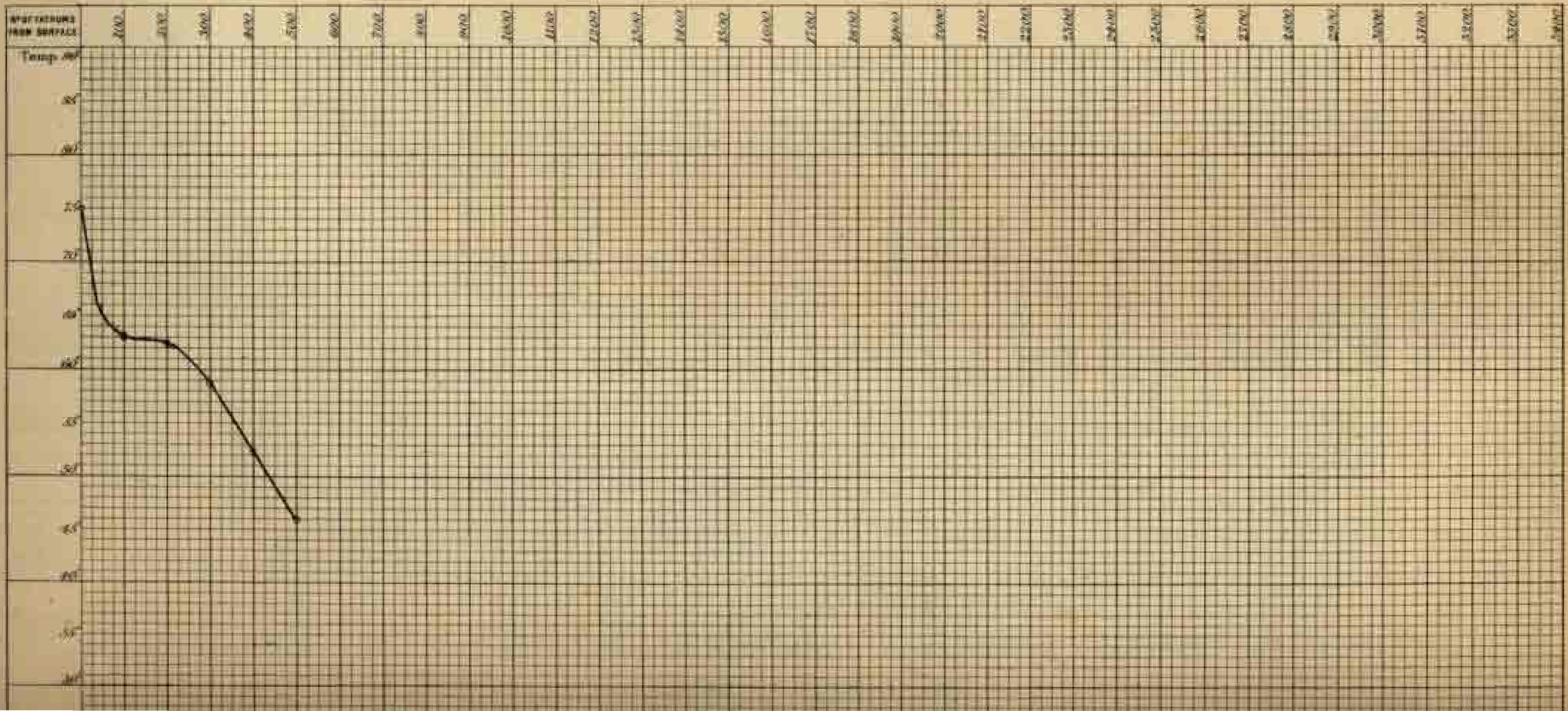
N° of Sounding 128.
Station 64.

Depth, None obtained.

Latitude 35° 35′ N.
Longitude 50° 27′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
N° OF THERMOMETER											40									
TEMPERATURE SHEWN BY THERMOMETER	75.0										63.2									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	75.0										63.2									

N° OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER	62				41	63	44																		
TEMPERATURE SHEWN BY THERMOMETER	60.5				58.8	52.5	46.0																		
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	60.5				58.8	52.5	46.0																		



SECTION. BERMUDA TO THE AZORES.

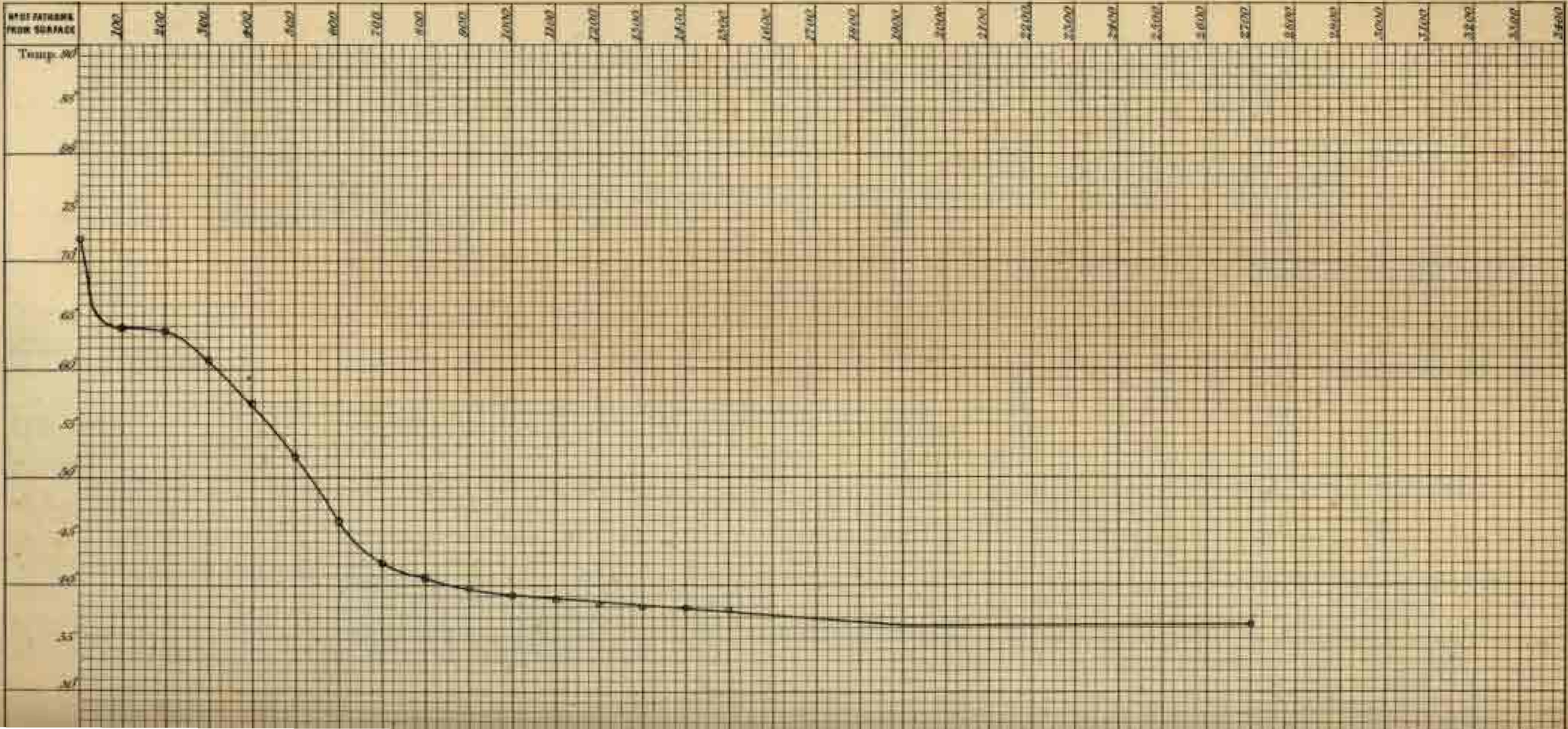
21 June 1873.

Nº of Sounding 129.
Station 65.

Depth 2700 fathoms.

Latitude 36° 33′ N.
Longitude 47° 58′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											44										65				49	63	55	44	65	46	63	53	49	44	45	67	35								57
TEMPERATURE SHEWN BY THERMOMETER	72.5										63.8										63.6				61.0	57.2	52.0	45.2	42.0	41.0	40.0	39.2	38.6	38.2	38.0	38.0	37.9								36.2
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	72.5										64.0										63.5				61.0	57.2	52.0	45.0	42.0	41.0	40.0	39.3	38.7	38.4	38.1	37.8	37.5								36.2



SECTION. BERMUDA TO THE AZORES

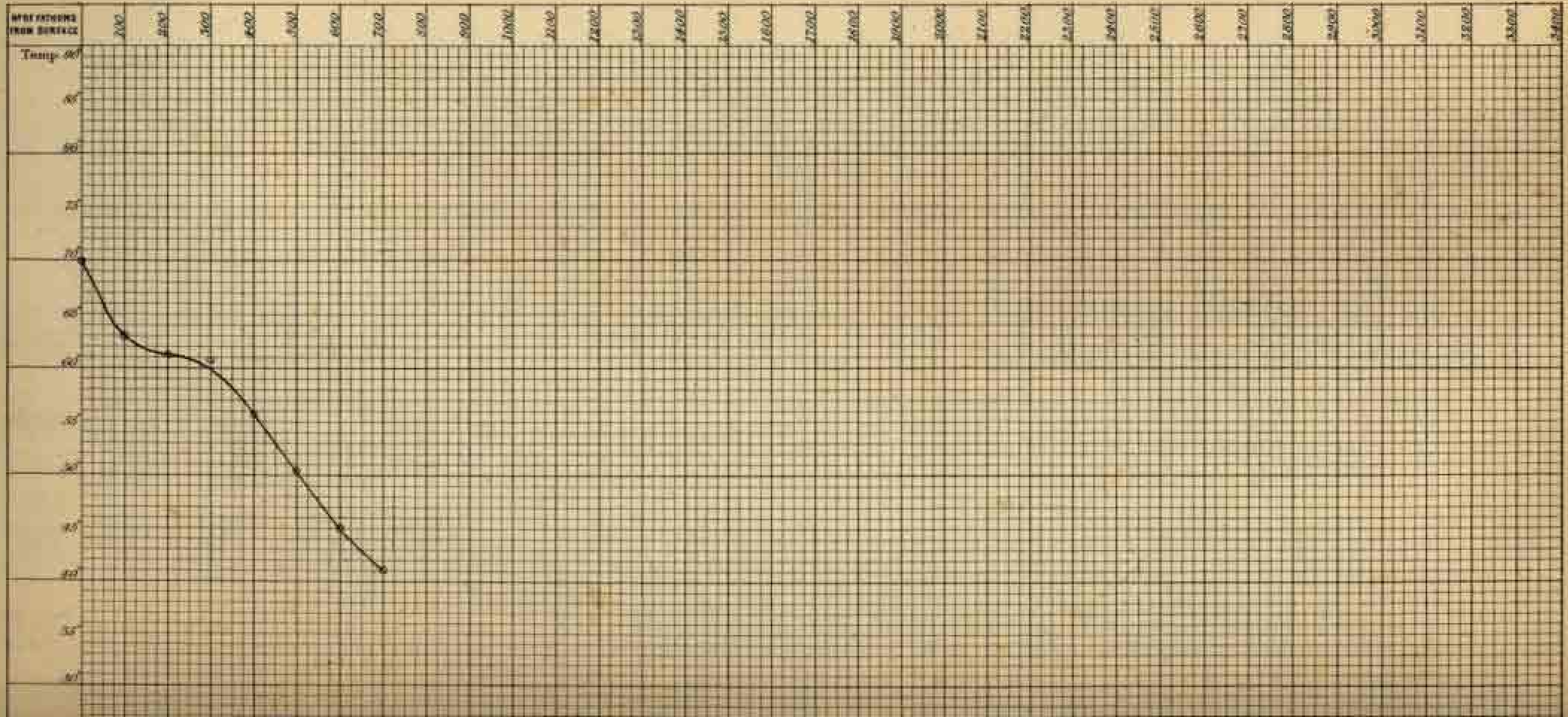
22 June 1873.

N° of Sounding 180.
Station 66.

Depth 2750 fathoms.

Latitude 37° 24′ N.
Longitude 44° 14′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER											37										39				49	44	55	63	63																64
TEMPERATURE SHOWN BY THERMOMETER	70.0										63.0										61.5				60.8	55.8	50.4	45.0	41.2																36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	70.0										63.0										61.5				60.1	55.8	50.2	45.0	41.2																36.5



SECTION. BERMUDA TO THE AZORES.

23 June 1873.

No. of Sounding 131.
" " Station 67.

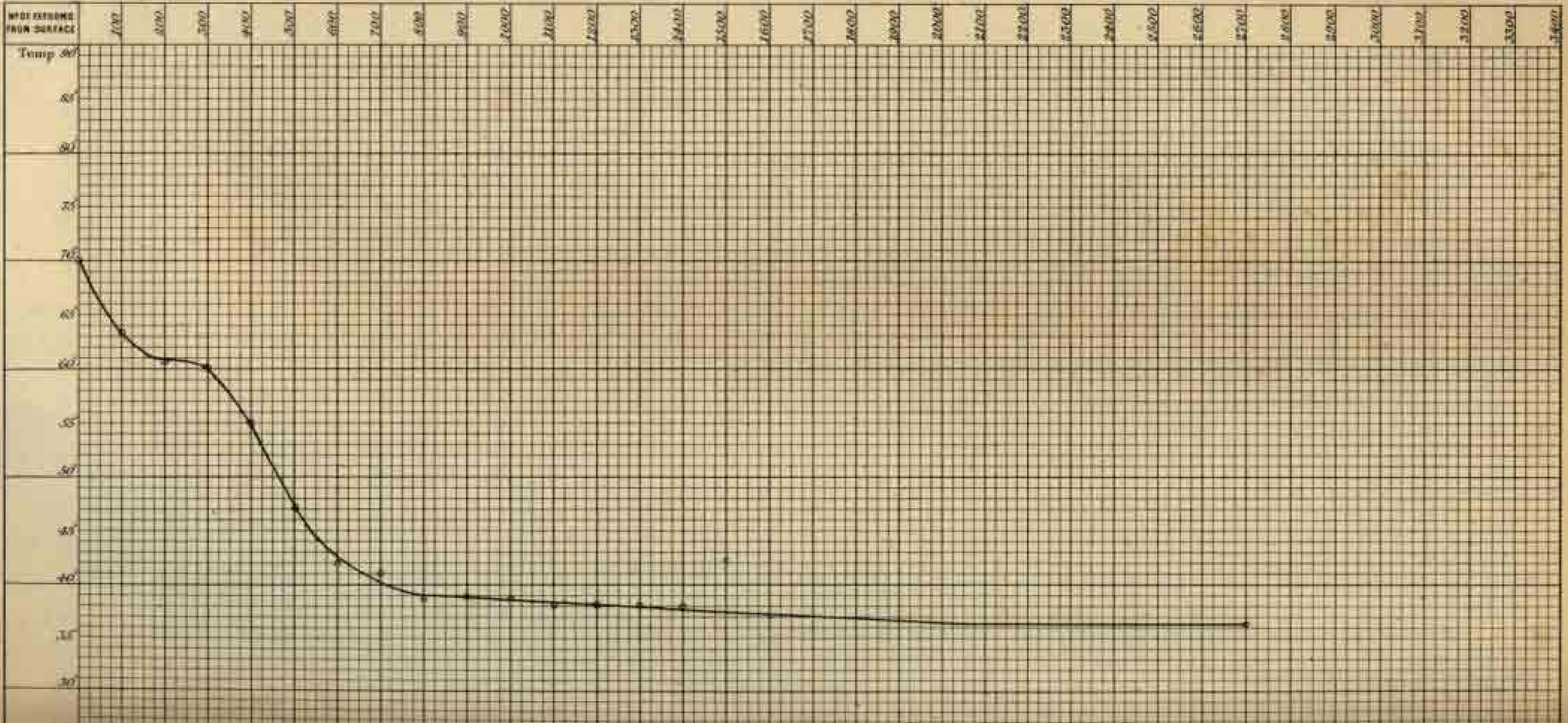
Depth 2700 fathoms.

Latitude 37° 54′ N.
Longitude 41° 44′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. of thermometer											49									
Temperature shewn by thermometer	70.0										63.6									
Error of thermometer																				
Corrected temperature																				
Temperature from curve	70.0										63.6									

No. of fathoms from surface	200	225	250	275	300	400	500	600	700	800	900	1000
No. of thermometer	65				57	64	63	49	44	64	65	63
Temperature shewn by thermometer	60.8				60.1	55.0	47.0	42.0	41.0	38.5	38.4	38.5
Error of thermometer												
Corrected temperature												
Temperature from curve	60.8				60.1	55.0	47.0	42.5	40.0	38.9	38.5	38.3

No. of fathoms from surface	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer	65	64	44	63	55								57
Temperature shewn by thermometer	37.8	37.8	38.0	38.0	42.2								36.3
Error of thermometer													
Corrected temperature													
Temperature from curve	38.1	37.9	37.7	37.5	37.3								36.3



SECTION. BERMUDA TO THE AZORES

22 June 1873.

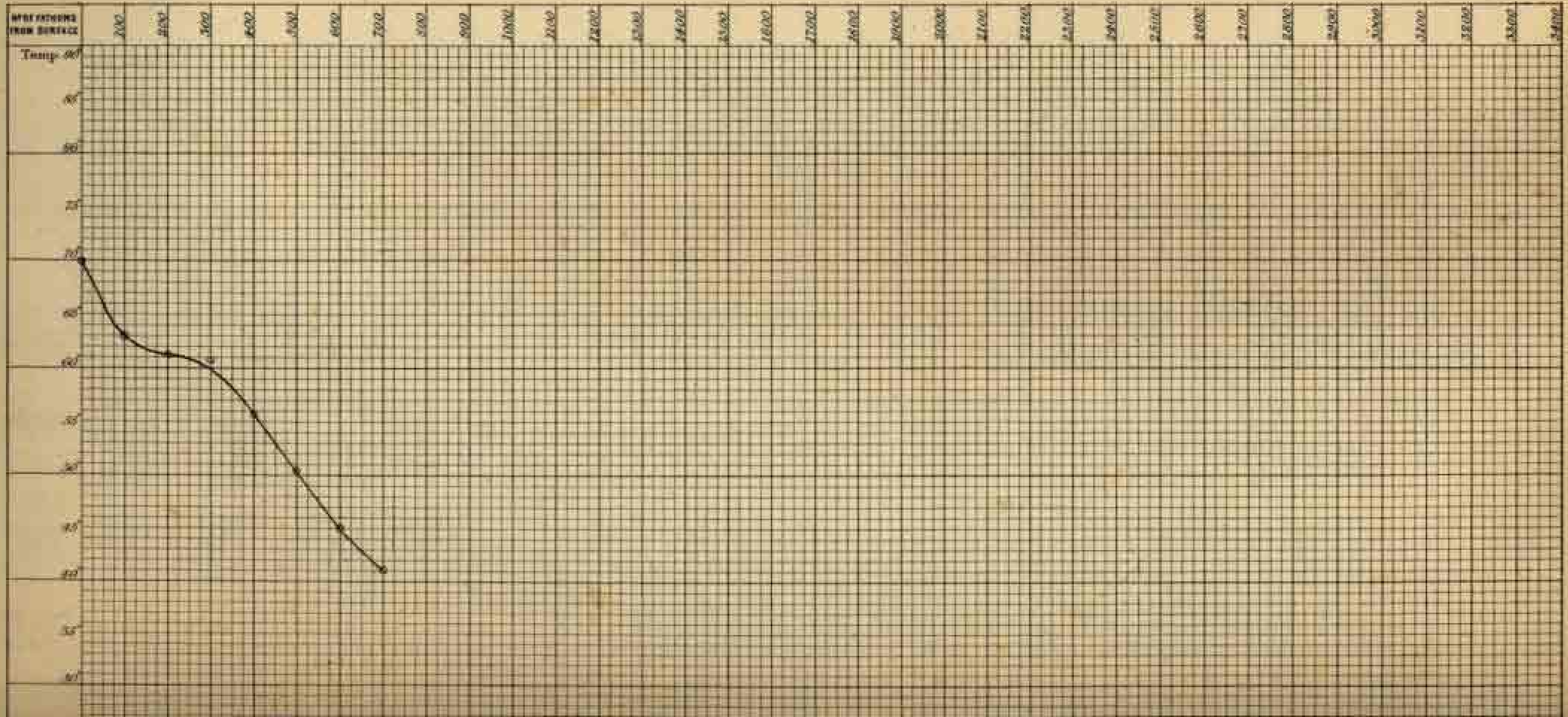
N° of Sounding 180.
Station 66.

Depth 2750 fathoms.

Latitude 37° 24′ N.
Longitude 44° 14′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. of Thermometer											37									
Temperature shown by Thermometer	70.0										63.0									
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	70.0										63.0									

No. of Fathoms from Surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	30				49	44	55	63	63																64
Temperature shown by Thermometer	61.5				60.8	55.8	50.5	45.0	41.2																36.5
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	61.5				60.1	55.8	50.2	45.0	41.2																36.5



SECTION. BERMUDA TO THE AZORES.

27 June 1873.

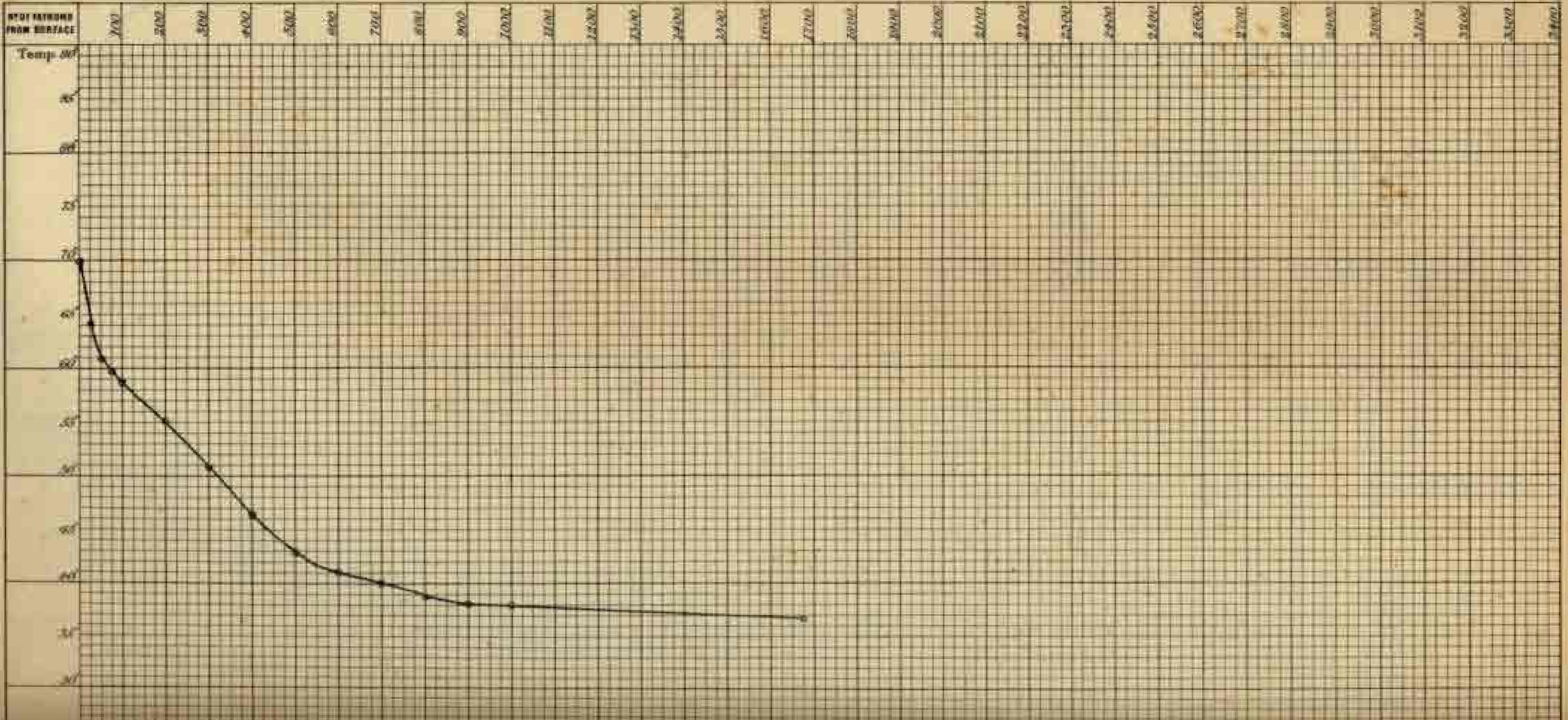
Nº of Sounding 135.
Station 71.

Depth 1675 fathoms.

Latitude 38° 18′ N.
Longitude 34° 48′ W.

Nº of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº of thermometer			44			55		65			64										65
Temperature shewn by thermometer	71.0		64.9			61.0		59.9			58.3										55.7
Error of thermometer																					
Corrected temperature																					
Temperature from curve	71.0		64.8			61.0		59.9			58.3										55.2

Nº of fathoms from surface	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer				65	11	37	64	65	37	63	55													37
Temperature shewn by thermometer				50.8	46.0	42.8	41.0	39.9	38.8	38.2	38.0													36.8
Error of thermometer																								
Corrected temperature																								
Temperature from curve				50.8	46.0	42.8	41.0	40.0	39.0	38.4	37.5													36.8



SECTION: BERMUDA TO THE AZORES

28 June 1873.

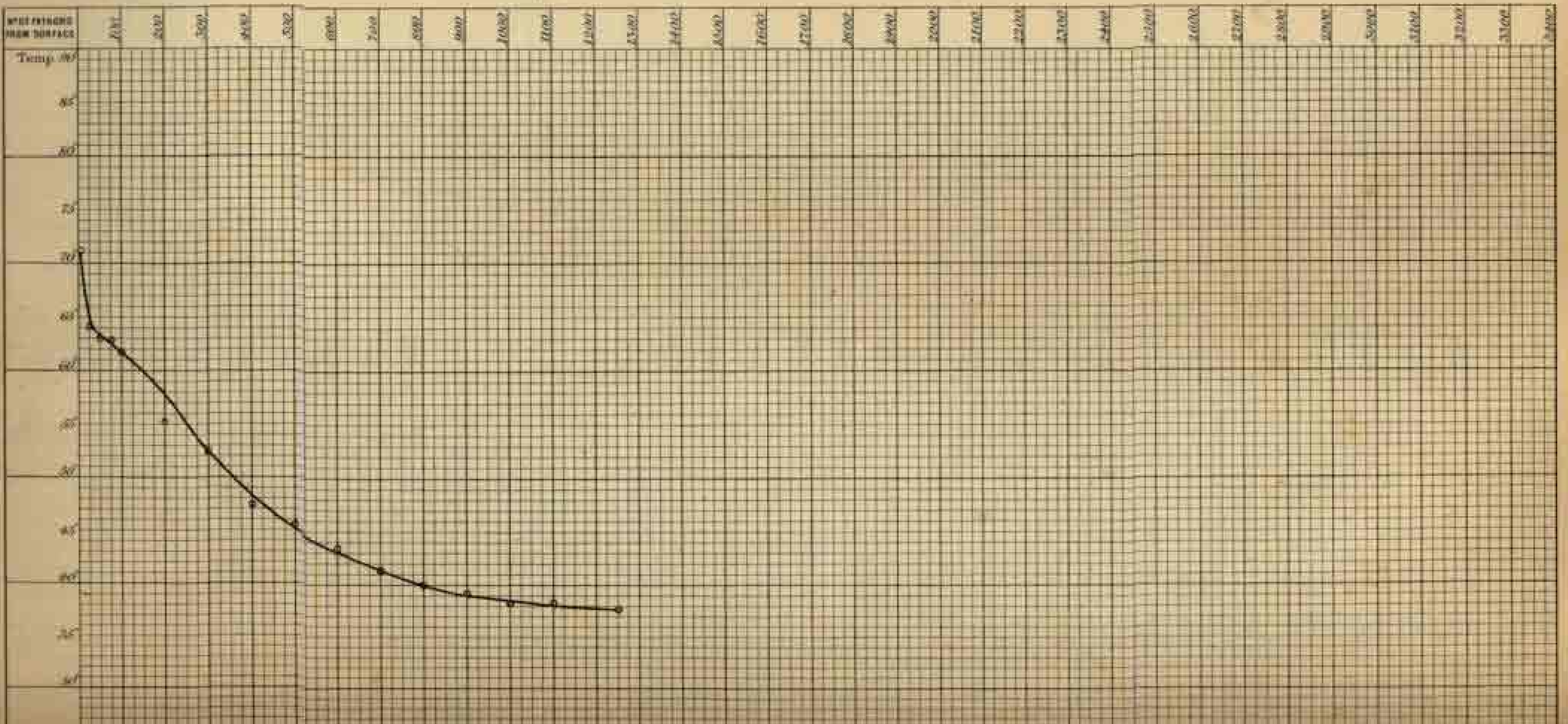
Nº of Sounding 136.
Station 72.

Depth 1240 fathoms

Latitude 38° 34′ N.
Longitude 32° 47′ W.

Nº of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº of Thermometer			63			61		49			44										57
Temperature shewn by Thermometer	71.0		64.0			63.2		62.8			61.8										55.9
Error of Thermometer																					
Corrected Temperature																					
Temperature from Curve	71.0		64.2			63.4		62.6			61.8										57.7

Nº of Fathoms from Surface	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer				63	64	49	44	39	63	44	65	49												64
Temperature shewn by Thermometer				52.5	47.5	45.5	43.5	41.3	40.0	39.1	38.2	38.3												37.8
Error of Thermometer																								
Corrected Temperature																								
Temperature from Curve				52.5	48.0	45.8	43.8	41.3	40.0	39.0	38.1	38.1												37.8



SECTION. BERMUDA TO THE AZORES.

30 June 1873.

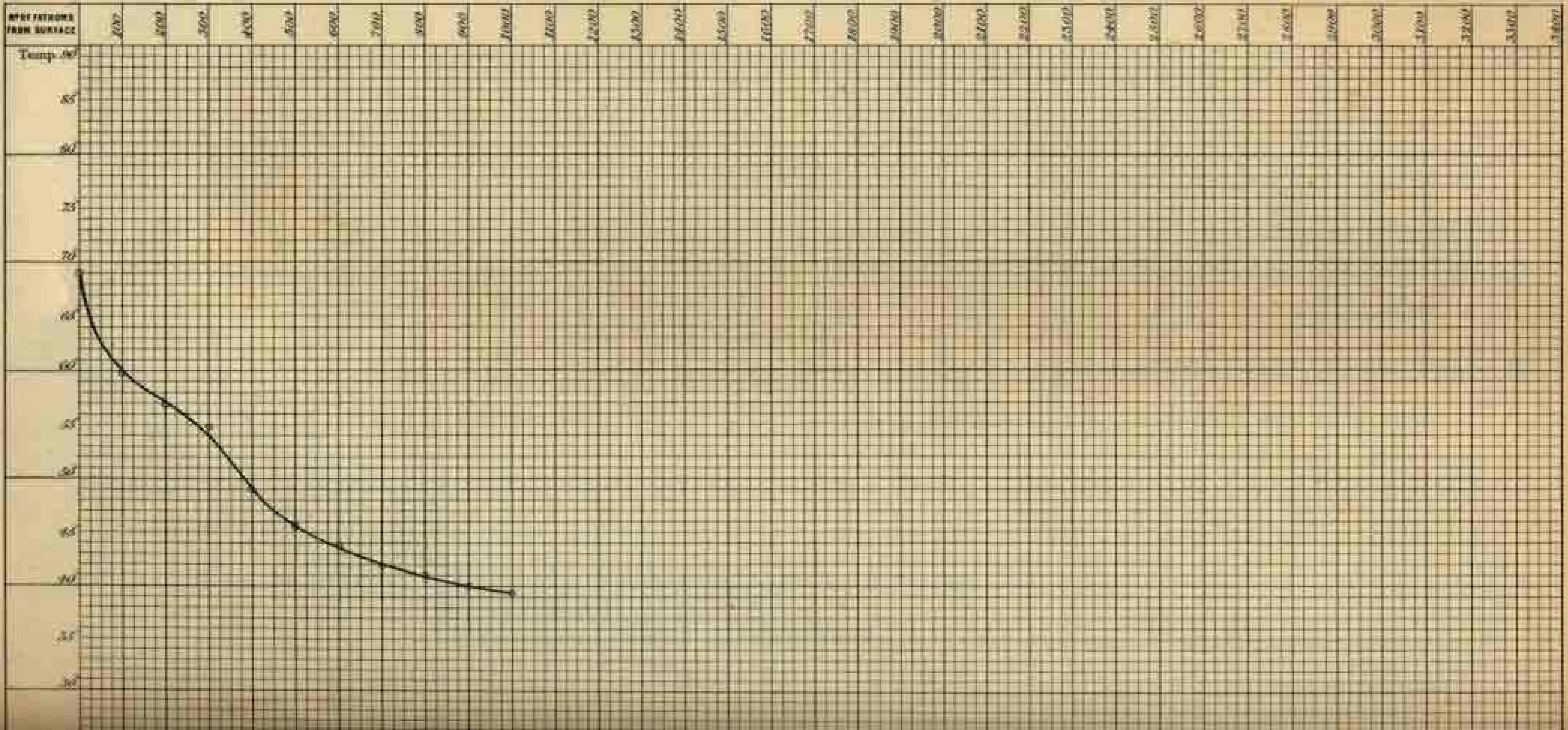
Nº of Sounding 137.
. . . *Station* 73.

Depth 1000 fathoms.

Latitude 38° 30′ N.
Longitude 31° 14′ W.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
Nº of Thermometer											49										44	
Temperature shown by Thermometer	69.0										59.8										57.0	
Error of Thermometer																						
Corrected Temperature																						
Temperature from Curve	69.0										59.8										57.0	

Nº of Fathoms from Surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer			65	30	63	30	44	49	63														65
Temperature shown by Thermometer			54.8	49.0	45.3	43.8	41.9	41.0	40.0														39.4
Error of Thermometer																							
Corrected Temperature																							
Temperature from Curve			54.0	49.0	45.3	43.4	42.0	41.0	40.0														39.4



SECTION. BERMUDA TO THE AZORES.

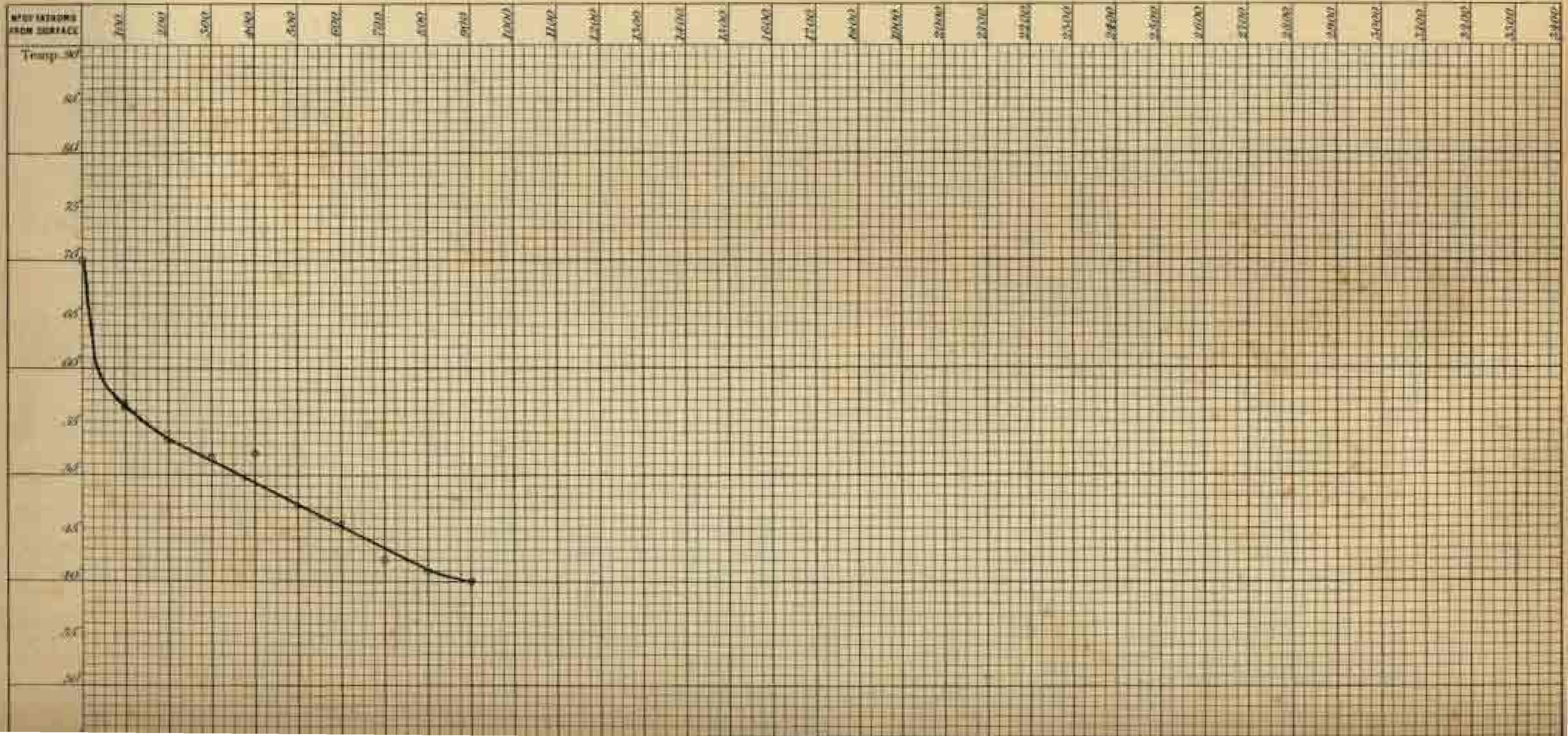
3 July 1873.

N.^o of Sounding 140.
Station 76.

Depth 900 *fathoms*

Latitude 38° 11′ N.
Longitude 27° 9′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		Bottom
No. of Thermometer											44										63				63	57	36	63	65	37														37
Temperature shown by Thermometer	70.0										56.5										53.6				51.8	52.0	47.2	45.4	41.8	41.0														40.0
Error of Thermometer																																												
Corrected Temperature																																												
Temperature from Curve	70.0										56.5										53.6				51.6	49.5	47.5	45.0	42.8	41.0														40.0



SECTION. THE AZORES TO MADEIRA.

10 July 1873.

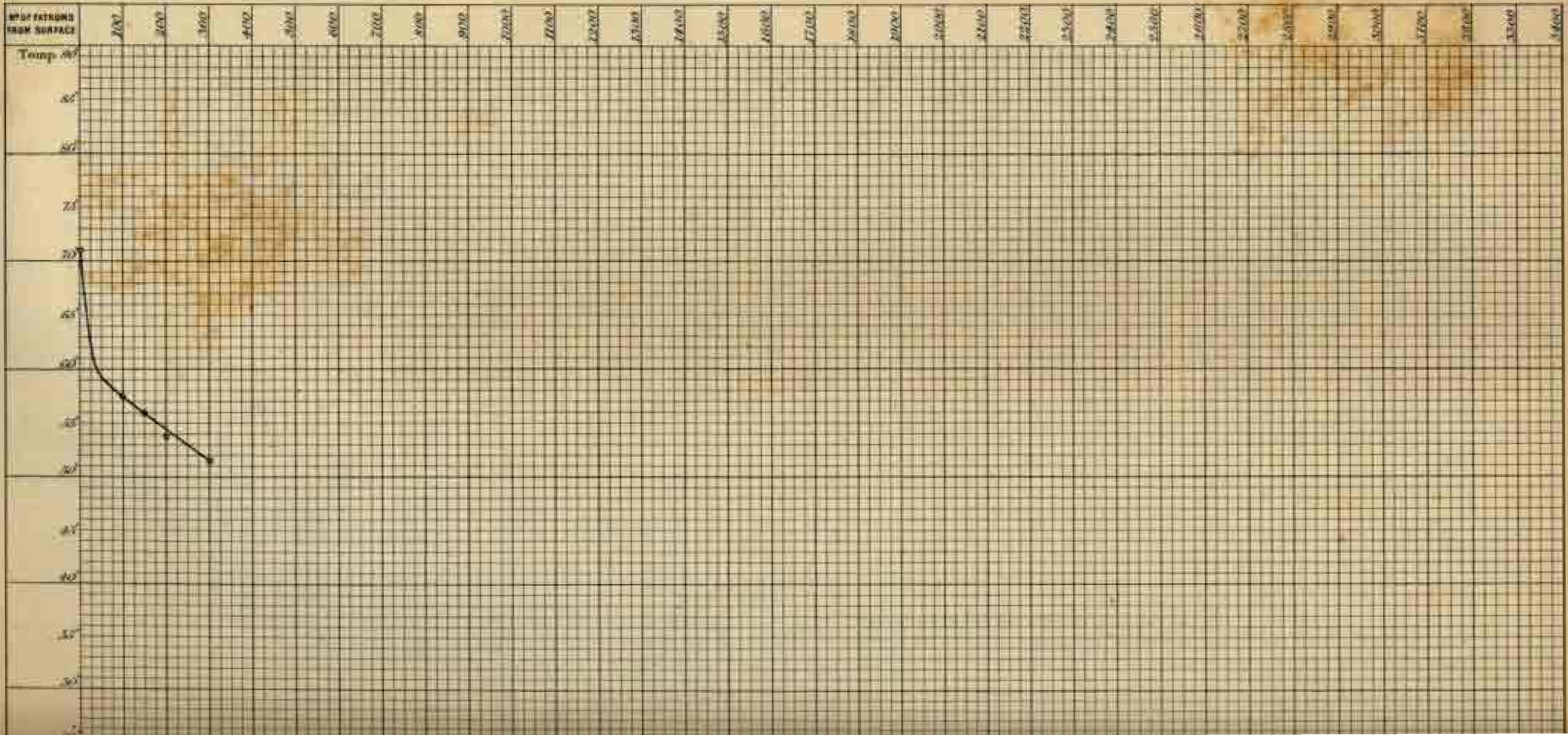
Depth 1000 fathoms.

No. of Sounding 142.
" Station 78.

Latitude 37° 26′ *N.*
Longitude 25° 13′ *W.*

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300
No. OF THERMOMETER											30					44					63				65
TEMPERATURE SHEWN BY THERMOMETER	71.0										57.6					56.0					53.8				51.4
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	71.0										57.6					56.0					54.5				51.5

No. OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER																				
TEMPERATURE SHEWN BY THERMOMETER																				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE																				



SECTION. THE AZORES TO MADEIRA.

11 July 1873.

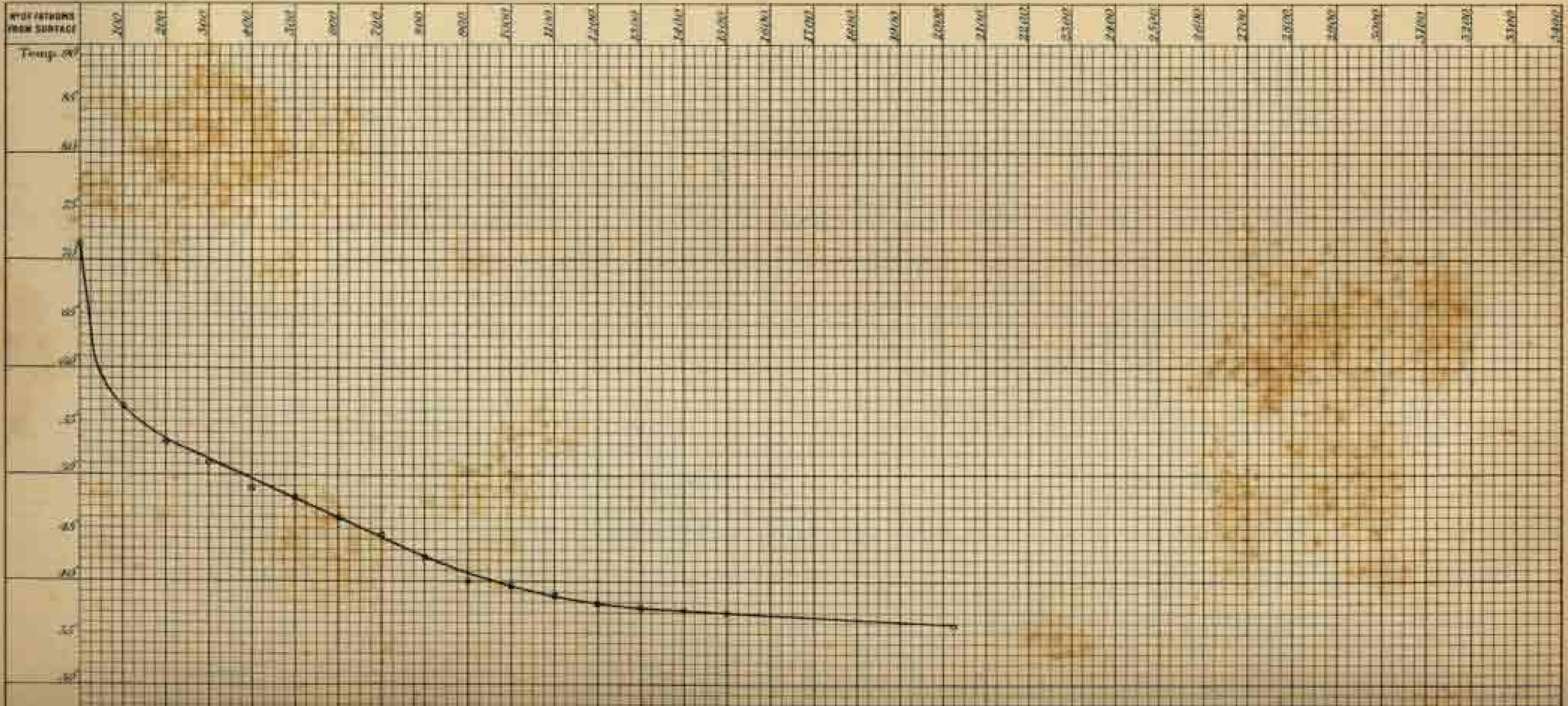
No. of Sounding 148.
Station 79.

Depth 2025 fathoms

Latitude 36° 21′ N
Longitude 23° 31′ W

No. OF FATHOMS (FROM SURFACE)	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. OF THERMOMETER											30									
TEMPERATURE SHEWN BY THERMOMETER	71.3										56.4									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	71.5										56.4									

No. OF FATHOMS (FROM SURFACE)	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	44				40	61	65	30	44	40	63	65	40	37	44	63	59								37
TEMPERATURE SHEWN BY THERMOMETER	53.4				51.5	48.9	47.9	45.9	44.4	42.2	40.0	39.6	38.8	38.0	37.5	37.3	37.2								35.9
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	53.5				51.0	49.8	47.9	46.0	44.9	42.3	40.8	39.6	38.5	38.0	37.7	37.4	37.2								35.9



SECTION. THE AZORES TO MADEIRA.

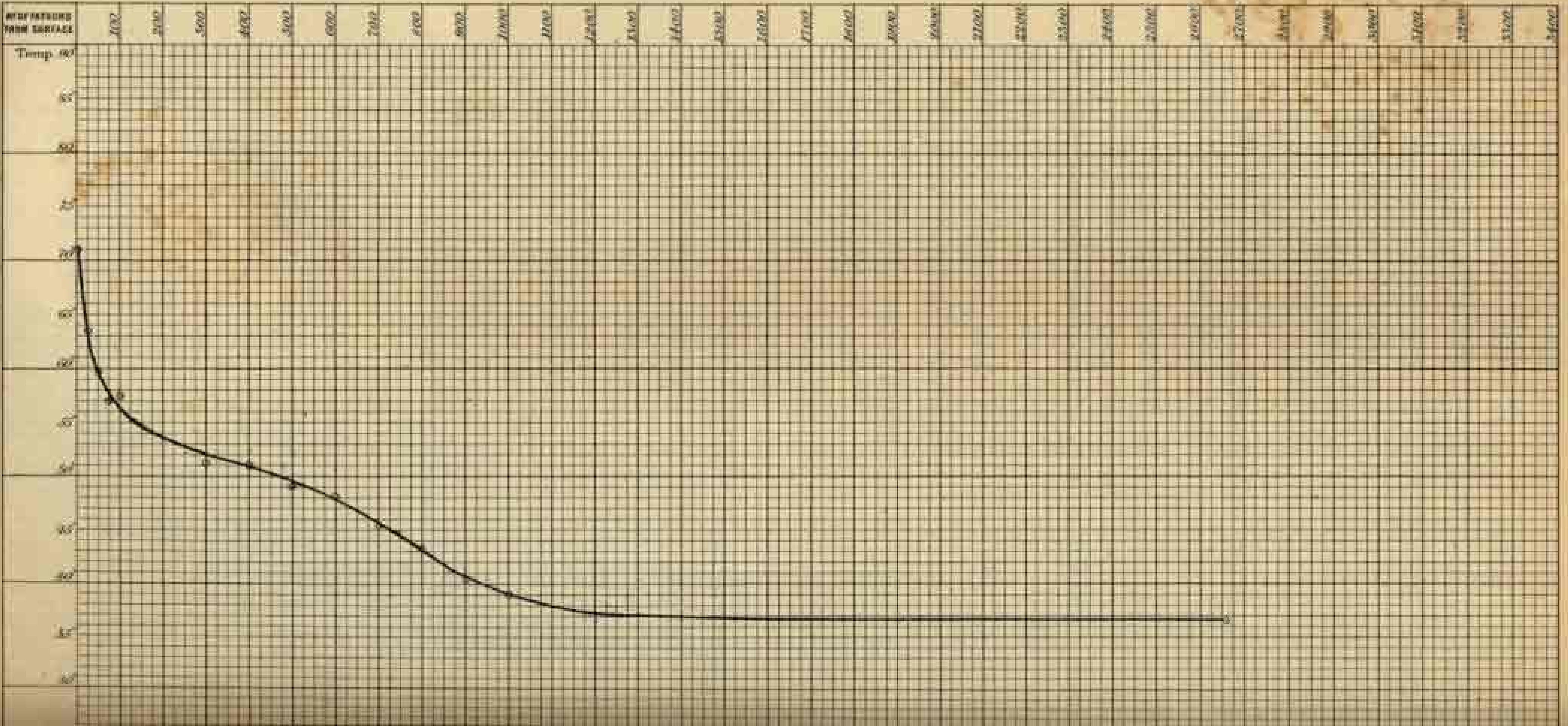
12 July 1873.

No. of Sounding 144.
Station 80.

Depth 2660 fathoms.

Latitude 35° 3′ N.
Longitude 21° 25′ W.

No. of fathoms from surface	No. of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		71.0			71.0
10					
25	49	63.5			63.2
30					
40					
50	63	59.7			59.7
60					
75	65	57.4			57.8
80					
90					
100	44	55.1			55.4
110					
120					
130					
140					
150					
160					
170					
180					
190					
200	38	53.8			53.6
225					
250					
275					
300	63	51.2			52.0
400	49	51.0			50.8
500	44	49.0			49.3
600	62	48.0			47.9
700	30	45.2			45.2
800	49	43.2			43.1
900	44	40.4			40.5
1000	62	39.0			39.0
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
Bottom	63	36.6			36.6



SECTION. THE AZORES TO MADEIRA.

14 July 1873.

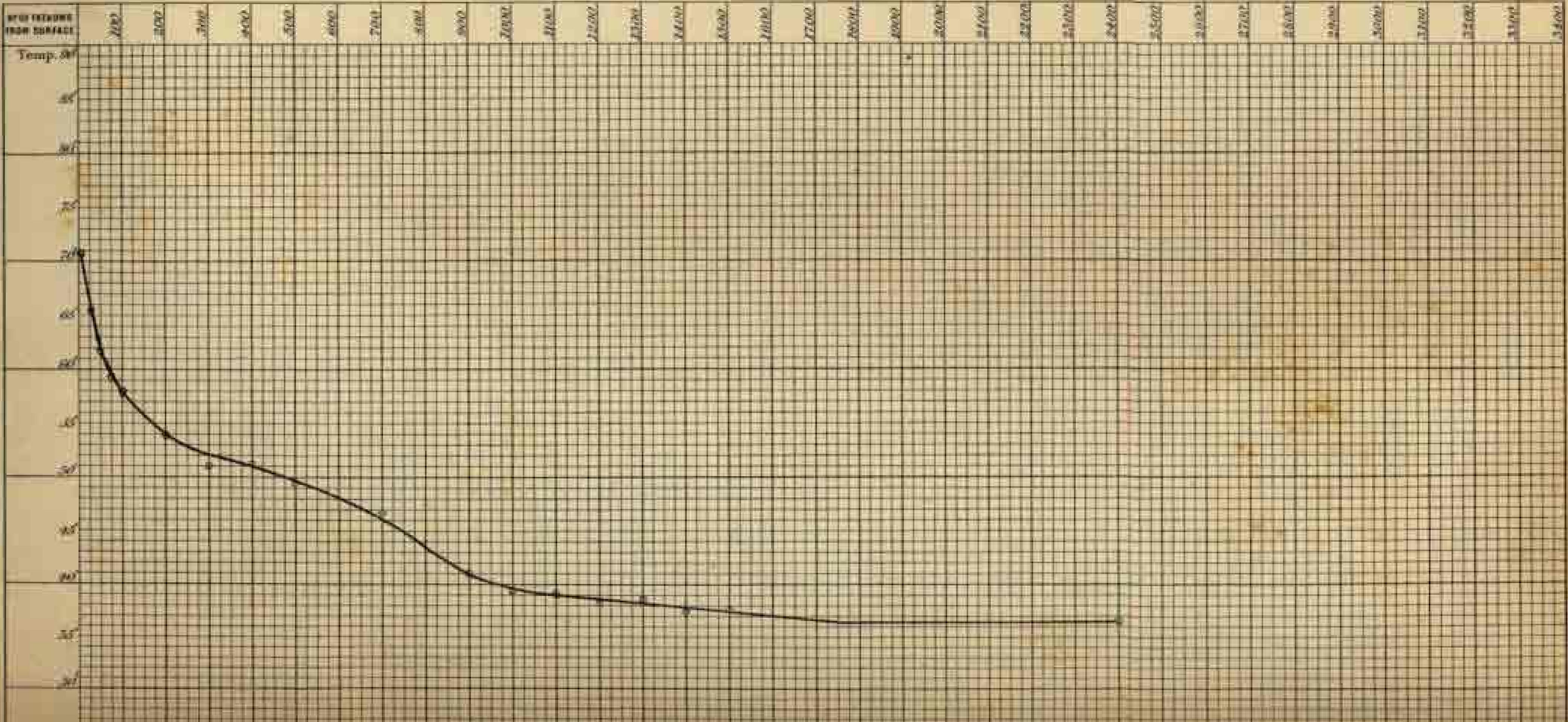
No. of Sounding 146.
Station 82.

Depth 2400 *fathoms.*

Latitude 33° 40' N.
Longitude 19° 17' W.

No. of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225
No. of thermometer			65			44		40			63										63	
Temperature shown by thermometer	70.7		65.5			61.8		59.2			57.8										53.8	
Error of thermometer																						
Corrected temperature																						
Temperature from curve	70.7		65.5			61.8		59.2			57.8										53.8	

No. of fathoms from surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			30	44	40		63	42	44	65	63	65	30	44	42								63
Temperature shown by thermometer			51.0	51.2	49.5		46.8	42.8	41.1	39.5	39.0	38.2	38.6	37.5	37.6								36.6
Error of thermometer																							
Corrected temperature																							
Temperature from curve			52.0	51.0	49.6	48.0	46.0	43.8	41.2	39.7	39.0	38.8	38.2	37.8	37.5								36.6



SECTION. MADEIRA TO ST. VINCENT.

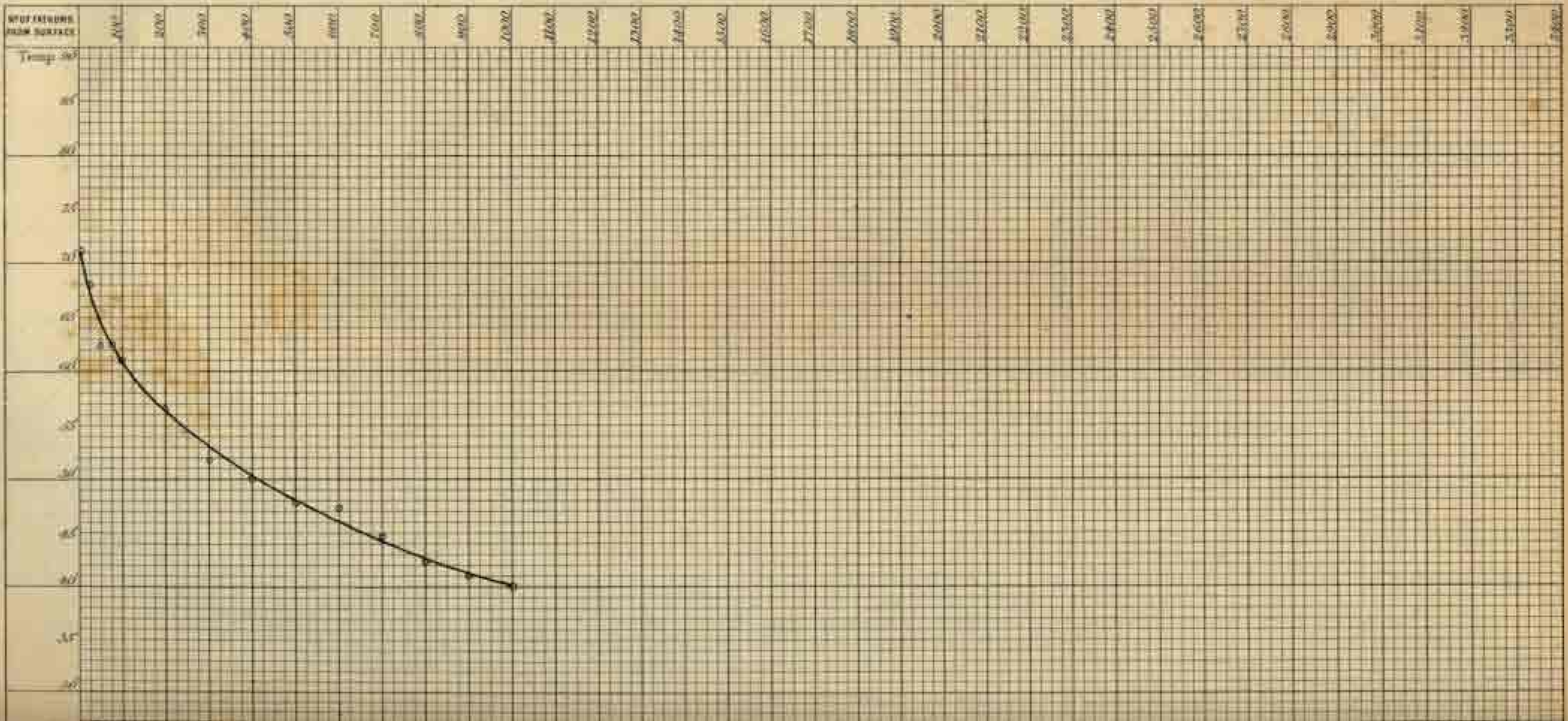
18 July 1873.

No. of Sounding 148.
Station 84.

Depth None obtained.

Latitude 30° 38′ N.
Longitude 18° 5′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER			40			62		65			a 16										49				65	44	63	a 16	40	65	44	63 a 16													
TEMPERATURE SHEWN BY THERMOMETER	71.0		68.0			62.6		62.4			61.2										56.5				52.8	50.0	48.0	47.5	45.0	42.5	41.0	40.0 40.0													
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	71.0		68.0			64.6		62.5			61.0										56.3				53.0	50.5	48.2	46.0	44.4	42.6	41.2	40.0													



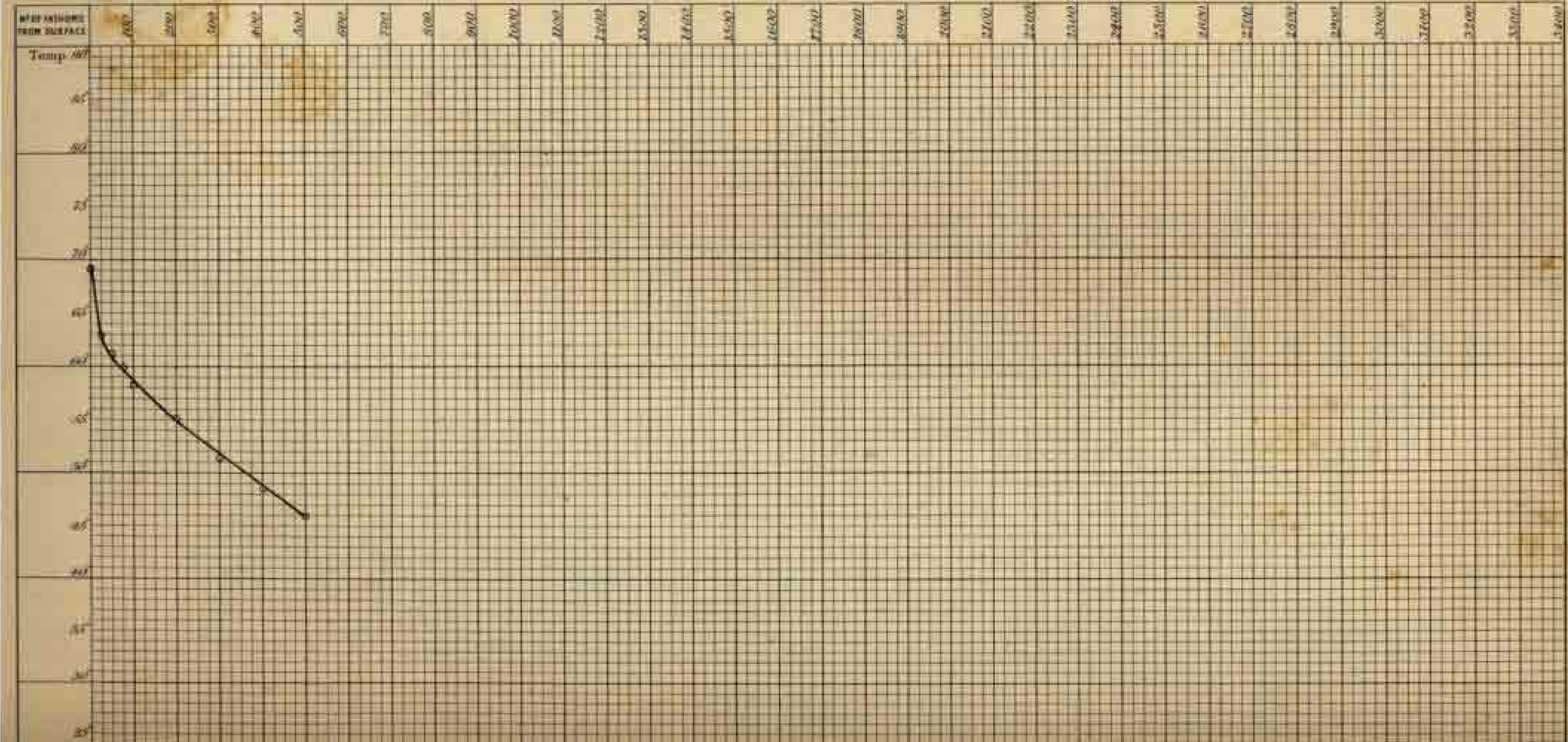
19 July 1873.

Nº of Sounding 149.
Station. 85.

Depth 1125 fathoms.

Latitude 28° 42′ N.
Longitude 18° 6′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			49			65		44			63										49				63	44	63																		
TEMPERATURE SHEWN BY THERMOMETER	69.0		63.0			61.2		60.0			58.5										55.1				51.5	48.5	46.0																		
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	69.0		63.0			61.2		59.8			58.5										54.3				51.5	48.5	46.0																		



SECTION. MADEIRA TO ST. VINCENT.

22 July 1873.

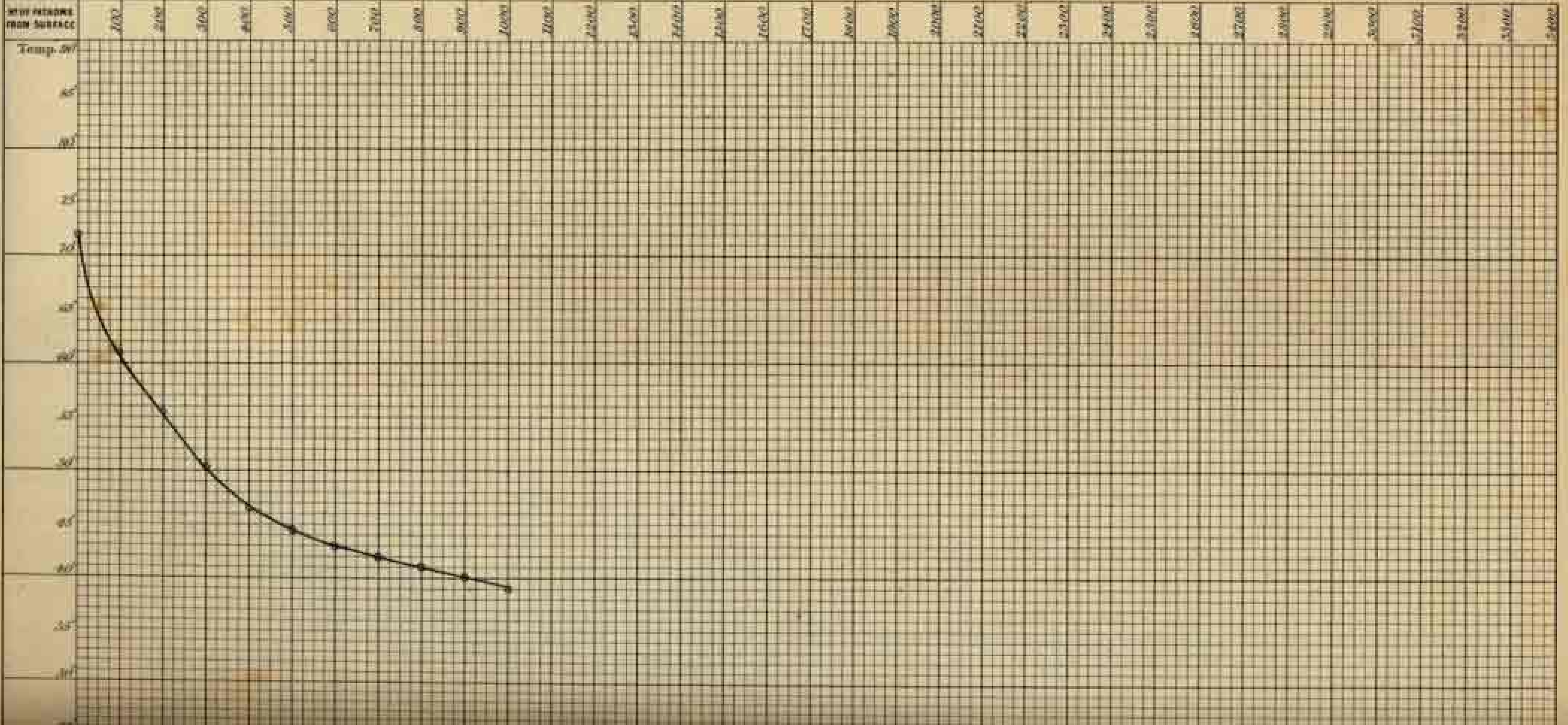
Nº of Sounding 152.
Station 88.

Depth 2300 *fathoms.*

Latitude 23° 58′ *N*
Longitude 21° 18′ *W*

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER											65										44
TEMPERATURE SHEWN BY THERMOMETER	72.0										61.0										55.6
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	72.0										61.0										55.4

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER				a 16	65	49	49	65	49	a 15	44													65
TEMPERATURE SHEWN BY THERMOMETER				50.5	46.3	44.5	43.2	42.0	41.0	40.3	39.0													36.4
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE				50.4	46.8	44.5	43.2	42.0	41.0	40.1	39.3													36.4



SECTION MADEIRA TO ST. VINCENT.

23 July 1873.

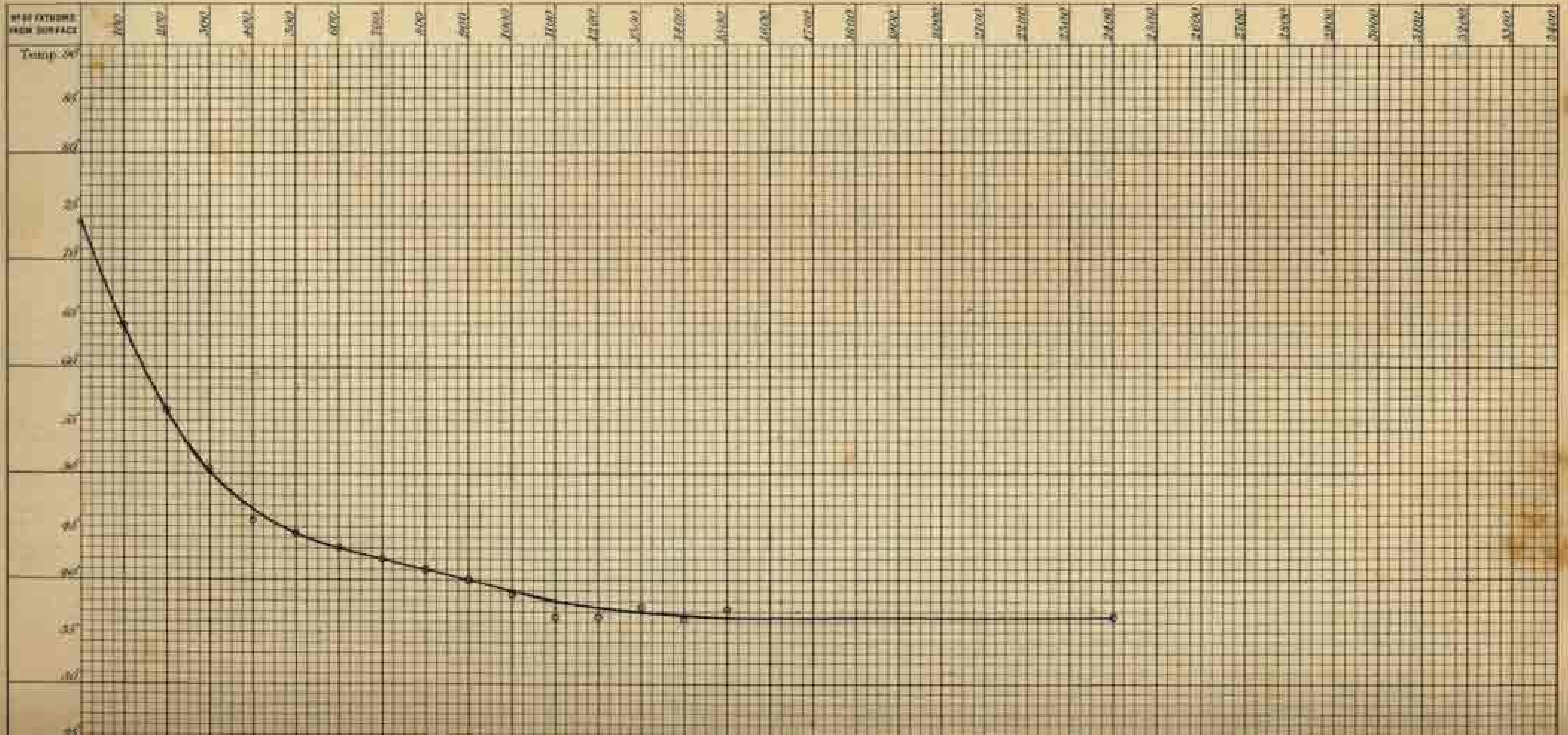
N.o of Sounding 153.
" Station 89.

Depth 2400 fathoms.

Latitude 22° 18′ N.
Longitude 22° 2′ W.

N.o OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
N.o OF THERMOMETER											44										49
TEMPERATURE SHEWN BY THERMOMETER	73.5										64.0										56.0
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	73.5										64.0										56.0

N.o OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.o OF THERMOMETER				63	63	49	a 8	63	a 16	a 1	44	a 8	63	63	a 16	a 1								63
TEMPERATURE SHEWN BY THERMOMETER				50.5	45.8	44.3	43.0	42.0	41.0	39.9	38.7	36.4	36.5	37.5	36.3	37.0								36.6
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE				50.5	47.0	44.3	43.0	42.0	41.0	40.0	39.0	38.0	37.4	37.0	36.8	36.7								36.6



SECTION. MADEIRA TO ST. VINCENT.

24 July 1873.

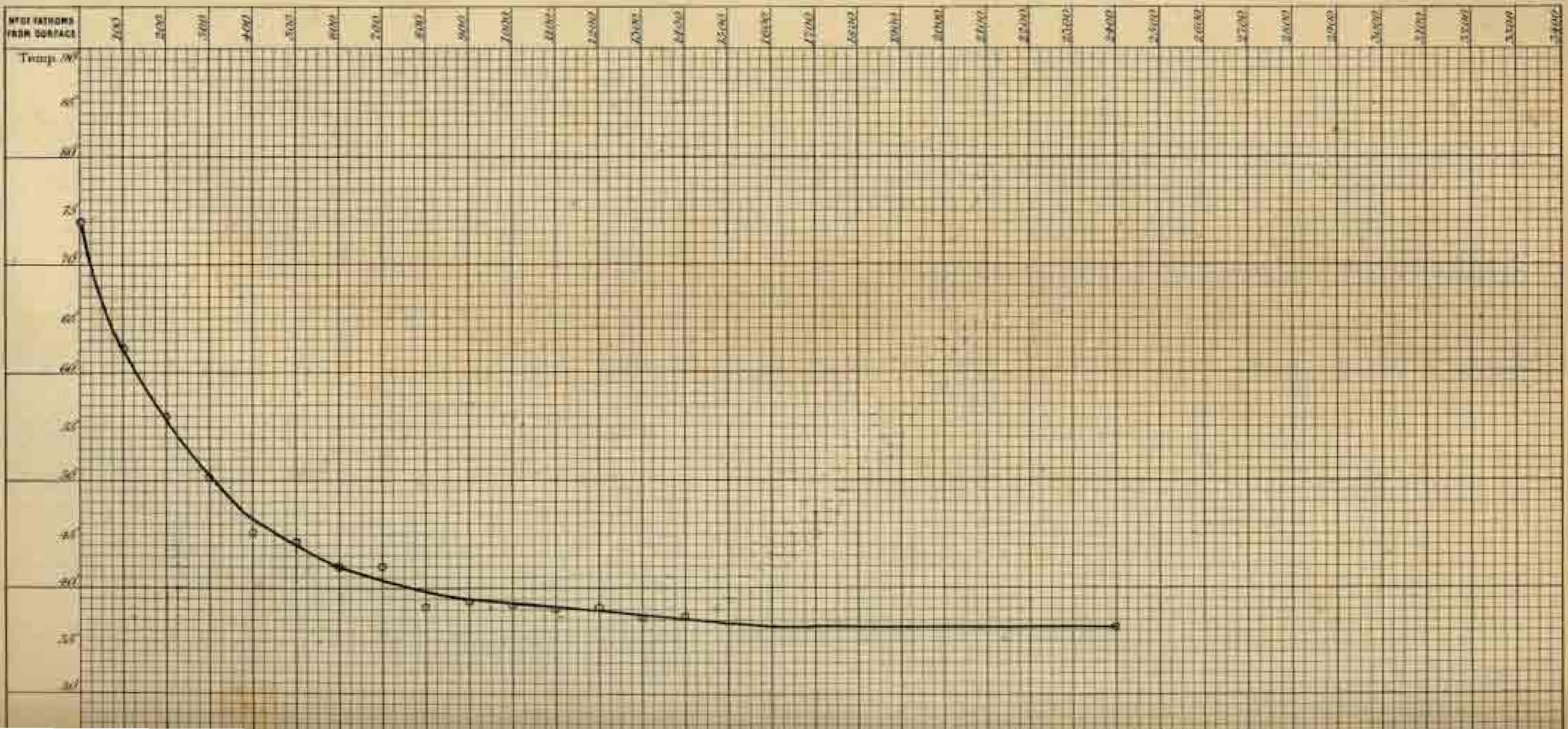
Nº of Sounding 154.
Station 90.

Depth 2400 fathoms

Latitude 20° 58′ N.
Longitude 22° 57′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER											63									
TEMPERATURE SHEWN BY THERMOMETER	74·0										62·2									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	74·0										62·2									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	44				63	40	a 16	63	a 2	a 8	44	44	a 8	a 1	63	a 16									63
TEMPERATURE SHEWN BY THERMOMETER	58·0				50·2	45·2	44·5	42·2	42·0	38·2	39·0	38·5	38·0	38·0	37·2	37·4									36·4
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	58·0				50·7	46·7	44·0	42·2	40·8	39·8	39·1	38·6	38·2	37·8	37·4	37·0									36·4



SECTION. MADEIRA TO ST. VINCENT.

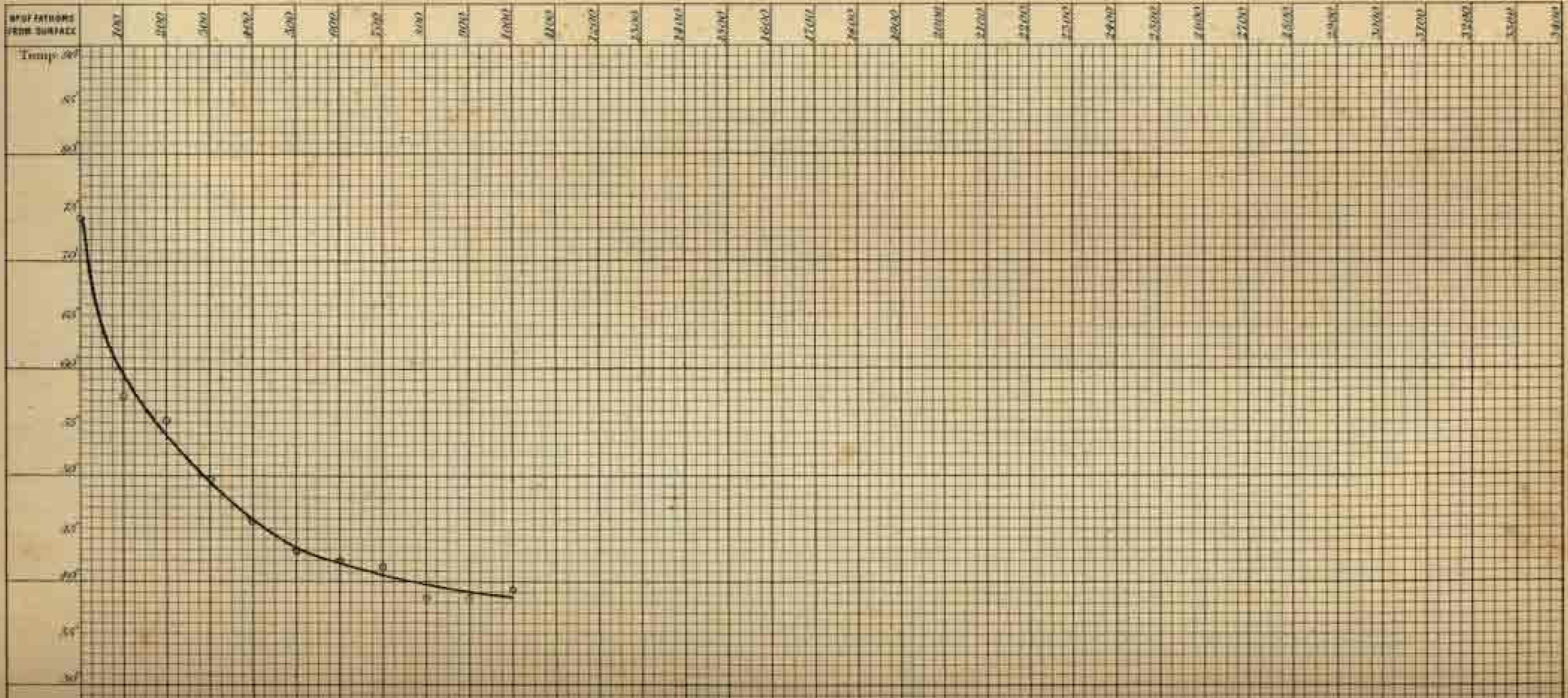
25 July 1873.

No. of Sounding 155.
Station 91.

Depth 2075 fathoms.

Latitude 19° 4′ N.
Longitude 24° 6′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER											49										49				49	49	# 19	# 8	49	63	# 16	# 1													63
TEMPERATURE SHEWN BY THERMOMETER	74.0										57.5										55.2				49.7	46.4	43.4	41.9	41.5	38.4	38.5	39.2													36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	74.0										60.0										54.0				49.5	46.0	43.5	41.9	40.7	39.8	39.1	38.6													36.5



SECTION. MADEIRA TO ST. VINCENT.

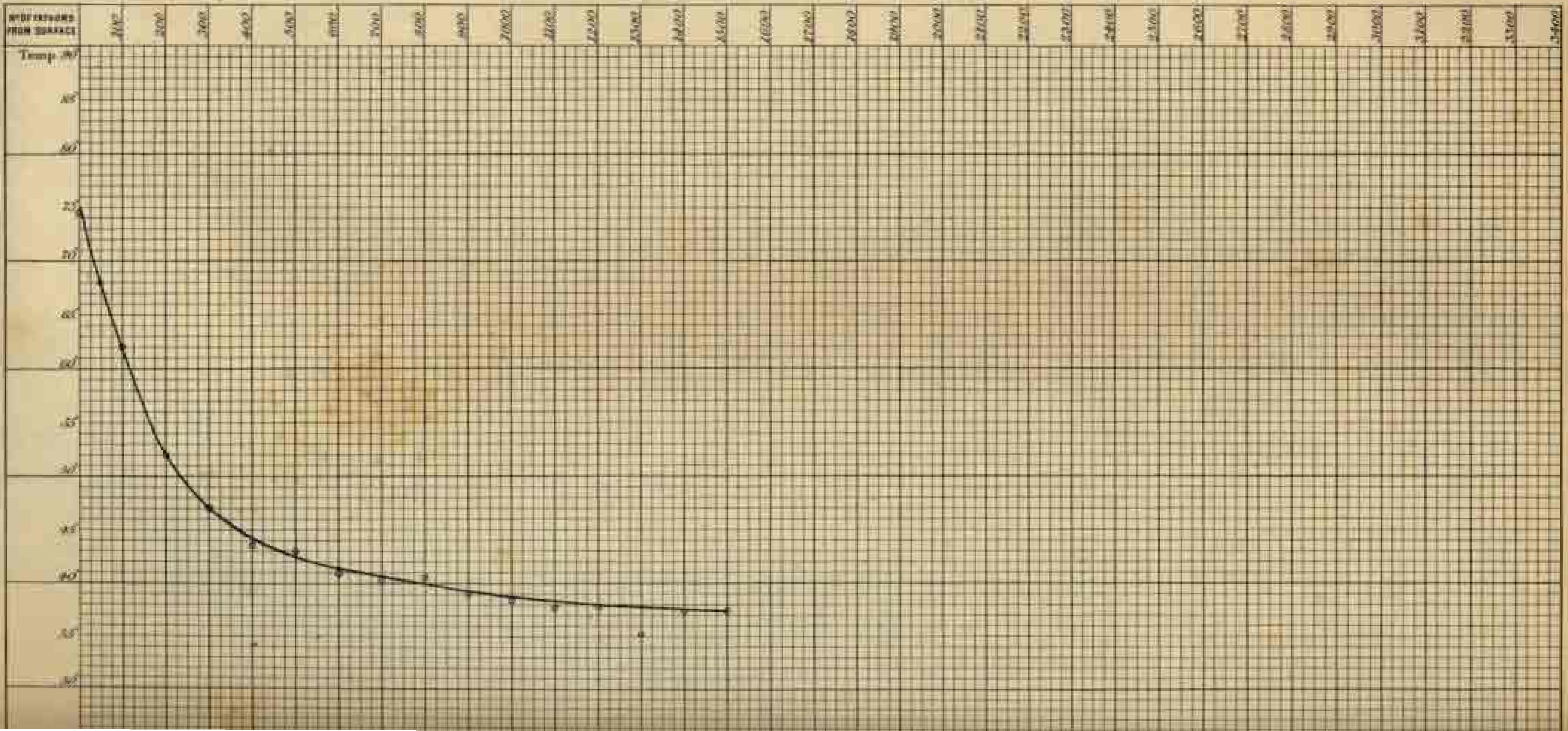
26 July 1873.

Nº of Sounding 156.
Station 92.

Depth 1975 *fathoms.*

Latitude 17° 54′ N.
Longitude 24° 41′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						44					44										A 19				63	55	A 1	A 16	49	44	A 16	A 1	A 3	63	65	49	44								
TEMPERATURE SHEWN BY THERMOMETER	74.7					68.0					60.0										52.0				47.9	43.5	43.0	41.0	40.4	40.3	39.0	38.4	37.8	37.8	35.4	37.4	37.8								
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	74.7					68.0					60.0										52.0				47.8	44.7	43.4	41.4	40.5	39.9	39.3	38.8	38.3	38.0	37.8	37.6	37.5								



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

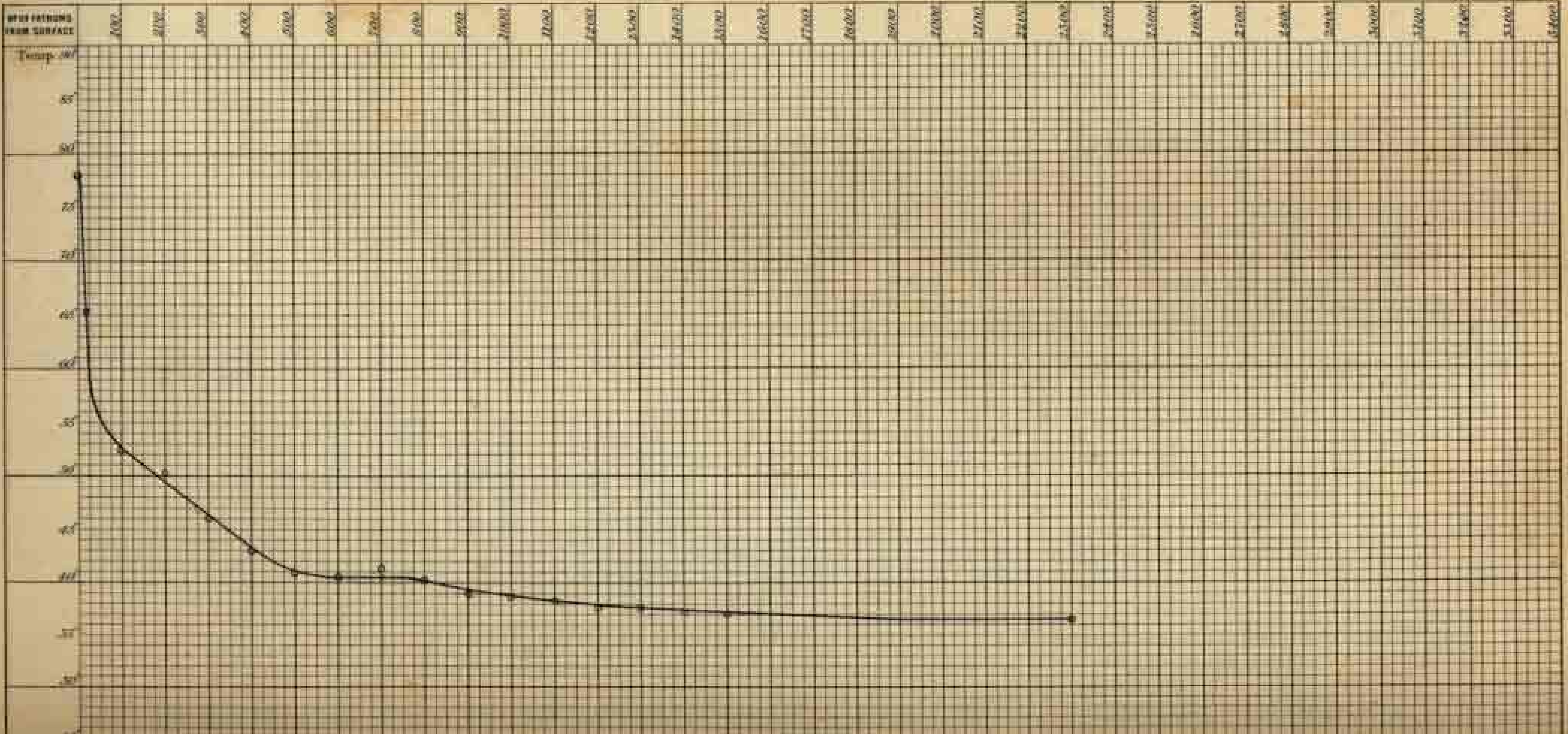
10 August 1873.

N.º of Sounding 166.
Station 95.

Depth 2300 fathoms.

Latitude 13° 36′ N.
Longitude 22° 49′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	5	10	15	25	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER		49	49	a 19	a 1						a 1										a 19				65	a 16	44	a 8	49	a 25	a 25	49	a 8	44	a 16	65	a 19								63
TEMPERATURE SHOWN BY THERMOMETER	79.0	77.8	76.0	69.0	65.2						52.4										50.3				46.2	43.0	40.9	40.5	41.2	40.0	39.0	38.3	38.1	37.8	37.3	37.1	37.2								36.9
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	79.0		76.0		65.2						52.5										49.5				46.4	43.2	41.1	40.5	40.0	39.7	39.3	38.9	38.5	38.1	37.8	37.6	37.4								36.5



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

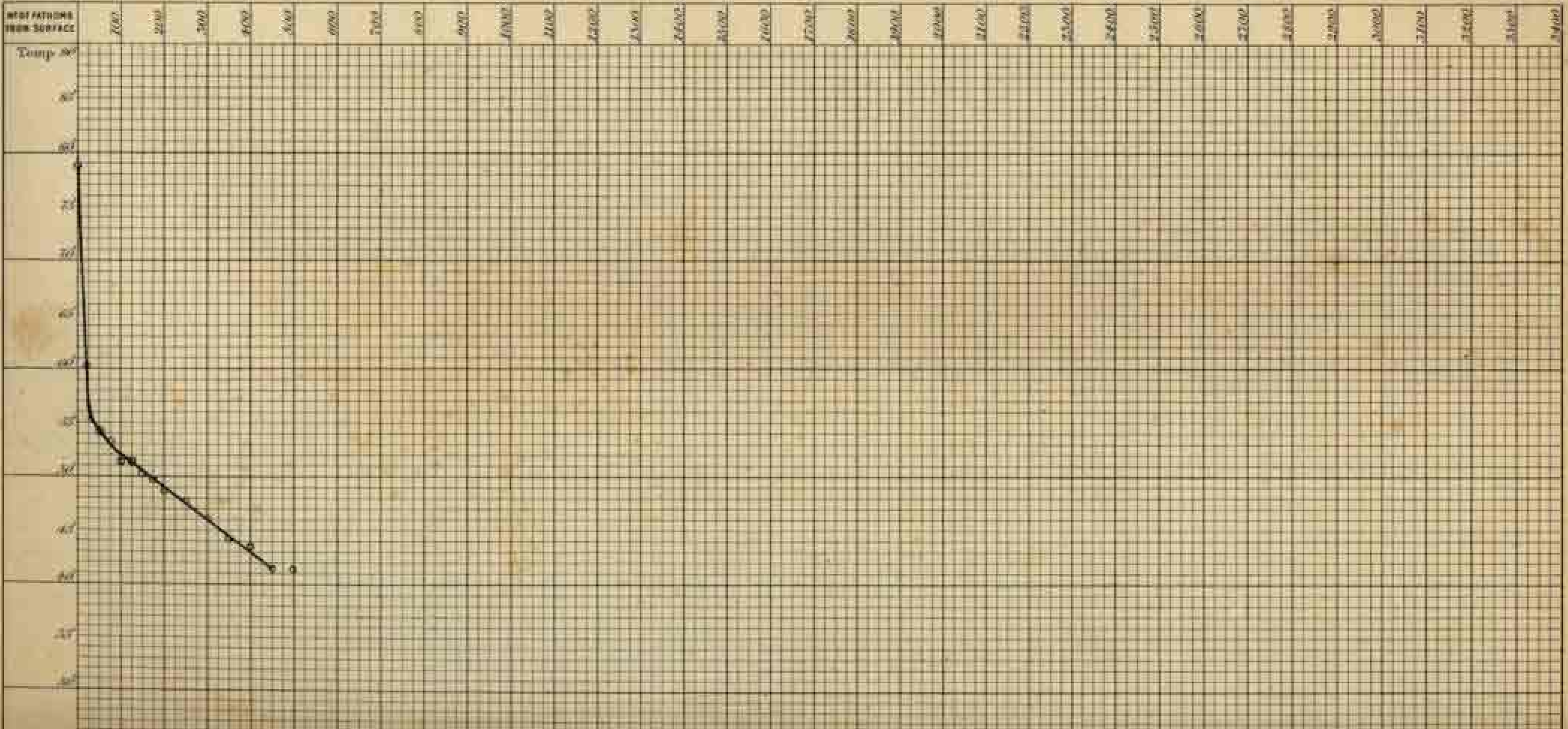
11 August 1873.

Nº of Sounding 167.
Station 96.

Depth None obtained.

Latitude 12° 15′ N.
Longitude 22° 28′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	25	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	350	400	450	500	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		44	# 25	# 16		85		# 19			83		44			# 8		# 25			# 19		83		# 16	85	# 8	# 18	# 25																
TEMPERATURE SHEWN BY THERMOMETER	78.9	70.5	62.8	60.0		54.2		53.0			51.6		51.4			50.2		49.8			48.8		47.7		46.0	44.4	43.4	41.4	41.5																
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.7	70.3	62.8	60.0		54.7		53.0			52.2		51.4			50.6		49.8			49.1		47.3		45.9	44.4	42.9	41.4	39.9																



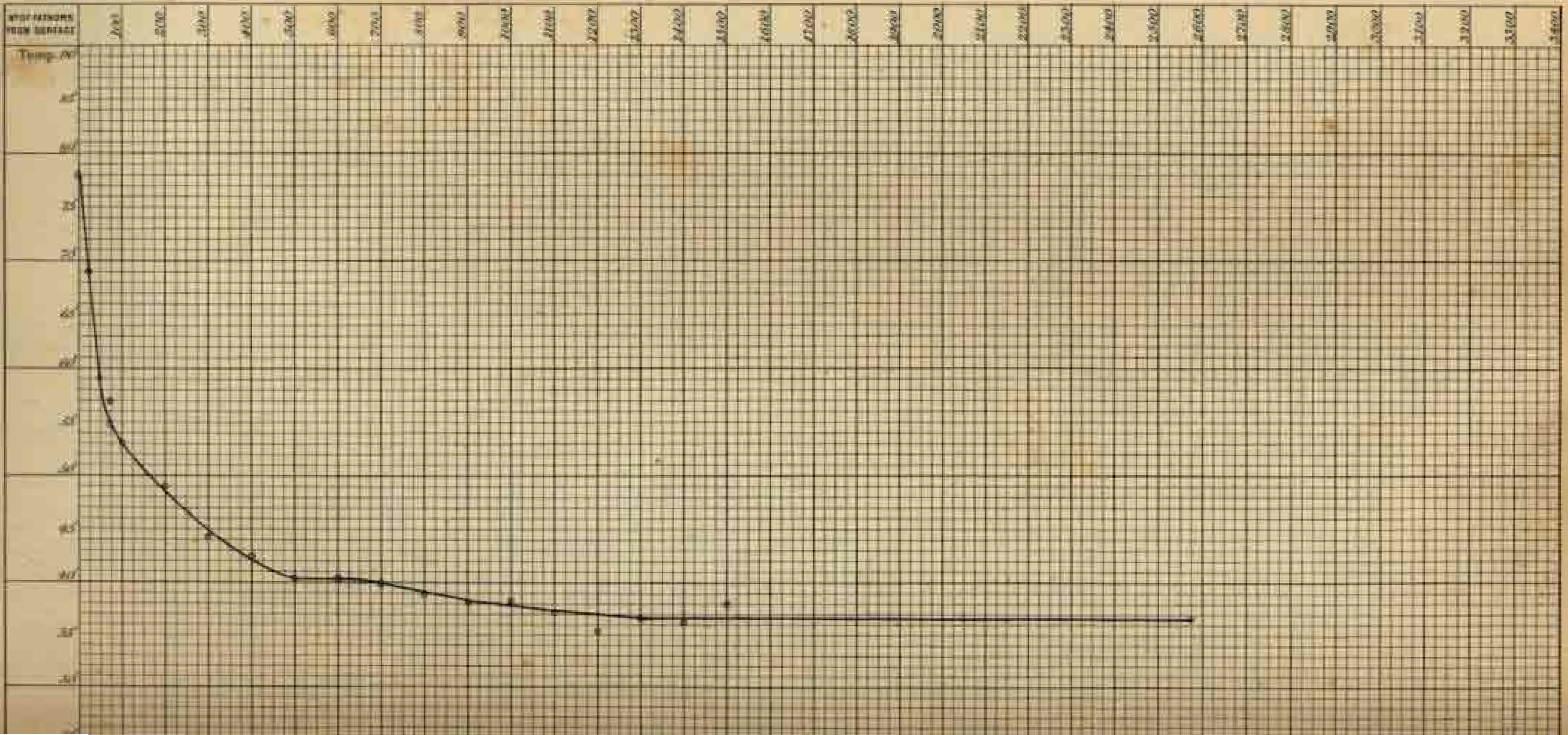
10 August 1873.

Nº of Sounding 168.
Station 97.

Depth 2575 fathoms.

Latitude 10° 25′ N.
Longitude 20° 30′ W.

NO. OF FATHOMS FROM SURFACE	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER			a 11			a 4		63			a 16										b 97				a 3	b 79	a 8	a 25	a 19	65	63	a 19	a 25	a 8	b 79	a 3	b 97								a 16 63
TEMPERATURE SHEWN BY THERMOMETER	78.0		69.0			59.4		54.0			53.7										49.0				44.2	42.5	40.5	40.2	39.9	39.0	38.4	38.4	37.2	35.6	36.8	36.9	38.0								36.8 36.3
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0		69.0			59.4		55.0			53.2										48.7				43.0	42.2	40.5	40.2	40.0	39.2	38.4	38.0	37.6	37.2	36.8	36.7	36.7								36.6



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

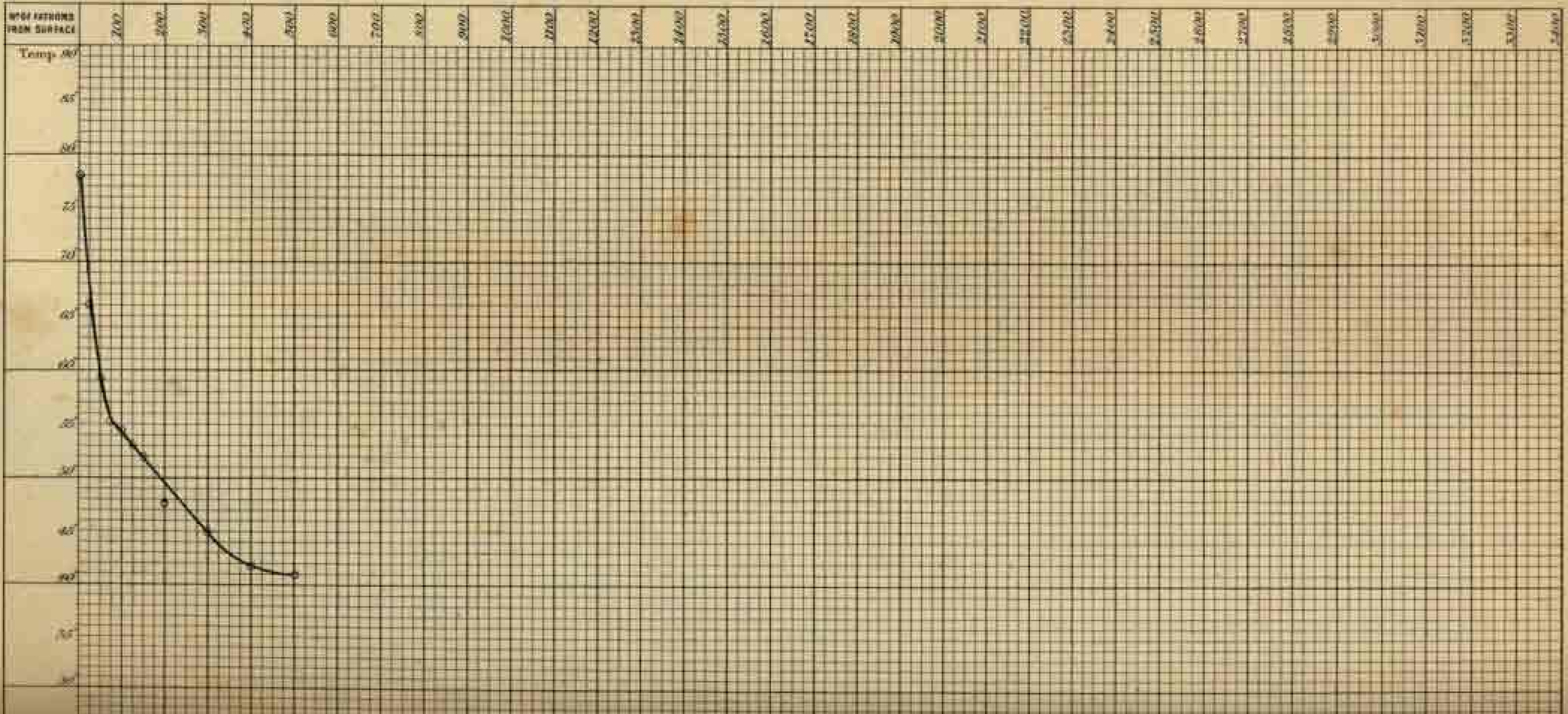
14 August 1873.

N° of Sounding 169.
Station 98.

Depth 1750 fathoms.

Latitude 9° 21′ N.
Longitude 18° 28′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			b 96			44		65			b 93		b 75			49					65				b 93	b 79	49																		63 66
TEMPERATURE SHEWN BY THERMOMETER	78.2		66.5			59.3		55.3			54.6		53.0			50.0					47.8				45.2	41.9	41.0																		36.6 36.8
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0		66.5			59.3		55.5			54.2		53.1			52.0					49.7				45.4	42.0	41.2																		36.7



15 August 1873.

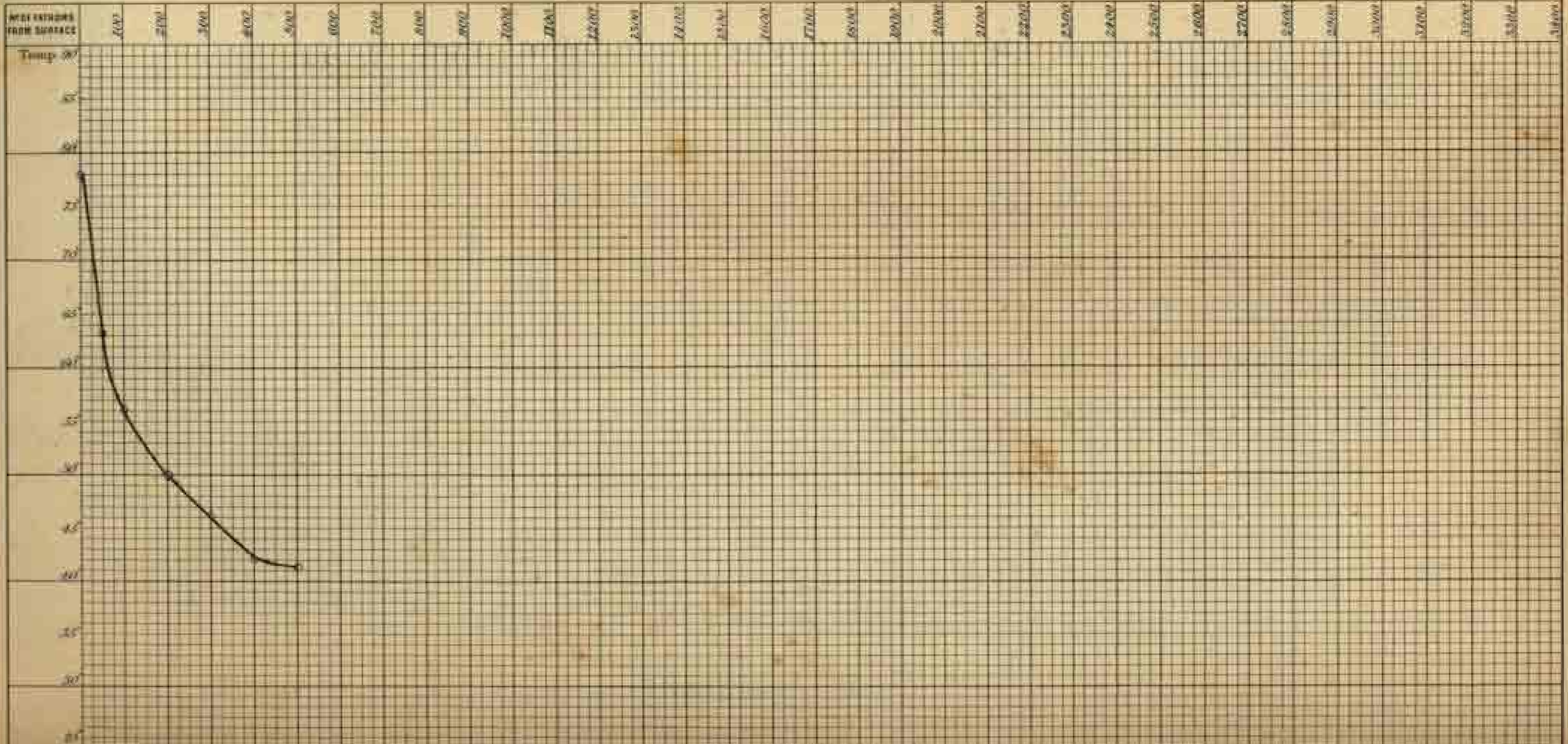
N.º of Sounding 170.
Station 99.

Depth None obtained.

Latitude 7° 53′ N.
Longitude 17° 26′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº OF THERMOMETER						49					89										65			
TEMPERATURE SHEWN BY THERMOMETER	78.0					63.9					56.2										49.8			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	78.0					63.9					56.2										49.8			

Nº OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	69	93	49																		
TEMPERATURE SHEWN BY THERMOMETER	45.8	42.8	41.4																		
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	45.8	42.8	41.4																		



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

16 August 1873.

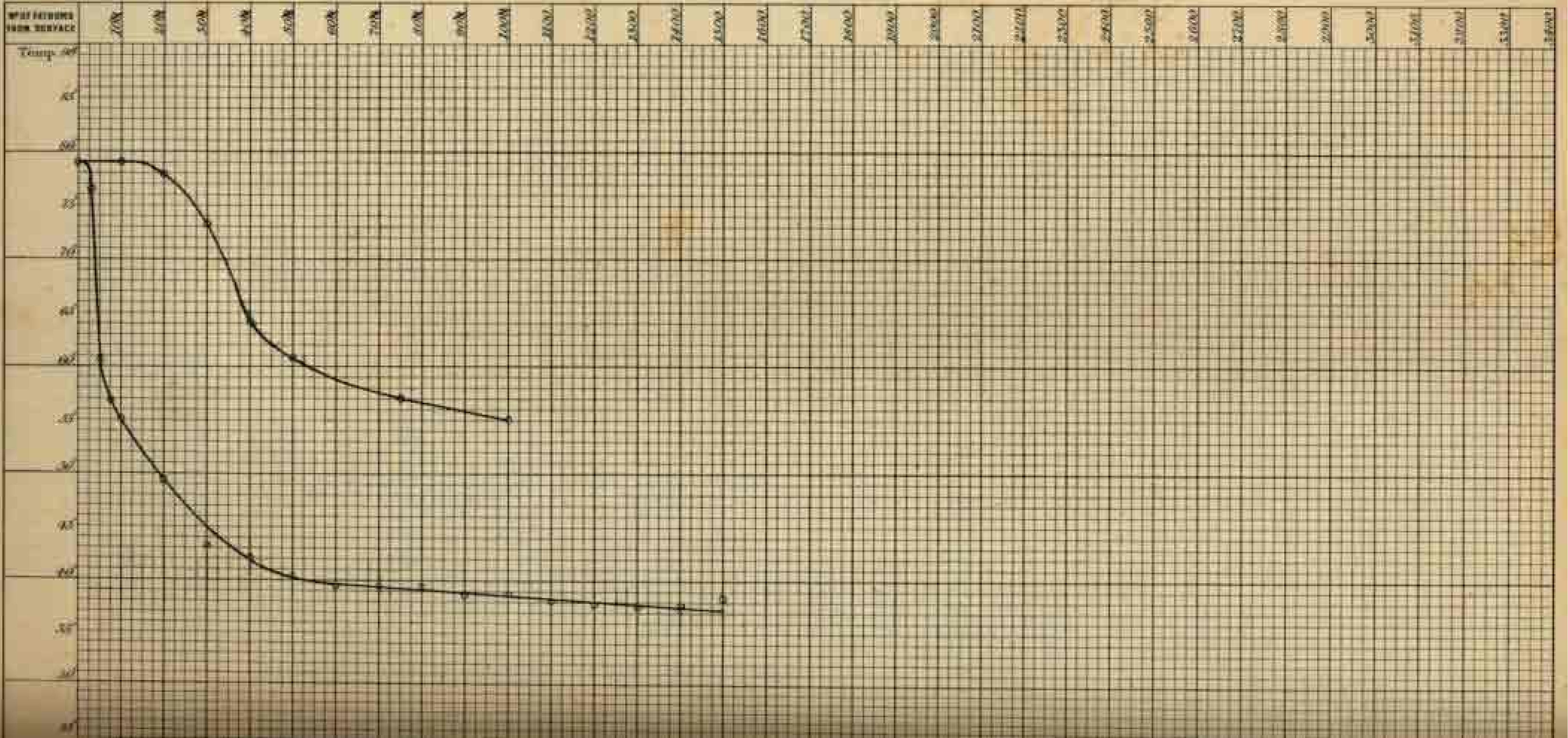
No. of Sounding 171.
Station 100.

Depth 2425 fathoms.

Latitude 7° 1′ N.
Longitude 15° 55′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200
No. of thermometer		69	44	B 89	86	B 96		B 96			B 79										B 89
Temperature shown by thermometer	79·0	79·0	78·0	73·4	64·2	60·8		56·8			55·2										49·5
Error of thermometer																					
Corrected temperature																					
Temperature from curve	79·0	79·0	78·0	73·4	64·4	60·8		56·8			55·4										49·5

No. of fathoms from surface	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer				B 79	67	44	B 96	B 93	41	40	69	B 93	B 96	44	67	B 89								
Temperature shown by thermometer				43·2	42·0	40·5	39·6	39·6	39·5	38·6	38·0	38·0	37·9	37·5	37·7	38·5								
Error of thermometer																								
Corrected temperature																								
Temperature from curve				43·0	42·0	40·4	39·7	39·4	39·1	38·8	38·5	38·2	38·0	37·8	37·6	37·4								



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

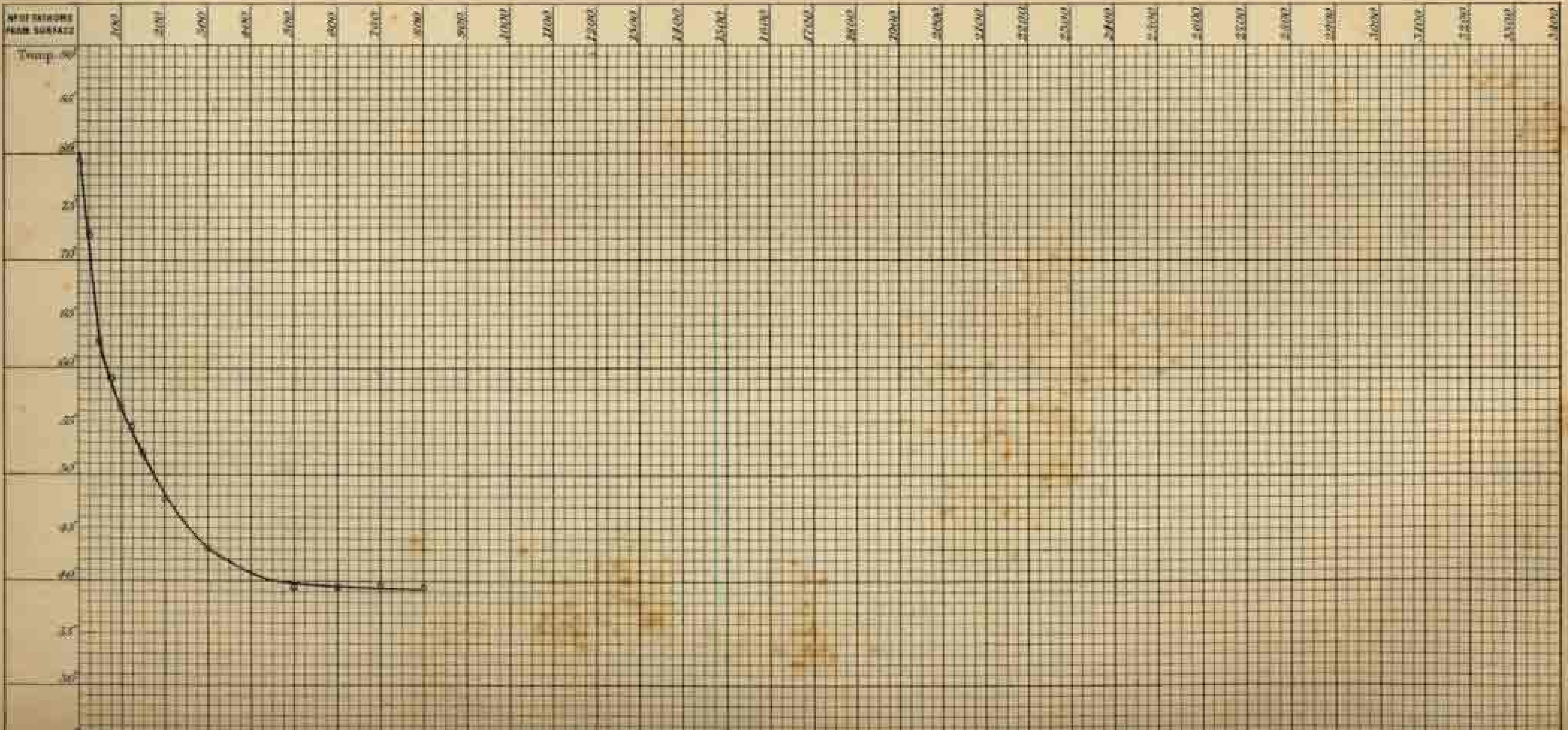
19 August 1873.

N.º of Sounding 172.
Station 101.

Depth 2500 fathoms.

Latitude 5° 48′ N.
Longitude 14° 20′ W.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER			66			B 79		B 93			A 3		49			B 91					B 91				41	70	A 3	B 93	B 79	66															69 44
TEMPERATURE SHEWN BY THERMOMETER	79.8		72.6			60.3		59.0			56.2		54.4			52.2					47.9				43.3	40.9	39.5	39.4	39.6	39.5															36.8 36.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	79.0		72.6			60.3		58.8			56.2		54.1			52.0					48.3				43.5	40.8	39.7	39.5	39.4	39.3															36.4



SECTION. THE CAPE VERDE ISLANDS TOWARDS ASCENSION.

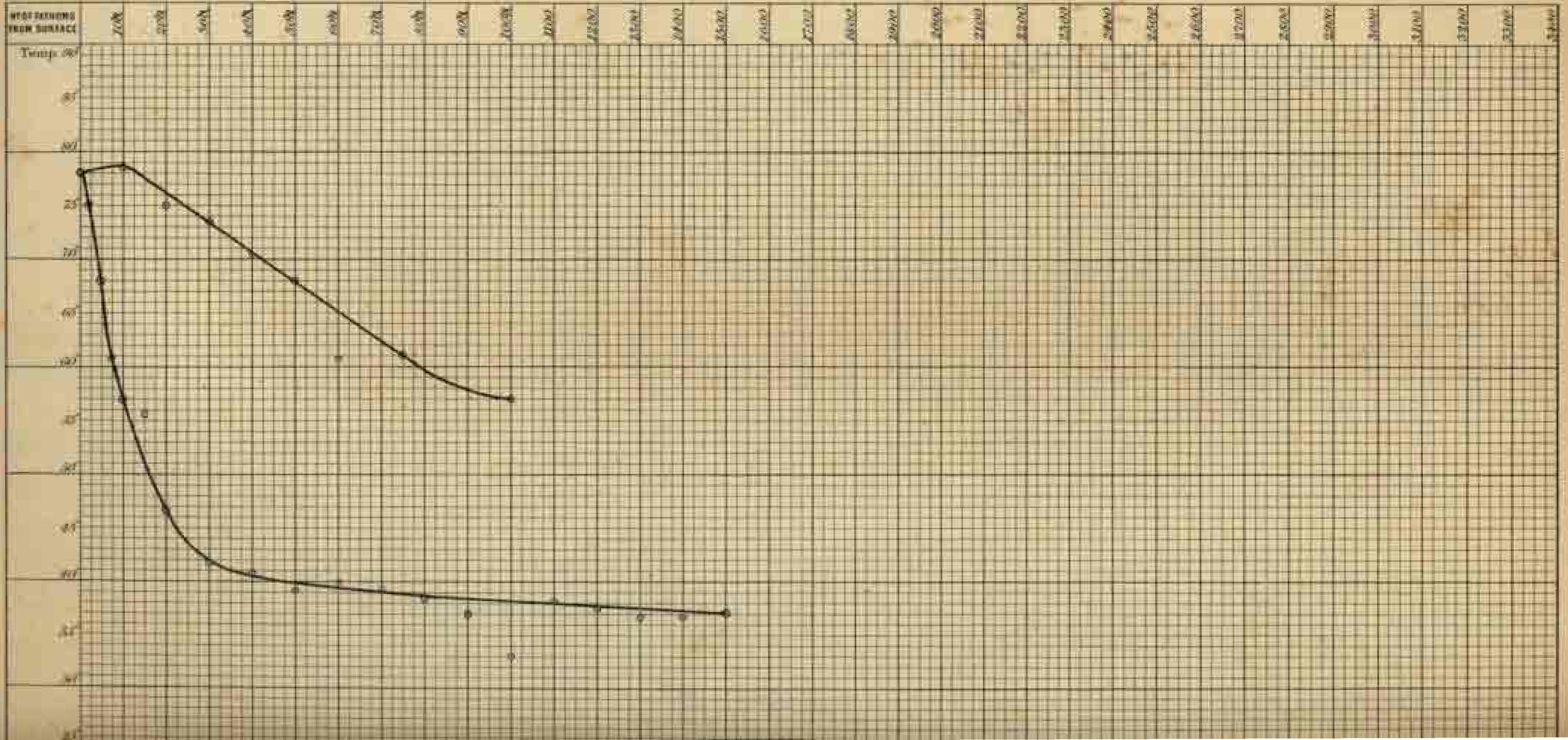
21 August 1873.

No. of Sounding 173.
Station 102.

Depth 2450 fathoms.

Latitude 8° 8′ N.
Longitude 14° 49′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER		49	#3	66	44	44	B 91	B 79			B 91					B 91					B 77				B 91	49	B 96	69	#3	66	B 79	65	B 91	44	#3	B 96	49								66 44
TEMPERATURE SHEWN BY THERMOMETER	78.0	78.5	75.4	73.4	70.5	68.0	62.8	61.0			57.0					54.8					46.8				41.8	40.8	39.2	40.0	39.0	38.5	36.9	39.0	38.0	37.6	36.8	35.9	36.9								36.8 36.1
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0	78.5	76.0	73.5	70.3	64.8	63.0	61.0			57.0					54.3					46.8				41.8	40.6	39.9	39.4	39.0	38.7	38.4	38.1	37.8	37.6	37.4	37.2	37.0								36.3



28 August 1873.

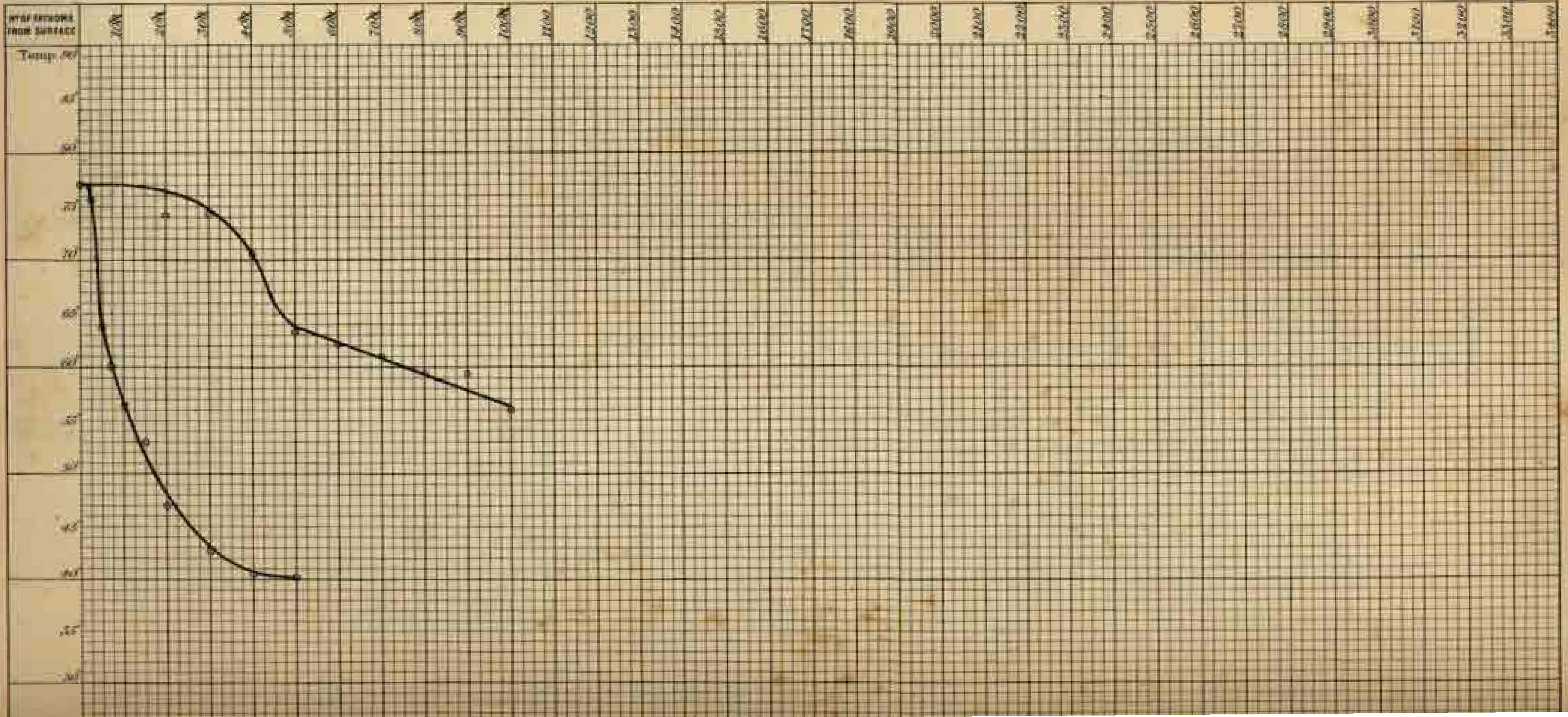
Nº of Sounding 174.
Station 103.

Depth 2475 fathoms.

Latitude 2° 52' N.
Longitude 17° 0' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº OF THERMOMETER			44	69	66	43	69	67	67	70	65					70					49			
TEMPERATURE SHEWN BY THERMOMETER	77.0		76.0	74.5	70.5	63.4	62.2	61.0	59.5	55.5	56.0					53.0					47.0			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	77.0		76.5	74.7	70.1	63.8	62.2	60.8	59.4	57.9	56.4					51.5					47.5			

Nº OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	67	70	69																		44 43 66
TEMPERATURE SHEWN BY THERMOMETER	42.8	40.8	40.2																		36.0 35.1 36.2
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	43.0	40.6	40.2																		36.0



A POSITION IN *Lat. 3° 8′ N.* TO ST. PAUL'S ROCKS,
Long. 14° 49′ W.

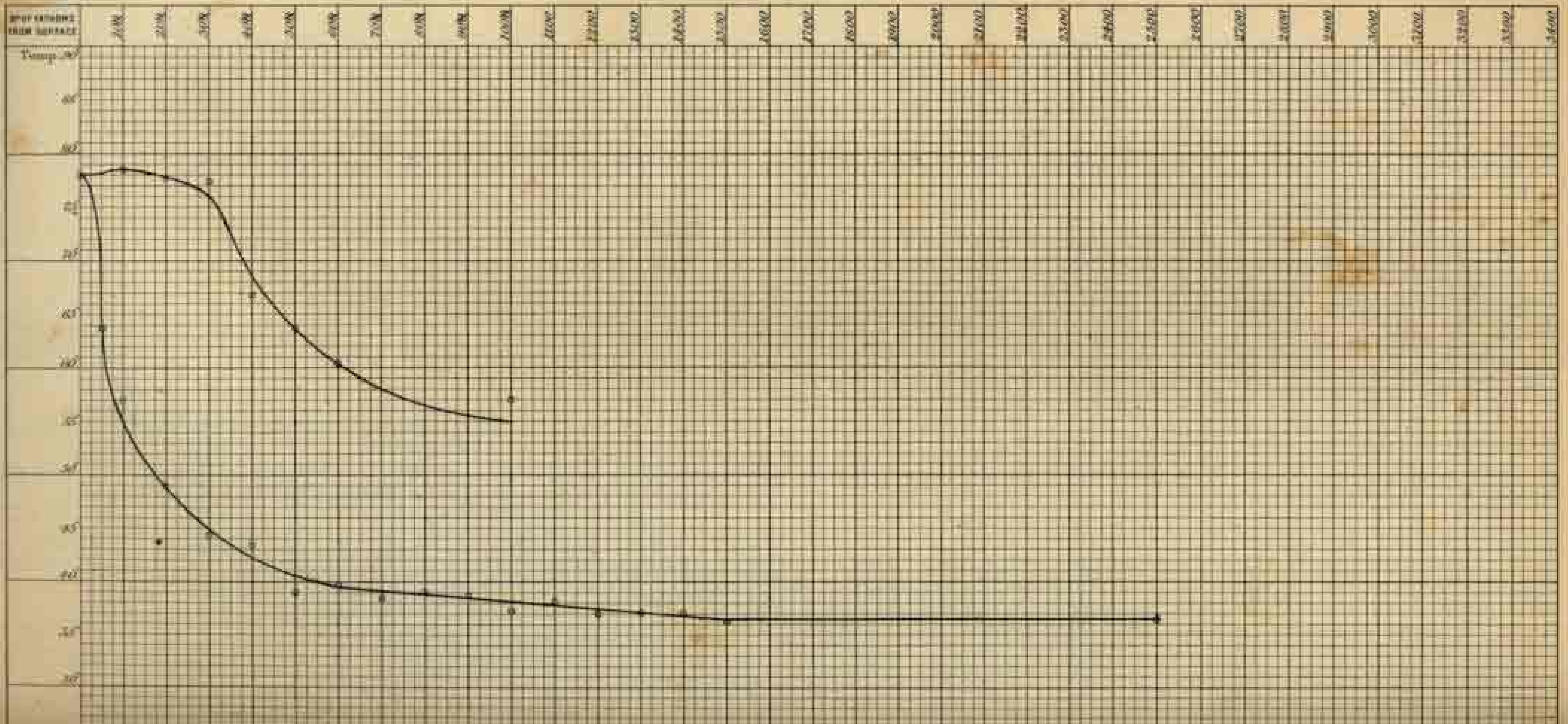
23 August 1873.

Nº of Sounding 175.
Station 104.

Depth 2500 fathoms.

Latitude 2° 25′ N.
Longitude 20° 1′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		67	70	91	23	78	69				74										49				66	65	23	78	91	67	66	65	78	23	70	67	91								74
TEMPERATURE SHEWN BY THERMOMETER	78.0	78.4	77.8	72.6	66.8	63.8	60.5				57.0										49.0				44.5	43.5	39.0	39.9	38.6	39.2	38.8	37.2	38.2	37.0	37.1	37.2	36.4								36.6
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0	78.4	77.8	76.0	68.8	63.8	60.5				55.0										49.0				43.0	42.4	40.7	39.7	39.2	38.9	38.6	38.2	37.9	37.6	37.3	37.0	36.7								36.6

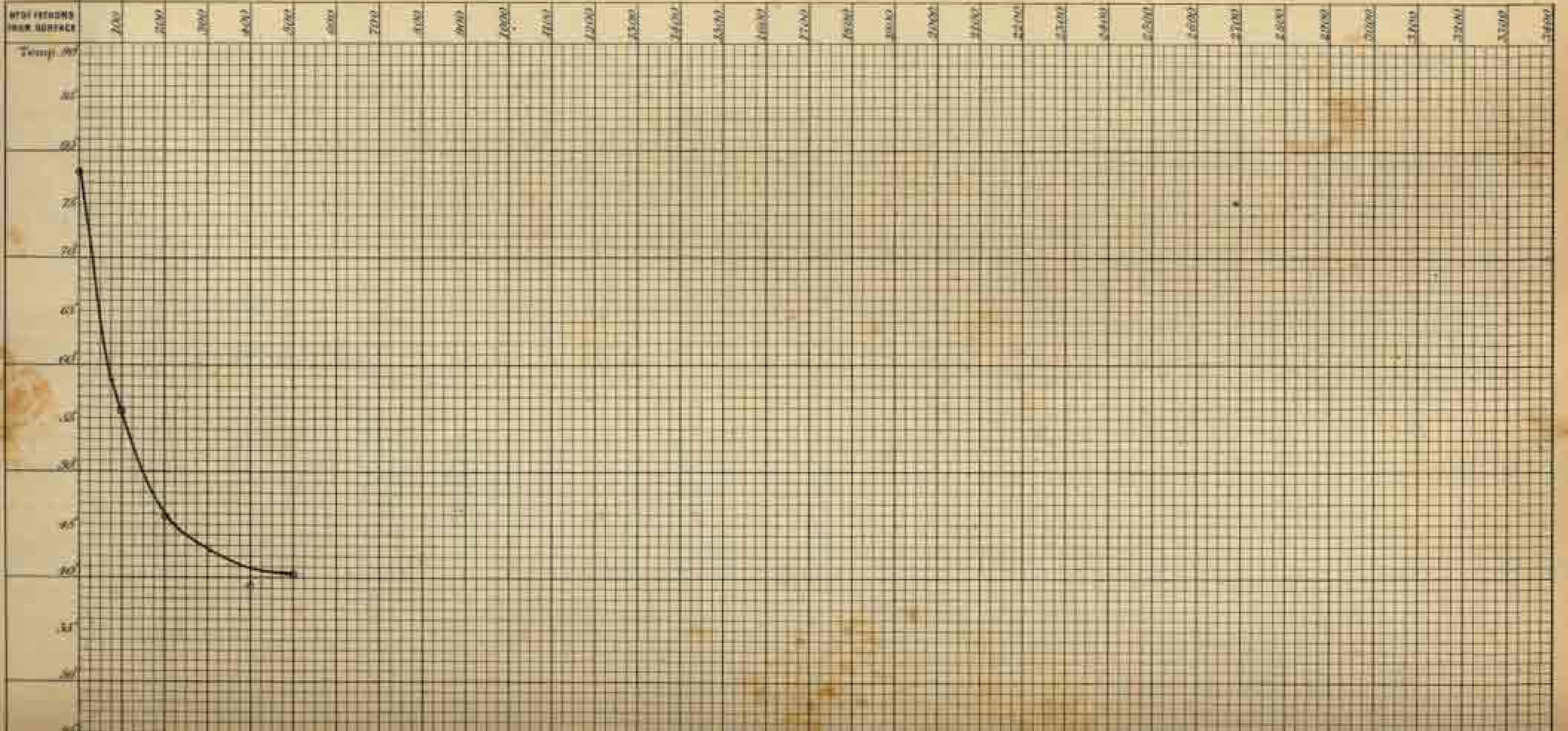


24 August 1873.

N° of Sounding 176. *Depth 2275 fathoms* *Latitude 2° 6′ N.*

Station 105. *Longitude 22° 53′ W.*

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											A 98										70				74	83	69																		65 76
TEMPERATURE SHEWN BY THERMOMETER	78.0										56.0										46.0				42.3	39.8	40.4																		35.5 36.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0										56.0										46.0				42.8	41.0	40.4																		36.0



SECTION. FROM A POSITION IN { Lat. 3° 8' N. Long. 14° 49' W. } TO ST. PAUL'S ROCKS.

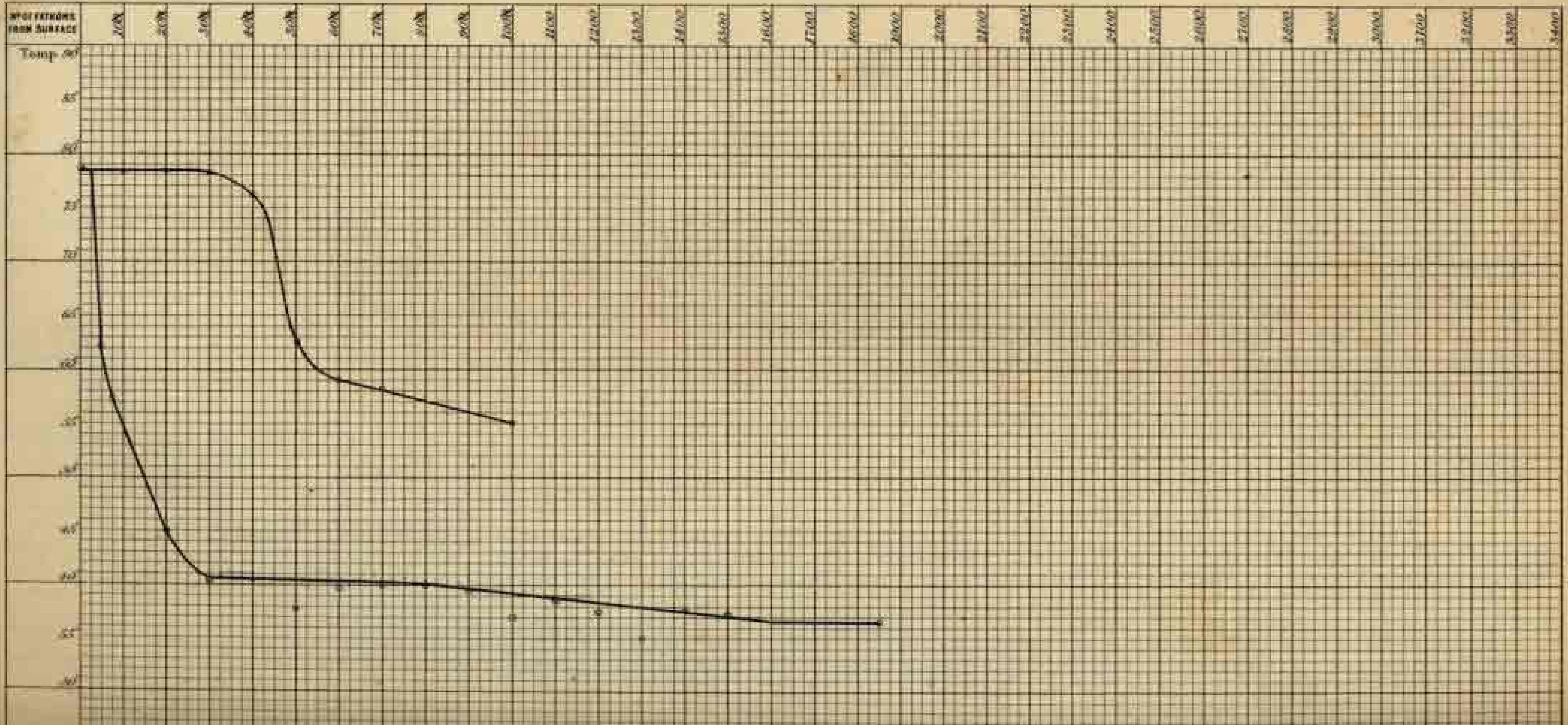
25 August 1873.

Nº of Sounding 177.
Station 106.

Depth 1850 fathoms.

Latitude 1° 47' N.
Longitude 24° 26' W.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer		67	70	74	73	78	49	69			73										91				70	73	74	67	69	60	66	69	67	74	65	78	70								78 69
Temperature shewn by Thermometer	78.8	78.5	78.3	78.2	76.2	62.4	59.0	58.4			55.0										45.0				40.5	40.4	37.8	39.3	39.1	40.0	39.5	37.0	38.5	37.4	35.4	37.3	37.2								35.8 36.5
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	78.8	78.6	78.4	78.2	76.2	62.4	59.0	58.0			55.0										45.0				40.7	40.5	40.3	40.2	40.1	40.0	39.6	39.4	38.8	38.3	37.9	37.5	37.6								36.6



SECTION. ST. PAUL'S ROCKS TO FERNANDO NORONHA.

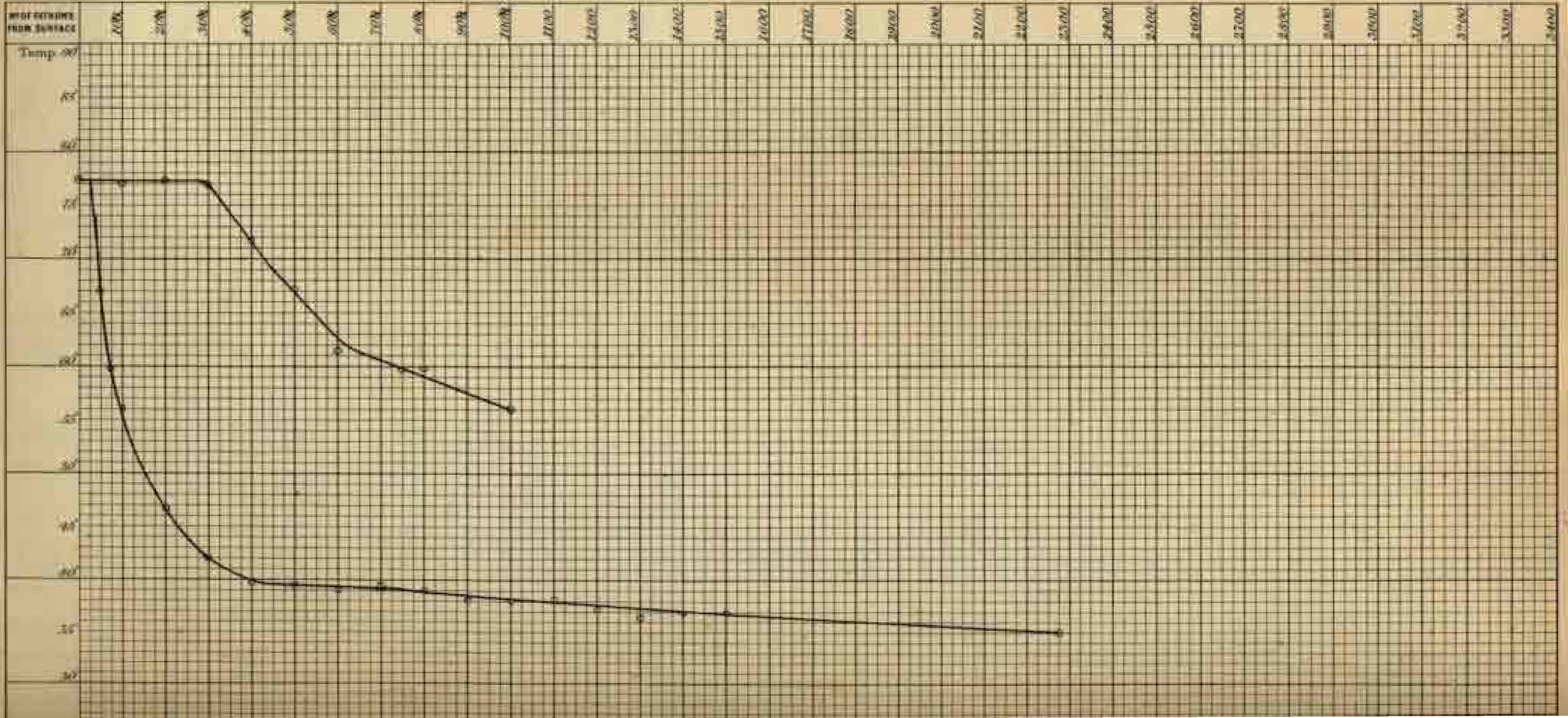
30 August 1873.

Nº of Sounding 185.
Station 110.

Depth 2275 fathoms.

Latitude 0° 9′ N.
Longitude 30° 18′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		92	74	49	78	61	70	89			70										70				113	69	66	63	69	91	67	70	69	113	66	91	65								78
TEMPERATURE SHEWN BY THERMOMETER	77.3	77.0	77.3	77.0	71.8	67.2	61.3	59.8			56.2										46.8				42.0	39.8	39.5	39.0	39.1	39.2	38.0	38.0	38.1	37.2	38.4	37.0	36.9								34.8
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	77.3	77.4	77.0	77.0	71.8	67.0	60.7	59.8			56.2										46.8				41.0	40.0	39.8	39.6	39.4	39.2	38.8	38.4	38.0	37.6	37.3	37.0	36.8								34.8



SECTION. ST. PAUL'S ROCKS TO FERNANDO NORONHA.

1 September 1873.

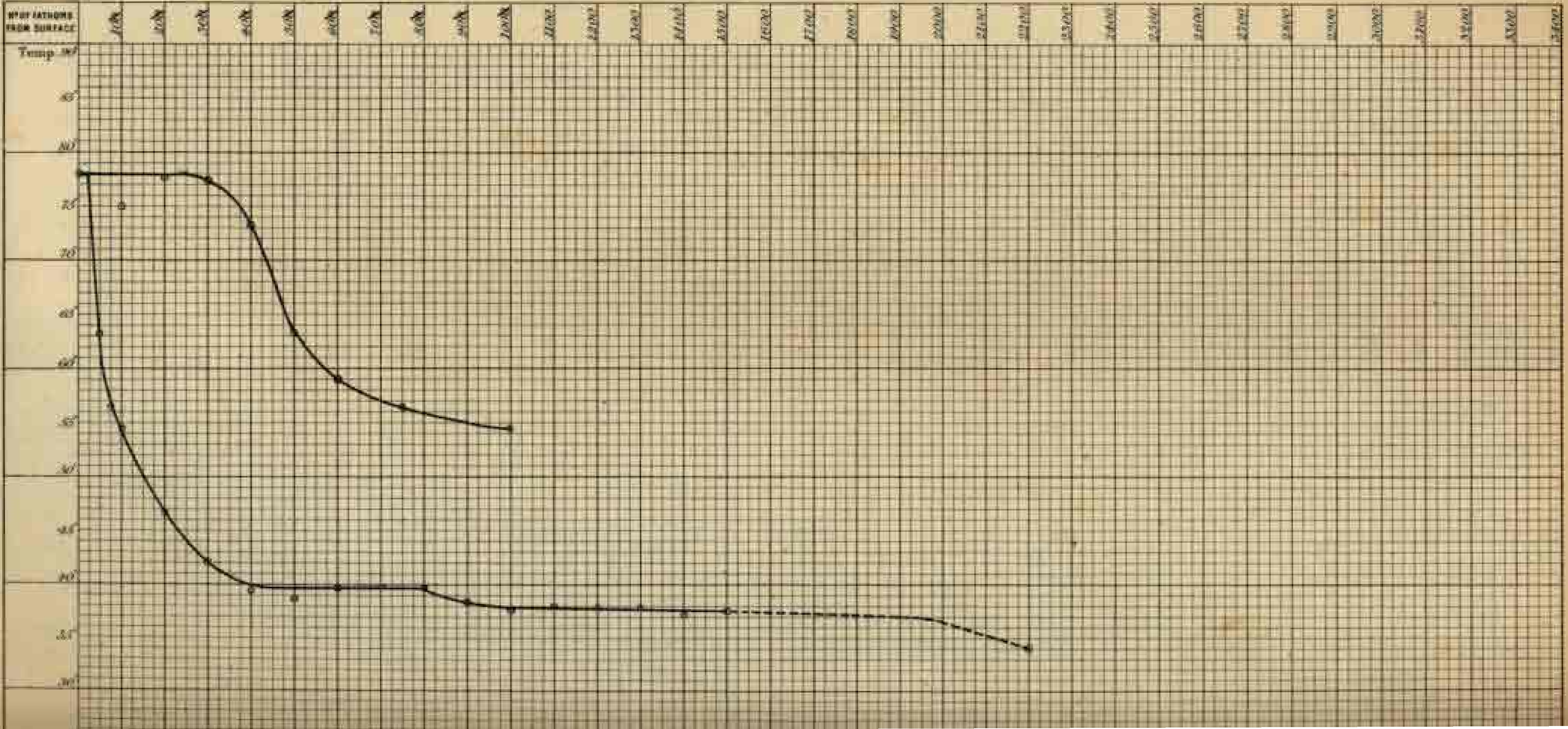
N.° of Sounding 187.
Station 112.

Depth 2200 fathoms.

Latitude 3° 33' S
Longitude 32° 16' W

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
N.° OF THERMOMETER		49	70	b 96	69	31	48	64			74										66			
TEMPERATURE SHEWN BY THERMOMETER	78.0	75.0	78.0	77.5	73.1	63.2	59.0	56.5			54.4										46.8			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	78.0	78.0	78.0	77.5	73.3	63.2	59.0	56.5			54.4										46.8			

N.° OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER	85	74	72	69	67	b 96	66	65	74	72	69	b 96	67								92 73
TEMPERATURE SHEWN BY THERMOMETER	42.0	39.5	38.8	39.6	39.8	40.0	38.6	37.9	38.0	37.8	37.8	37.4	37.3								34.0 BROKEN
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	42.0	40.0	39.7	39.7	39.7	39.7	38.6	38.1	37.9	37.8	37.7	37.6	37.5								34.0



SECTION. FERNANDO NORONHA TO ST. PAUL'S ROCKS.

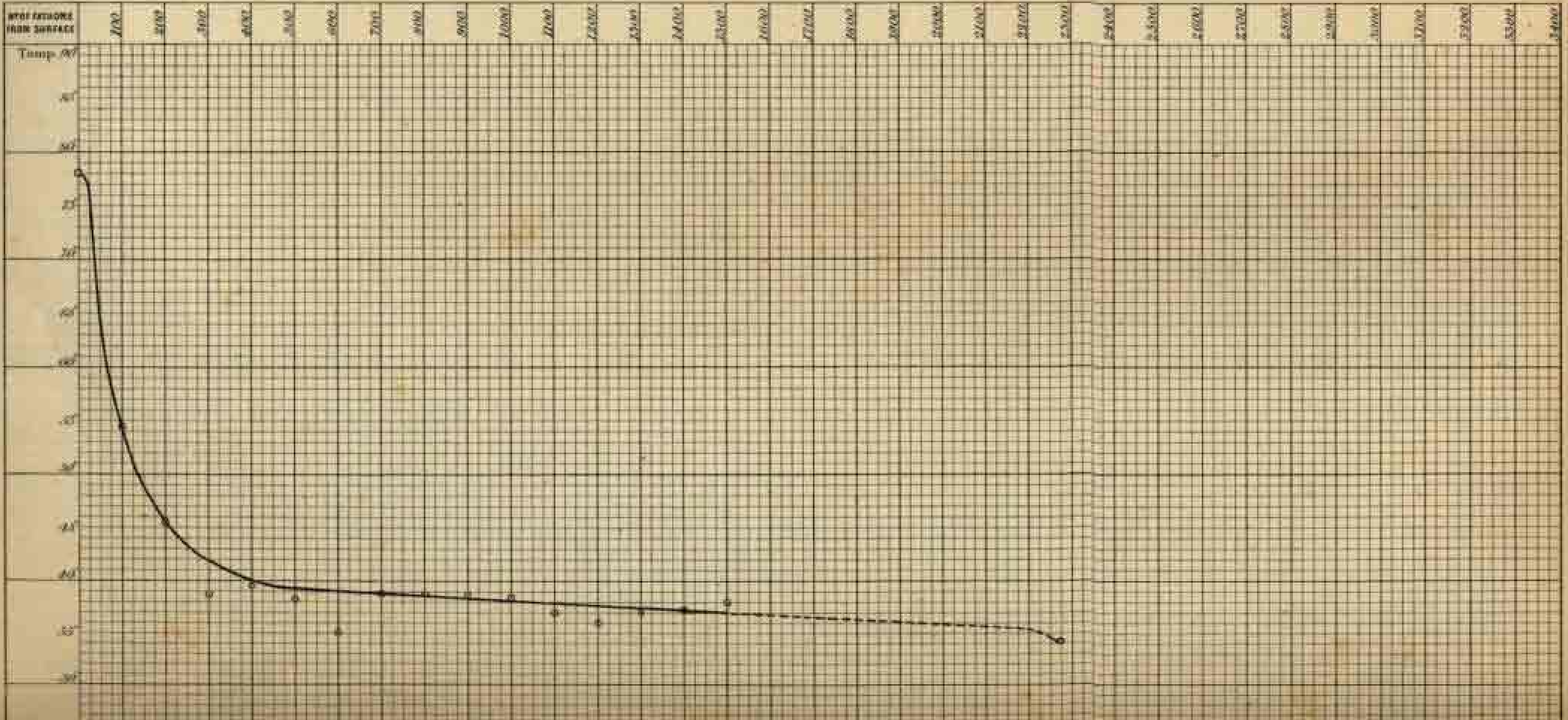
4 September 1873.

No. of Sounding 194.
Station 116.

Depth 2275 *fathoms.*

Latitude 5° 1' S.
Longitude 33° 50' W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer											65										69				70	67	43	74	B 96	66	41	67	43	74	70	B 96	66								69 91
Temperature shown by Thermometer	78.0										54.5										45.4				38.8	39.5	38.2	35.0	38.8	38.8	38.9	38.5	37.0	36.0	37.6	37.2	38.0								34.4 34.3
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	78.0										54.5										45.4				41.5	40.0	39.3	39.0	38.7	38.5	38.3	38.1	37.9	37.7	37.5	37.2	37.0								34.3



SECTION. FERNANDO NORONHA TO PERNAMBUCO.

8 September 1873.

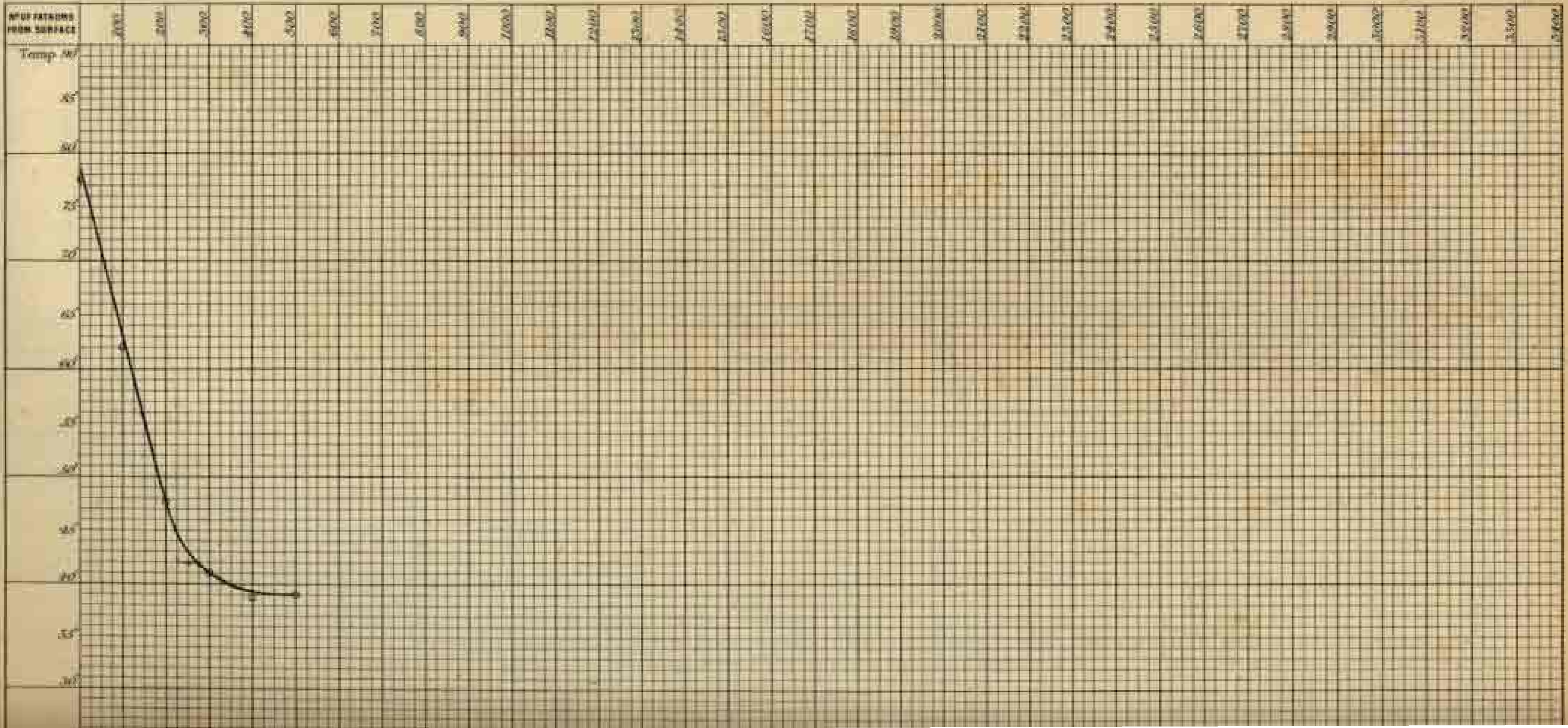
Nº of Sounding 198.
Station 119.

Depth 1650 fathoms.

Latitude 7° 39′ S.
Longitude 34° 12′ W.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of Thermometer											91									
Temperature shewn by Thermometer	77·1										62·0									
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	77·1										62·0									

Nº of Fathoms from Surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	66				69	79	67																		74
Temperature shewn by Thermometer	47·5				41·0	38·8	39·0																		37·2
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	47·5				41·0	39·3	39·0																		37·2



30 September 1873.

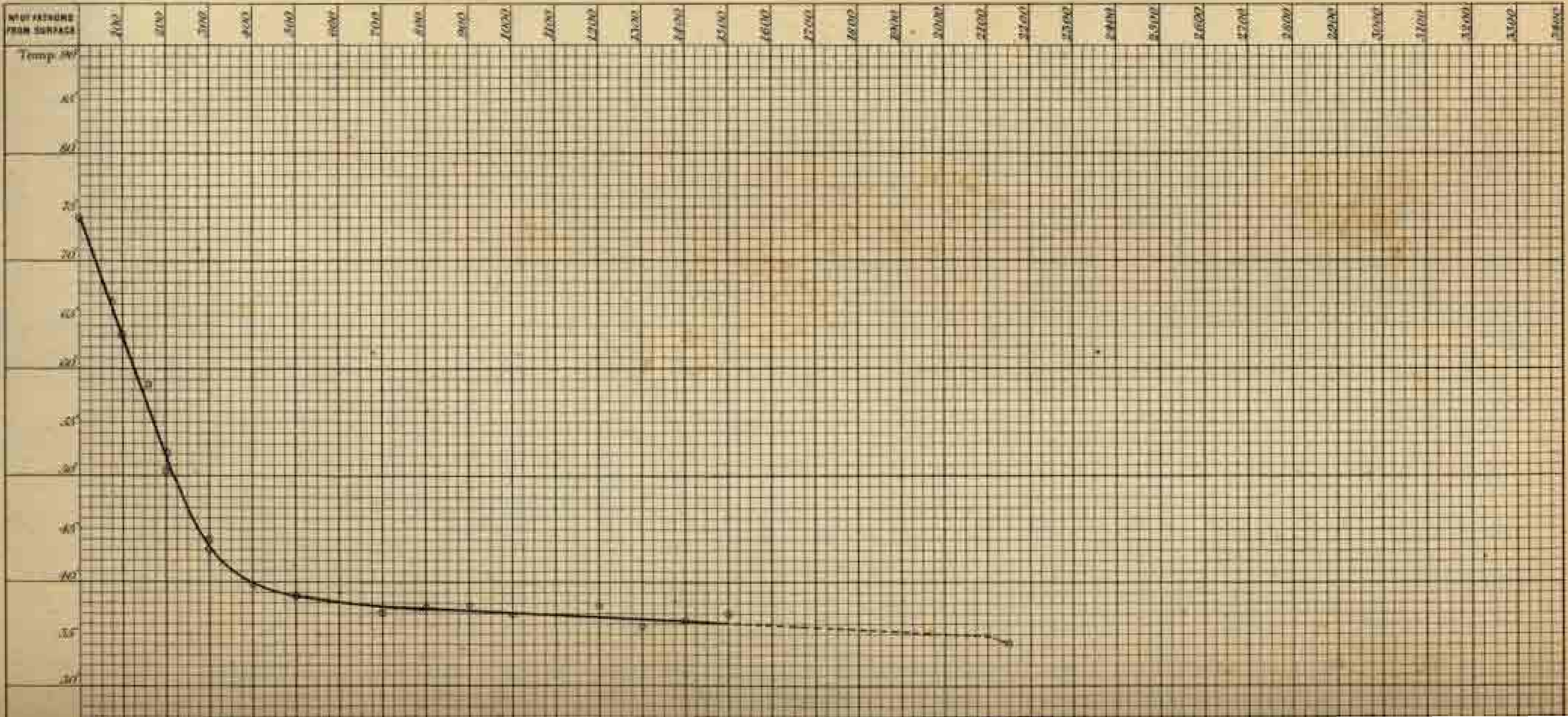
Nº of Sounding 212.
Station 129.

Depth 2150 *fathoms*

Latitude 20° 13′ S.
Longitude 35° 19′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	75	80	90	100	110	120	130	140	150	165	170	180	190	200	225	250	275
Nº of thermometer								65			69						67				70 66			
Temperature shewn by thermometer	74.0							66.0			63.2						58.5				52.0 50.5			
Error of thermometer																								
Corrected temperature																								
Temperature from curve	74.0							65.9			63.2										51.5			

Nº of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	8 96 70	69	66	74	4 3	67	70	8 98	91	68	74	[illegible]	67								69
Temperature shewn by thermometer	44.0 43.0	39.8	38.8		37.0	37.5	37.8	36.8		37.8	33.8	36.2	37.0								34.0
Error of thermometer																					
Corrected temperature																					
Temperature from curve	43.5	40.1	38.8	38.1	37.7	37.3	37.1	36.9	36.7	36.5	36.3	36.1	36.0								34.0



SECTION. ABROLHOS ISLAND TO TRISTAN D'ACUHNA.

3 October 1873.

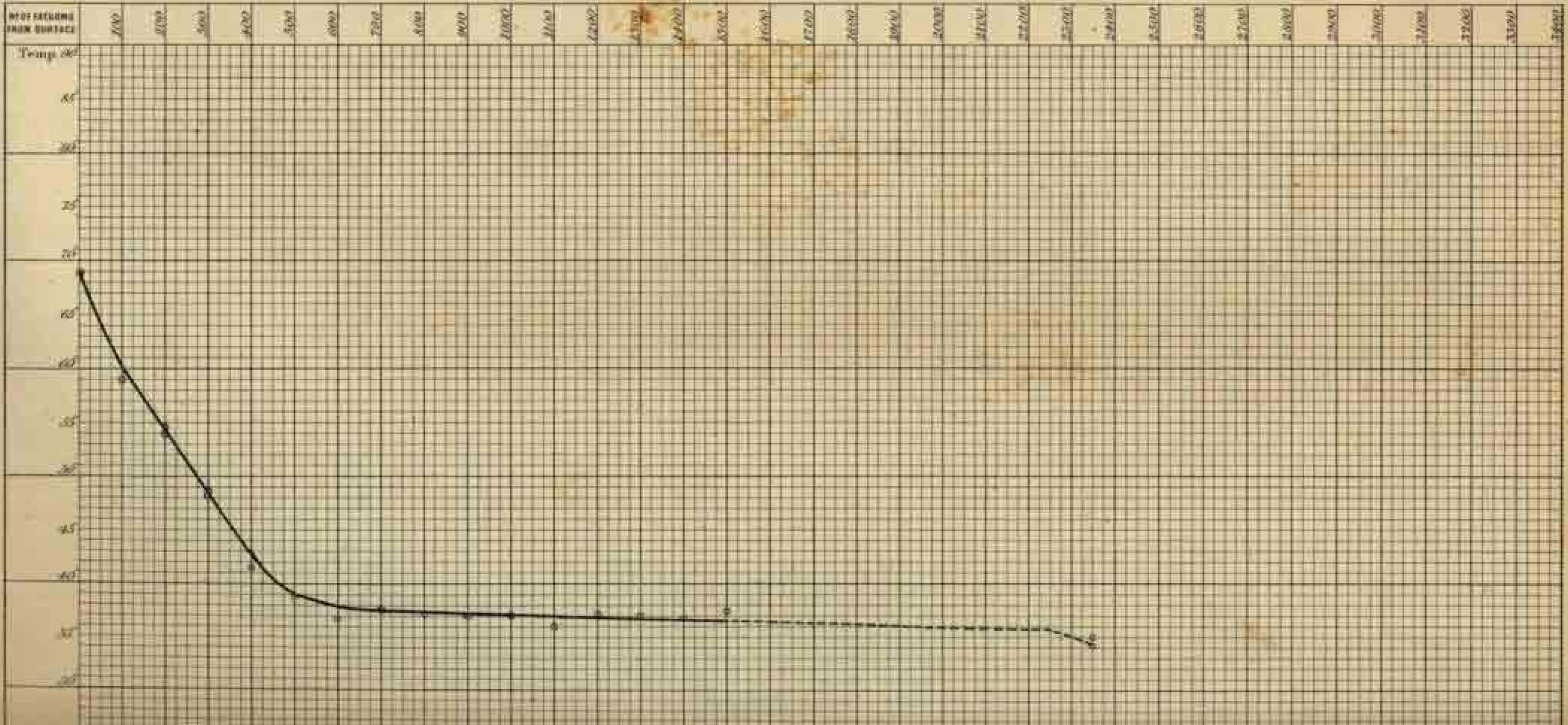
Nº of Sounding 213.
" " Station 130.

Depth 2350 fathoms.

Latitude 26° 15' S.
Longitude 32° 56' W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº of thermometer											56										49 65			
Temperature shewn by thermometer	69.0										59.0										54.0 54.3			
Error of thermometer																								
Corrected temperature																								
Temperature from curve	69.0										60.5										54.3			

Nº of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	49 A 3	67	70	B 96	69	83	70	60	91	B 96	65	A 3	66								66 69
Temperature shewn by thermometer	48.3 48.0	41.3	38.9	36.7	37.3	37.1	37.0	37.2	36.0	37.2	37.0	36.8	37.0								35.9 34.4
Error of thermometer																					
Corrected temperature																					
Temperature from curve	48.3	42.8	39.0	38.0	37.3	37.2	37.1	37.0	36.9	36.8	36.7	36.6	36.5								34.7



6 October 1873.

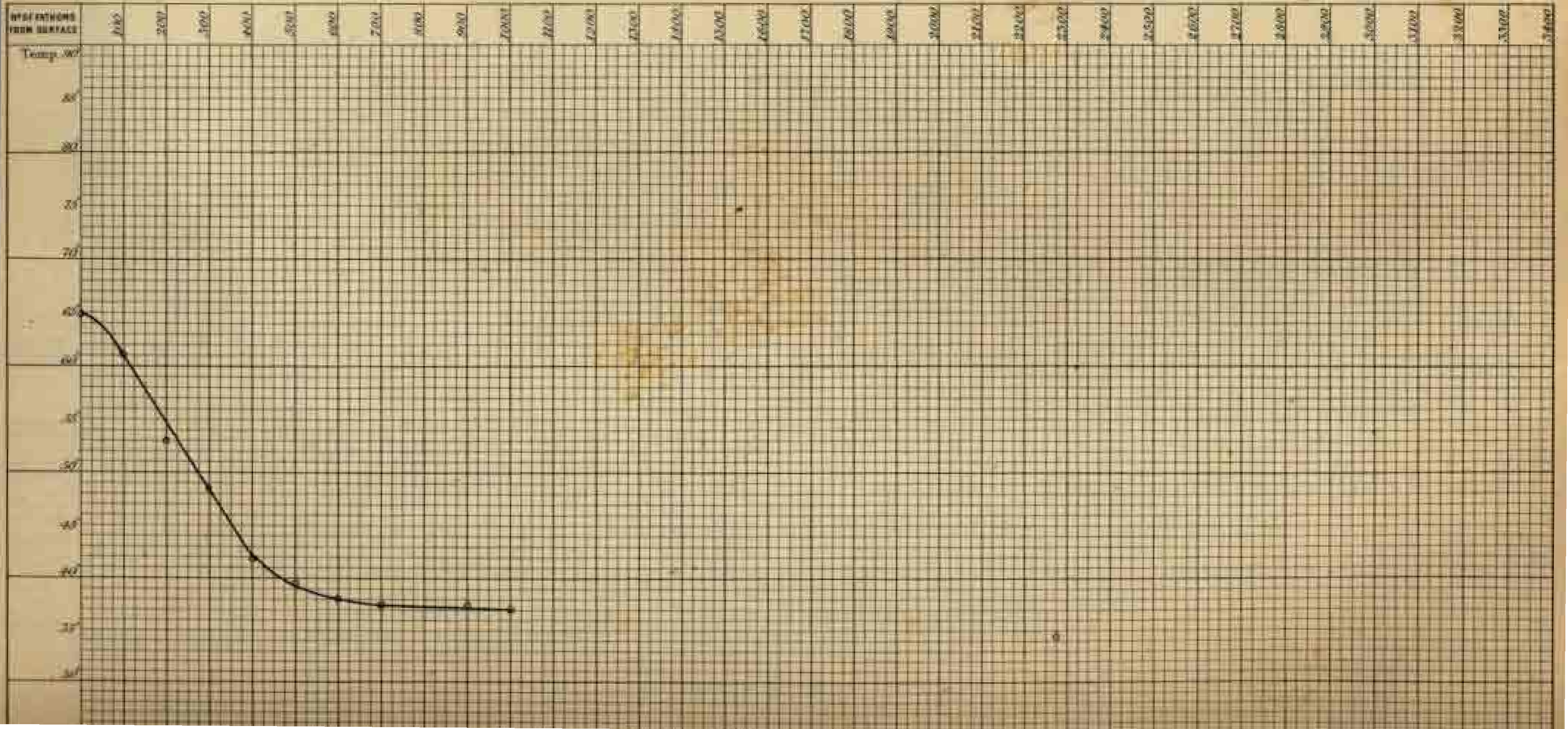
Nº of Sounding 214.
Station 131.

Depth 2275 fathoms.

Latitude 29° 35′ S.
Longitude 28° 9′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of thermometer											43									
Temperature shewn by thermometer	65.0										61.0									
Error of thermometer																				
Corrected temperature																				
Temperature from curve	65.0										61.0									

Nº of fathoms from surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	A 96				69	70	74	67	69		67	72													66 69
Temperature shewn by thermometer	53.0				48.6	42.0	39.4	38.0	37.5		37.3	37.0													34.8 34.4
Error of thermometer																									
Corrected temperature																									
Temperature from curve	54.7				48.5	41.3	39.2	37.9	37.5	37.3	37.1	37.0													34.6



SECTION. ABROLHOS ISLAND TO TRISTAN DA CUNHA.

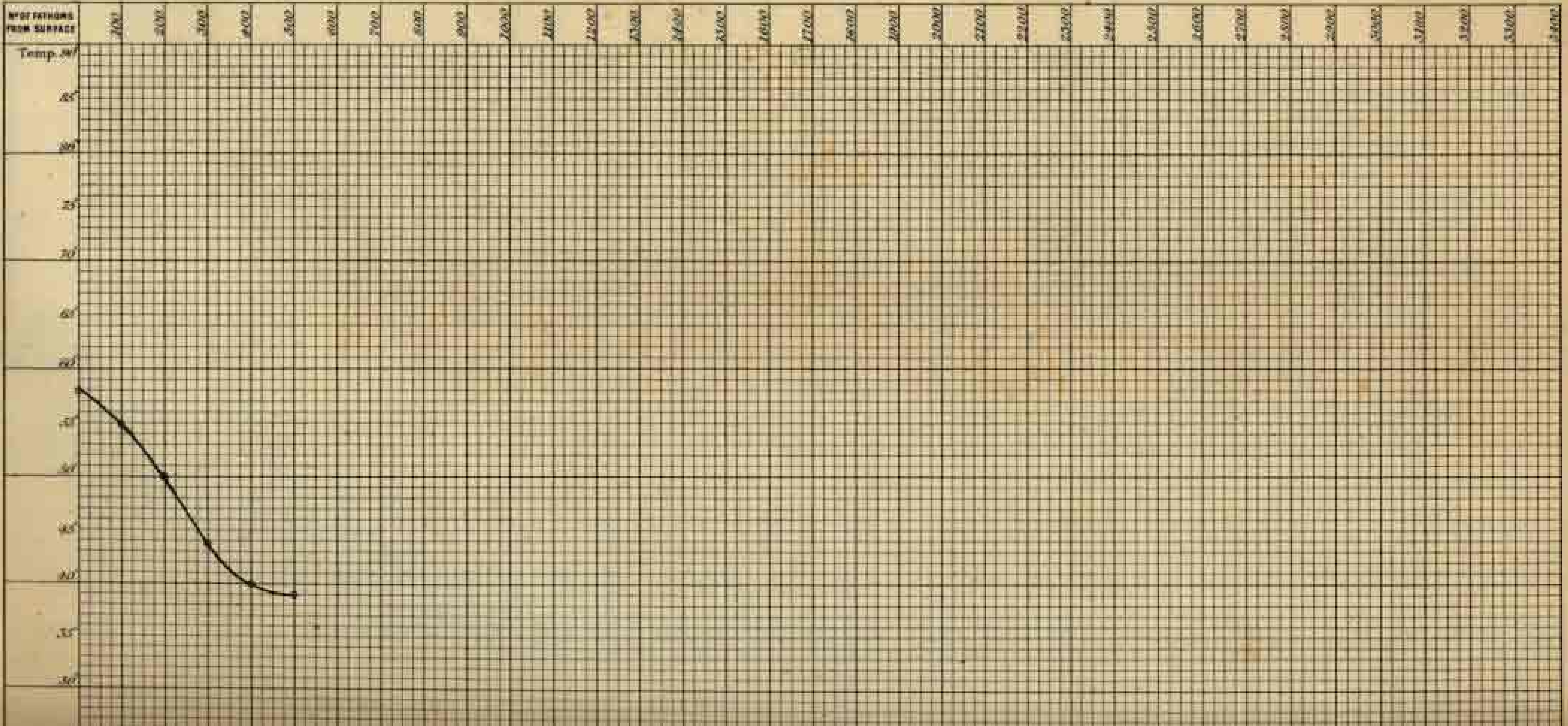
10 October 1873.

N° of Sounding 215.
Station 132.

Depth 2050 *fathoms*

Latitude 35° 25' S.
Longitude 23° 40' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											91										65				67	66	69																		68 69
TEMPERATURE SHOWN BY THERMOMETER	58.0										55.2										50.0				43.8	40.0	38.8																		35.0 35.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	58.0										55.2										50.0				43.8	40.0	38.8																		35.0



11 October 1873.

No. of Sounding 216.
Station 133.

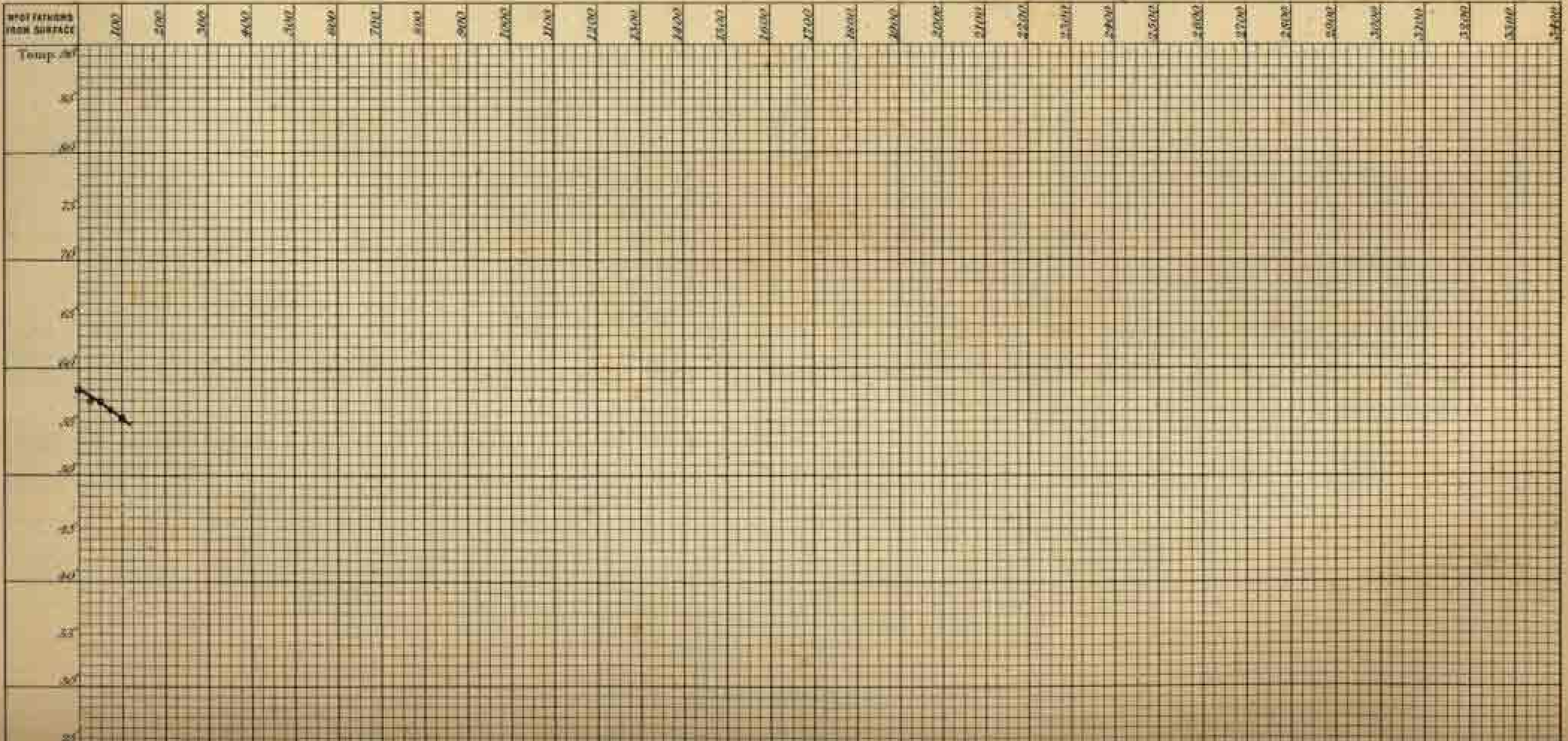
Depth 1900 fathoms.

Latitude 35° 41′ S.
Longitude 20° 55′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150
No. of Thermometer			43			74		48			70					
Temperature shewn by Thermometer	58.0		57.0			57.0		56.2			55.5					
Error of Thermometer																
Corrected Temperature																
Temperature from Curve	58.0		57.3			56.9		56.2			55.5					

No. of Fathoms from Surface	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000
No. of Thermometer																
Temperature shewn by Thermometer																
Error of Thermometer																
Corrected Temperature																
Temperature from Curve																

No. of Fathoms from Surface	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer													66
Temperature shewn by Thermometer													35.4
Error of Thermometer													
Corrected Temperature													
Temperature from Curve													35.4



SECTION. ABROLHOS ISLAND TO TRISTAN DA CUNHA.

14 October 1873.

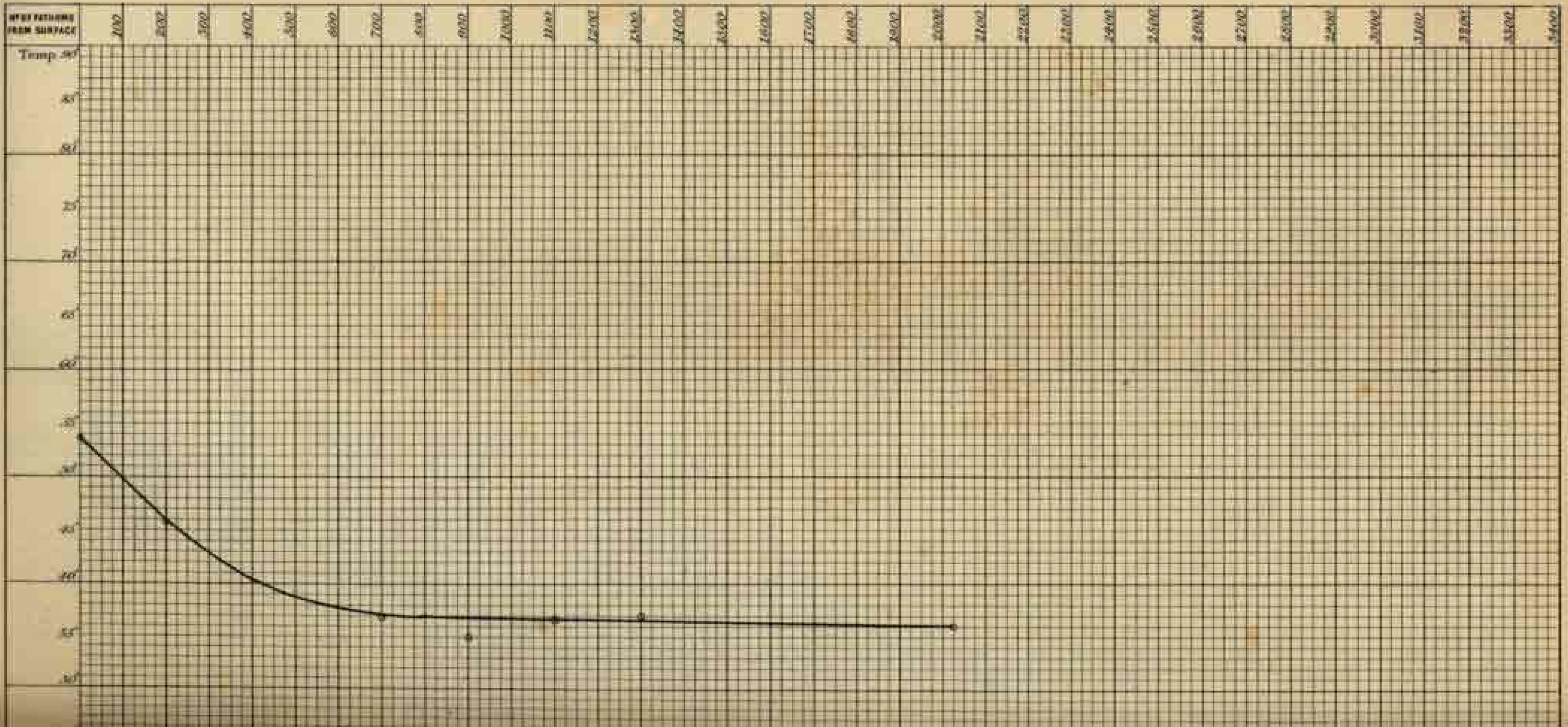
Nº of Sounding 217.
" Station 134.

Depth 2025 fathoms.

Latitude 36° 12′ S.
Longitude 12° 16′ W.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of Thermometer																				
Temperature shewn by Thermometer	53.5																			
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	53.5																			

Nº of Fathoms from Surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	70								70		74		67		69										66
Temperature shewn by Thermometer	46.0								37.0		35.0		36.8		37.0										36.0
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	46.0								37.0		37.0		36.8		36.6										36.0



18 October 1873.

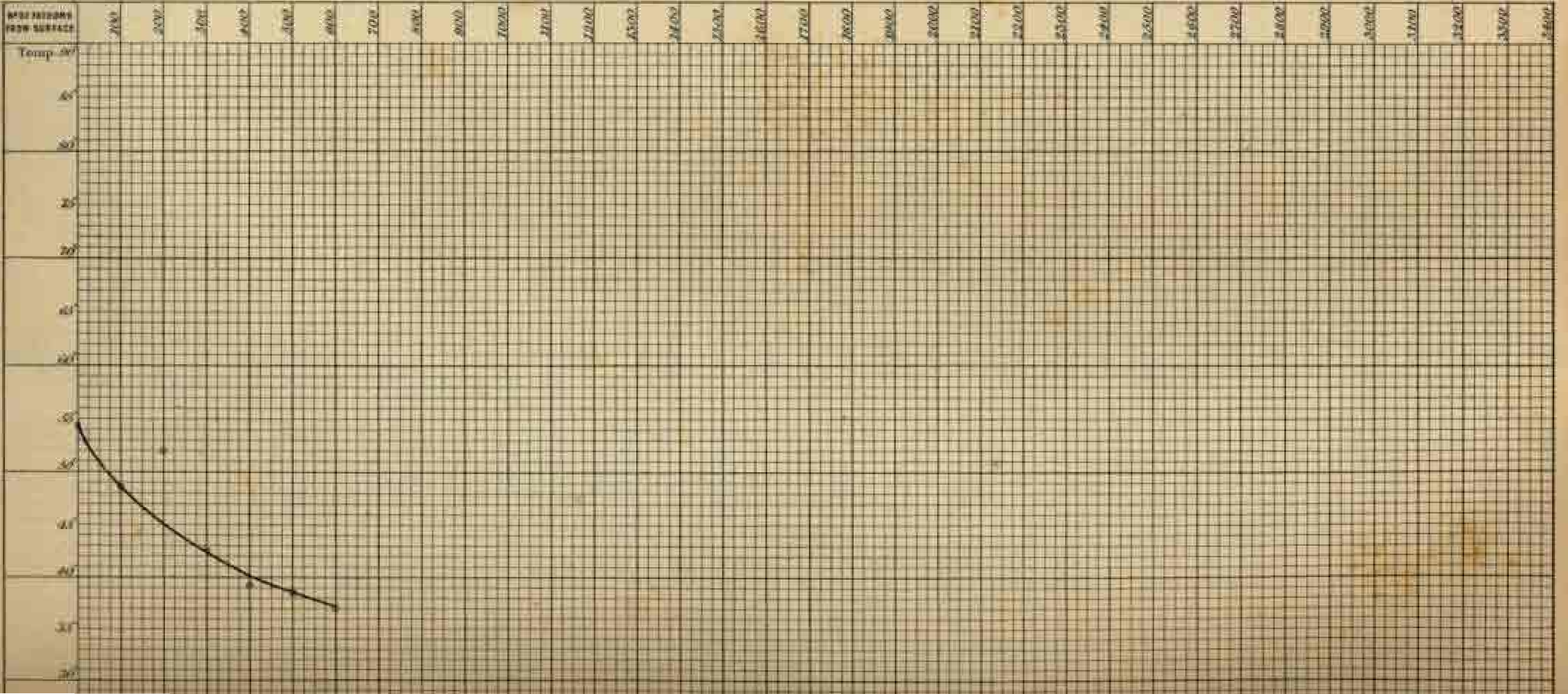
No. of Sounding 223.
Station 135. e.

Depth 1000 fathoms.

Latitude 37° 21′ 0″ S.
Longitude 12° 22′ 30″ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. OF THERMOMETER											74									
TEMPERATURE SHEWN BY THERMOMETER	53.5										48.5									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	53.5										48.5									

No. OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	83				66	69	67	70																	
TEMPERATURE SHEWN BY THERMOMETER	45.0				41.5	39.7	38.3	37.0																	
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	45.1				41.3	40.0	38.3	37.8																	



SECTION. TRISTAN DA CUNHA TO CAPE OF GOOD HOPE.

20 October 1873.

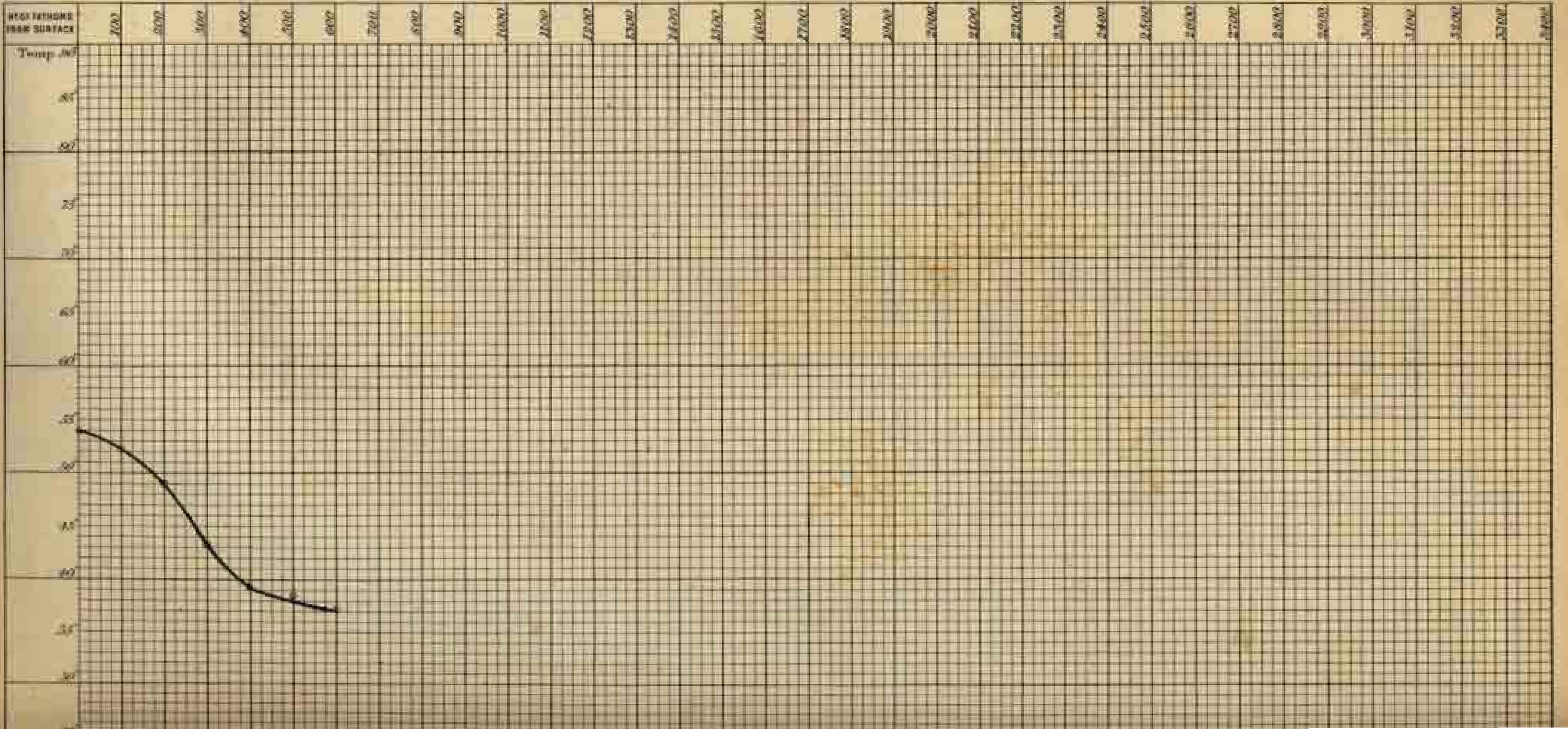
N° of Sounding 226.
Station 136.

Depth 2100 fathoms.

Latitude 36° 43' N.
Longitude 7° 13' W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of thermometer											A 96									
Temperature shewn by thermometer	54.0										52.2									
Error of thermometer																				
Corrected temperature																				
Temperature from curve	54.0										52.2									

Nº of fathoms from surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	91				69	49	67	70																	60 66
Temperature shewn by thermometer	49.2				43.4	39.5	38.5	37.9																	35.0 35.4
Error of thermometer																									
Corrected temperature																									
Temperature from curve	49.2				43.2	39.5	38.0	37.2																	35.2



SECTION. TRISTAN DA CUNHA TO CAPE OF GOOD HOPE.

23 October 1873.

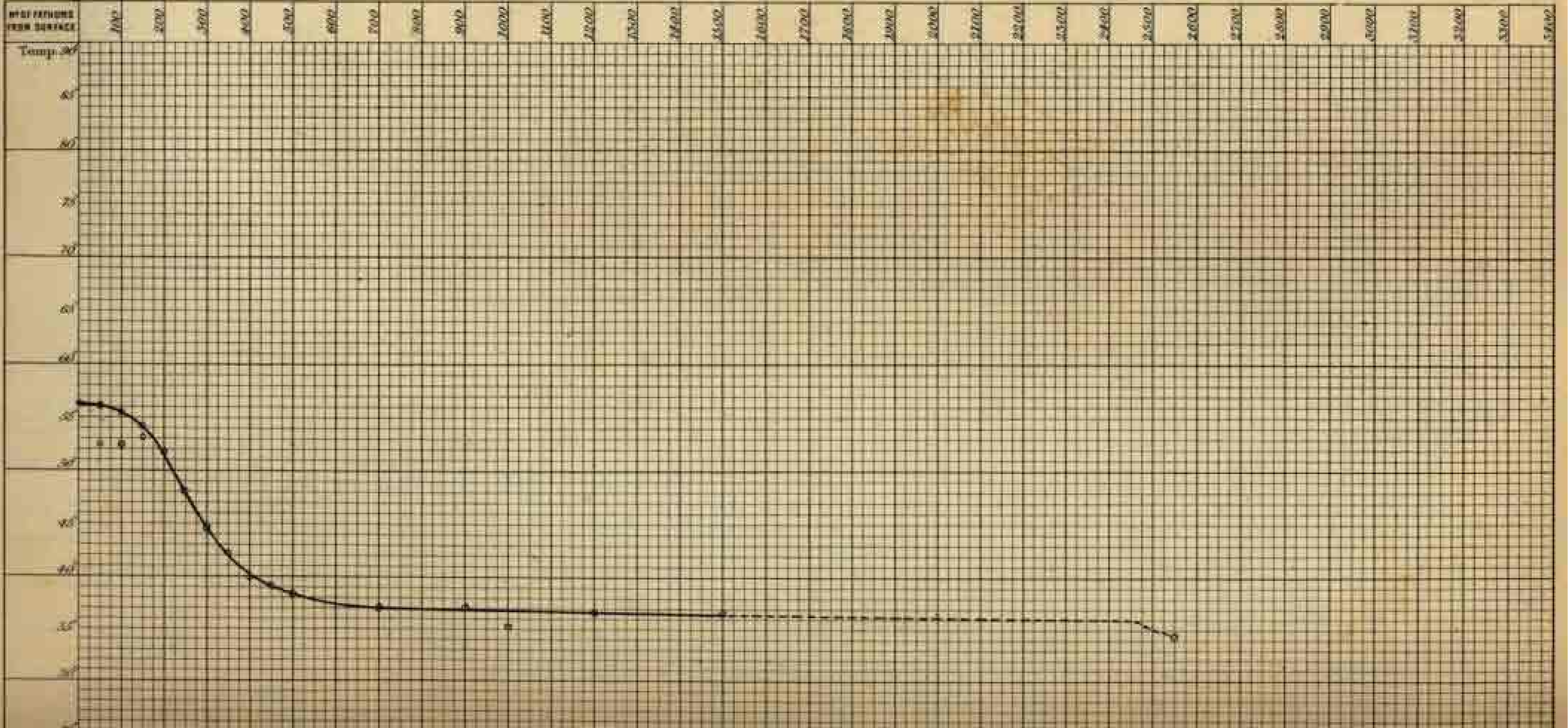
Nº of Sounding 227.
Station 137.

Depth 2550 *fathoms*

Latitude 35° 59′ S.
Longitude 1° 34′ E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº of thermometer	A 56					49 67					65 #3					A 56 70				
Temperature shewn by thermometer	56.1					56.0 52.6					55.6 54.3					54.3 53.9				
Error of thermometer																				
Corrected temperature																				
Temperature from curve	56.1					56.0					55.6					54.3				

Nº of fathoms from surface	200	225	250	300	350	400	450	500	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	49		91	49	#3	65	67	70	72		91		74		69		66								68 69
Temperature shewn by thermometer	51.9		47.8	44.3	42.3	40.0	39.4	38.8	37.0		37.0		35.9		35.6		36.0								34.5 34.6
Error of thermometer																									
Corrected temperature																									
Temperature from curve	51.8		47.9	44.6	42.3	40.4	39.4	38.7	37.0		36.8		36.6		36.5		36.4								34.5



SECTION. TRISTAN DA CUNHA TO CAPE OF GOOD HOPE.

25 October 1873.

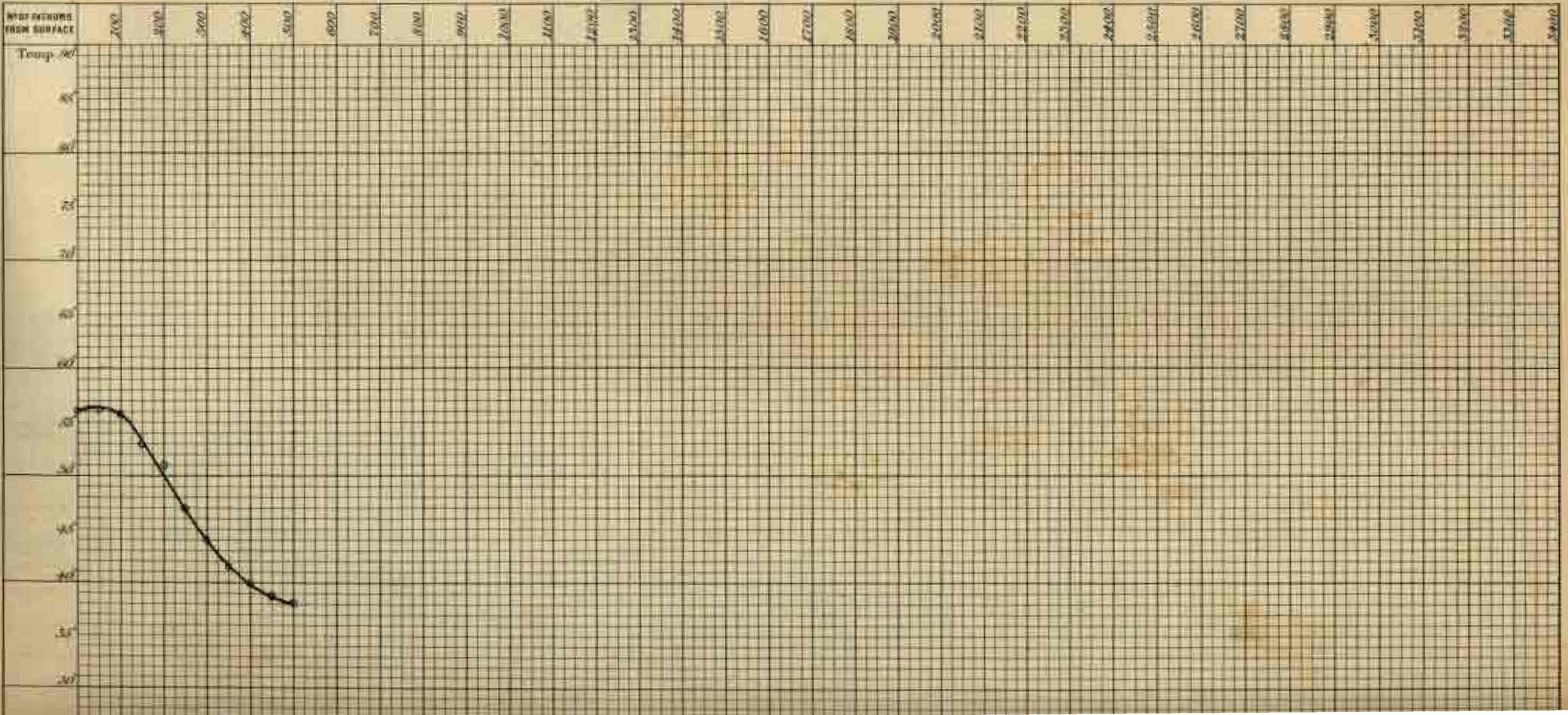
Nº of Sounding 228.
Station 138.

Depth 2650 fathoms.

Latitude 36° 22′ S.
Longitude 8° 12′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER	74					92					49					A 96				
TEMPERATURE SHEWN BY THERMOMETER	56.2					56.1					55.2					53.4				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	56.2					56.1					55.0					53.3				

Nº OF FATHOMS FROM SURFACE	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	65	91	A 96	63	67	69	66																		60 69
TEMPERATURE SHEWN BY THERMOMETER	50.8	48.9	44.2	41.5	40.0	39.0	38.3																		35.0 35.3
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	50.5	47.0	44.0	41.3	39.9	38.9	38.3																		35.1



27 October 1873.

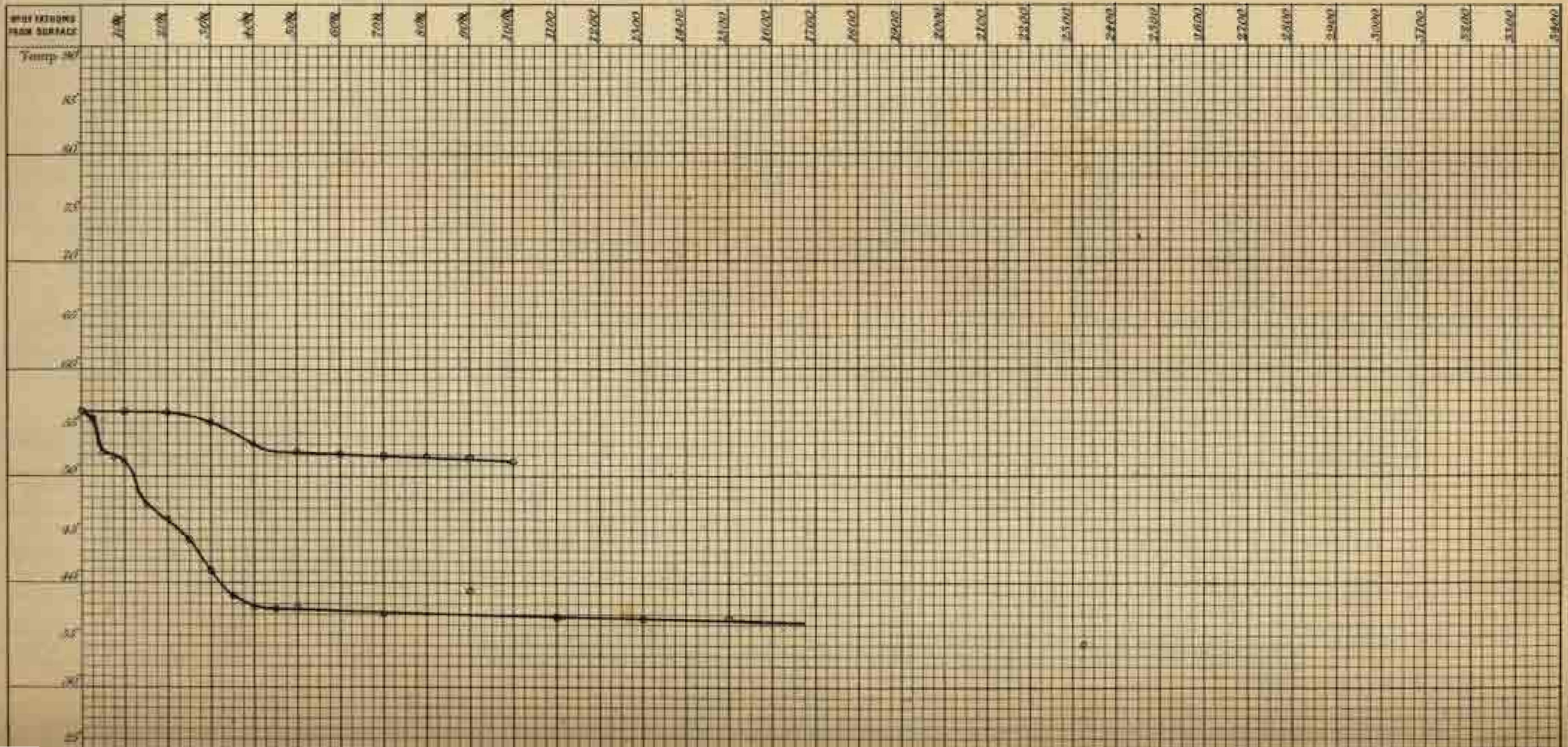
Nº of Sounding 229.
 " Station 139.

Depth 2325 fathoms.

Latitude 35° 35′ S.
Longitude 16° 9′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER		70	74	91	66	92	74	65	66	70	67 72					74				
TEMPERATURE SHEWN BY THERMOMETERS	56.2	56.1	56.0	55.0	52.9	52.3	52.1	52.0	52.0	51.8	51.7 51.4					47.3				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	56.2	56.1	56.0	55.0	52.9	52.3	52.1	52.0	51.8	51.6	51.5					47.3				

Nº OF FATHOMS FROM SURFACE	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	74	67	b 96	b 96	74	67	85		67		b 96		70		69		66								66 69
TEMPERATURE SHEWN BY THERMOMETERS	46.0	44.0	41.0	38.7	37.8	37.6	37.7		37.1		37.0		36.8		36.6		36.3								34.1 34.1
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	45.8	44.0	41.0	39.0	38.0	37.6	37.3		37.2		37.0		36.8		36.6		36.4								34.1



SECTION. TRISTAN DA CUNHA TO CAPE OF GOOD HOPE.

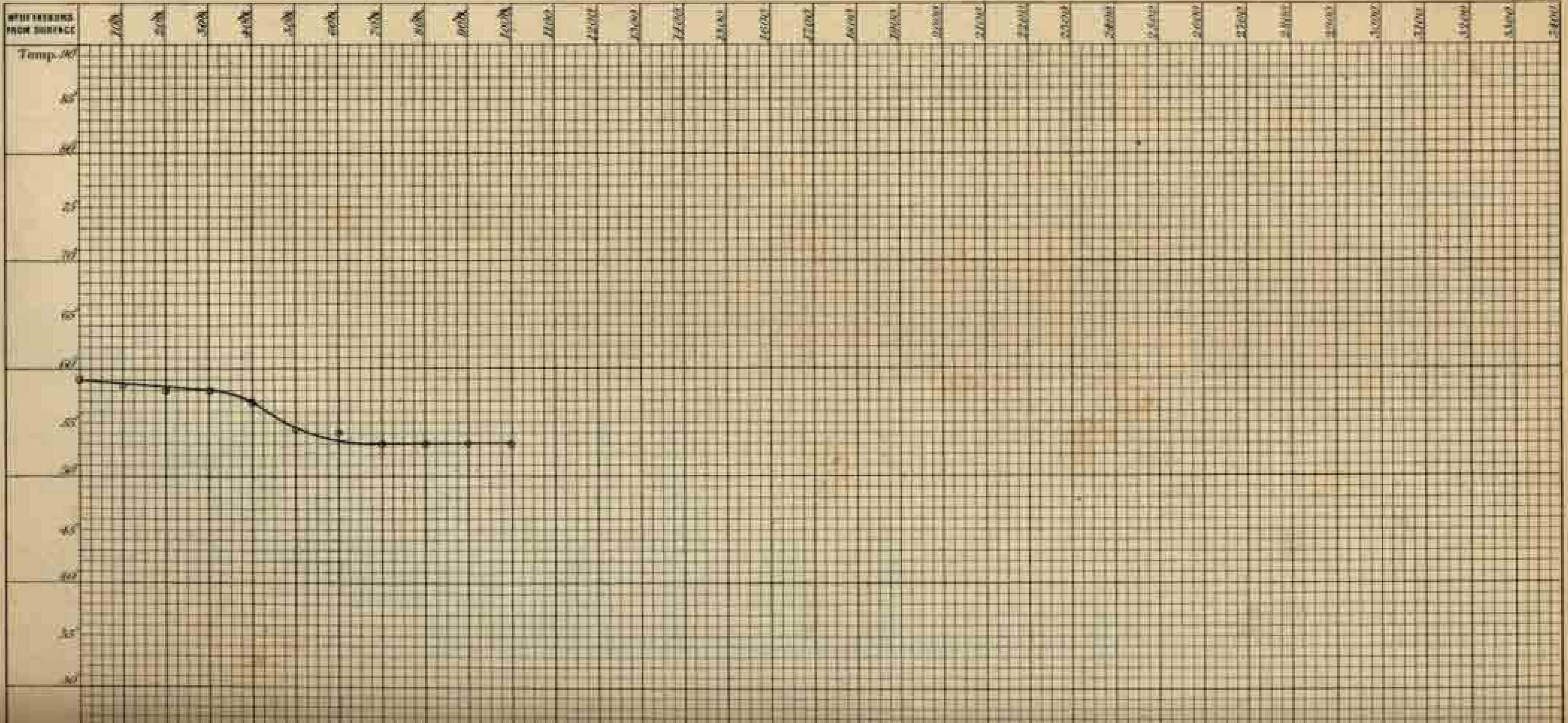
28 October 1873.

Nº of Sounding 330.
Station 140.

Depth 1250 fathoms

Latitude 35° 0′ S.
Longitude 17° 57′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		67	70	69	74	68	67	70	69	74	66																																		
TEMPERATURE SHEWN BY THERMOMETER	59.0	58.3	58.0	58.0	56.8	54.5	54.0	52.9	52.9	53.0	53.0																																		
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	59.0	58.7	58.4	58.1	56.9	54.6	53.5	53.0	53.0	53.0	53.0																																		



17 December 1873.

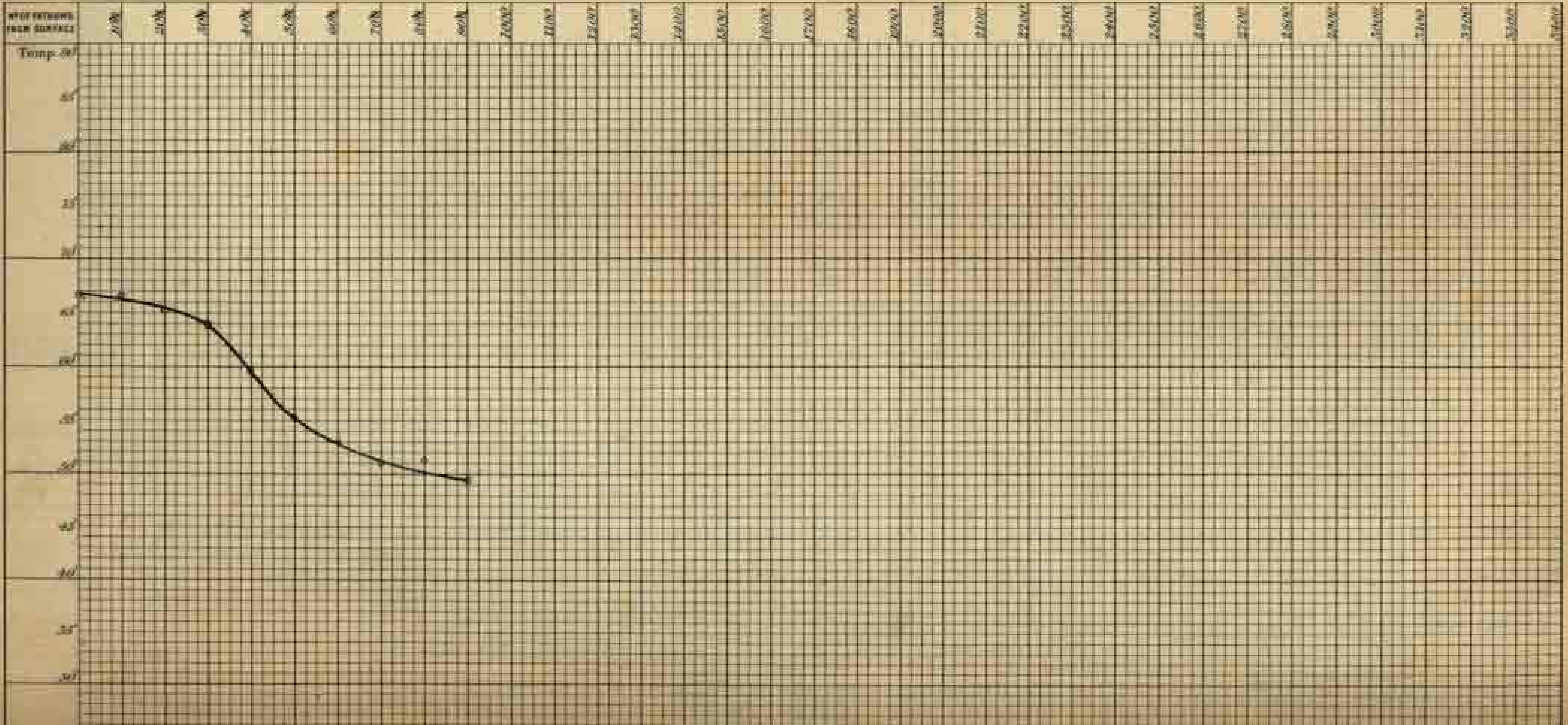
No. of Sounding 231.
Station 141.

Depth 98 fathoms.

Latitude 34° 41′ S.
Longitude 18° 36′ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300
No. of Thermometer		74	94	72	67	84	49	69	94	74															
Temperature shewn by Thermometer	65.5	65.3	63.2	64.0	59.8	54.8	52.8	51.2	51.0	49.5															
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	65.5	66.2	65.3	63.2	59.8	54.9	52.8	51.4	50.5	49.8															

No. of Fathoms from Surface	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer																				
Temperature shewn by Thermometer																				
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve																				



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

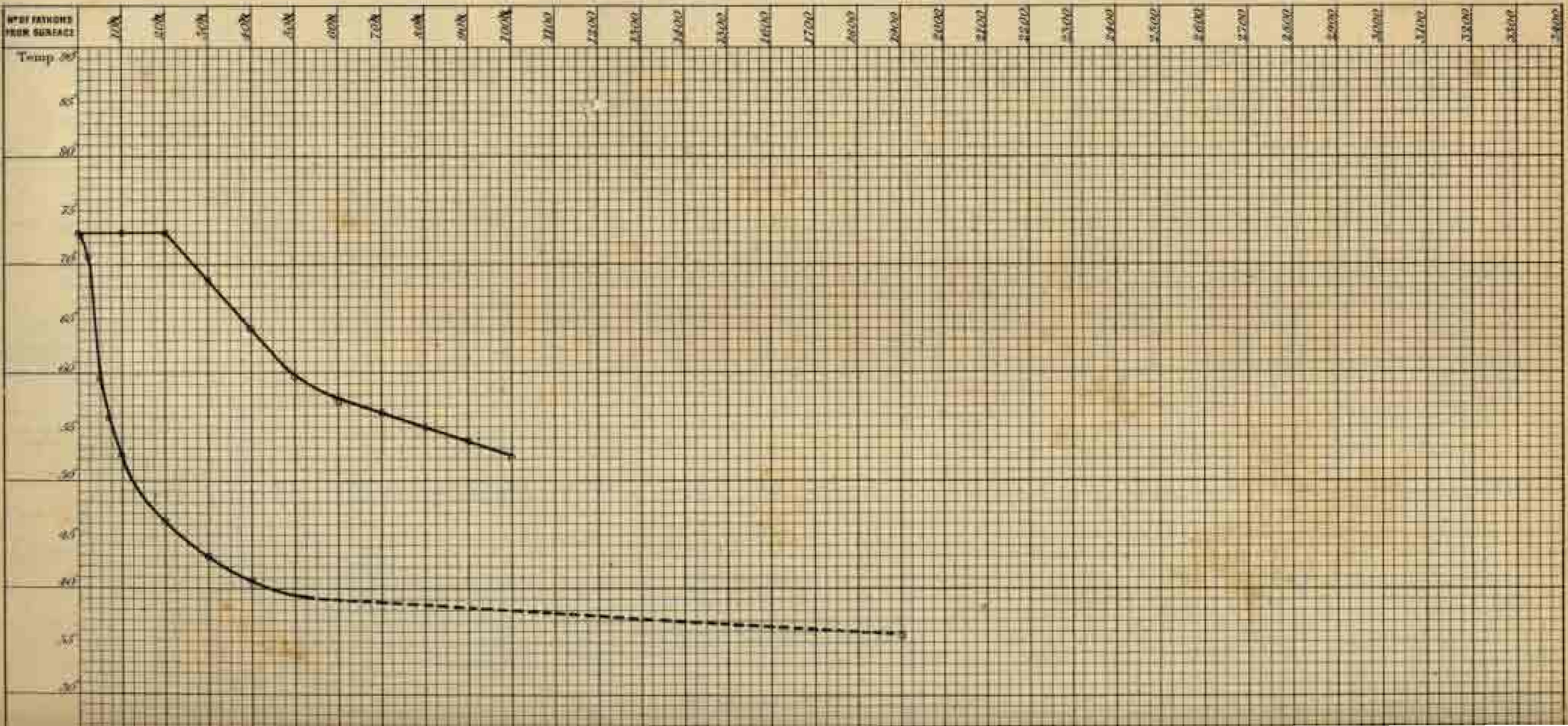
No of Sounding 223.
" Station 143.

19 December 1873.
Depth 1900 fathoms.

Latitude 36° 48′ S.
Longitude 19° 24′ E.

No OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No OF THERMOMETER		68	66	94	84	70	72	84	94	66	66									
TEMPERATURE SHEWN BY THERMOMETER	73.0	73.0	73.0	68.5	64.0	59.5	57.0	56.5	55.4	53.8	52.2									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	73.0	73.0	73.0	68.5	64.0	59.5	57.7	56.5	55.0	53.8	52.5									

No OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No OF THERMOMETER	69				84	94																			60 69
TEMPERATURE SHEWN BY THERMOMETER	46.2				43.0	40.8																			33.7 33.5
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	46.2				43.0	40.8																			33.6



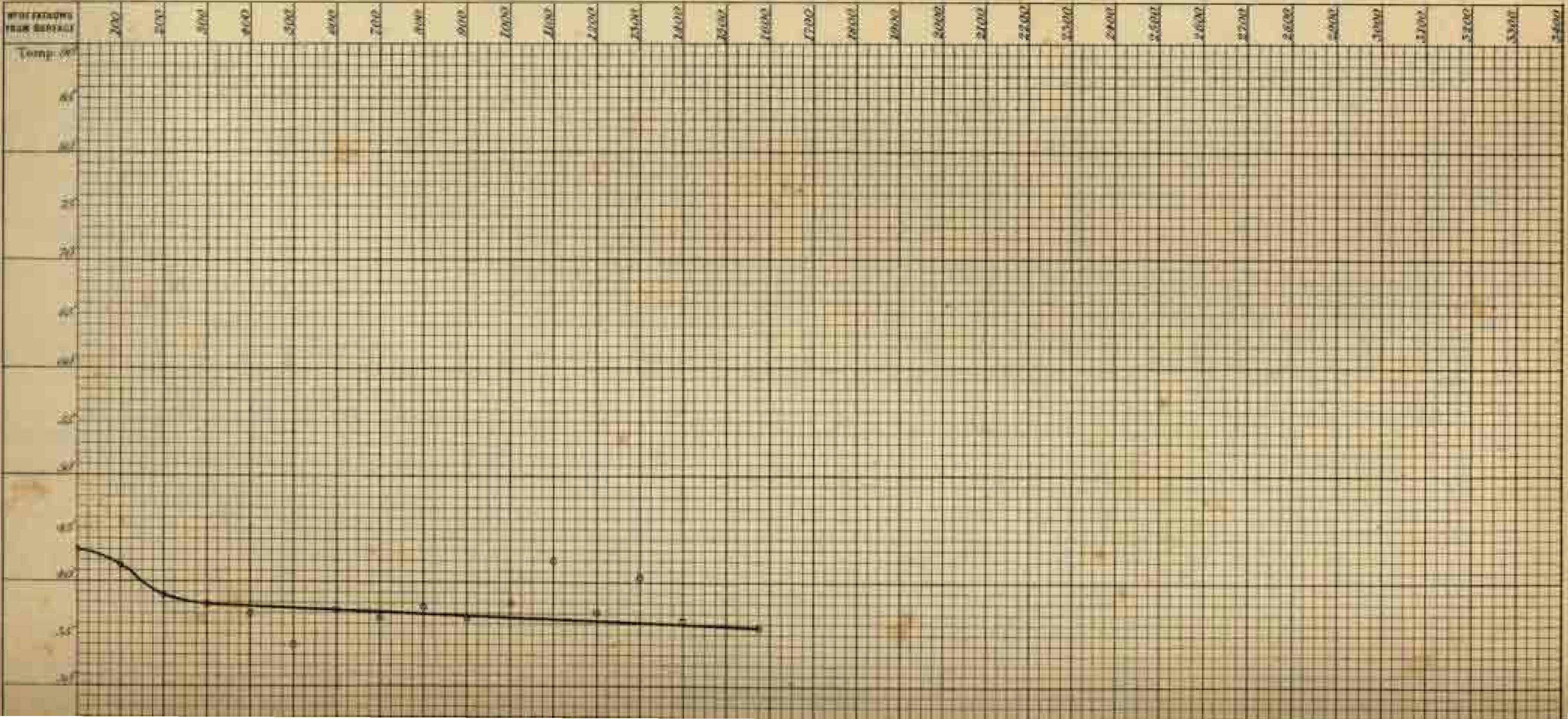
24 December 1873.

Nº of Sounding 234.
Station 144.

Depth 1570 fathoms.

Latitude 45° 57′ S.
Longitude 34° 39′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											49										70				79	67	68	69	94	84	94	65	66	84	68	79									66 69
TEMPERATURE SHOWN BY THERMOMETER	43.0										41.6										38.5				38.0	36.9	34.0	37.3	36.7	37.7	36.8	36.0	41.0	37.0	40.5	36.3									36.1 35.5
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	43.0										41.6										38.5				38.0	37.8	37.6	37.4	37.2	37.0	36.9	36.8	36.6	36.4	36.2	36.1									35.8



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

29 December 1873.

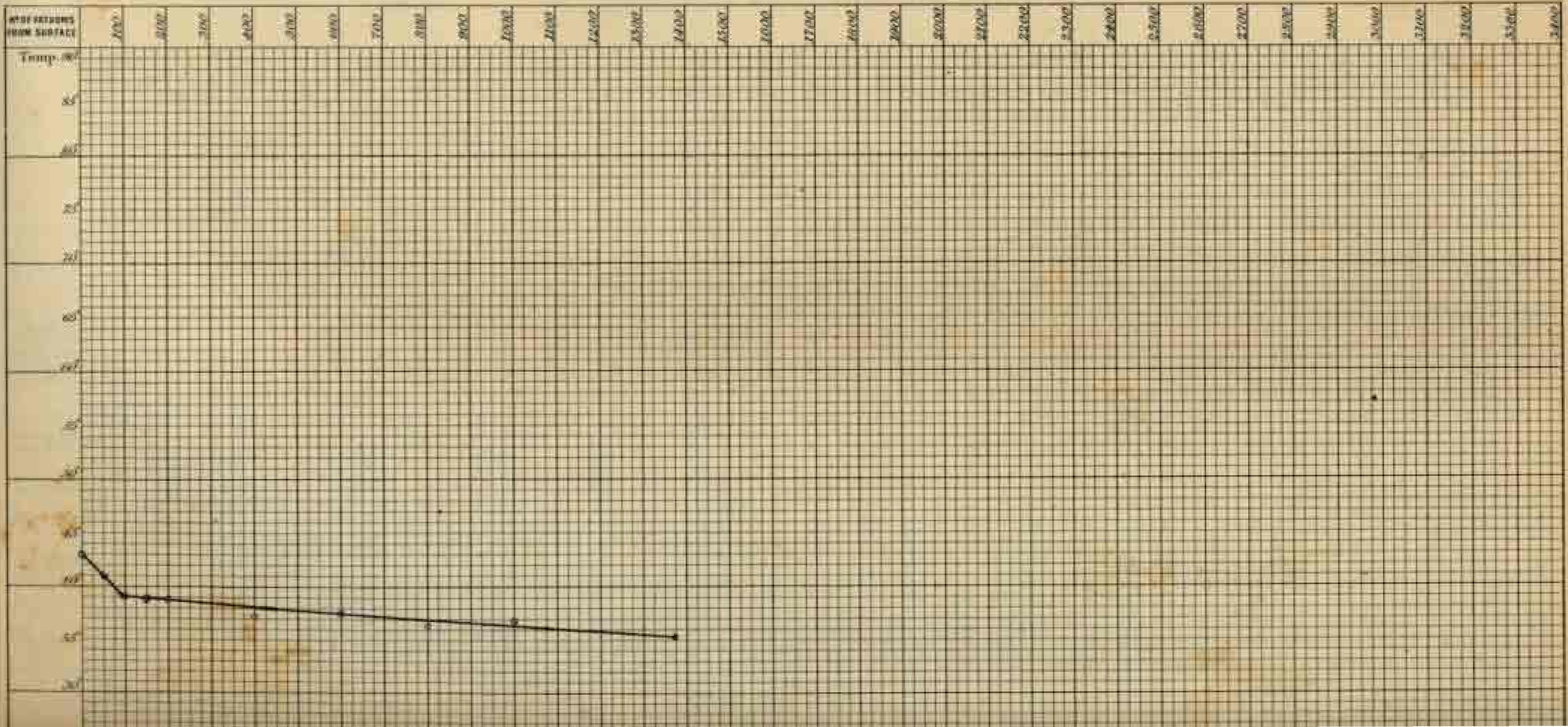
No. of Sounding 238.
Station 146.

Depth 1375 fathoms.

Latitude 46° 48′ S.
Longitude 45° 31′ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300
No. of Thermometer						66					84					67					87				
Temperature shewn by Thermometer	43.0					41.1					39.2					39.0					38.3				
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	43.0					41.1					39.2					39.0					38.8				

No. of Fathoms from Surface	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	94		69		67		69													69 67
Temperature shewn by Thermometer	37.2		37.8		36.4		37.0													35.8 35.5
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	38.2		37.8		37.4		36.6													35.6



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

30 December 1873.

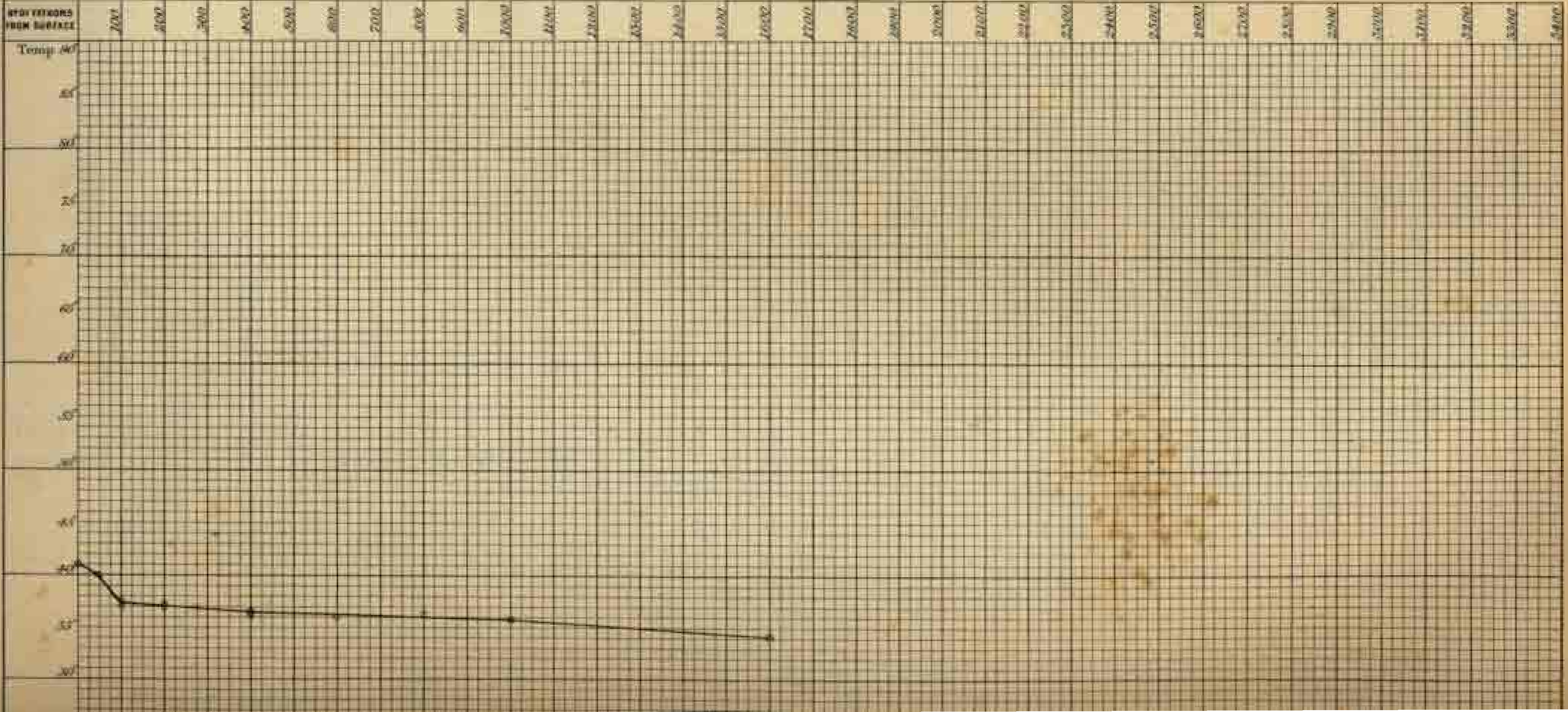
Nº of Sounding 239.
Station 147.

Depth 1600 fathoms

Latitude 46° 16′ S.
Longitude 48° 27′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
Nº OF THERMOMETER						94					70 68										67 79	
TEMPERATURE SHEWN BY THERMOMETER	41.0					40.0					37.0 37.4										37.2 37.0	
ERROR OF THERMOMETER																						
CORRECTED TEMPERATURE																						
TEMPERATURE FROM CURVE	41.0					40.0					37.4										37.1	

Nº OF FATHOMS FROM SURFACE	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER				78 67		67 79		68 69		94 70													69 68
TEMPERATURE SHEWN BY THERMOMETER				36.3 36.5		36.3 36.4		36.4 36.5		35.8 35.7													34.7 34.8
ERROR OF THERMOMETER																							
CORRECTED TEMPERATURE																							
TEMPERATURE FROM CURVE				36.4		36.2		36.0		35.8													34.6



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

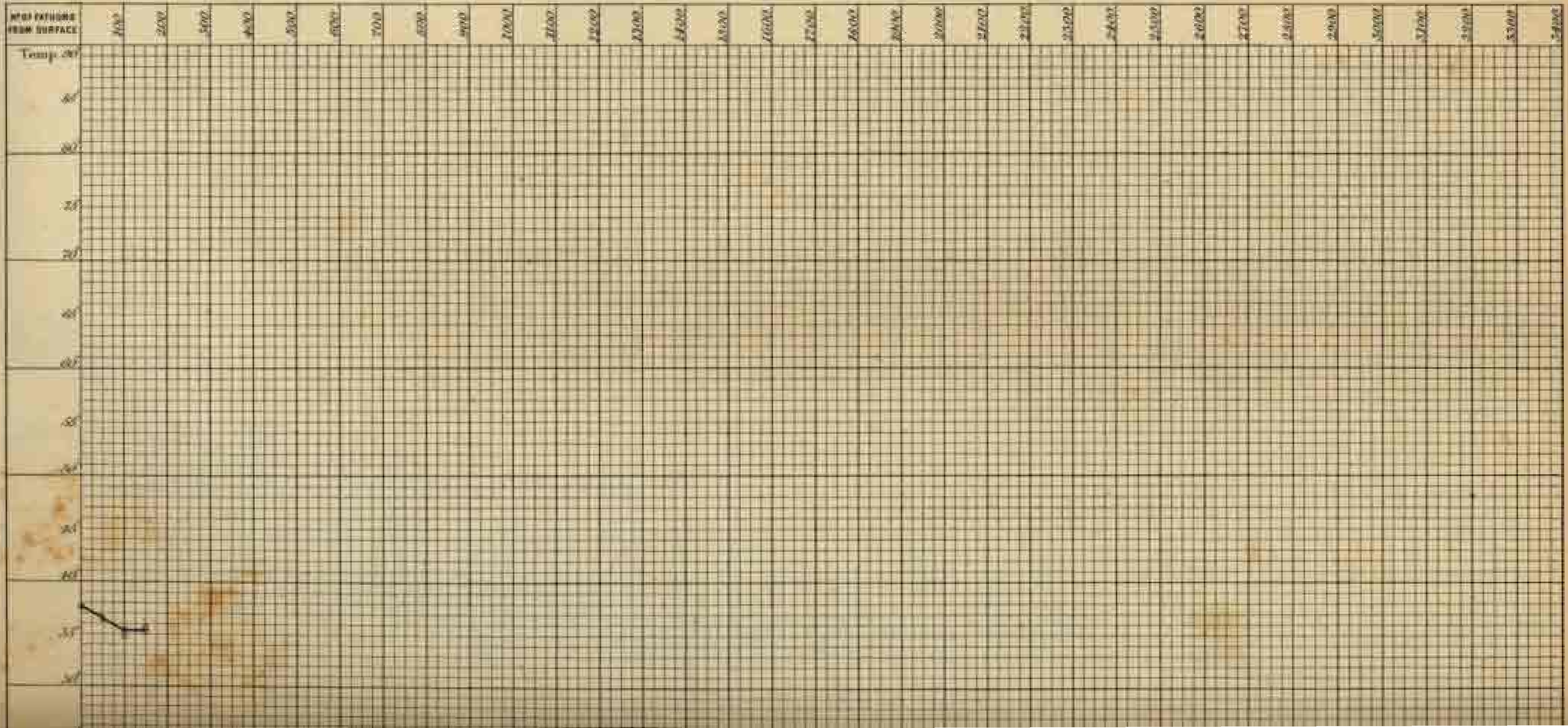
2 February 1874.

Nº of Sounding 254.
Station 150.

Depth 150 fathoms.

Latitude 52° 4′ S.
Longitude 71° 22′ E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer						66 74					69 67					69 67																													
Temperature shown by thermometer	37·3					36·5 36·5					34·8 35·2					35·2 35·4																													
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	37·3					36·3					35·2					35·2																													



11 February 1874.

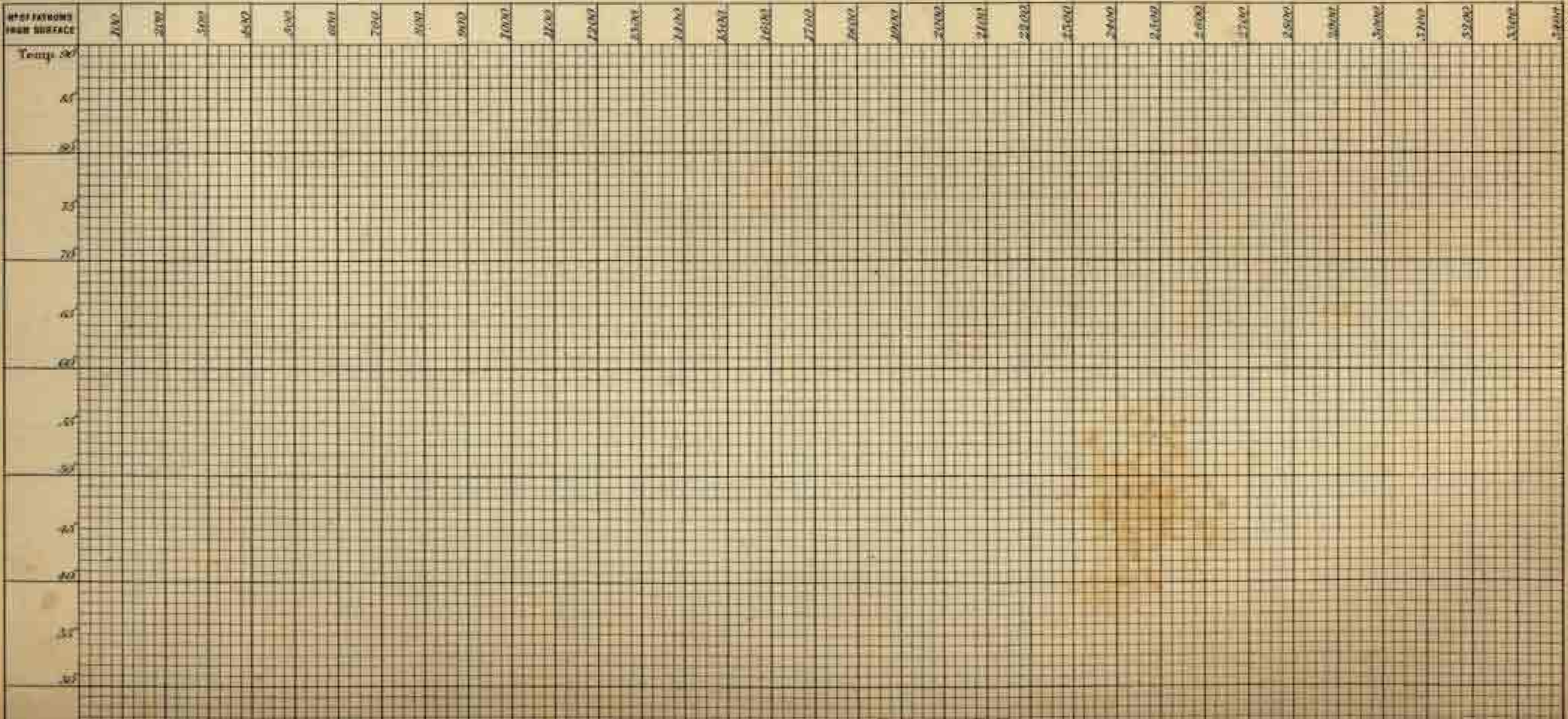
Nº of Sounding 256.
" " Station 152.

Depth 1260 fathoms.

Latitude 60° 52′ S.
Longitude 80° 20′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	25	30	40	50	60	70	80	90	100	110	130	140	150	160	170	180	190	200	225	250	275	300
Nº OF THERMOMETER		90	84	66	67	68	66 62	74	49	68	67	66 70 69				84					70 70 70				49
TEMPERATURE SHEWN BY THERMOMETER	34.5	34.0	33.5	31.2	30.0	30.2	30.3 30.0	32.0	32.4	32.5	32.8	33.0 33.0 33.0				32.8					35.2 35.0 35.8				35.5
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE																									

Nº OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																				
TEMPERATURE SHEWN BY THERMOMETER																				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE																				



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

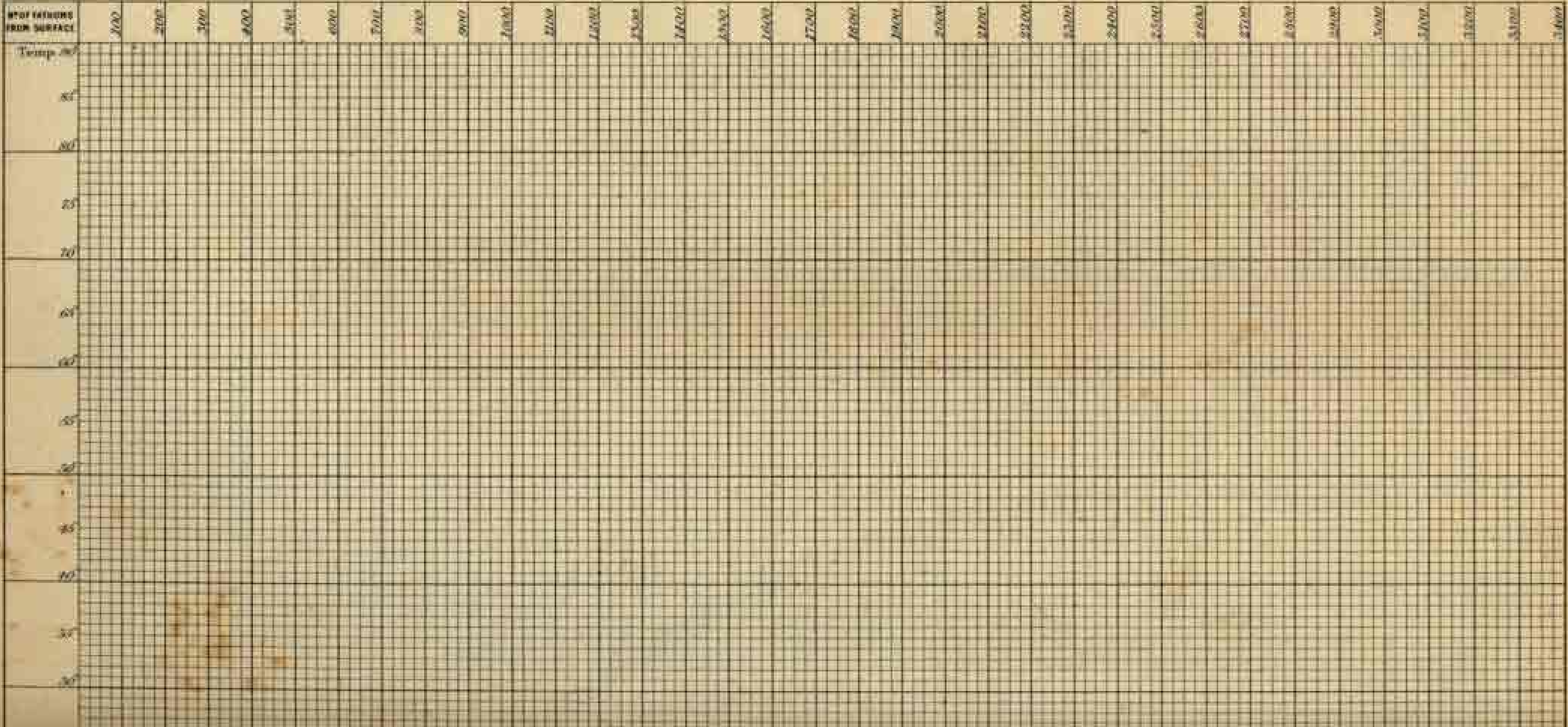
14 February 1874.

N.° of Sounding 257.
Station 153.

Depth: 1675 *fathoms.*

Latitude 65° 42′ S.
Longitude 79° 49′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						67 66					67 66										67 66				67 66		67 66																		67 66
TEMPERATURE SHEWN BY THERMOMETER	29.5					29.0 29.0					29.0 29.0										30.5 30.5				32.0 32.0		32.8 32.8																		33.0 33.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE																																													



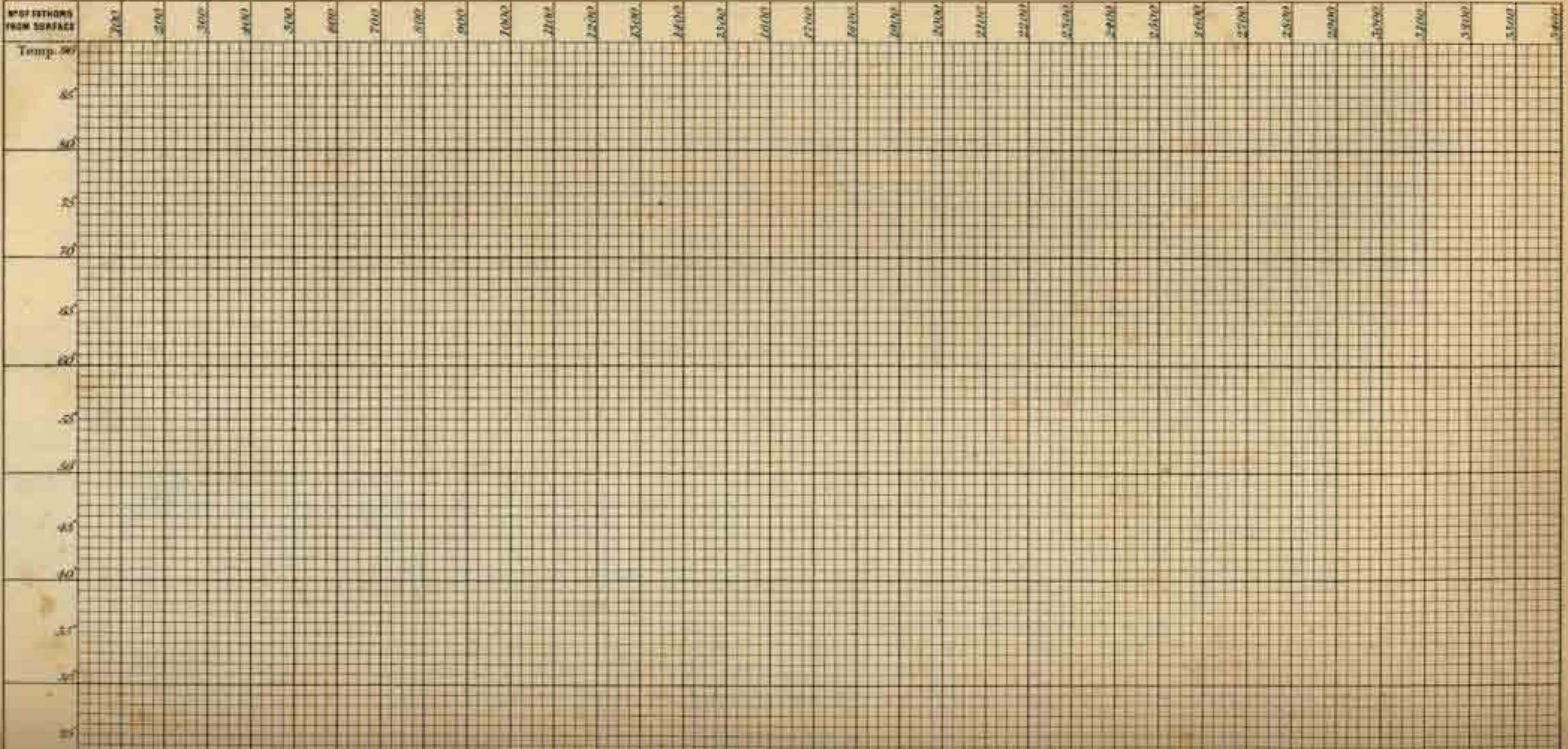
19 February 1874.

N° of Sounding 258.
Station. 154.

Depth 1800 fathoms

Latitude 64° 37′ S.
Longitude 85° 49′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						94					68														79																				68 94
TEMPERATURE SHEWN BY THERMOMETER	32·0					29·8					29·0														33·8																				32·9 33·0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE																																													



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

26 February 1874.

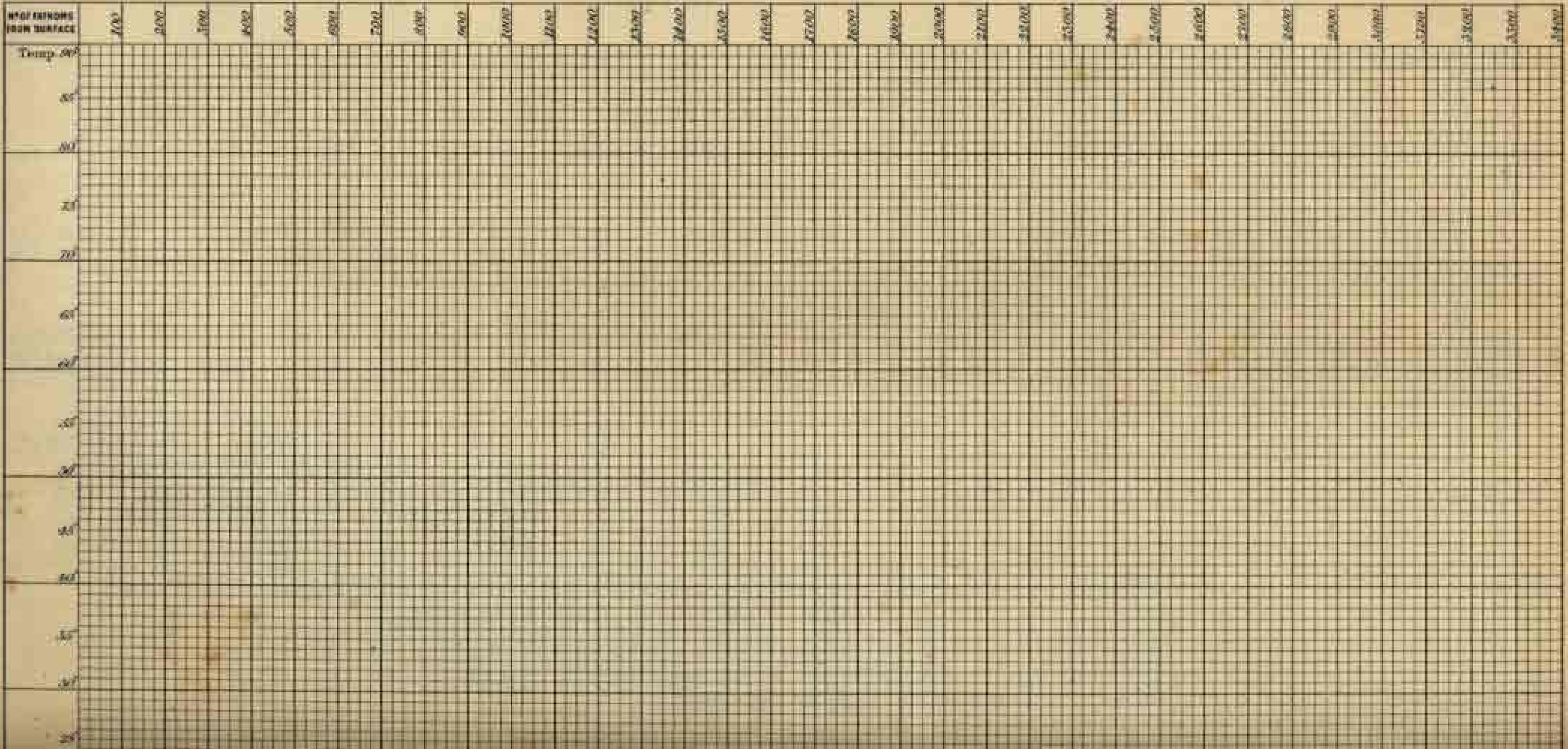
No. of Sounding 260.
Station 156.

Depth 1975 fathoms.

Latitude 62° 26′ S.
Longitude 95° 44′ E.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250
No. of thermometer											69 66					69 68					74 52		
Temperature shewn by thermometer	33.0										31.8 32.0					34.0 34.0					34.0 34.0		
Error of thermometer																							
Corrected temperature																							
Temperature from curve																							

No. of fathoms from surface	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer																						67
Temperature shewn by thermometer																						32.3
Error of thermometer																						
Corrected temperature																						
Temperature from curve																						



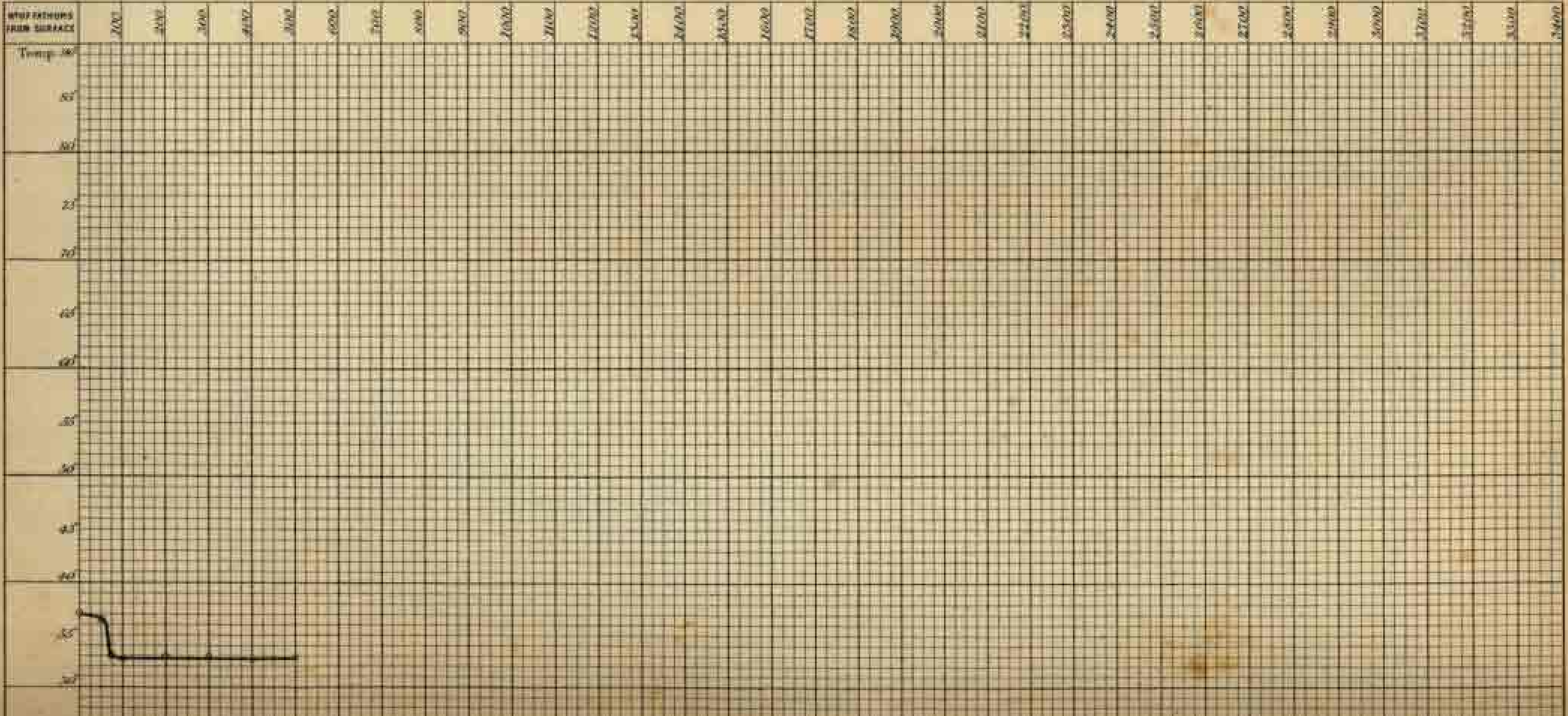
3 March 1874.

N.º of Sounding 261.
Station 157.

Depth 1950 fathoms.

Latitude 53° 55′ S.
Longitude 108° 35′ E.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER		70	66	94	74	79	89	70	79	68	78 79										94				84	70	74																		69 66
TEMPERATURE SHEWN BY THERMOMETER	37.2	36.8	36.8	36.8	36.8	36.8	36.6	33.0	32.5	32.5	32.7 32.6										33.0				33.0	32.6	32.8																		32.0 32.2
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE																																													



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

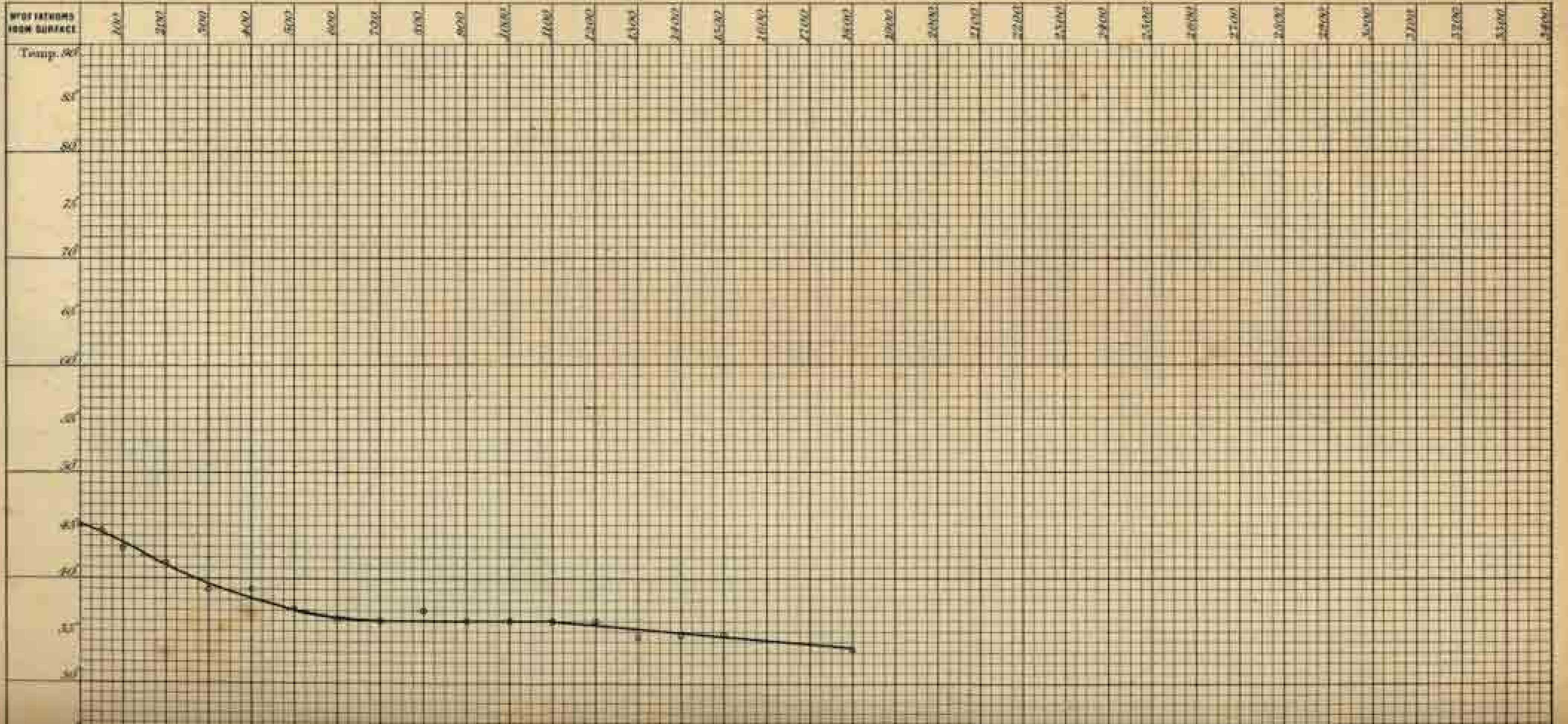
7 March 1874.

Nº of Sounding 262.
" Station 158.

Depth 1800 fathoms.

Latitude 50° 1′ S.
Longitude 123° 4′ E.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer						74					84					66					79				70	94	67	84	66	74	79	69	70	67	84	66	74								68 69
Temperature shown by Thermometer	45·0					44·6					42·3					42·2					41·5				39·0	39·0	37·2	36·2	36·0	37·0	36·0	36·0	36·0	36·0	34·5	34·8	34·8								33·5 33·5
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	45·0					44·3					43·4					42·3					41·3				39·5	38·2	37·0	36·5	36·0	36·0	36·0	36·0	36·0	35·7	35·3	35·0	34·7								33·5



SECTION, CAPE OF GOOD HOPE TO MELBOURNE.

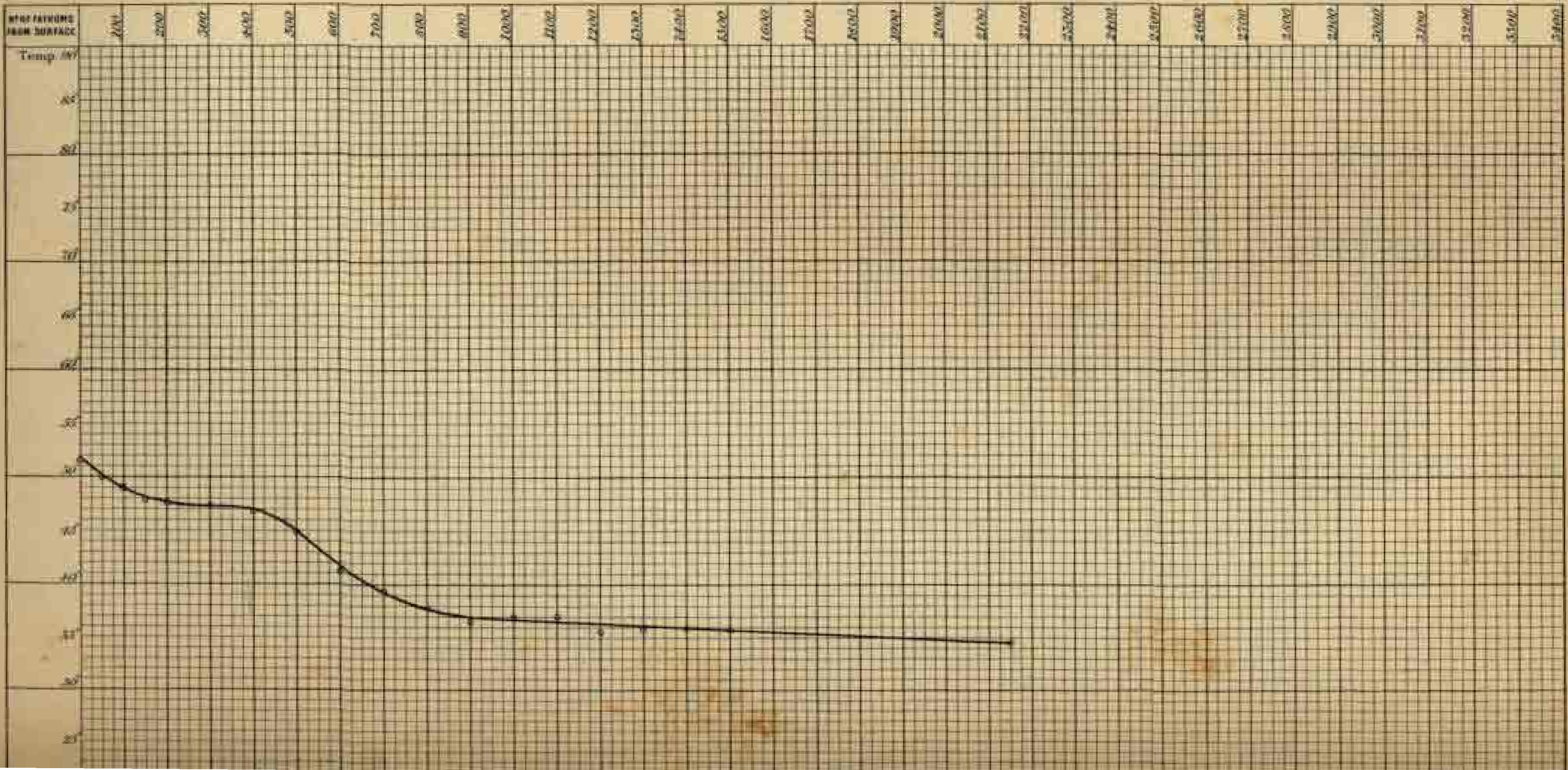
10 March 1874.

Nº of Sounding 263.
Station 159.

Depth 2150 fathoms.

Latitude 47° 25'
Longitude 130° 22'

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer						94					67					69					72				70	68	84	67	74	91	94	74	87	84	68	70	72								66 69
Temperature shewn by Thermometer	51.5					50.0					49.0					48.0					47.4				47.2	46.9	44.8	41.3	39.4	37.7	36.6	37.0	37.0	35.6	36.0	36.0	35.8								34.6 34.4
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	51.3					50.0					49.0					48.1					47.4				47.2	46.9	44.8	41.8	39.4	38.3	37.9	37.7	37.3	37.3	37.1	36.9	36.7								34.5



SECTION. CAPE OF GOOD HOPE TO MELBOURNE.

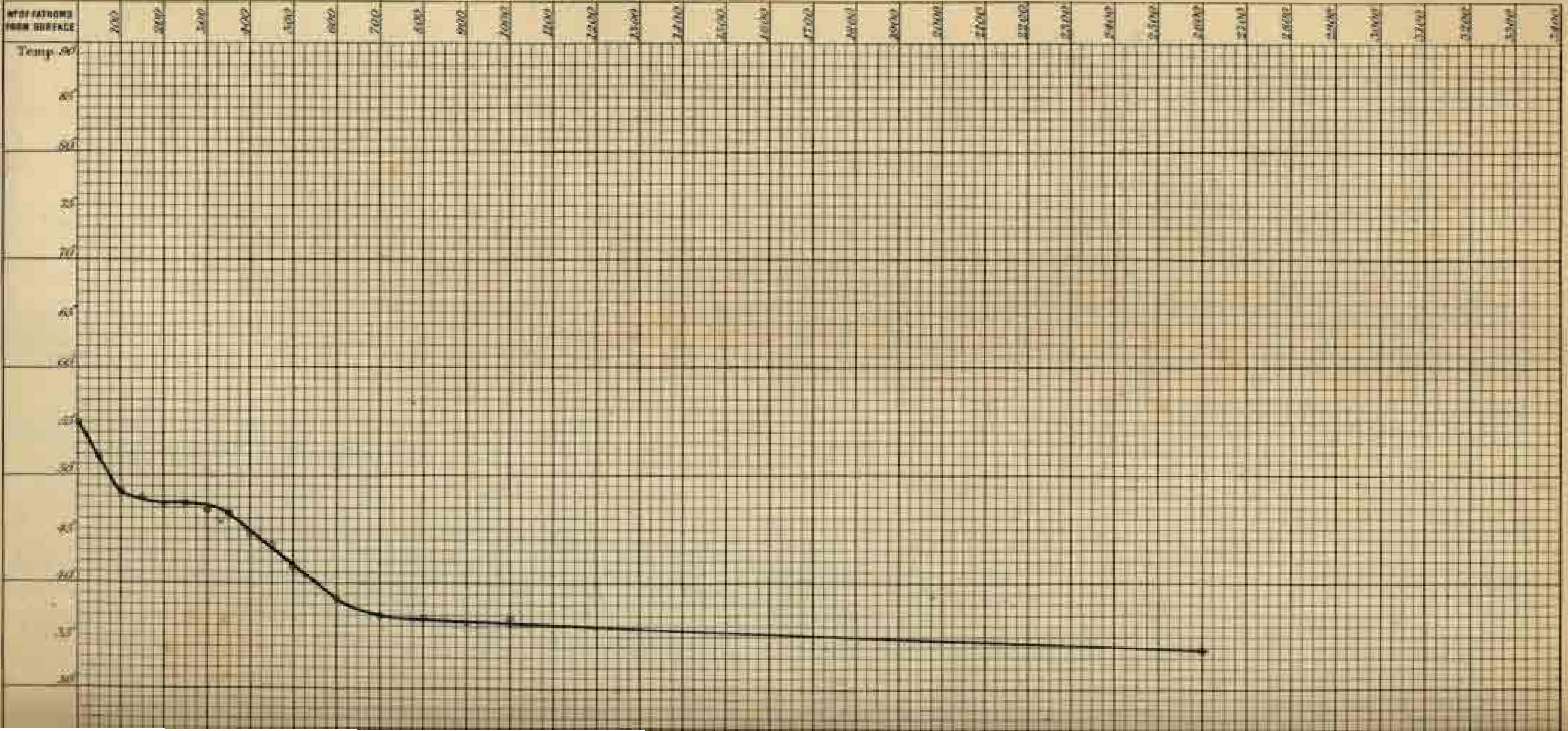
13 March 1874.

N° of Sounding 264.
- - Station 160.

Depth 2600 fathoms.

Latitude 42° 42′ S.
Longitude 134° 10′ E.

N° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	350	400	450	500	600	700	800	900	1000	1200	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER						94					84					79					69		68		79	74	94	84	70	66	98	84	70	67											66 69
TEMPERATURE SHEWN BY THERMOMETER	55.0					51.8					48.5					48.0					47.5		47.3		46.8	46.5	44.8	43.5	41.5	38.5	37.0	36.8	36.5	36.8											33.8 34.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	55.0					51.8					48.5					47.9					47.7		47.5		47.2	46.5	44.9	43.3	41.6	38.5	37.0	36.2	35.6	35.4											33.9



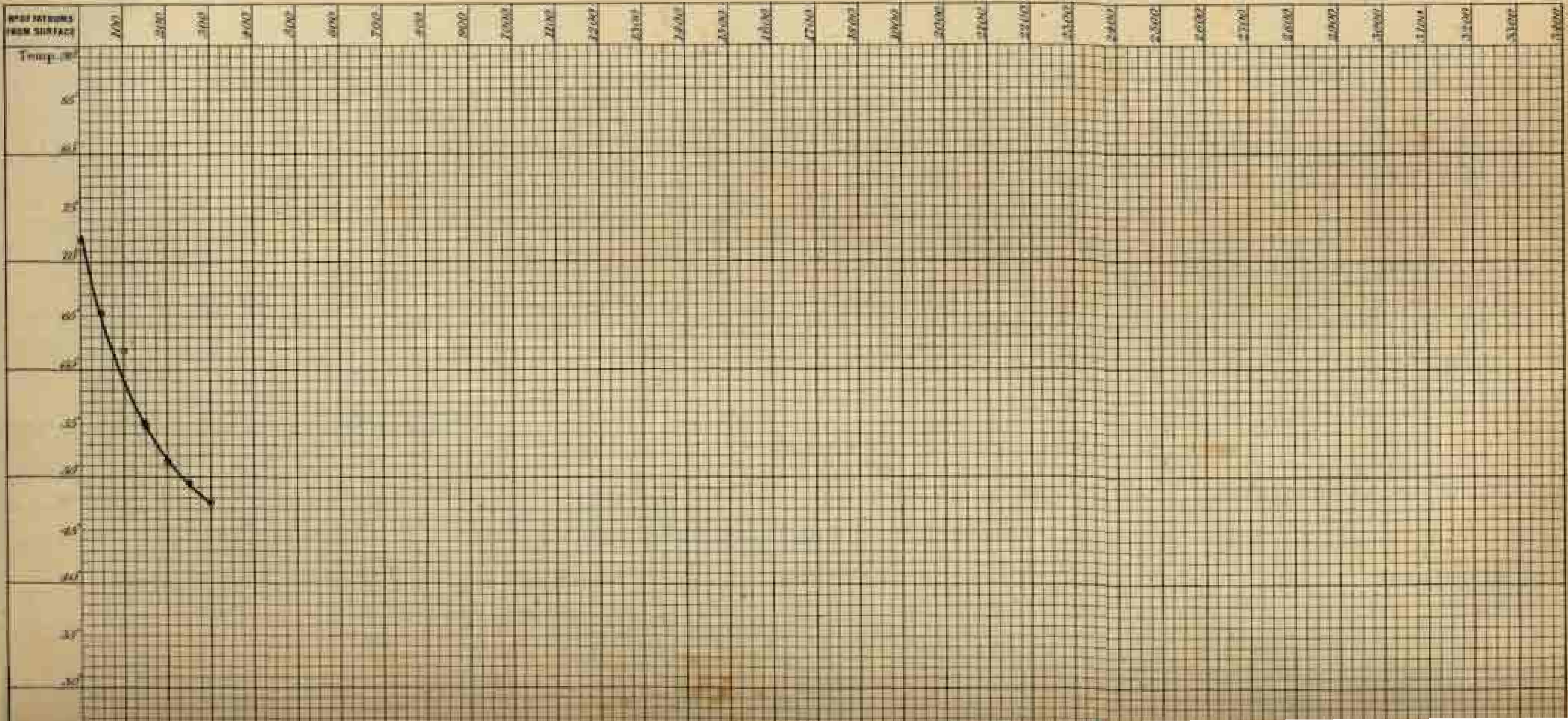
4 April 1874.

N.º of Sounding 267.
Station 163.

Depth 2200 *fathoms.*

Latitude 36° 57′ S.
Longitude 150° 34′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						79					74					66					68		79		74																				74 77
TEMPERATURE SHEWN BY THERMOMETER	72.0					65.0					61.9					54.9					51.4		49.5		47.8																				34.8 34.9
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	72.0					65.0					59.3					54.9					51.4		49.2		47.8																				34.5



SECTION. MISCELLANEOUS.

13 June 1874.

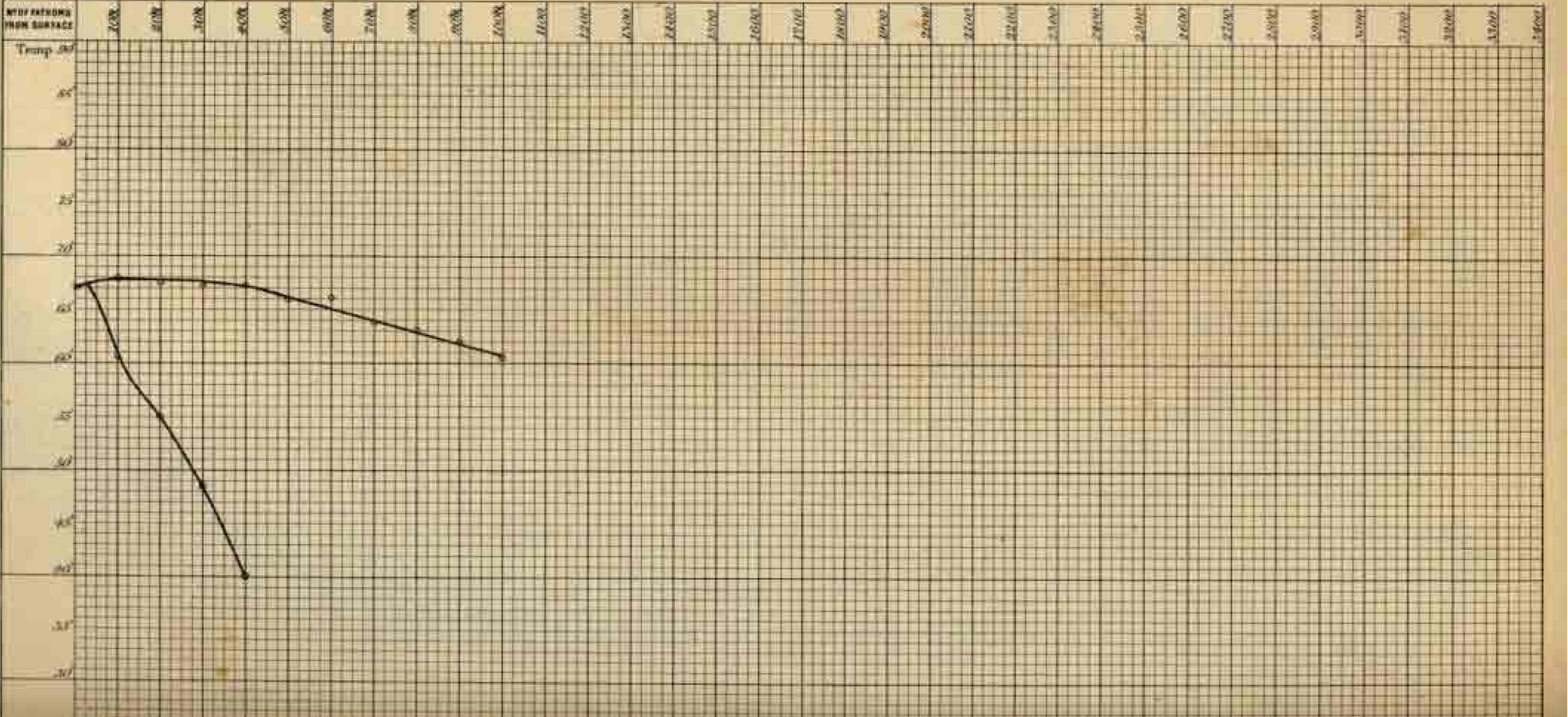
Nº of Sounding 277.
Station 164 e.

Depth 400 *fathoms.*

Latitude 34° 19′ S.
Longitude 151° 31′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER		66	72	67	74	69	67	70	66	74	69									
TEMPERATURE SHEWN BY THERMOMETER	67.0	68.0	67.5	67.2	67.2	66.0	66.0	64.0	63.2	62.0	60.8									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	67.0	68.0	67.8	67.6	67.2	66.3	65.3	64.2	63.0	61.8	60.7									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	67				66																				66
TEMPERATURE SHEWN BY THERMOMETER	53.0				48.5																				40.0
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	53.0				48.5																				40.0



SECTION. SYDNEY TO WELLINGTON.

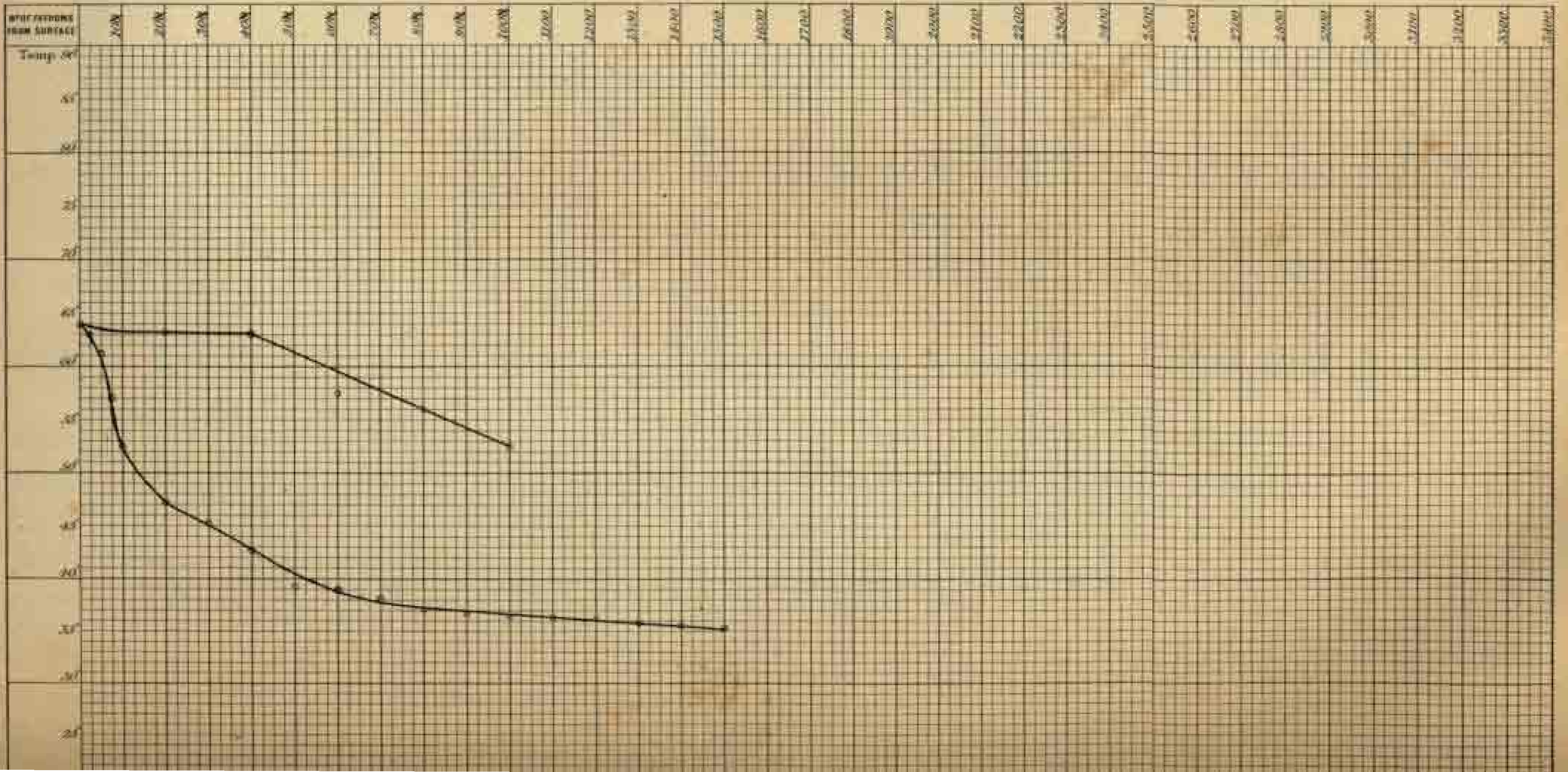
16 June 1874.

No. of Sounding 279.
. . *Station* 164 a.

Depth 2550 fathoms.

Latitude 34° 27' S.
Longitude 154° 57' E.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			82		49		73		81		73										82				81	84	73	82	87	68	84	69	49	68	74	84	69								
Temperature shewn by thermometer	64.0		63.2		63.0		59.4		56.0		54.4										48.2				45.1	42.8	40.9	39.0	38.0	37.2	36.7	36.5	36.3	36.1	35.8	35.4	35.2								
Error of thermometer	0.0		0.0		0.0		−1.8		0.0		−1.8										0.0				0.0	0.0	−1.8	0.0	+0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
Corrected temperature	64.0		63.2		63.0		57.6		56.0		52.6										48.2				45.1	42.8	39.1	39.0	38.1	37.2	36.7	36.5	36.3	36.1	35.8	35.4	35.2								
Temperature from curve	64.0		63.2		63.0		59.1		56.0		52.5										48.2				45.1	42.8	40.4	38.9	37.8	37.2	36.9	36.6	36.3	36.0	35.7	35.4	35.1								



SECTION. SYDNEY TO WELLINGTON.

19 June 1874.

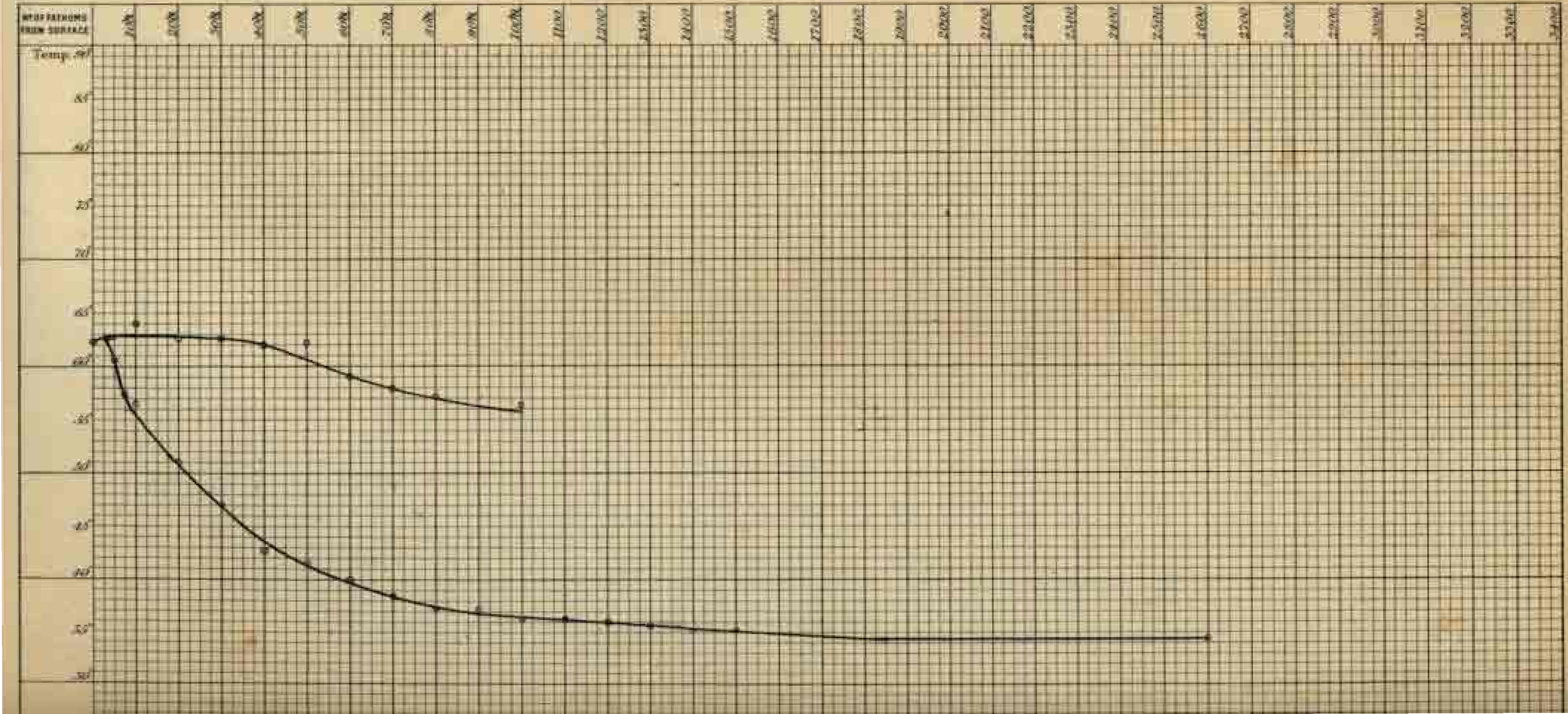
Nº of Sounding 281.
Station 165 a.

Depth 2600 fathoms

Latitude 36° 41′ S.
Longitude 158° 29′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº OF THERMOMETER											82										88			
TEMPERATURE SHEWN BY THERMOMETER	62.5	64.0	62.5	62.5	62.0	62.0	59.0	58.0	57.0		56.5										51.0			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	62.5	62.8	62.5	62.5	62.0	60.5	59.2	58.0	57.0	56.4	55.8										51.8			

Nº OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	73	84	81	77	87	80	73	84	91	87	80	77	73								68 69
TEMPERATURE SHEWN BY THERMOMETER	47.0	43.8	41.6	40.0	38.6	37.4	37.2	36.5	36.2	36.0	35.6	35.2	33.8								34.6 34.3
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	47.0	43.8	41.6	39.8	38.6	37.5	36.9	36.5	36.2	36.0	35.7	35.4	35.1								34.4

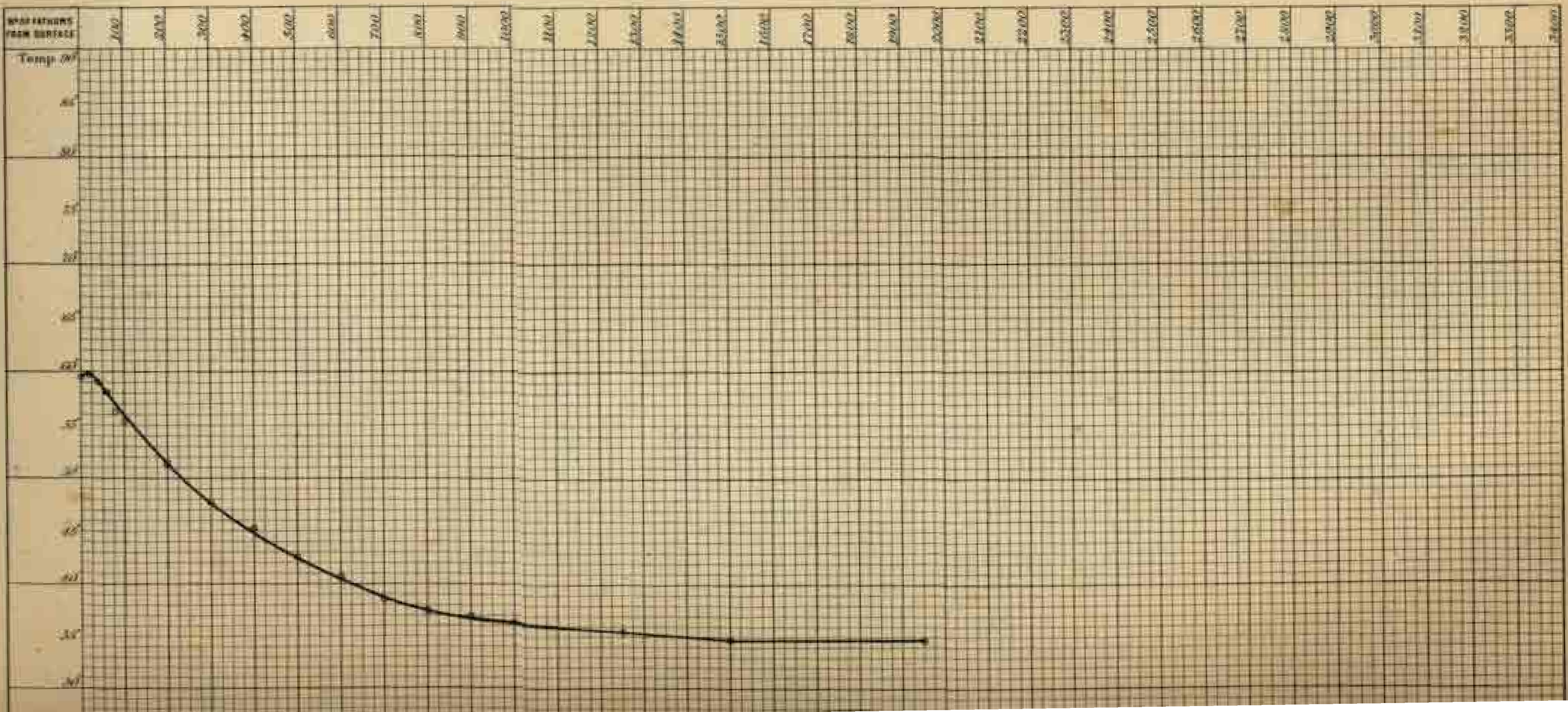


21 June 1874.

No. of Sounding 282. *Depth 1975 fathoms* *Latitude* 37° 53′ S.
Station 165. *h.* *Longitude* 163° 18′ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. of Thermometer			69		67		84		82		54									
Temperature shown by Thermometer	59·5		59·8		59·0		58·0		56·2		55·4									
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	59·5		59·8		59·0		58·0		57·2		55·9									

No. of Fathoms from Surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1250	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	57				82	73	81	77	77	81	71	80		67			85								69 68
Temperature shown by Thermometer	51·4				47·9	45·0	41·6	40·5	38·3	37·3	37·0	36·5		35·7			34·8								34·3 35·0
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	51·3				47·8	44·9	41·5	40·4	38·7	37·5	36·8	36·4		35·7			34·8								34·3



SECTION. SYDNEY TO WELLINGTON.

22 June 1874.

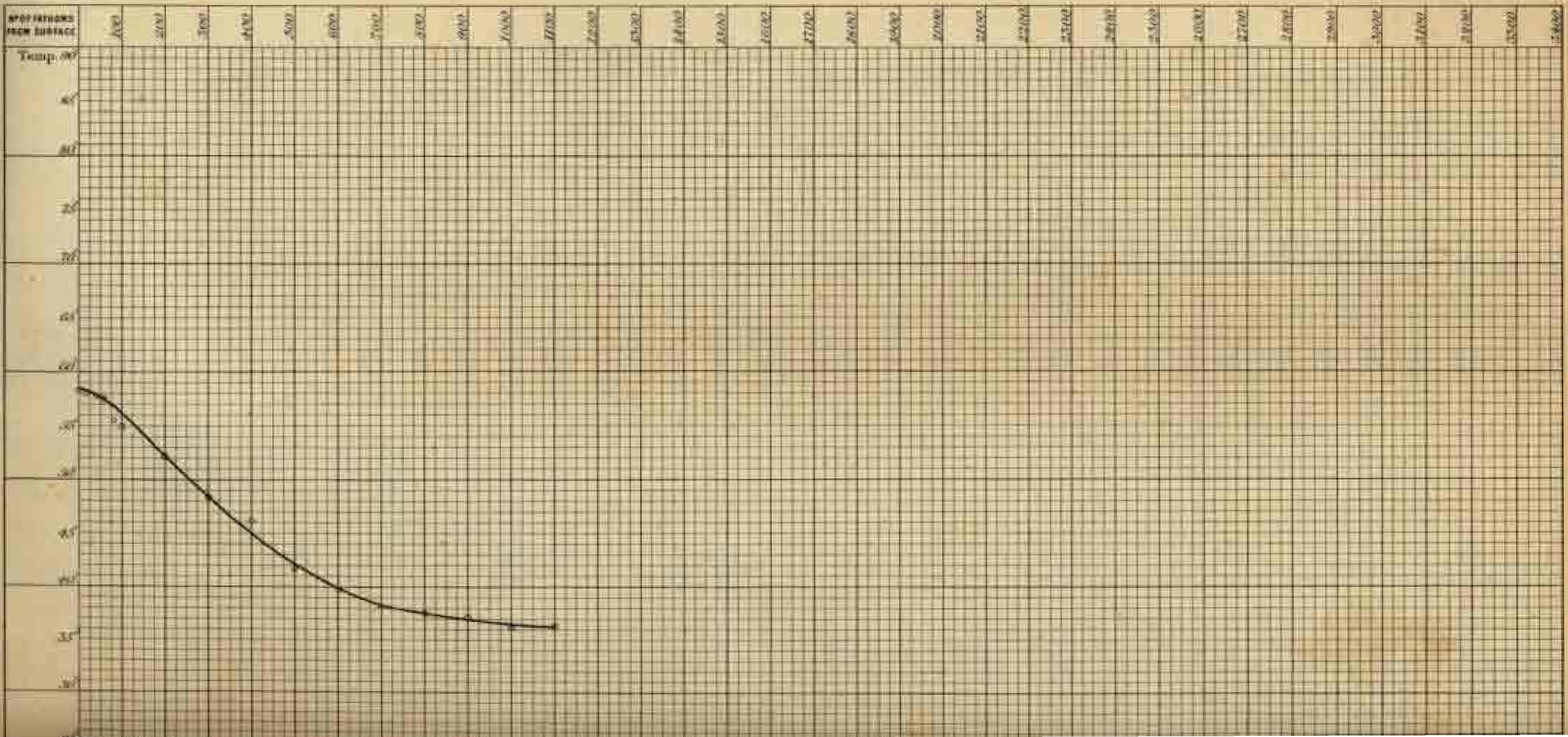
N.° of Sounding 283.
Station 165 c.

Depth 1100 fathoms.

Latitude 38° 30′ S.
Longitude 166° 39′ E.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
N.° OF THERMOMETER											69									
TEMPERATURE SHEWN BY THERMOMETER	58.2		58.0		57.8		57.4		55.6		55.0									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	58.2		58.1		57.8		57.4		56.6		55.9									

N.° OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER	49				68	81	74	87	82	77	84	85													68 69
TEMPERATURE SHEWN BY THERMOMETER	52.2				48.5	46.0	41.8	39.8	38.0	37.5	37.0	36.5													36.4 36.4
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	52.4				48.5	45.3	42.0	39.8	38.0	37.4	36.9	36.5													36.4



SECTION. SYDNEY TO WELLINGTON.

23 June 1874.

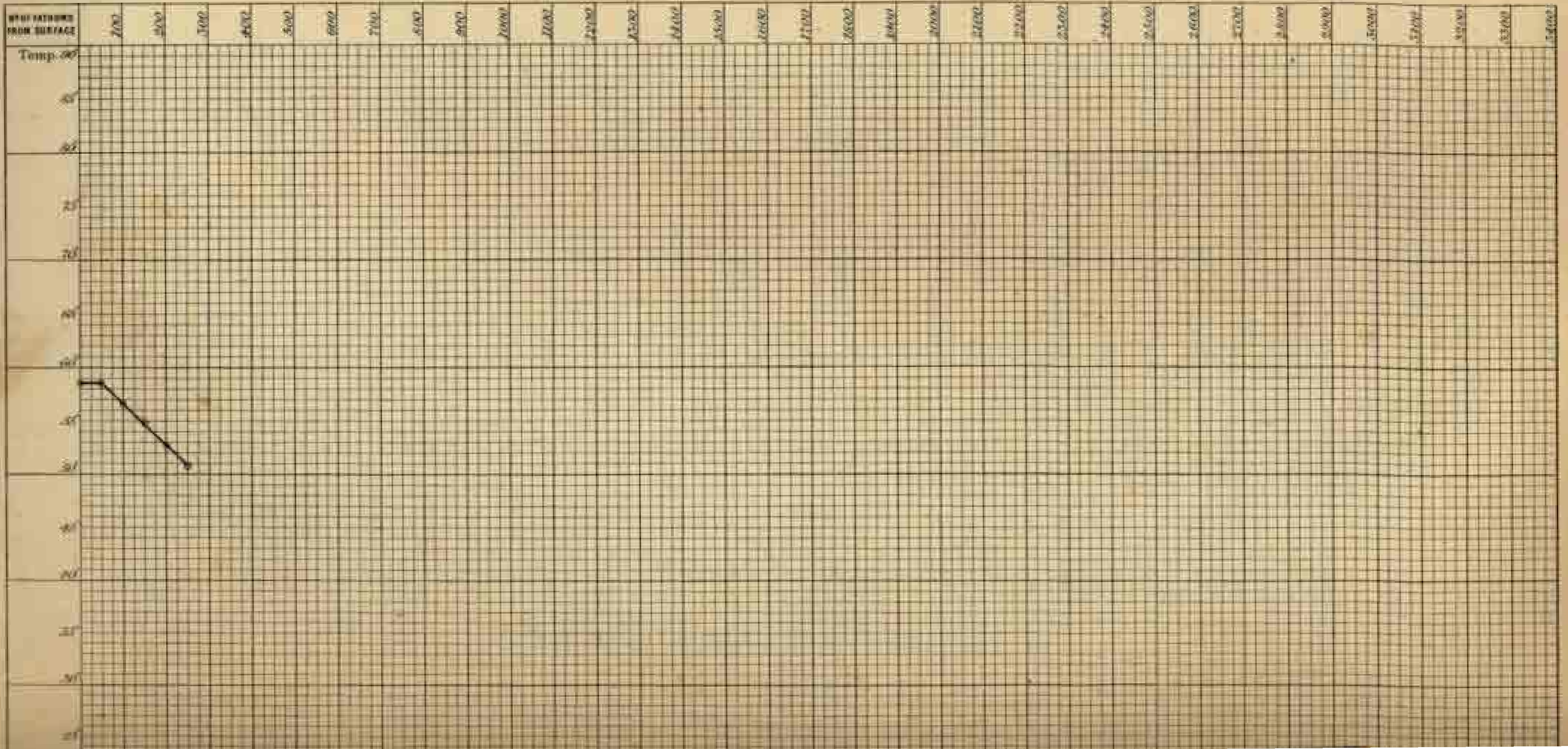
N.° of Sounding 284.
Station 166.

Depth 275 *fathoms.*

Latitude 38° 50′ S.
Longitude 169° 20′ E.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
N.° OF THERMOMETER						49					68					77					82
TEMPERATURE SHOWN BY THERMOMETER	58.5					58.5					56.5					54.7					52.7
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	58.5					58.5					56.5					54.7					52.7

N.° OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER		87																						
TEMPERATURE SHOWN BY THERMOMETER		50.8																						
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE		50.8																						



SECTION. NEW ZEALAND TO FIJI ISLANDS.

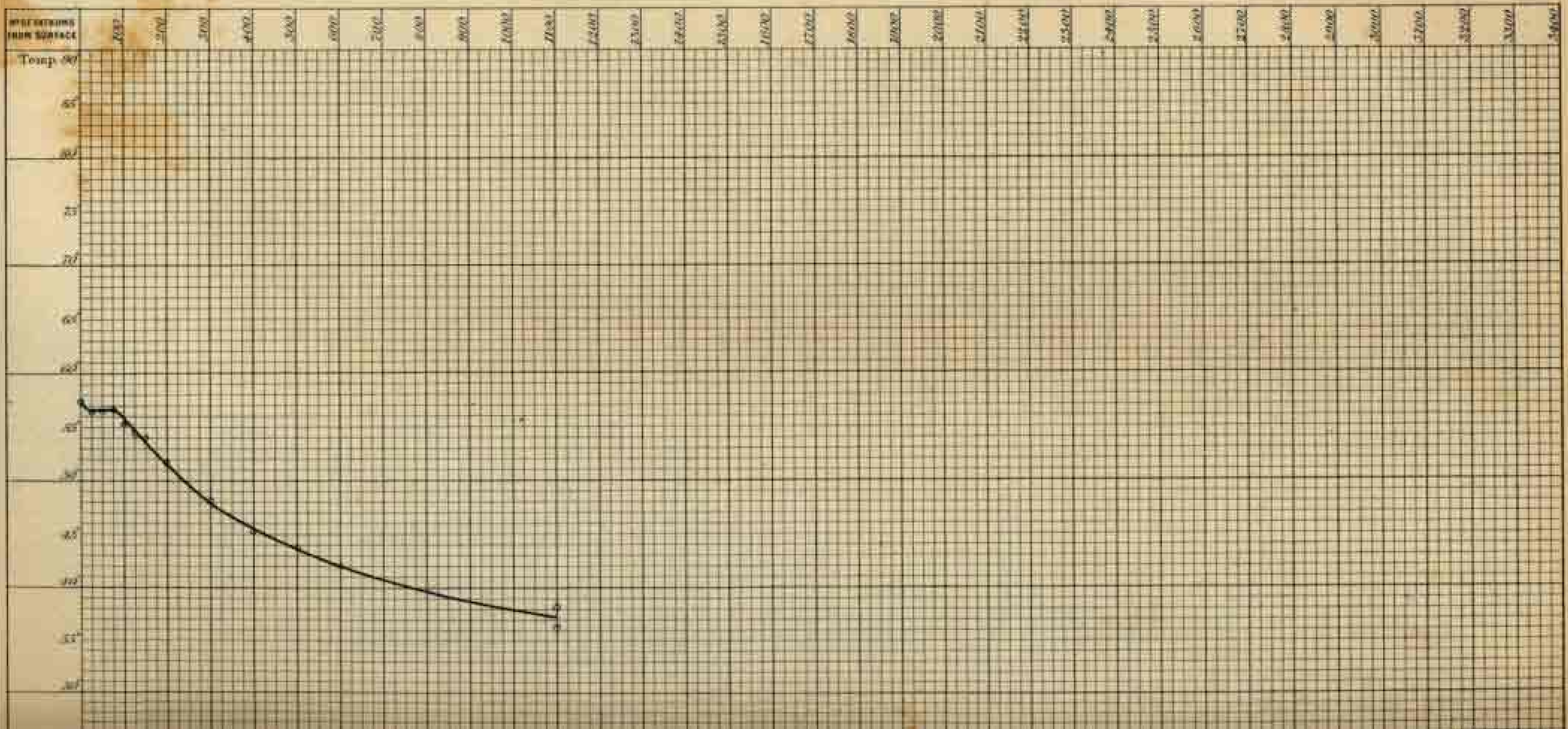
8 July 1874.

Nº of Sounding 290.
Station 168.

Depth 1100 fathoms

Latitude 40° 28′ S.
Longitude 177° 43′ E.

Nº of fathoms from surface	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº of thermometer			48			87		77			84		74			69					87				77	84	74	69																	69 73
Temperature shown by thermometer	57.0		56.5			56.5		56.0			55.3		54.7			54.0					51.7				48.2	45.4	43.8	42.2																	36.2 36.2
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	57.0		56.5			56.5		56.5			55.7		54.8			53.9					51.2				48.0	45.4	43.7	42.1																	37.2



SECTION NEW ZEALAND TO FIJI ISLANDS.

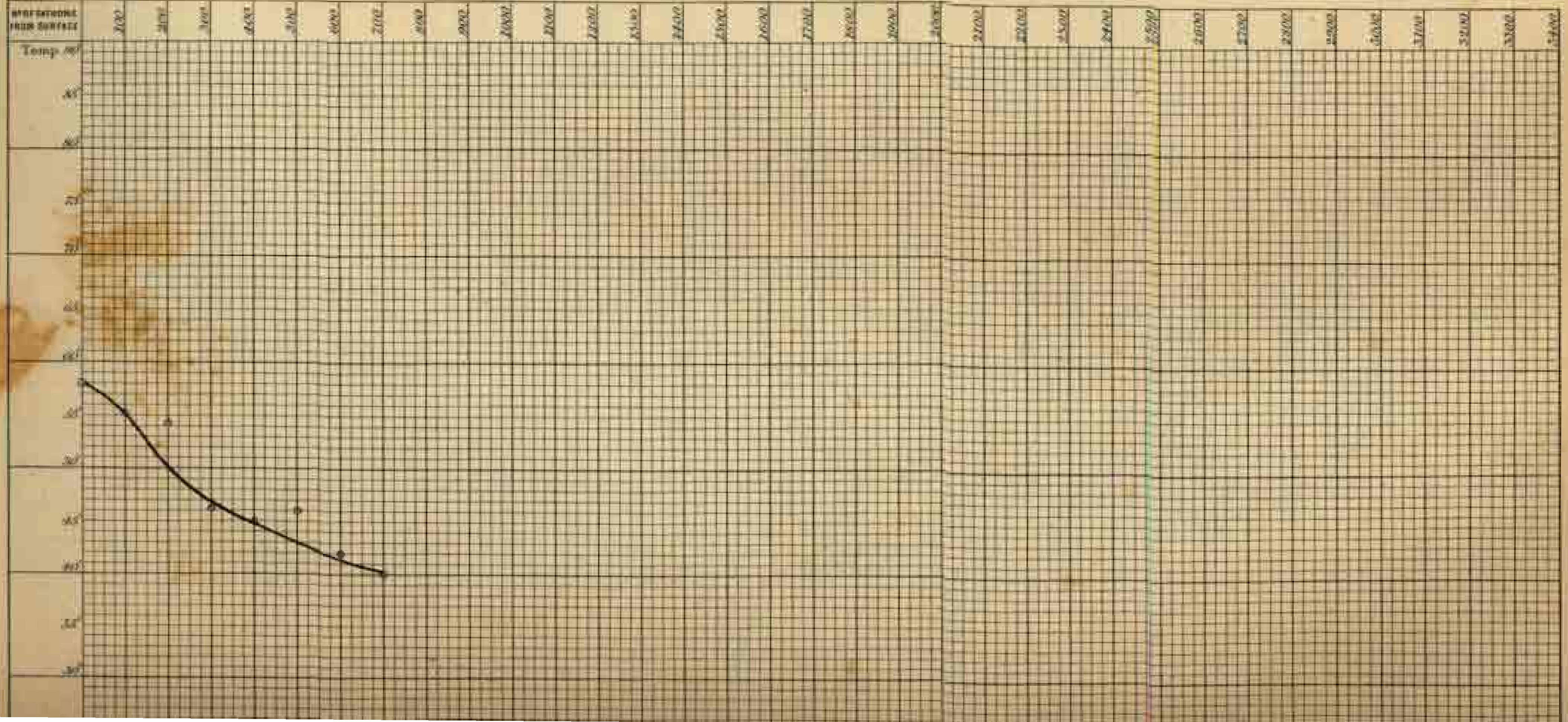
10 July 1874.

Nº of Sounding 291.
Station 169.

Depth 700 fathoms

Latitude 37° 34′ S.
Longitude 179° 22′ E.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer											84										49				85	87	77	69																	87 69
Temperature shewn by Thermometer	58.0										55.7										54.3				46.8	45.1	46.0	42.0																	40.0 39.0
Error of Thermometer																																													
Corrected Temperature																																													
Temperature from Curve	58.0										55.2										50.0				46.7	44.8	43.0	41.5																	40.0



SECTION. NEW ZEALAND TO FIJI ISLANDS.

14 July 1874.

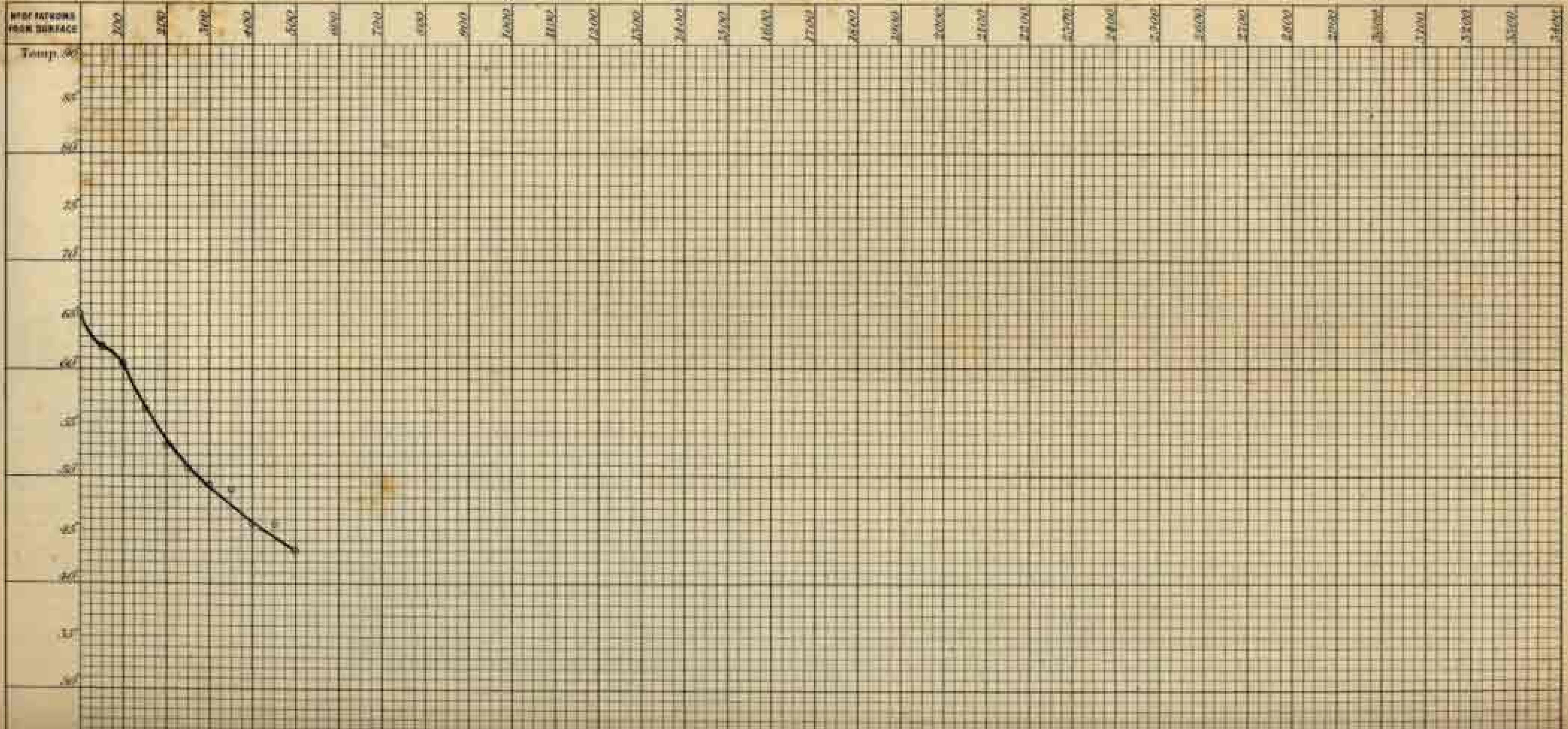
Nº of Sounding 292.
" Station 170.

Depth 520 fathoms.

Latitude 29° 55′ S.
Longitude 178° 14′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER						74					73					69					69
TEMPERATURE SHEWN BY THERMOMETER	65.0					62.0					60.5					56.2					53.0
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	65.0					62.0					60.5					56.2					53.0

Nº OF FATHOMS FROM SURFACE	225	250	300	350	400	450	500	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		87	77	72	82	84	69																	
TEMPERATURE SHEWN BY THERMOMETER		50.8	49.2	48.8	45.6	45.6	43.0																	
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE		50.8	49.0	47.4	45.7	44.6	43.0																	



SECTION. NEW ZEALAND TO FIJI ISLANDS.

17 July 1874.

Nº of Sounding 295.
Station 171 a.

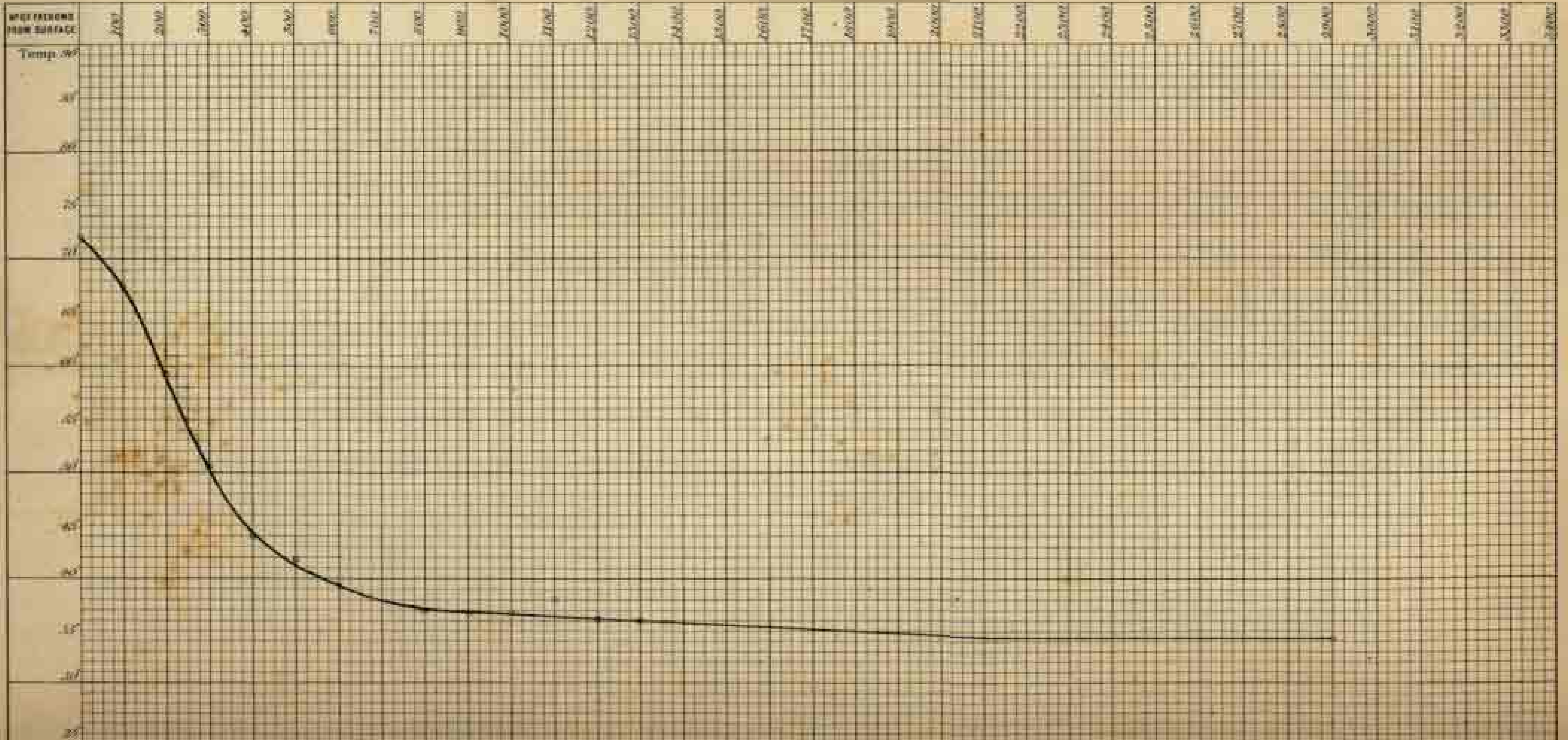
Depth 2900 fathoms

Latitude 25° 5′ S.
Longitude 172° 56′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER											81									
TEMPERATURE SHEWN BY THERMOMETER	72.0										67.6									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	72.0										67.6									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300
Nº OF THERMOMETER	84				72	81	77	87		69	77	80	73	84	81
TEMPERATURE SHEWN BY THERMOMETER	59.0				50.4	44.0	41.8	39.0		37.0	36.8	36.8	38.0	36.1	36.0
ERROR OF THERMOMETER															
CORRECTED TEMPERATURE															
TEMPERATURE FROM CURVE	59.0				50.4	44.0	41.3	39.0	37.9	37.2	36.9	36.7	36.4	36.2	36.0

Nº OF FATHOMS FROM SURFACE	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER										68 69
TEMPERATURE SHEWN BY THERMOMETER										34.4 34.3
ERROR OF THERMOMETER										
CORRECTED TEMPERATURE										
TEMPERATURE FROM CURVE										34.3



SECTION. OFF FIJI ISLANDS.

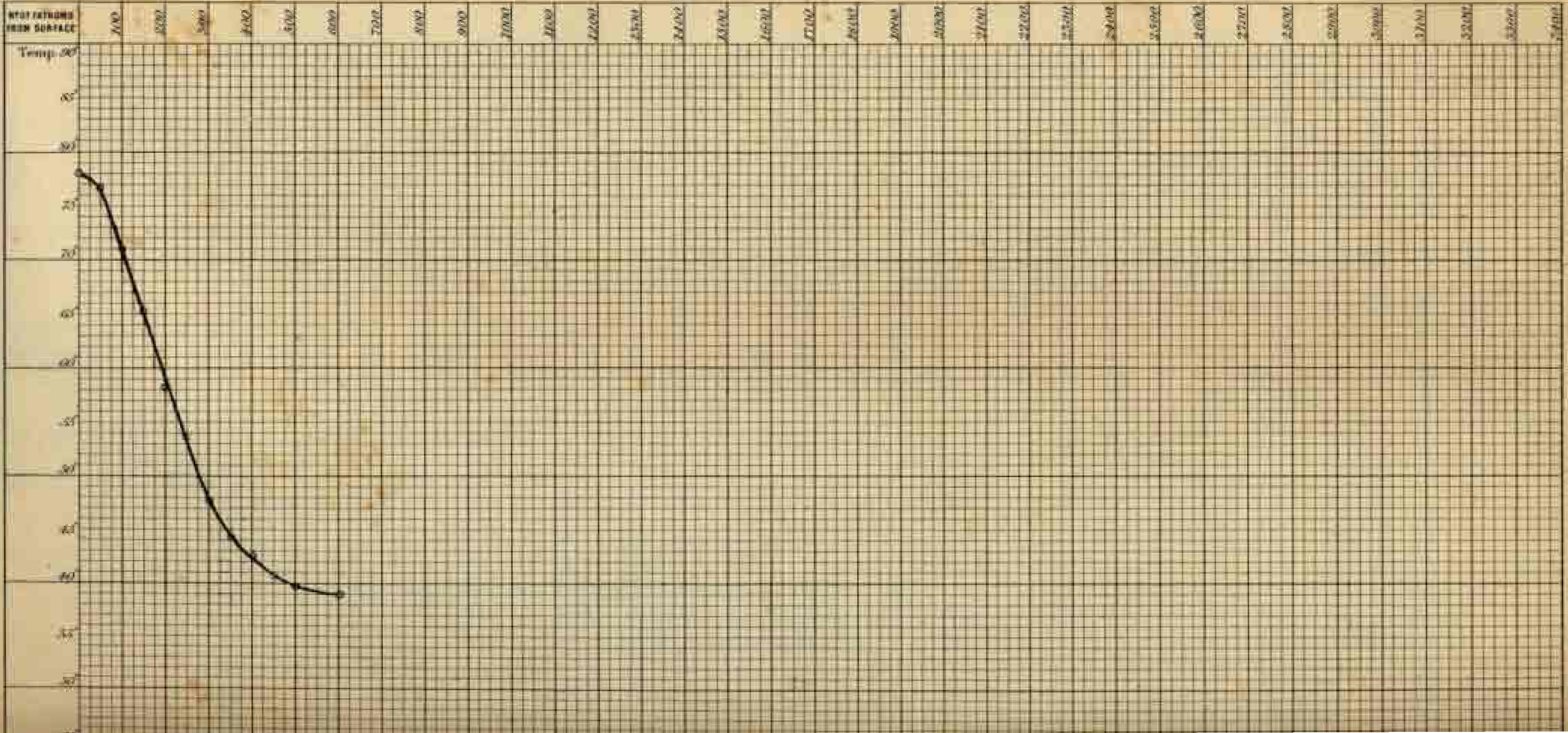
3 August 1874.

No. of Sounding 303.
Station 174 c.

Depth 610 *fathoms.*

Latitude 19° 7′ 50″ S.
Longitude 178° 19′ 35″ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	300	350	400	450	500	600	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		Bottom
No. of Thermometer						73					69					68					40		72	69	85	80	77	74	63															
Temperature shewn by Thermometer	78.0					76.8					71.0					65.2					58.3		53.7	47.8	44.2	42.6	40.9	39.8	39.0															
Error of Thermometer																																												
Corrected Temperature																																												
Temperature from Curve	78.0					76.8					71.0					65.2					59.5		53.7	47.8	44.2	42.3	40.9	39.8	39.0															



SECTION. FIJI ISLANDS TO RAINE ISLAND.

12 August 1874.

No. of Sounding 305.
Station 175.

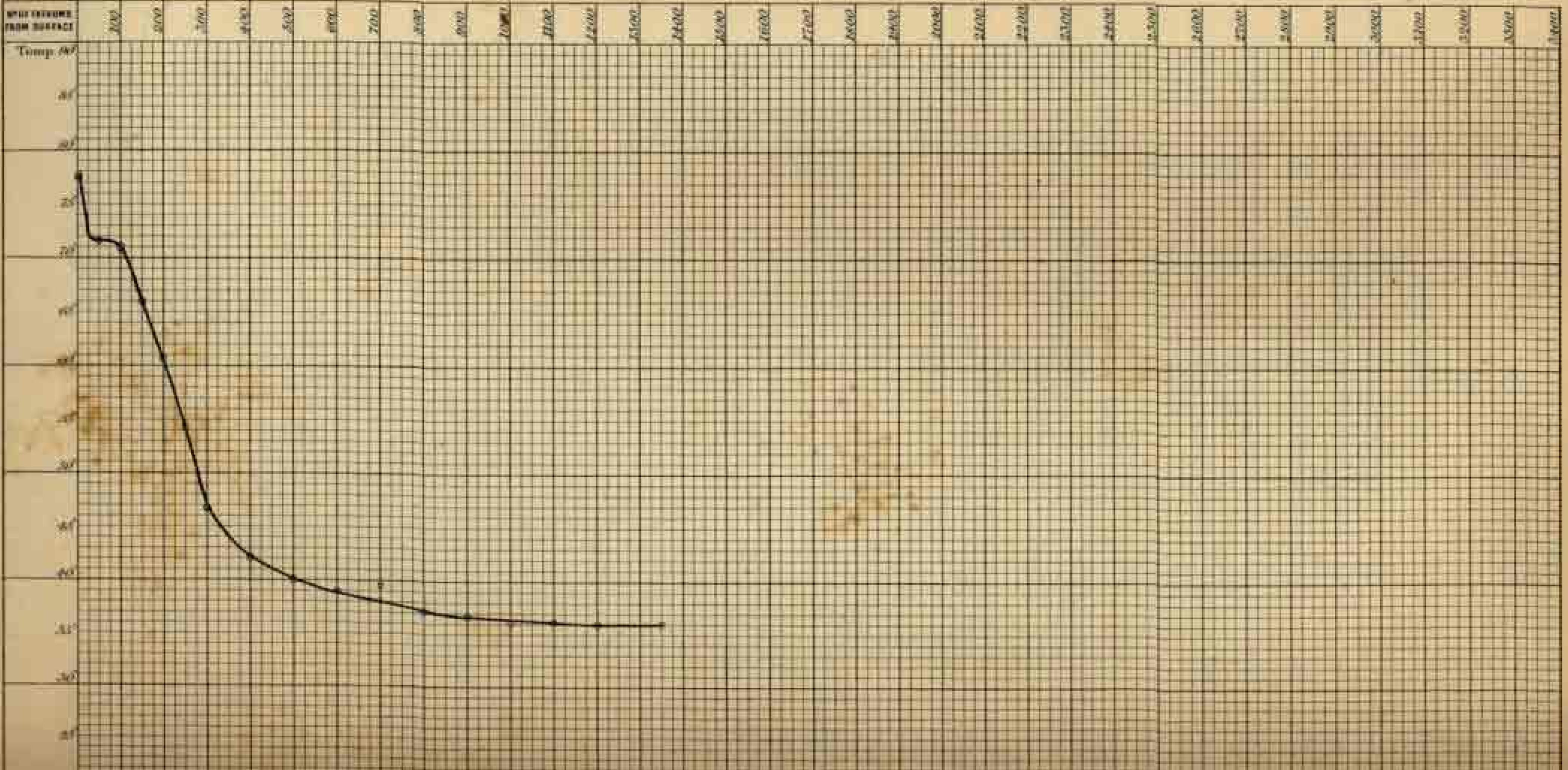
Depth 1350 *fathoms.*

Latitude 19° 2′ S.
Longitude 177° 10′ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140
No. of Thermometer						82					87				
Temperature shewn by Thermometer	77.5					71.5					70.8				
Error of Thermometer															
Corrected Temperature															
Temperature from Curve	77.5					71.5					70.8				

No. of Fathoms from Surface	150	160	170	180	190	200	225	250	275	300	400	500	600	700
No. of Thermometer	68					73		69		85	68	84	69	73
Temperature shewn by Thermometer	66.0					60.8		54.2		46.8	42.0	40.0	39.0	39.5
Error of Thermometer														
Corrected Temperature														
Temperature from Curve	66.0					60.8		54.2		47.0	42.0	40.0	38.9	37.9

No. of Fathoms from Surface	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	82	49	85	84	87											68 99
Temperature shewn by Thermometer	37.2	36.8	36.2	36.2	36.0											35.9 36.0
Error of Thermometer																
Corrected Temperature																
Temperature from Curve	37.2	36.8	36.4	36.2	36.0											36.0



SECTION. FIJI ISLANDS TO RAINE ISLAND.

15 August 1874.

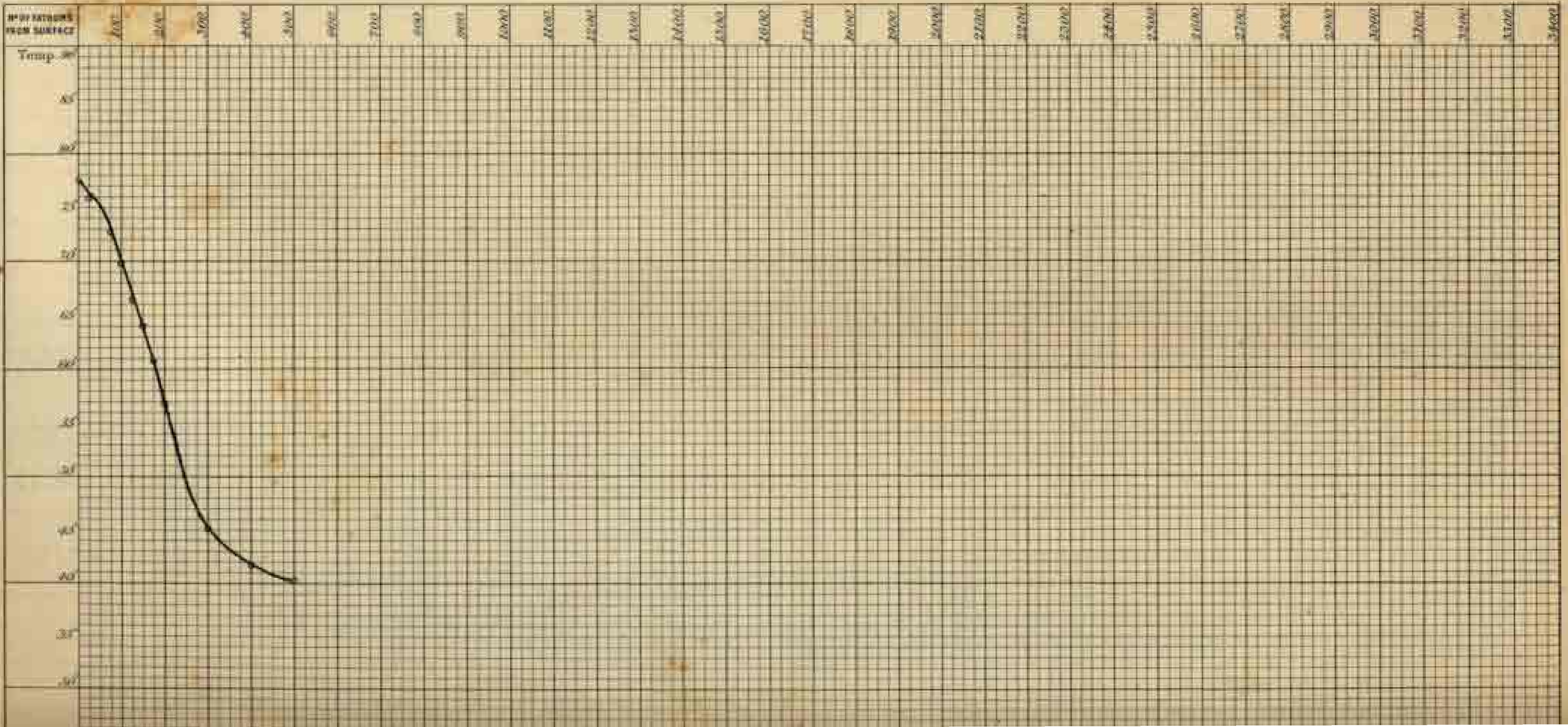
Nº of Sounding 306.
Station 176.

Depth 1450 fathoms.

Latitude 18° 30′ S.
Longitude 173° 52′ E.

Nº of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275
Nº of Thermometer			74			49		87			94		82			68		84			74			
Temperature shewn by Thermometer	77.5		76.0			75.2		72.9			69.7		66.6			64.0		60.8			56.8			
Error of Thermometer																								
Corrected Temperature																								
Temperature from Curve	77.5		76.0			75.2		72.9			69.7		67.0			64.0		61.0			56.8			

Nº of Fathoms from Surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	87	94	68																		69
Temperature shewn by Thermometer	45.2	41.8	40.3																		36.2
Error of Thermometer																					
Corrected Temperature																					
Temperature from Curve	45.2	41.8	40.3																		36.2



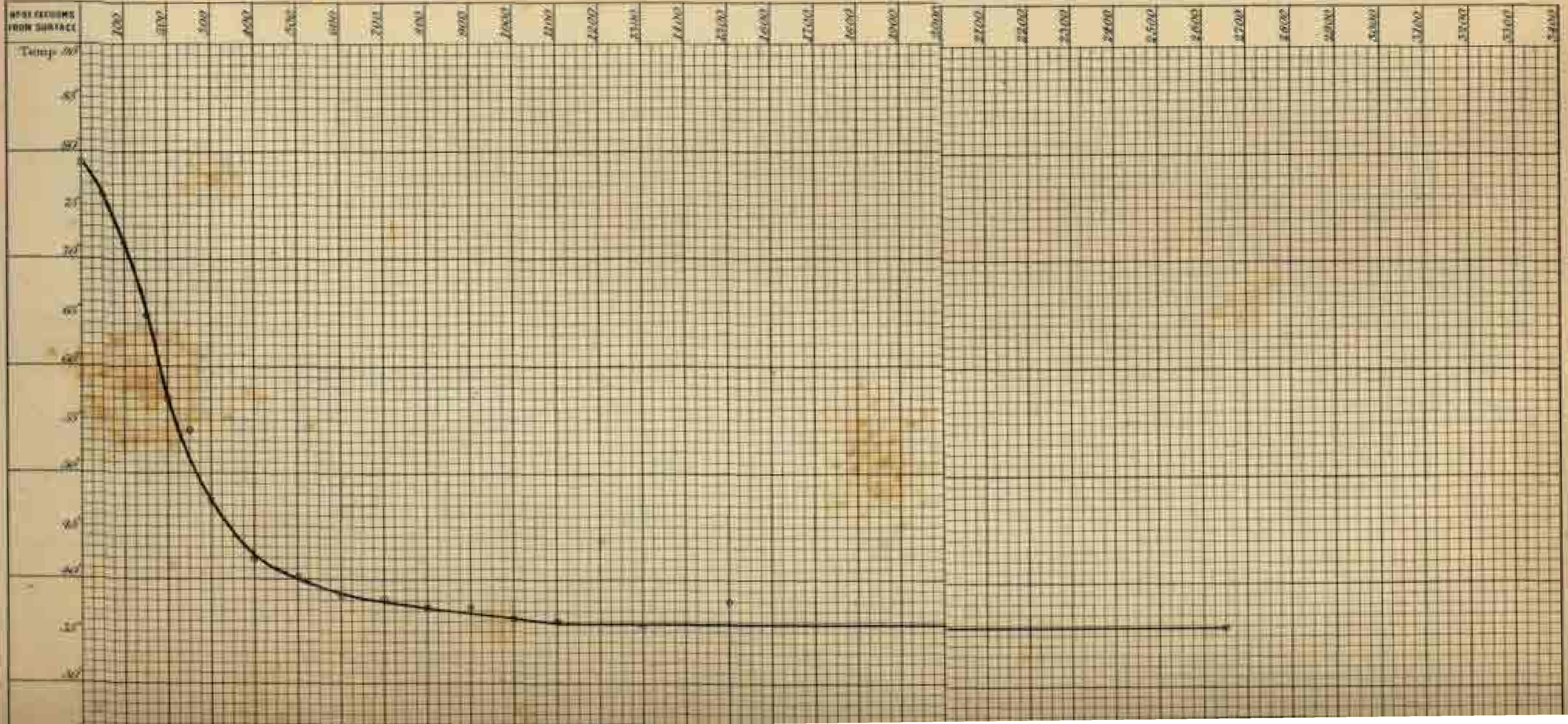
19 August 1874.

N.º of Sounding 308.
Station 178.

Depth 2650 fathoms.

Latitude 16° 47′ S.
Longitude 165° 20′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						82					73					94					94		73		82	87	84	74	49	77	84	87	94		82		73								83 88
TEMPERATURE SHEWN BY THERMOMETER	79.0					76.0					71.5					64.8					57.0		54.0		47.5	42.0	40.8	38.5	38.1	37.4	37.2	36.9	36.0		35.7		38.0								35.7 35.8
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	79.0					76.0					71.5					65.0					57.0		51.5		47.5	42.3	40.0	38.5	38.0	37.4	36.8	36.3	35.8		35.8		35.8								35.8



SECTION. FIJI ISLANDS TO RAINE ISLAND.

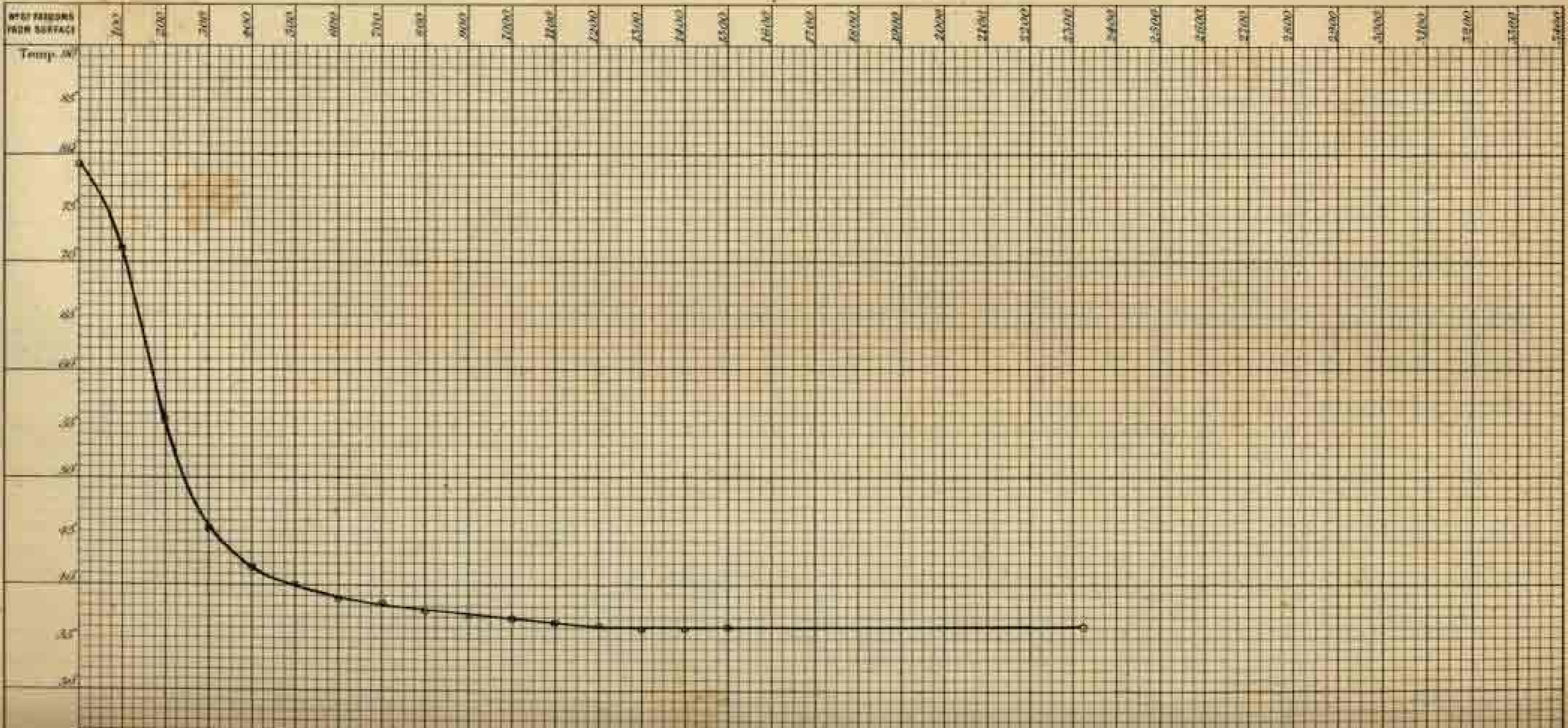
21 August 1874.

Depth 2325 fathoms.

Nº of Sounding 309.
Station 179.

Latitude 15° 58′ S.
Longitude 160° 48′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER											81 82										81 82				81 82	81 82	49	85	68	69	73	84	87	94	77	82	81								69 68
TEMPERATURE SHEWN BY THERMOMETER	79.0										71.0 71.2										55.5 55.5				45.2 45.3	41.6 41.6	40.0	38.8	38.3	37.7	39.0	36.8	36.4	36.2	35.9	35.9	36.0								35.9 36.0
ERROR OF THERMOMETER	0.0										0.0 0.0										0.0 0.0				0.0 0.0	0.0 0.0	0.0	0.0	0.0	0.0	−1.8	0.0	0.0	0.0	0.0	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	79.0										71.0 71.2										55.5 55.5				45.2 45.3	41.6 41.6	40.0	38.8	38.3	37.7	37.2	36.8	36.4	36.2	35.9	35.9	36.0								35.9 36.0
TEMPERATURE FROM CURVE	79.0										71.1										55.5				45.2	41.6	40.0	38.9	38.3	37.7	37.2	36.8	36.4	36.0	36.0	36.0	36.0								36.0



24 August 1874.

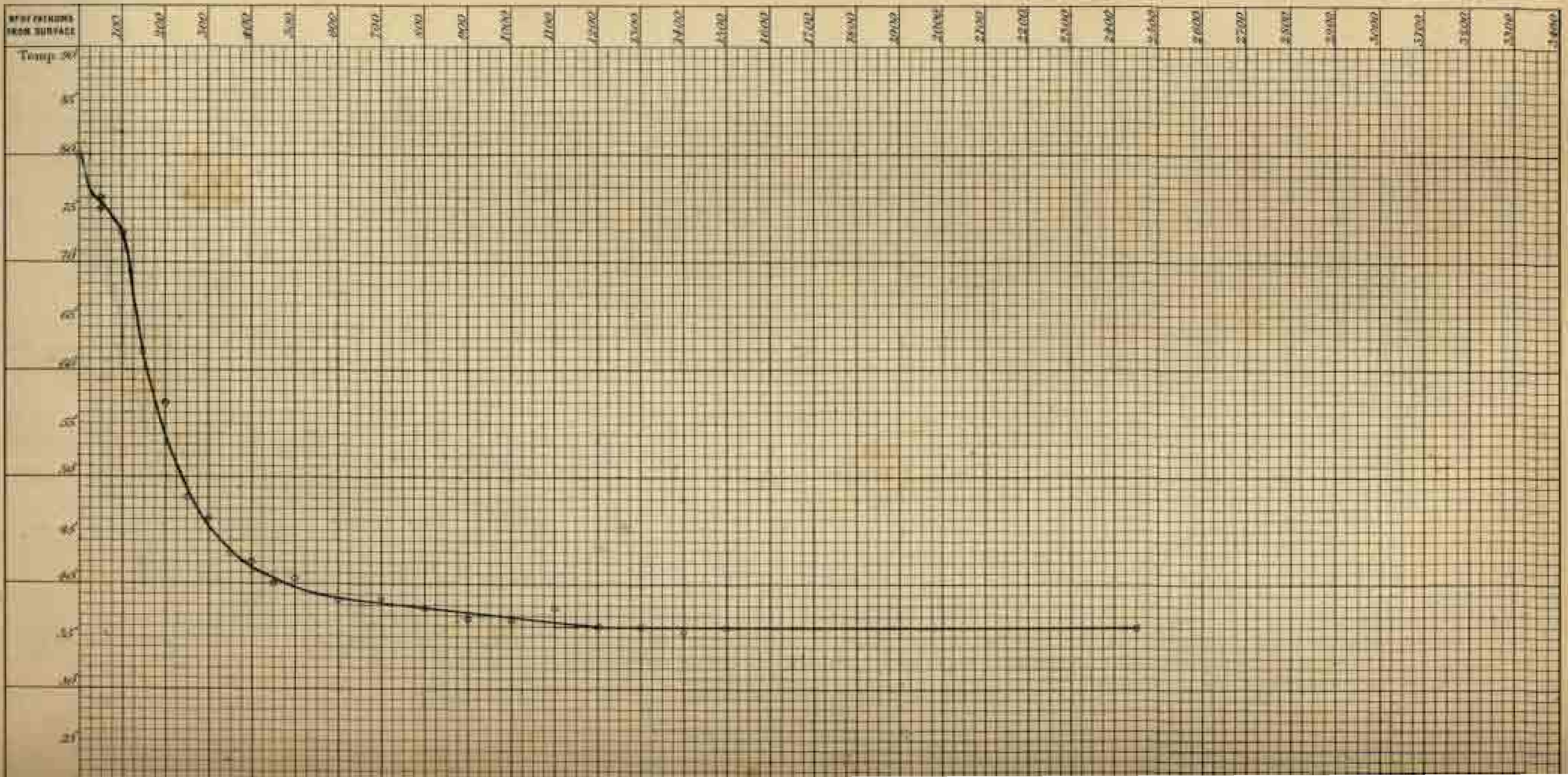
Nº of Sounding 310.
Station 180.

Depth 2450 fathoms.

Latitude 14° 7′ S.
Longitude 155° 43′ E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº of thermometer						69 49					77					82					87
Temperature shewn by thermometer	80.0					75.8 75.0					72.8					61.8					57.0
Error of thermometer																					
Corrected temperature																					
Temperature from curve	80.0					78.4					72.8					61.8					53.5

Nº of fathoms from surface	250	300	350	400	450	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	81	67	87	82	43	68	94	74	69	84	77	49	61	82	85	87								68 69
Temperature shewn by thermometer	48.0	46.0	42.9	42.0	40.0	40.5	38.5	38.6	37.8	36.7	36.6	37.8	36.1	36.0	35.6	36.0								35.8 36.0
Error of thermometer																								
Corrected temperature																								
Temperature from curve	48.5	45.5	43.2	41.5	40.5	39.6	38.8	38.3	37.8	37.3	36.8	36.4	36.0	36.0	36.0	36.0								36.0 36.0



SECTION. FIJI ISLANDS TO RAINE ISLAND.

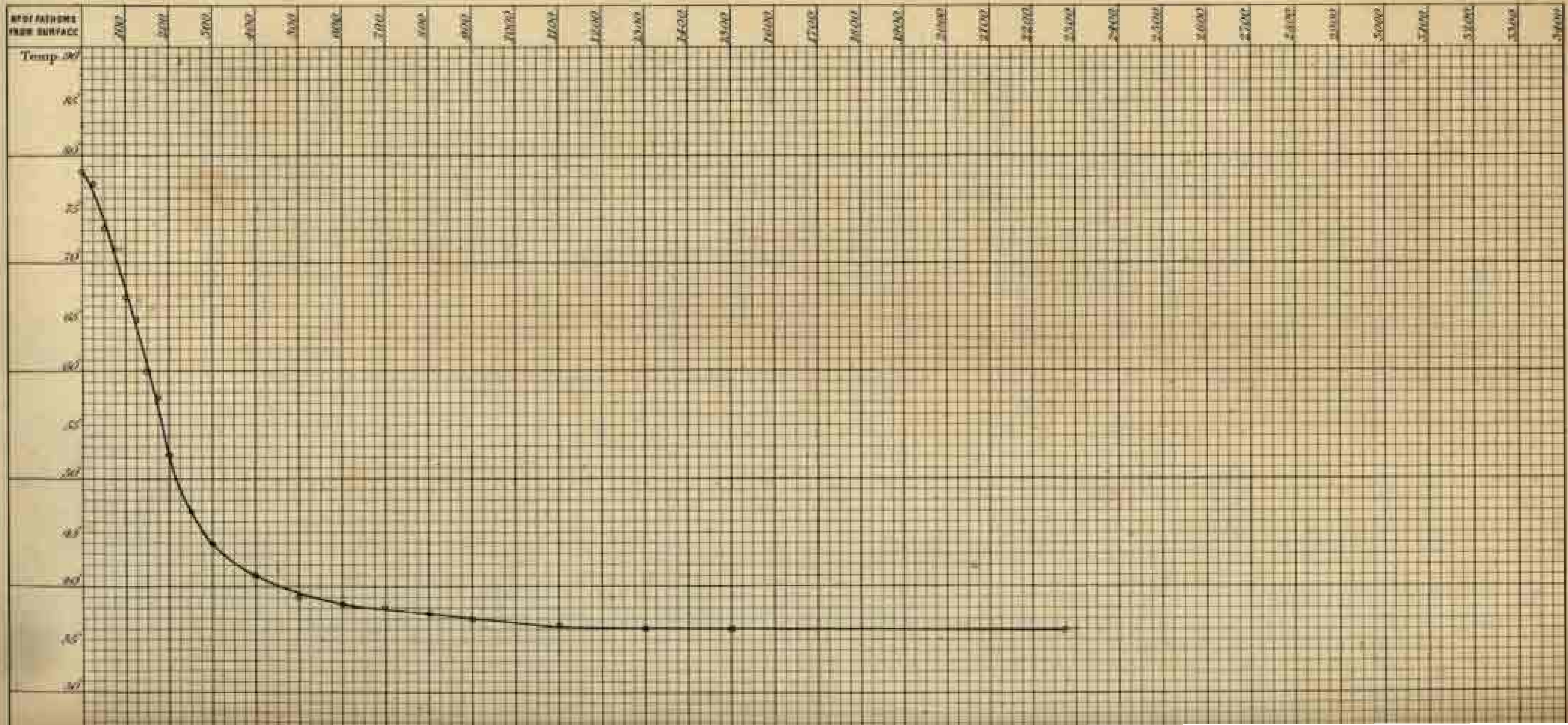
27 August 1874.

Nº of Sounding 312.
Station 182.

Depth 2275 fathoms

Latitude 13° 6′ S
Longitude 148° 37′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			69			85		80			74		68			81		69			82		87		77	76	89	85	74	81	82		87		77		78								68 69
TEMPERATURE SHEWN BY THERMOMETER	78.5		77.3			73.2		71.4			66.8		64.8			60.0		57.6			52.2		47.0		44.0	41.0	39.0	38.3	38.0	37.4	37.0		36.3		36.0		36.0								35.8 35.8
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.5		77.0			74.0		71.0			67.3		64.0			60.4		56.0			52.0		47.0		44.0	41.0	39.3	38.3	37.9	37.4	37.0		36.1		35.8		35.8								35.8



SECTION. FIJI ISLANDS TO RAINE ISLAND

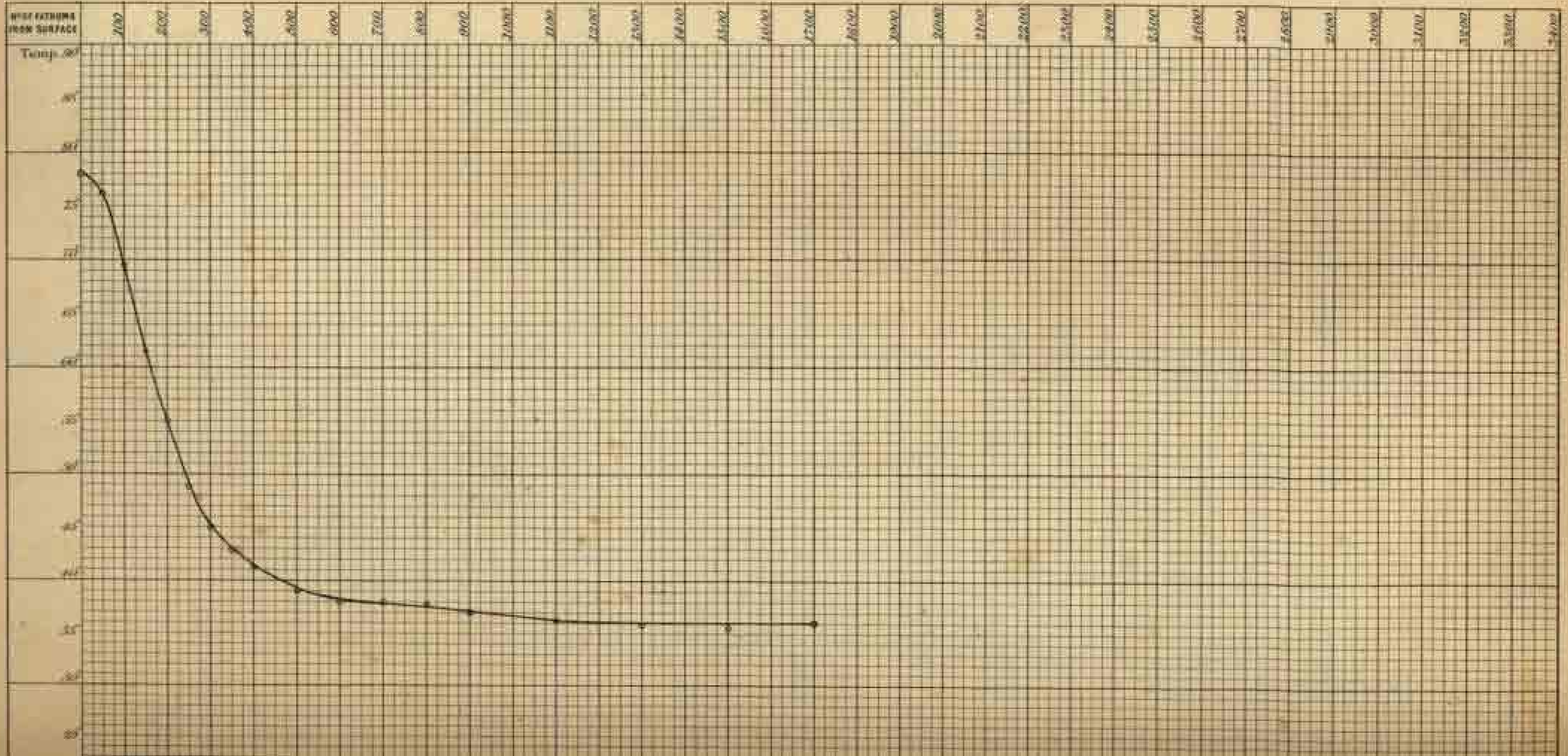
28 August 1874.

Nº of Sounding 313.
Station 183.

Depth 1700 fathoms.

Latitude 12° 42′ S.
Longitude 146° 46′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						94					82					69					80		88	82	87	89	94	77	74	87	84		81		76		89								[illegible]
TEMPERATURE SHEWN BY THERMOMETER	78.0					76.4					69.5					61.3					55.0		48.8	45.0	42.8	41.0	39.4	38.0	38.0	37.8	37.0		36.2		35.8		35.5								36.0 36.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	78.0					75.9					69.3					61.5					54.5		48.9	45.0	42.8	41.2	39.3	38.4	37.9	37.5	37.1		36.3		36.0		36.0								36.0



SECTION. FIJI ISLANDS TO RAINE ISLAND.

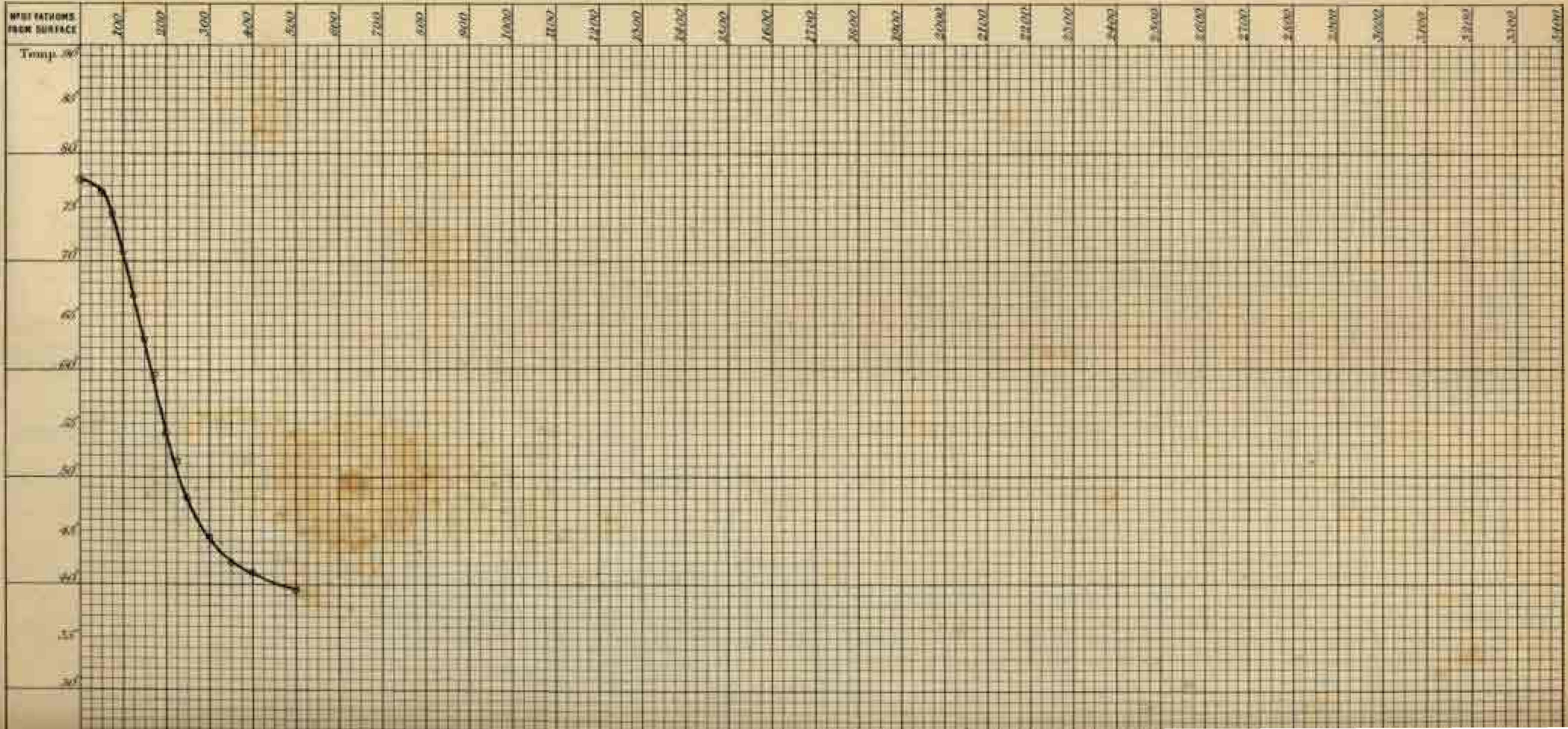
29 August 1874.

Nº of Sounding 314.
Station 184.

Depth 1400 fathoms.

Latitude 12° 8′ S.
Longitude 145° 10′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER						82		82			87		81			68		69			89	68	69	87	82	68	69																		68 69
TEMPERATURE SHEWN BY THERMOMETER	77.5					76.6		74.2			70.8		66.8			62.8		59.1			54.0	51.3	48.0	44.3	42.0	41.0	39.8																		36.0 36.0
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	77.5					76.0		74.2			70.8		66.8			62.5		58.2			54.2	51.0	48.0	44.3	42.1	41.0	39.7																		36.0



SECTION IN BANDA SEA.

23 September 1874.

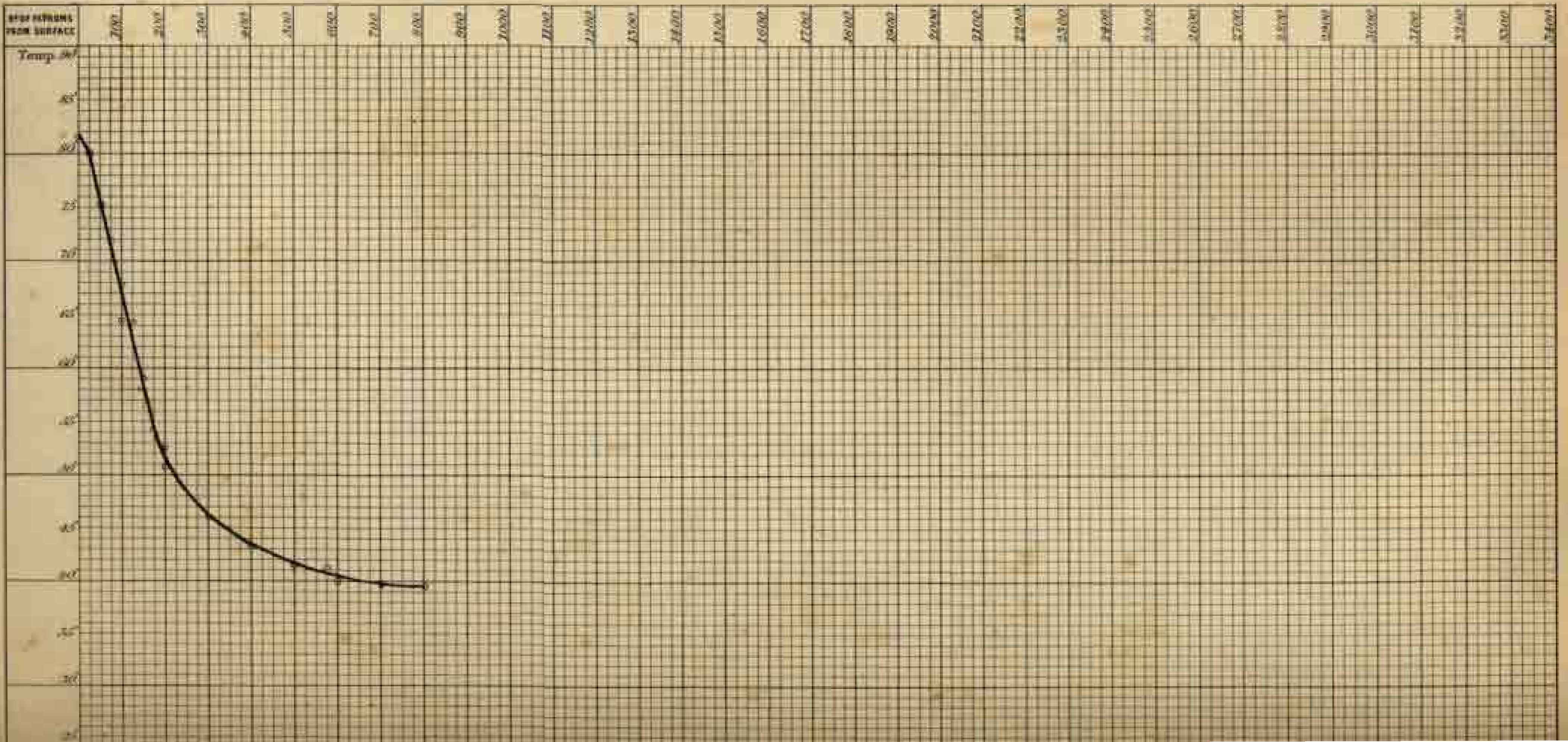
Nº of Sounding 323.
Station 191.

Depth 800 *fathoms.*

Latitude 5° 41′ 0″ S.
Longitude 134° 4′ 30″ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
Nº OF THERMOMETER											89									
TEMPERATURE SHOWN BY THERMOMETER	82.0										64.5									
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	82.0										67.5									

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	74				81	82	76	68	69																69 68
TEMPERATURE SHOWN BY THERMOMETER	50.8				46.0	43.2	41.5	40.0	39.8																39.5 39.4
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	51.5				46.0	43.2	41.5	40.3	39.8																39.3



SECTION. IN BANDA SEA.

24 September 1874.

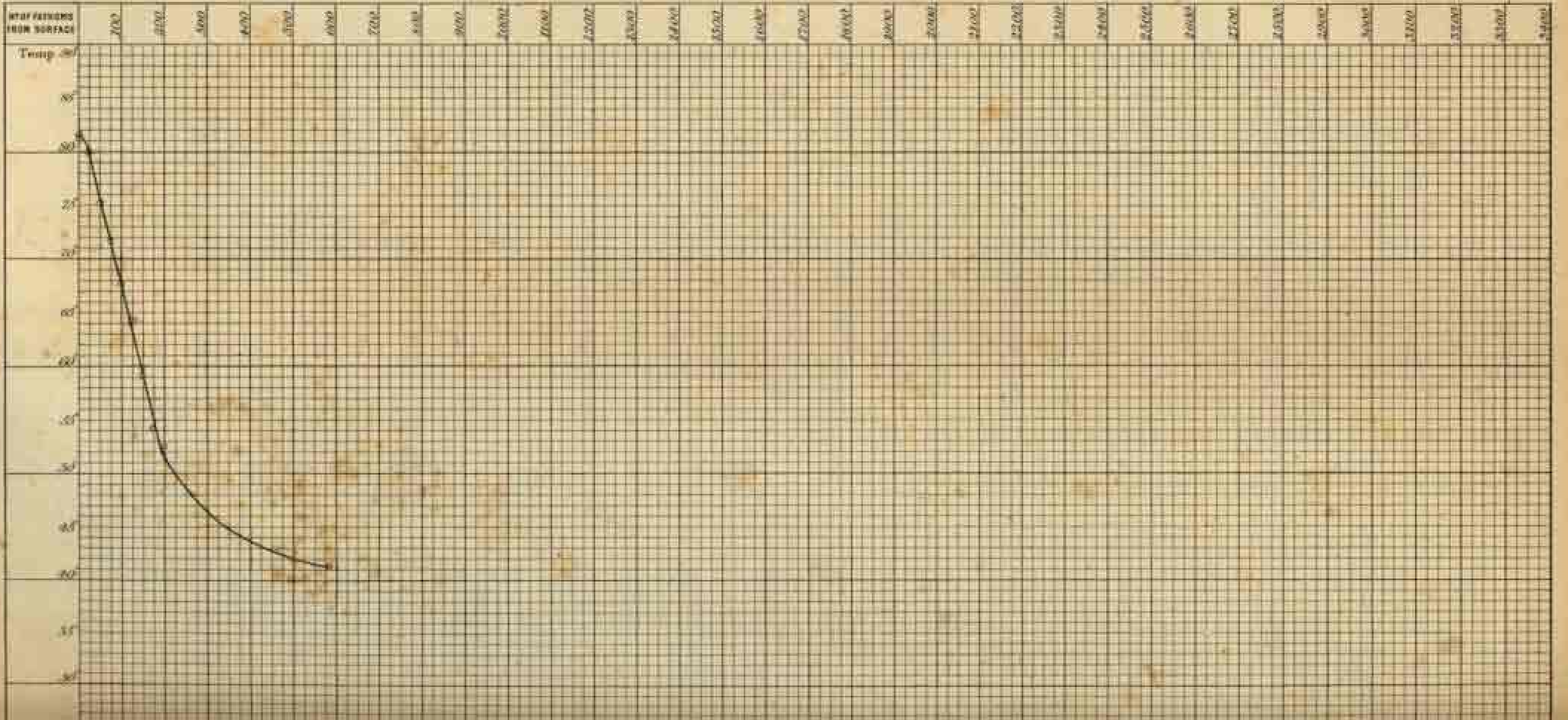
Nº of Sounding 324
Station 191 a.

Depth 580 fathoms.

Latitude 5° 26′ S.
Longitude 133° 19′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER			95			79		81			87		80			76		69			68
TEMPERATURE SHEWN BY THERMOMETER	81.5		80.0			78.4		71.7			67.7		64.0			59.0		54.8			52.5
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	81.5		80.0			78.5		71.5			67.5		65.0			59.0		54.7			51.5

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																								[illegible] [illegible]
TEMPERATURE SHEWN BY THERMOMETER																								41.2 41.0
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE																								41.2



SECTION IN BANDA SEA.

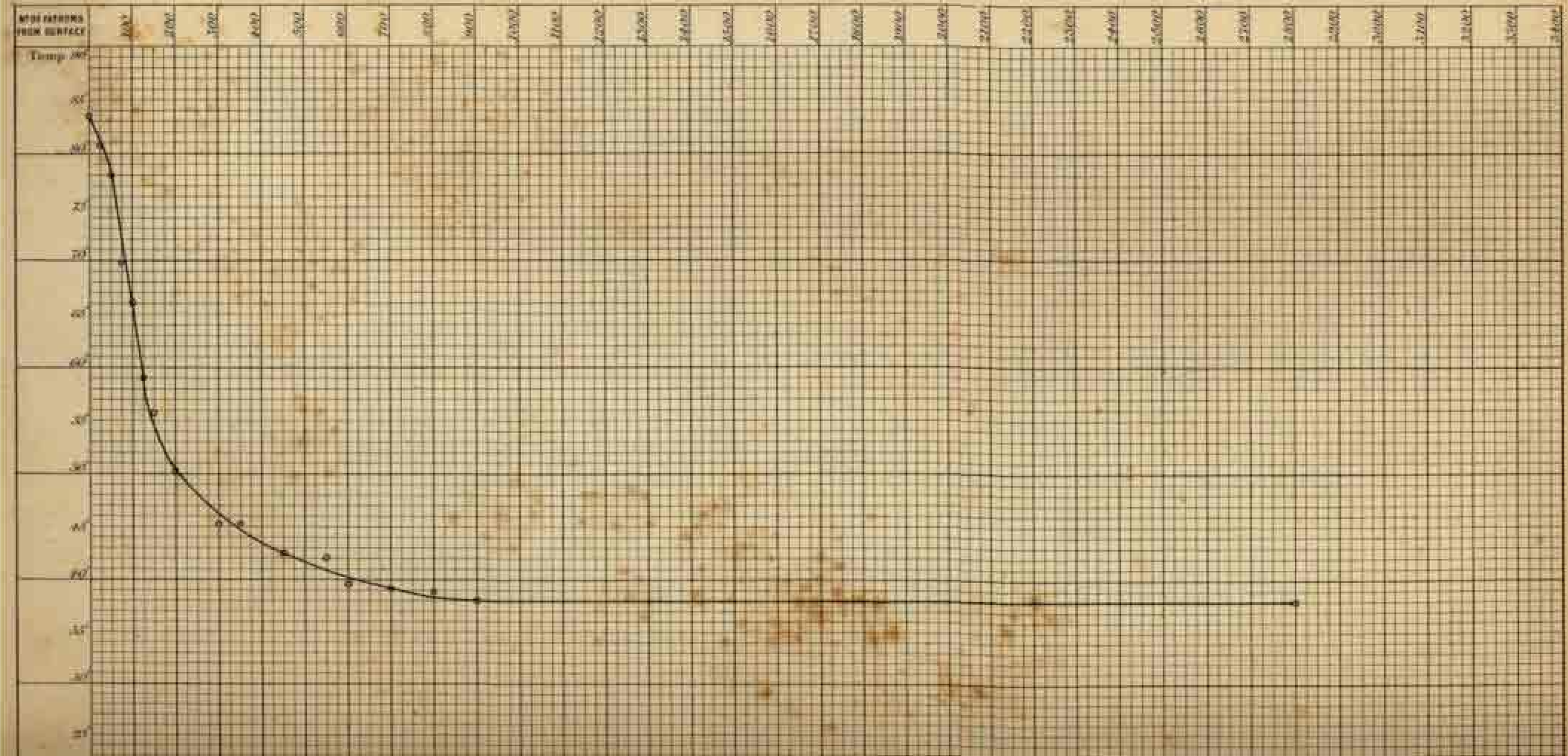
28 September 1874.

No. of Sounding 326.
Station 193.

Depth 2800 fathoms.

Latitude 5° 24' 0" S.
Longitude 130° 37' 15" E.

No. of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	300	350	450	550	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			85			94		84			76		82			87					89			89	81	81	83	87	82	76	81		85		85		89								67 88
Temperature shewn by thermometer	83.3		80.8			78.0		69.7			66.0		60.0			55.8					50.2			45.2	45.1	42.6	40.0	39.6	39.1	38.8	38.0		37.8		37.8		37.3								37.9 38.0
Error of thermometer																																													
Corrected temperature																																													
Temperature from curve	83.3		81.0			78.0		72.0			66.0		60.0			55.3					50.2			46.0	44.7	42.6	40.7	40.1	39.2	38.3	38.0		38.0		38.0		38.0								38.0



SECTION. IN MOLUCCA PASSAGE.

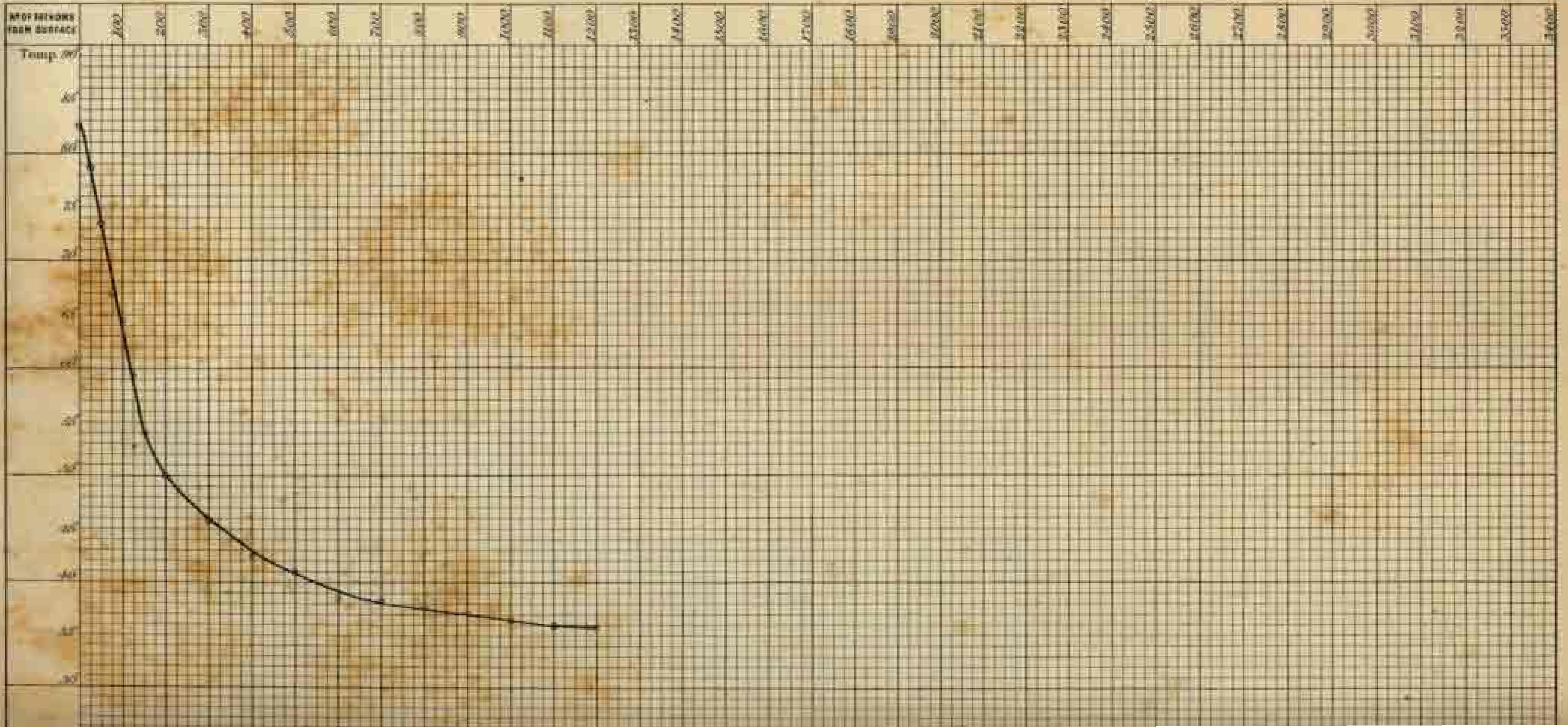
14 October 1874.

N.° of Sounding 331.
Station. 197.

Depth 1200 fathoms.

Latitude 0° 41′ N.
Longitude 126° 37′ E.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
N.° OF THERMOMETER			81			89		77			84		68			87					78				79	78	77	83	74	68	84	94	82											87 89
TEMPERATURE SHEWN BY THERMOMETER	82.5		78.8			73.5		69.0			64.4		53.2			54.0					50.0				45.8	43.4	41.0	38.8	38.2	37.7	37.1	36.5	36.0											36.0 35.8
ERROR OF THERMOMETER																																												
CORRECTED TEMPERATURE																																												
TEMPERATURE FROM CURVE	82.5		78.8			74.0		68.5			63.5		58.5			54.0					50.0				45.8	43.0	40.7	39.8	38.9	37.7	37.1	36.6	36.0											35.9



SECTION IN CELEBES SEA.

20 October 1874.

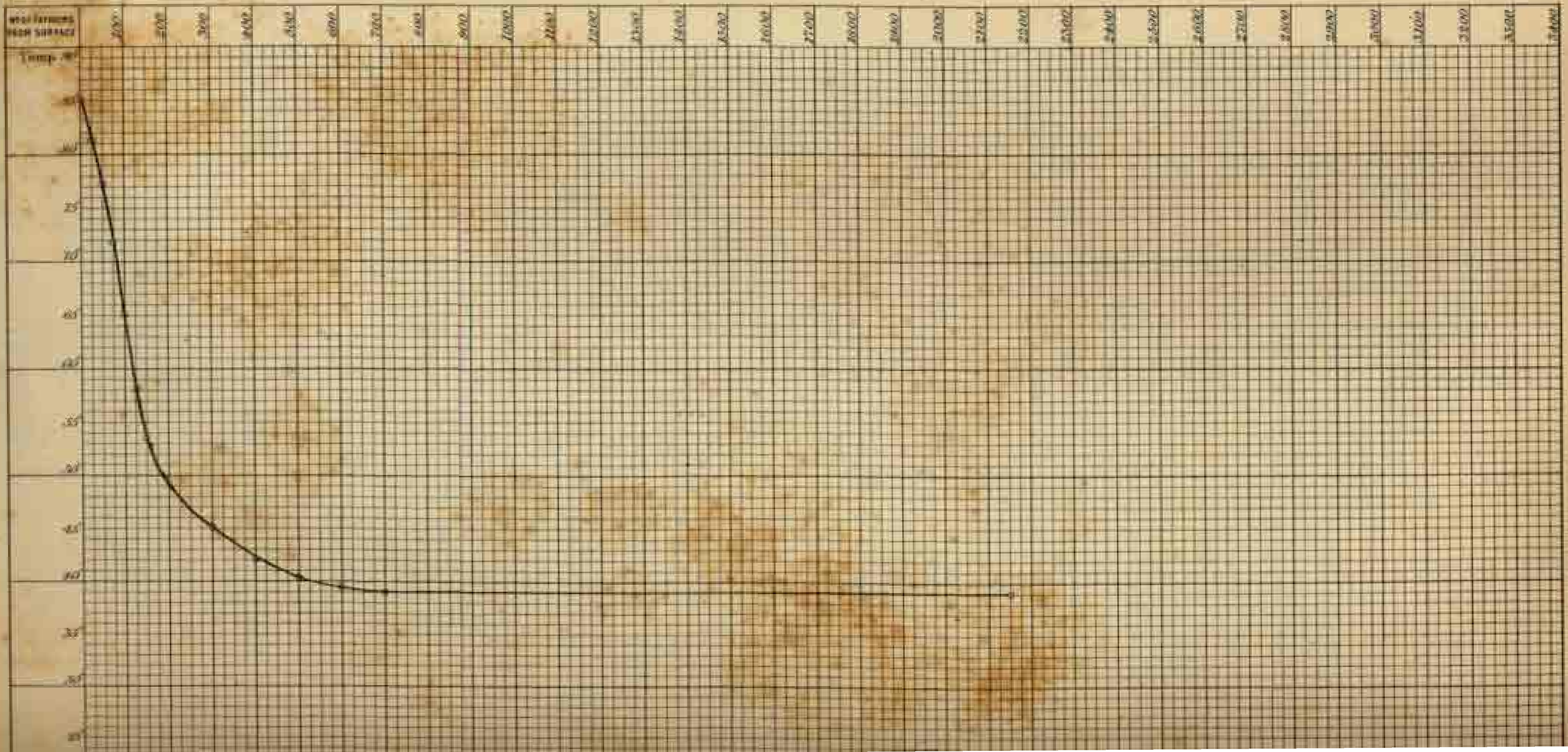
Nº of Sounding 332.
Station 198.

Depth 2150 fathoms

Latitude 2° 55′ N.
Longitude 124¼° 53′ E.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	170	180	190	200	225	250	275
NO. OF THERMOMETER			74			80		88			80		94			82					84			
TEMPERATURE SHEWN BY THERMOMETER	85.0		81.2			77.0		71.8			69.0		58.0			53.5					49.4			
ERROR OF THERMOMETER																								
CORRECTED TEMPERATURE																								
TEMPERATURE FROM CURVE	85.0		81.2			77.0		71.8			69.0		58.0			53.6					49.2			

NO. OF FATHOMS FROM SURFACE	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER	89	82 94	89	94	81	82 94 84															89 88
TEMPERATURE SHEWN BY THERMOMETER	45.0	42.0 42.0	40.3	39.3	39.0	39.0 39.0 39.0															39.0 38.8
ERROR OF THERMOMETER																					
CORRECTED TEMPERATURE																					
TEMPERATURE FROM CURVE	45.0	42.0	40.3	39.3	39.6	39.0															39.0



SECTION. IN CELEBES SEA.

22 October 1874.

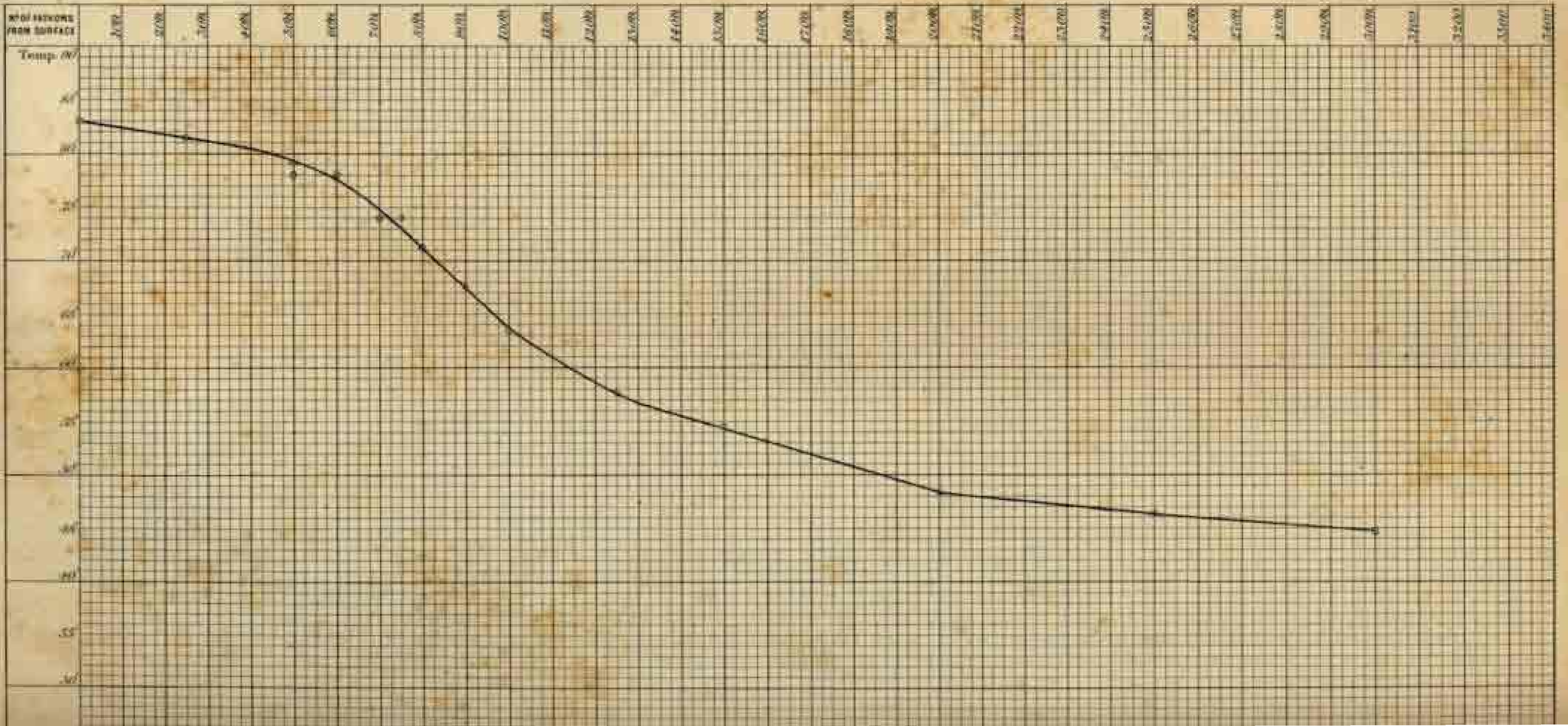
Nº of Sounding 233.
Station 199.

Depth 2000 fathoms.

Latitude 5° 44′ N.
Longitude 123° 34′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	70	75	80	90	100	125	130	140	150	160	170	180	190	200	225	250	275	300
Nº OF THERMOMETER			89			81 80	77	82	84	89	69	* 67	86			78					71		77		81
TEMPERATURE SHEWN BY THERMOMETER	83.0		81.4			78.0 79.2	78.0	74.6	74.0	71.2	67.5	61.8	57.6			54.5					48.3		46.2		44.8
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	83.0		82.5			79.2	77.7	74.8	72.9	71.2	67.3	63.8	57.6			54.6					48.3		46.2		44.8

Nº OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																				[illegible]
TEMPERATURE SHEWN BY THERMOMETER																				38.8 38.3
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE																				38.3



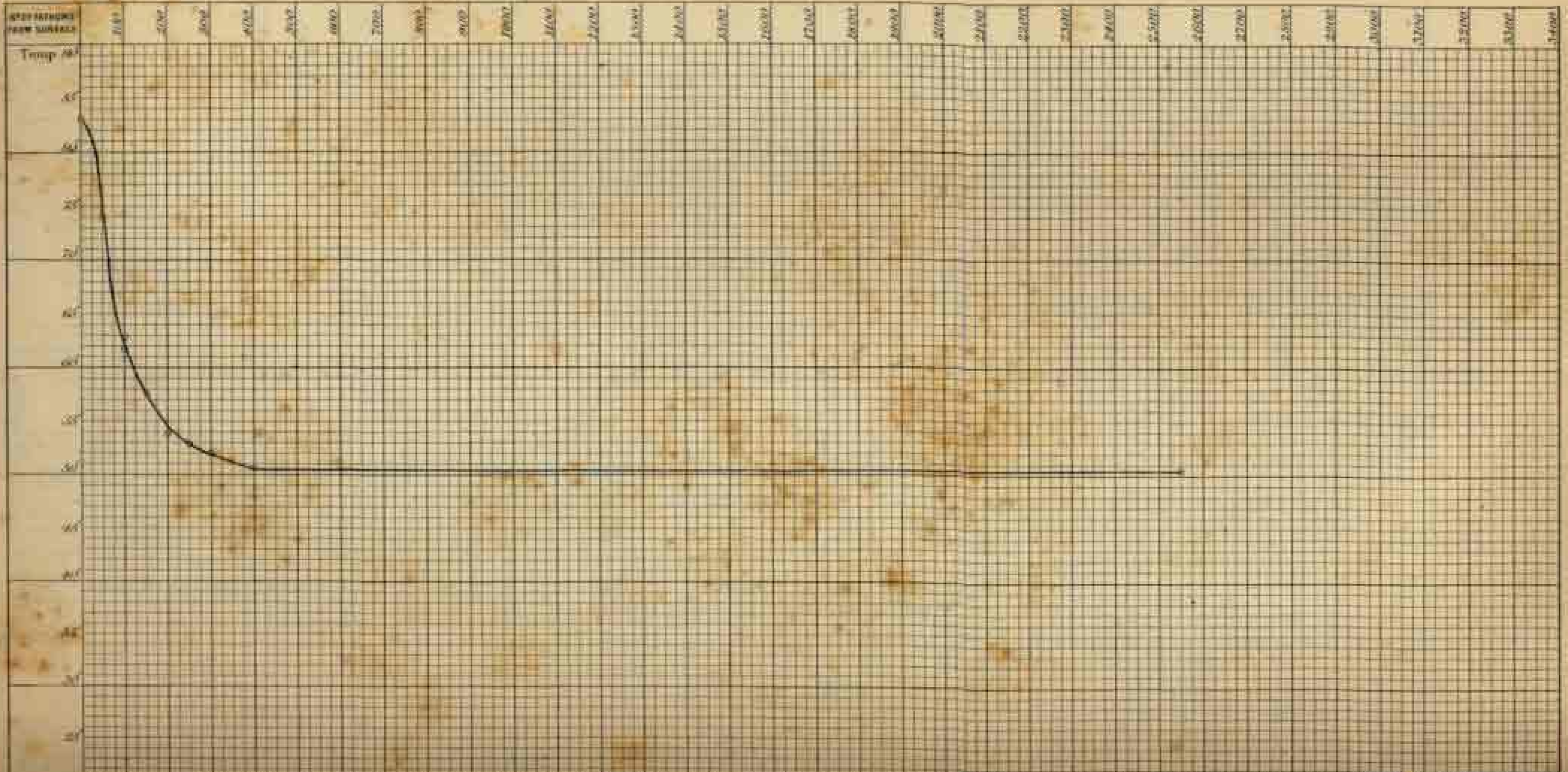
27 October 1874.

N° of Sounding 336.
Station 202.

Depth 2550 fathoms.

Latitude 8° 32′ N.
Longitude 121° 55′ E.

N° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER						87					87 89					74					89		87		77 94 77	87	74	94																	68 69
TEMPERATURE SHEWN BY THERMOMETER	83.0					74.7					69.3 68.9					57.4					53.8		52.3		52.2 52.0 52.0	50.3	50.4	50.1																	50.8 50.7
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	83.0					74.1					69.0					57.5					54.3		52.8		52.0	50.5	50.5	50.5																	50.5



SECTION. IN CHINA SEA.

13 November 1874.

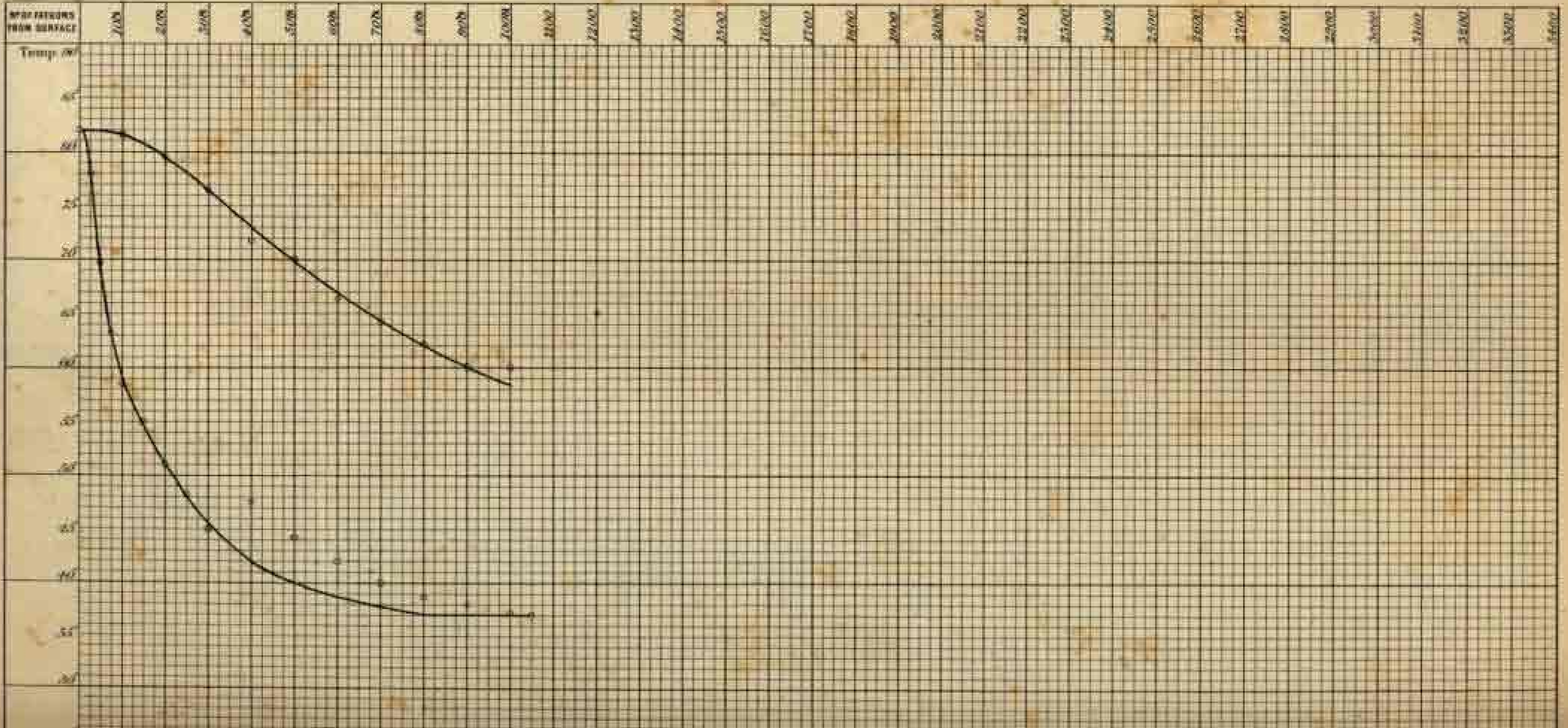
No. of Sounding 341.
Station 205.

Depth 1050 fathoms.

Latitude 16° 42′ N.
Longitude 119° 22′ E.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
No. of Thermometer		87	68	74	76	91	69	84	82	94	82					84				
Temperature shewn by Thermometer	82.0	81.5	79.5	76.3	71.8	70.0	66.4	64.2	62.2	60.0	60.0					55.0				
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	82.0	81.3	79.5	76.3	73.2	69.8	66.8	64.2	62.0	60.0	58.6					55.0				

No. of Fathoms from Surface	200	225	250	275	300	400*	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	69		88		81	78	94	77	81	68	69	84													68 69
Temperature shewn by Thermometer	51.0		48.2		45.0	47.5	44.2	40.0	40.0	38.2	38.0	37.8													37.0 37.0
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	51.2		48.0		45.3	42.0	40.0	38.8	37.8	37.0	37.0	37.0													37.0



SECTION. IN CHINA SEA.

8 January 1875.

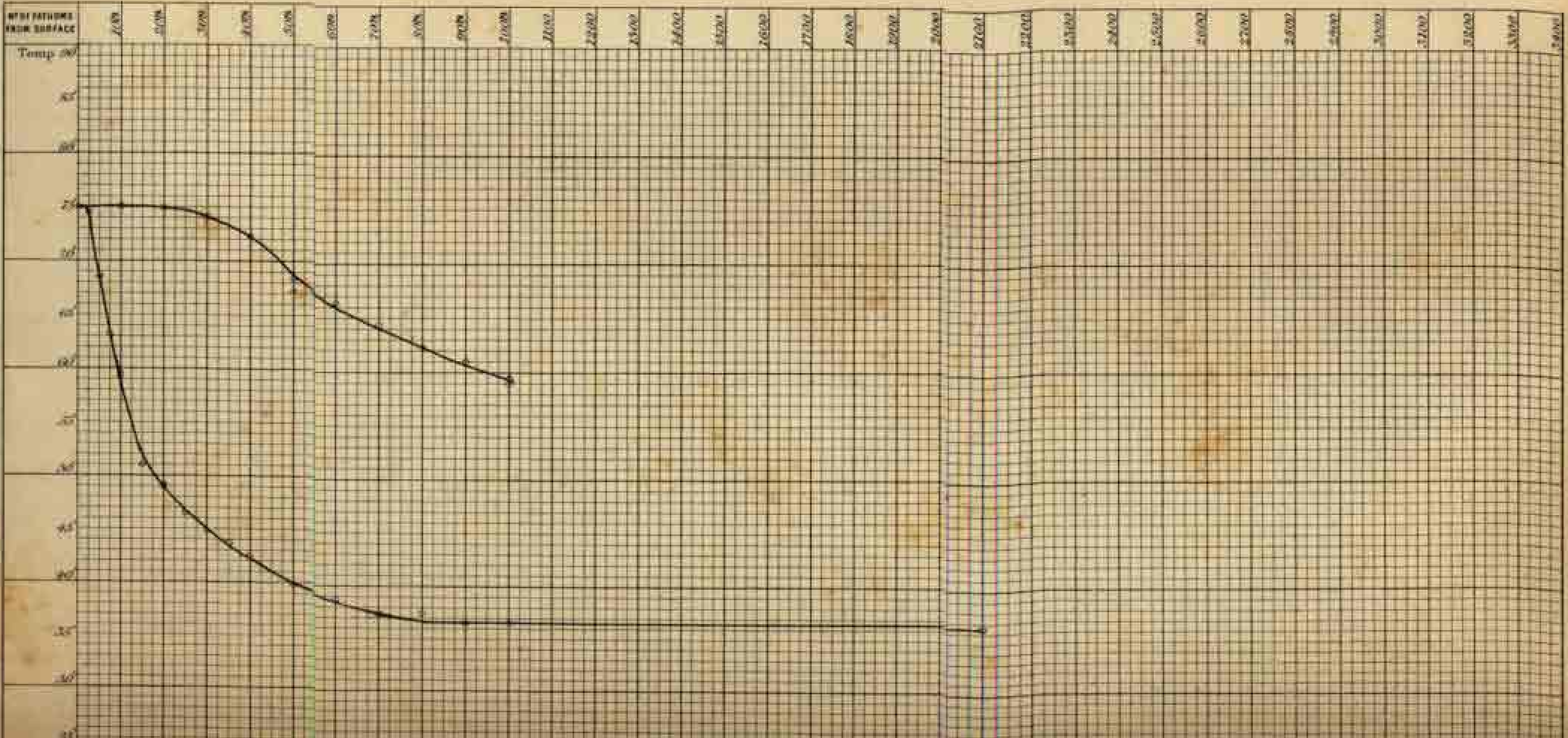
N.º of Sounding 342.
Station 206.

Depth 2100 fathoms.

Latitude 17° 54′ N.
Longitude 117° 14′ E.

N.º OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
N.º OF THERMOMETER		76	77	81	69	87 94	82	69	26	84	94 84					26				
TEMPERATURE SHEWN BY THERMOMETER	75.2	75.1	75.1	74.8	72.3	68.1 67.2	66.6	64.5	62.3	61.0	59.0 59.3					52.0				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE	75.2	75.1	75.0	74.7	72.3	68.5	66.0	64.0	62.2	60.6	59.2					51.6				

N.º OF FATHOMS FROM SURFACE	200	225	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.º OF THERMOMETER	69		72	87	68	87	82	69	26	84	94	68													68 69
TEMPERATURE SHEWN BY THERMOMETER	49.0		46.4	45.0	43.8	42.5	41.0	38.9	37.4	37.3	36.5	36.5													36.8 36.5
ERROR OF THERMOMETER																									
CORRECTED TEMPERATURE																									
TEMPERATURE FROM CURVE	48.5		46.5	45.0	43.6	42.4	41.0	38.7	37.5	36.7	36.5	36.5													36.5



SECTION. IN THE INNER WATERS OF THE PHILIPPINE ISLANDS.

16 January 1875.

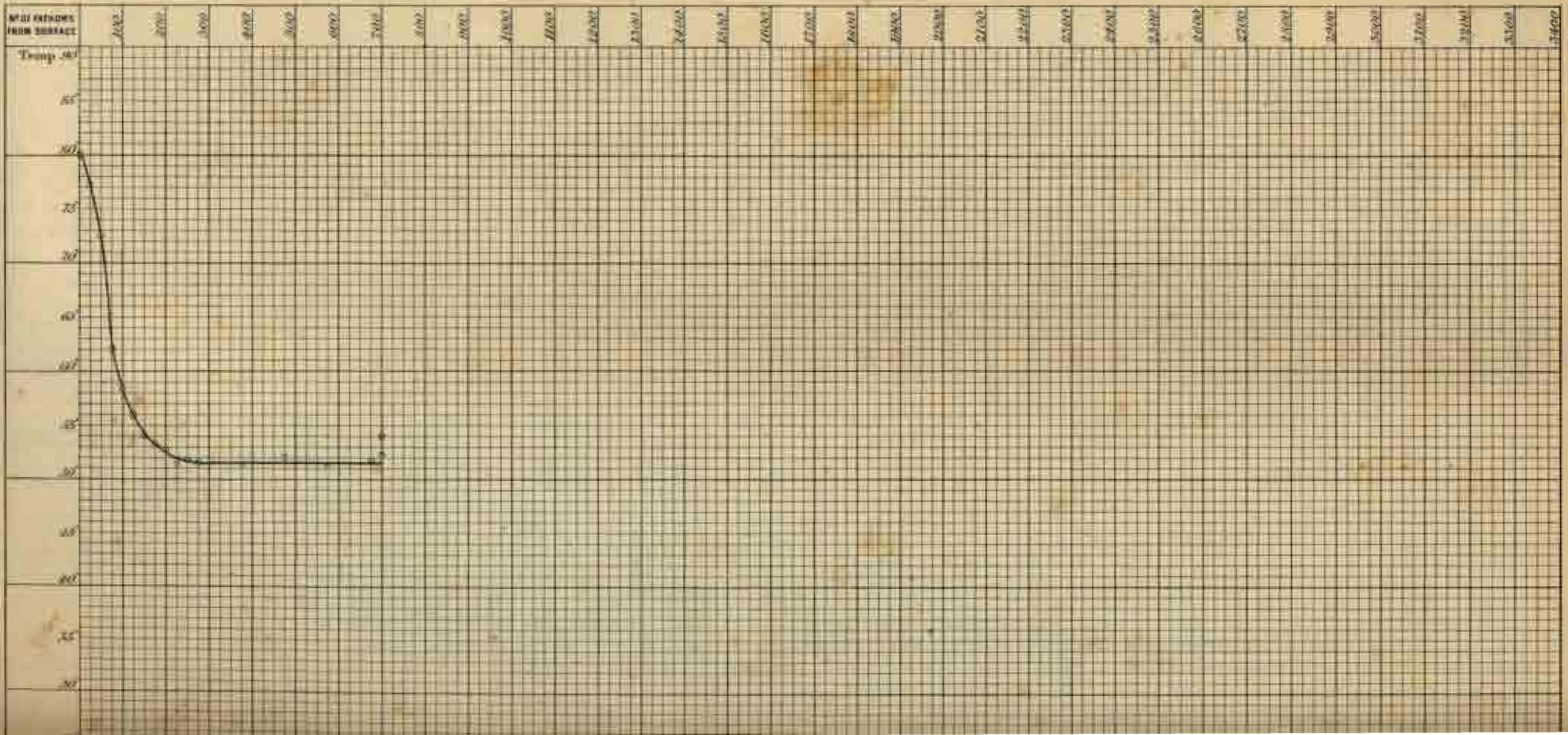
N° of Sounding 343.
Station 207.

Depth 700 *fathoms.*

Latitude 12° 21′ N.
Longitude 122° 15′ E.

N° of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
N° of Thermometer			74			94		87			89		77			82		76		
Temperature shown by Thermometer	80.0		77.0			72.6		60.0			58.5		56.0			54.0		53.1		
Error of Thermometer																				
Corrected Temperature																				
Temperature from Curve	80.0		77.0			72.5		60.0			58.5		56.0			54.2		53.1		

N° of Fathoms from Surface	200	225	250	275	375	475	575	675	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
N° of Thermometer	66	81	69	87	78	84	81	68																	84 69
Temperature shown by Thermometer	52.3	51.5	51.8	51.6	51.5	52.0	52.2	51.8																	52.0 52.2
Error of Thermometer																									
Corrected Temperature																									
Temperature from Curve	52.4	52.0	51.7	51.6	51.6	51.6	51.6	51.6																	51.6



SECTION. IN THE INNER WATERS OF THE PHILIPPINE ISLANDS.

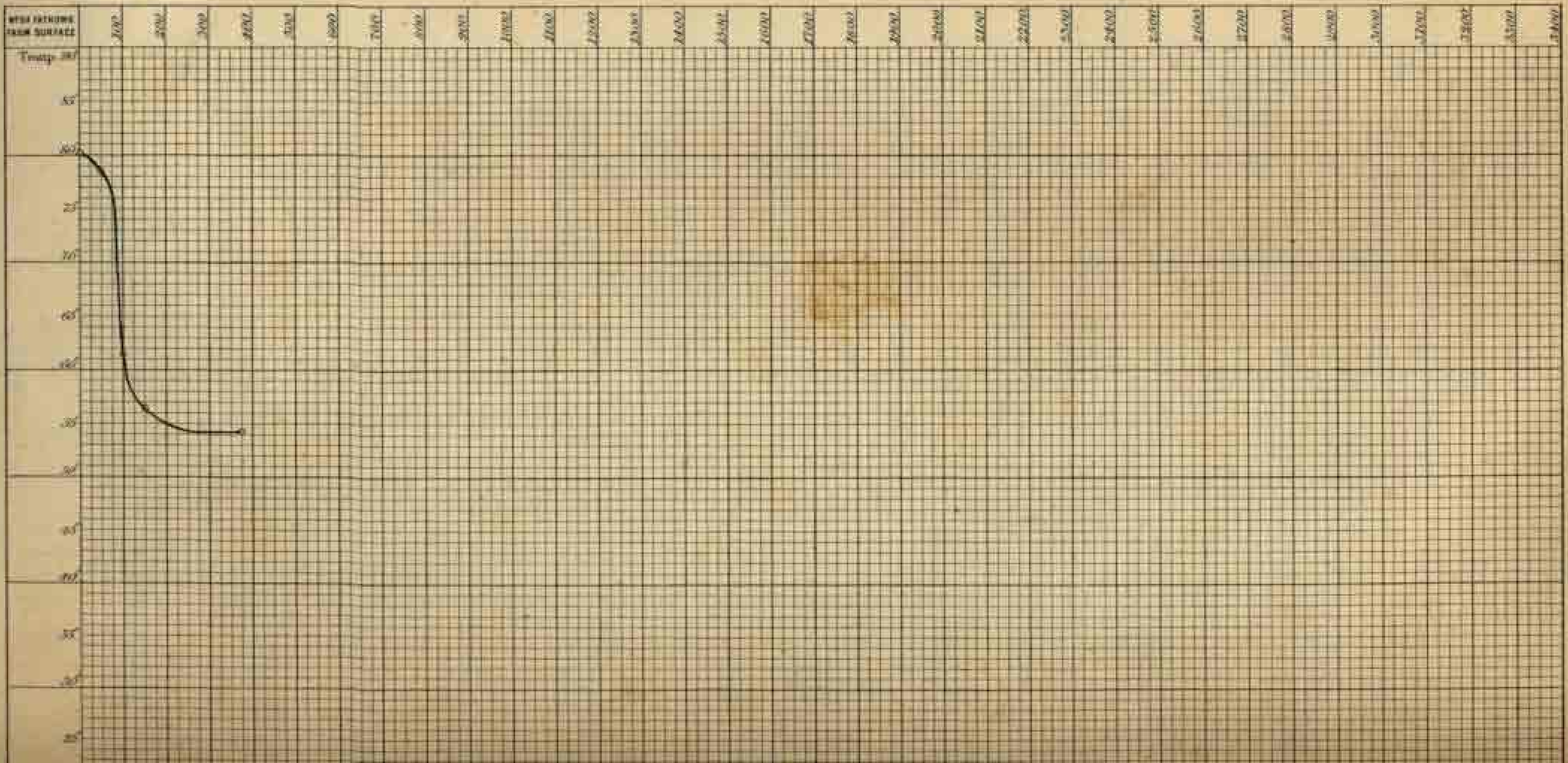
25 January 1875.

N.° of Sounding 346.
Station 210

Depth 375 *fathoms.*

Latitude 9° 26′ N.
Longitude 123° 45′ E.

NO. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
NO. OF THERMOMETER						84					68					89																													48 69
TEMPERATURE SHEWN BY THERMOMETER	80·2					78·5					61·5					56·6																													54·0 54·2
ERROR OF THERMOMETER																																													
CORRECTED TEMPERATURE																																													
TEMPERATURE FROM CURVE	80·2					78·5					61·3					56·6																													54·1



SECTION. IN SULU SEA.

28 January 1875.

N.° of Sounding 348.
Station 211.

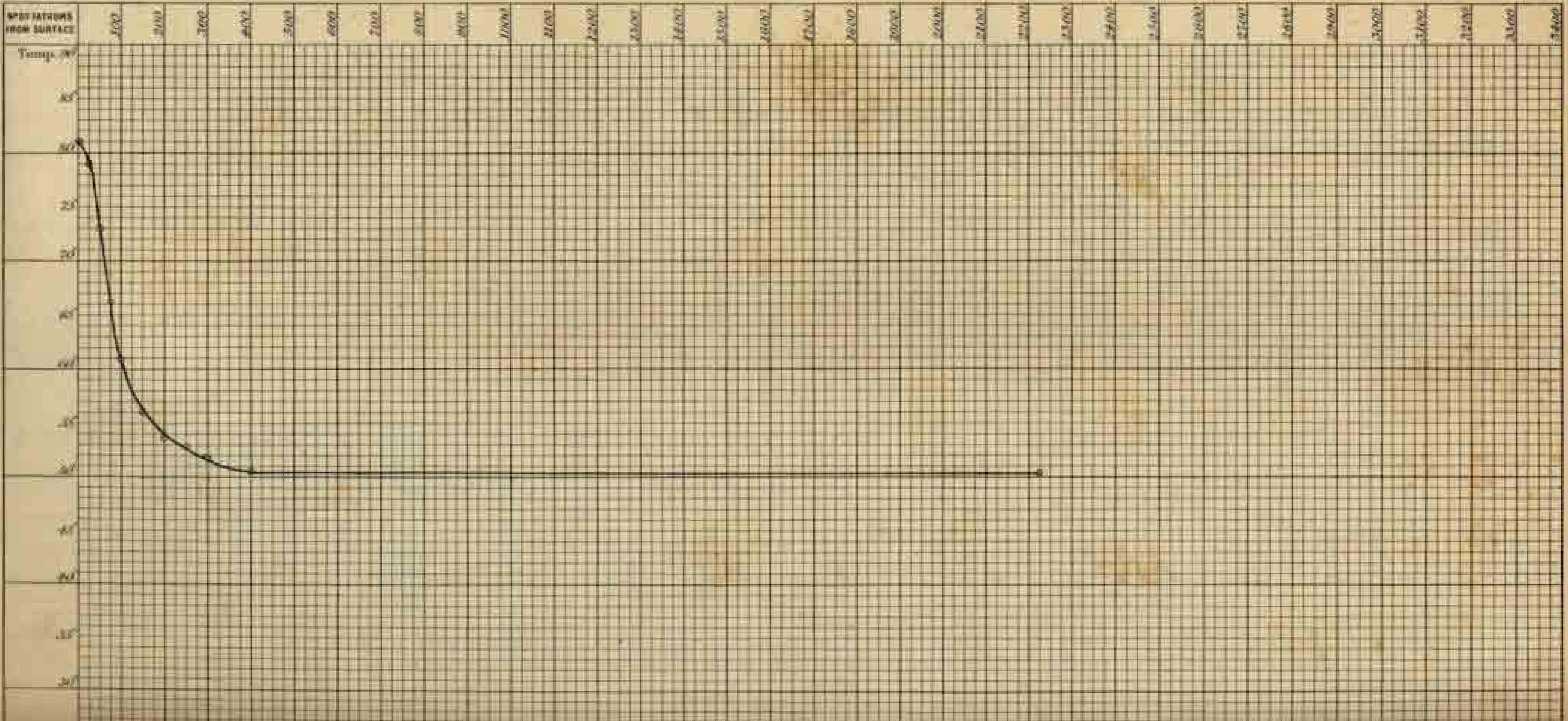
Depth 2225 *fathoms.*

Latitude 8° 0' N.
Longitude 121° 42' E.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	120	130	140
N° OF THERMOMETER			82			82		94			91				
TEMPERATURE SHEWN BY THERMOMETER	81.0		79.0			73.0		66.0			61.0				
ERROR OF THERMOMETER															
CORRECTED TEMPERATURE															
TEMPERATURE FROM CURVE	81.0		79.0			73.0		66.0			61.0				

N° OF FATHOMS FROM SURFACE	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800
N° OF THERMOMETER	77					76		84		69	68				
TEMPERATURE SHEWN BY THERMOMETER	56.0					53.8		52.6		51.8	50.5				
ERROR OF THERMOMETER															
CORRECTED TEMPERATURE															
TEMPERATURE FROM CURVE	56.0					53.8		52.3		51.8	50.5				

N° OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER															68 89
TEMPERATURE SHEWN BY THERMOMETER															50.4 50.8
ERROR OF THERMOMETER															
CORRECTED TEMPERATURE															
TEMPERATURE FROM CURVE															50.5



SECTION. IN CELEBES SEA.

8 February 1875.

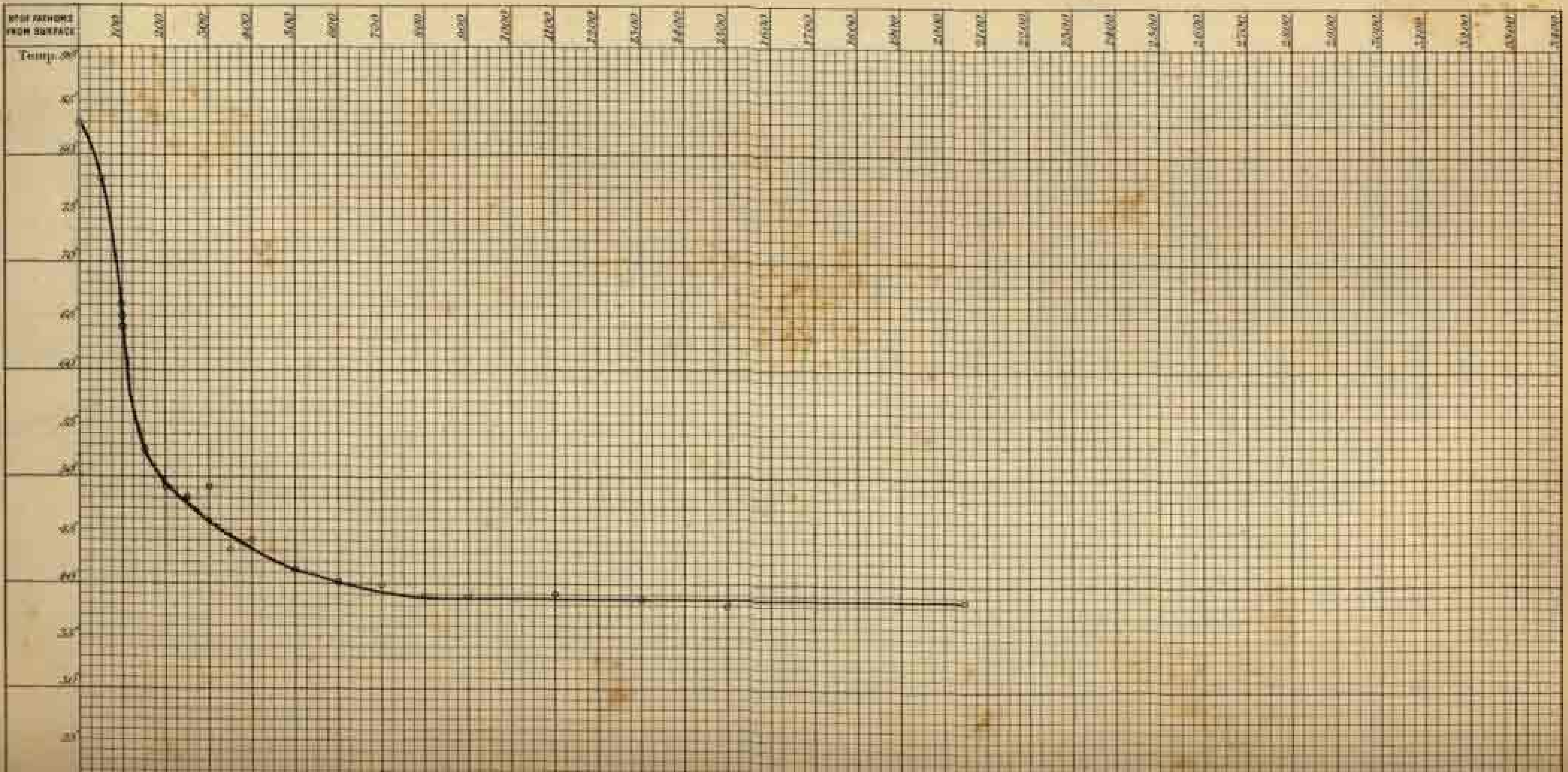
Nº of Sounding 350.
Station 218.

Depth 2050 *fathoms*

Latitude 5° 47′ N
Longitude 124° 1′ E

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
Nº OF THERMOMETER						74					74 64					82					81	
TEMPERATURE SHEWN BY THERMOMETER	83.0					77.8					65.0 64.0					52.5					49.0	
ERROR OF THERMOMETER																						
CORRECTED TEMPERATURE																						
TEMPERATURE FROM CURVE	83.0					77.8					65.0					52.5					49.3	

Nº OF FATHOMS FROM SURFACE	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	81	76 77	77	78	80	87	77 67	81	82		76		87		84								74 68
TEMPERATURE SHEWN BY THERMOMETER	48.0	45.8 45.0	43.7	44.0	41.2	40.0	39.5 39.8	38.8	38.8		39.0		38.3		38.0								38.8 38.4
ERROR OF THERMOMETER																							
CORRECTED TEMPERATURE																							
TEMPERATURE FROM CURVE	47.2	45.7	44.0	43.2	41.2	40.0	39.2	38.6	38.6		38.6		38.6		38.6								38.6



SECTION. MEANGIS ISLANDS TO ADMIRALTY ISLANDS.

10 February 1875.

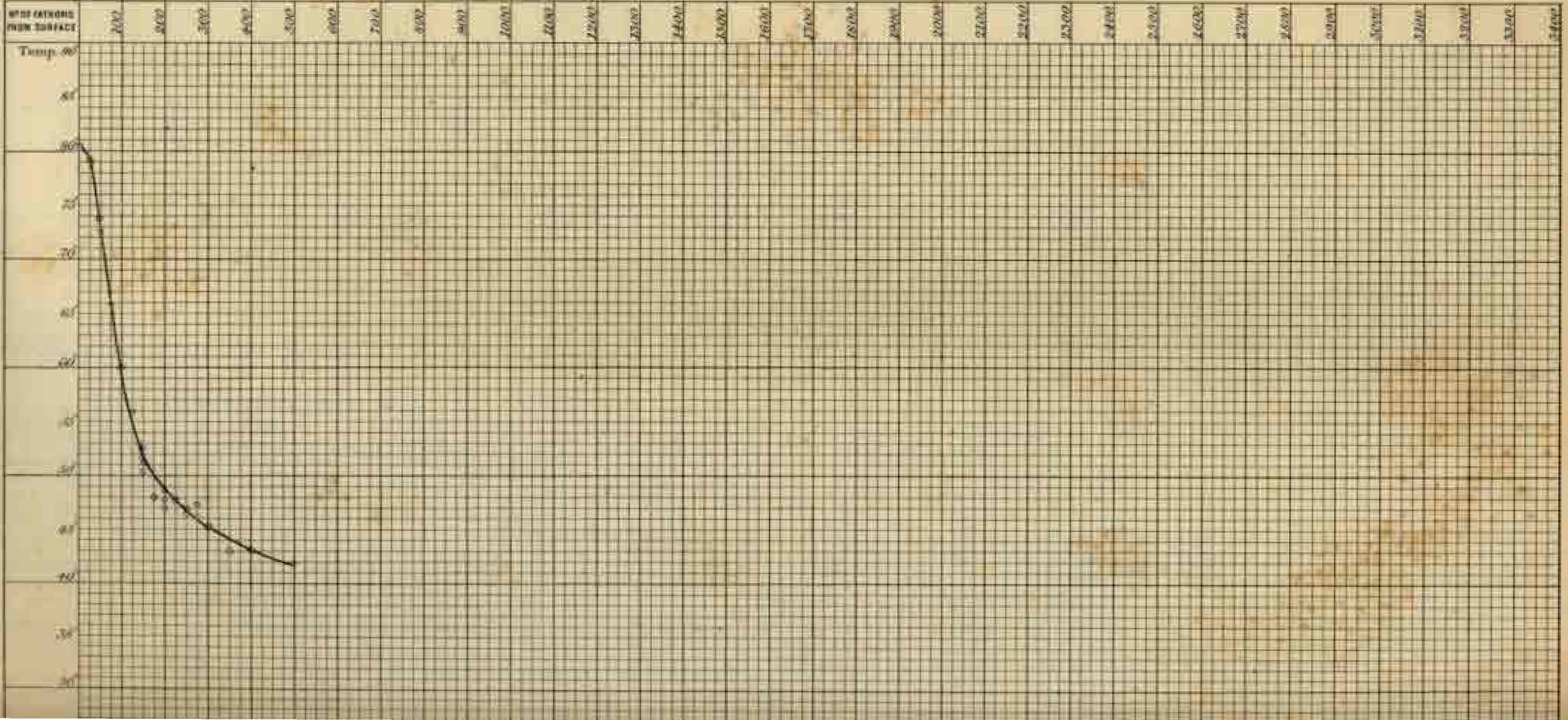
Nº of Sounding 351.
Station 214.

Depth 500 *fathoms*

Latitude 4° 33′ N.
Longitude 127° 6′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER			87			89 98		94			74		76			[illegible]		67			81 85 76
TEMPERATURE SHEWN BY THERMOMETER	80.3		79.0			72.2 73.8		66.0			60.0		56.0			[illegible]		48.0			48.5 47.2 47.0
ERROR OF THERMOMETER	0.0		+0.1			+0.2 0.0		−0.1			0.0		0.0			[illegible]		0.0			0.0 +0.5 0.0
CORRECTED TEMPERATURE	80.3		79.1			72.4 73.8		65.9			60.0		56.0			[illegible]		48.0			48.5 47.7 47.0
TEMPERATURE FROM CURVE	80.3		79.1			73.0		66.0			60.0		54.5			51.6		50.0			48.7

Nº OF FATHOMS FROM SURFACE	225	250	275	300	350	400	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	74	96 98	80 77	87	69	85																		69 87
TEMPERATURE SHEWN BY THERMOMETER	47.6	46.6 47.0	46.2 47.2	45.2	43.0	42.5																		41.8 41.8
ERROR OF THERMOMETER	+0.2	0.0 0.0	0.0 +0.2	+0.1	0.0	+0.5																		0.0 +0.1
CORRECTED TEMPERATURE	47.8	46.6 47.0	46.2 47.4	45.3	43.0	43.0																		41.8 41.9
TEMPERATURE FROM CURVE	47.3	46.3	45.9	45.2	43.8	43.0																		41.8



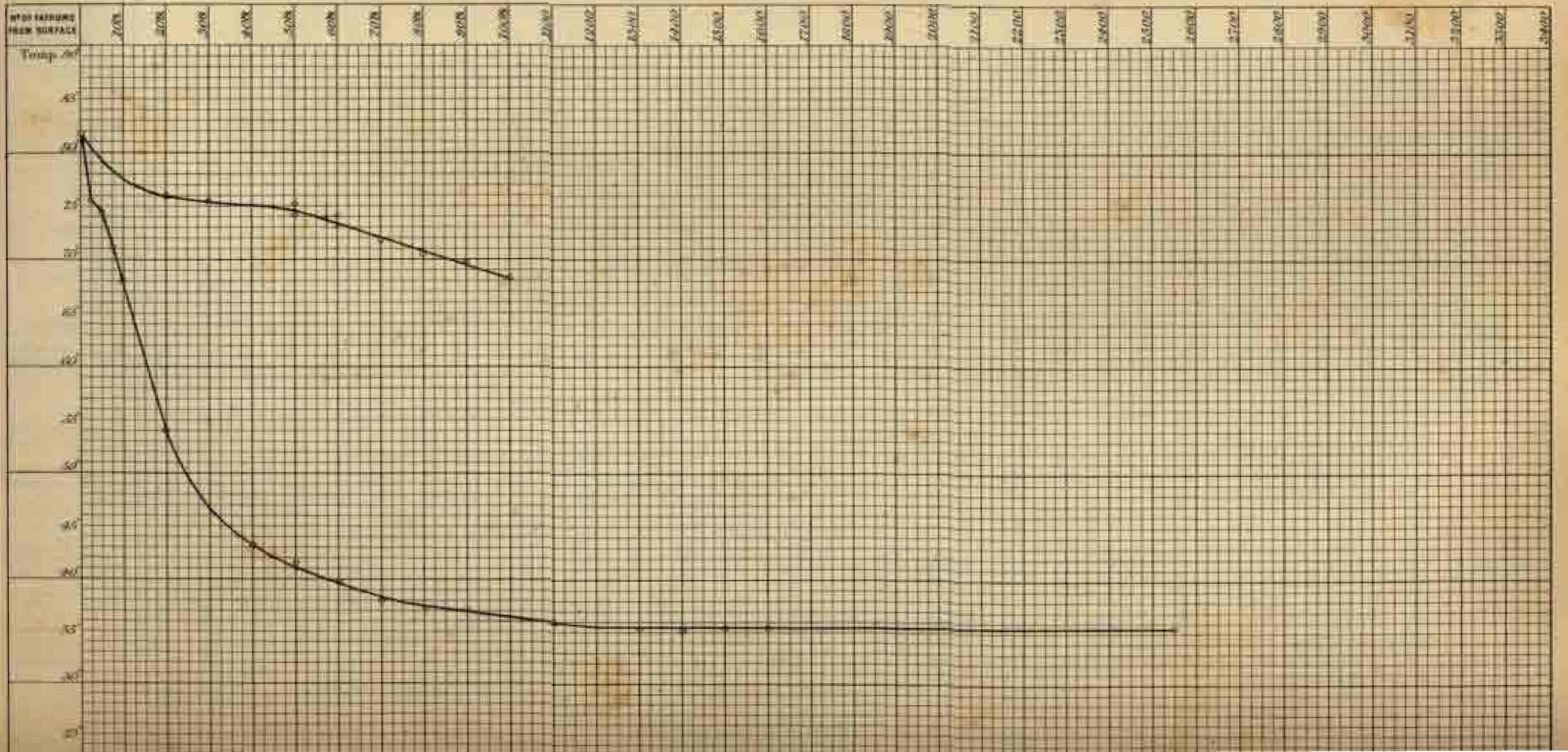
12 February 1875.

N.° of Sounding 352.
Station 215

Depth 2550 fathoms.

Latitude 4° 19′ N.
Longitude 130° 15′ E.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER		84	82	89	80	77 69	74	81	69	88	89										89					81	74	81	76	81	76		82		68	85	69	89							85 89
TEMPERATURE SHEWN BY THERMOMETER	81.3	80.0	76.0	75.2	75.0	75.0 74.0	74.0	71.8	70.4	69.8	68.0										53.8					43.2	41.3	39.9	38.0	37.4	37.2		36.0		35.4	34.6	35.4	35.2							35.4 35.2
ERROR OF THERMOMETER		−0.1	+0.1	+0.2	0.0	+0.2 +0.2	0.0	0.0	0.0	0.0	+0.2										+0.2					0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0	+0.5	0.0	+0.2							0.0 +0.2
CORRECTED TEMPERATURE	81.3	79.9	76.1	75.4	75.0	75.2 74.2	74.0	71.8	70.4	69.8	68.2										54.0					43.2	41.3	39.9	38.0	37.4	37.2		36.0		35.4	35.1	35.4	35.4							35.4 35.4
TEMPERATURE FROM CURVE	81.3	77.7	76.1	75.4	75.1	74.5	73.4	72.0	70.0	69.3	68.0										54.0					43.8	41.0	39.8	38.5	37.5	37.0		36.0		35.4	35.4	35.4	35.4							35.4 35.4



SECTION. MEANGIS ISLANDS TO ADMIRALTY ISLANDS.

16 February 1875.

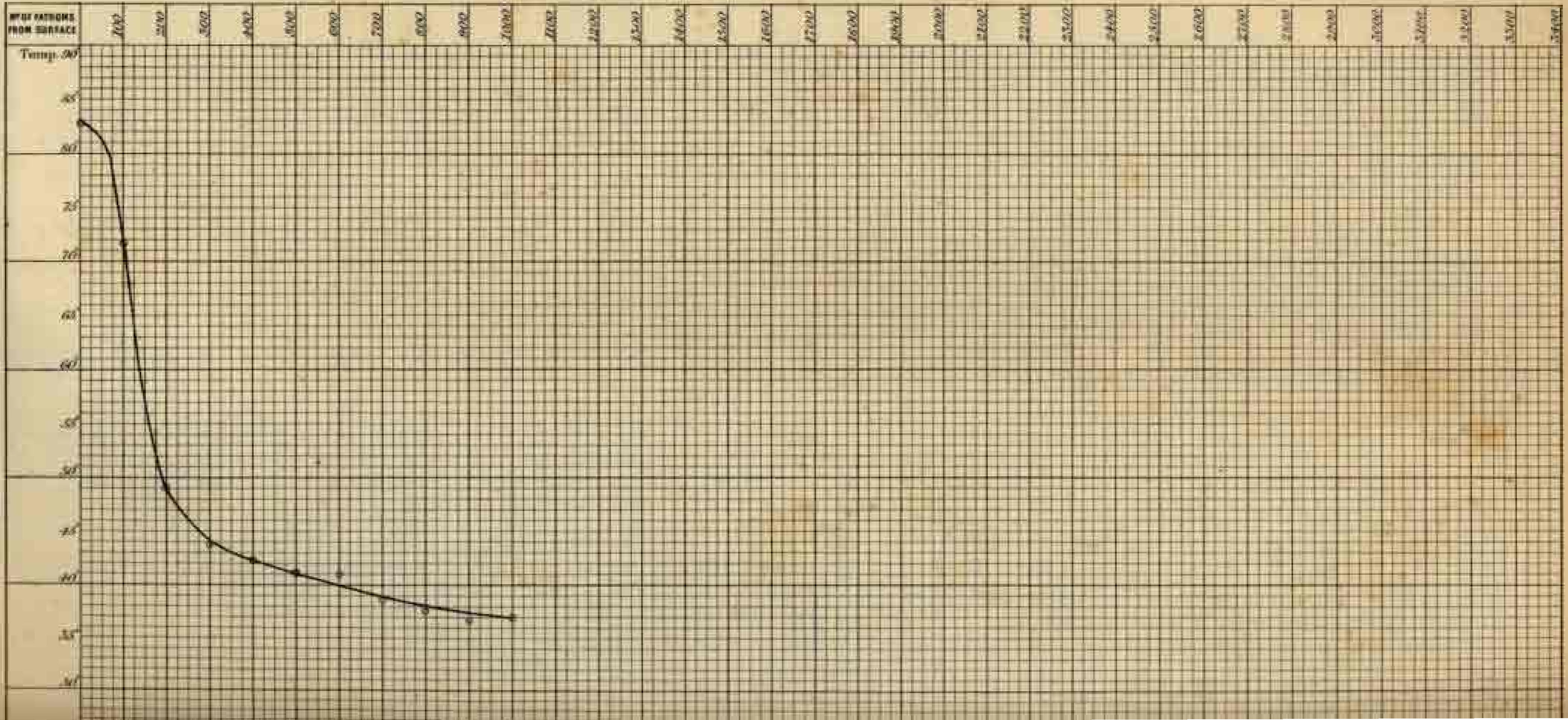
Nº of Sounding 353.
Station 216

Depth 1675 fathoms.

Latitude 2° 46′ N.
Longitude 133° 58′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER											68										84
TEMPERATURE SHEWN BY THERMOMETER	82.8										72.0										49.2
ERROR OF THERMOMETER	0.0										−0.1										0.0
CORRECTED TEMPERATURE	82.8										71.9										49.2
TEMPERATURE FROM CURVE	82.8										71.9										49.2

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER				77	87	58	77	74	85	81	87													80 69
TEMPERATURE SHEWN BY THERMOMETER				43.5	42.2	41.0	40.8	38.6	37.0	36.8	36.8													35.2 35.4
ERROR OF THERMOMETER				+0.2	+0.1	0.0	+0.2	0.0	+0.5	0.0	+0.1													+0.2 0.0
CORRECTED TEMPERATURE				43.7	42.3	41.0	41.0	38.6	37.5	36.8	36.9													35.4 35.4
TEMPERATURE FROM CURVE				44.3	42.3	41.0	39.9	38.9	38.0	37.4	37.0													35.4



SECTION. MEANGIS ISLANDS TO ADMIRALTY ISLANDS.

16 February 1875.

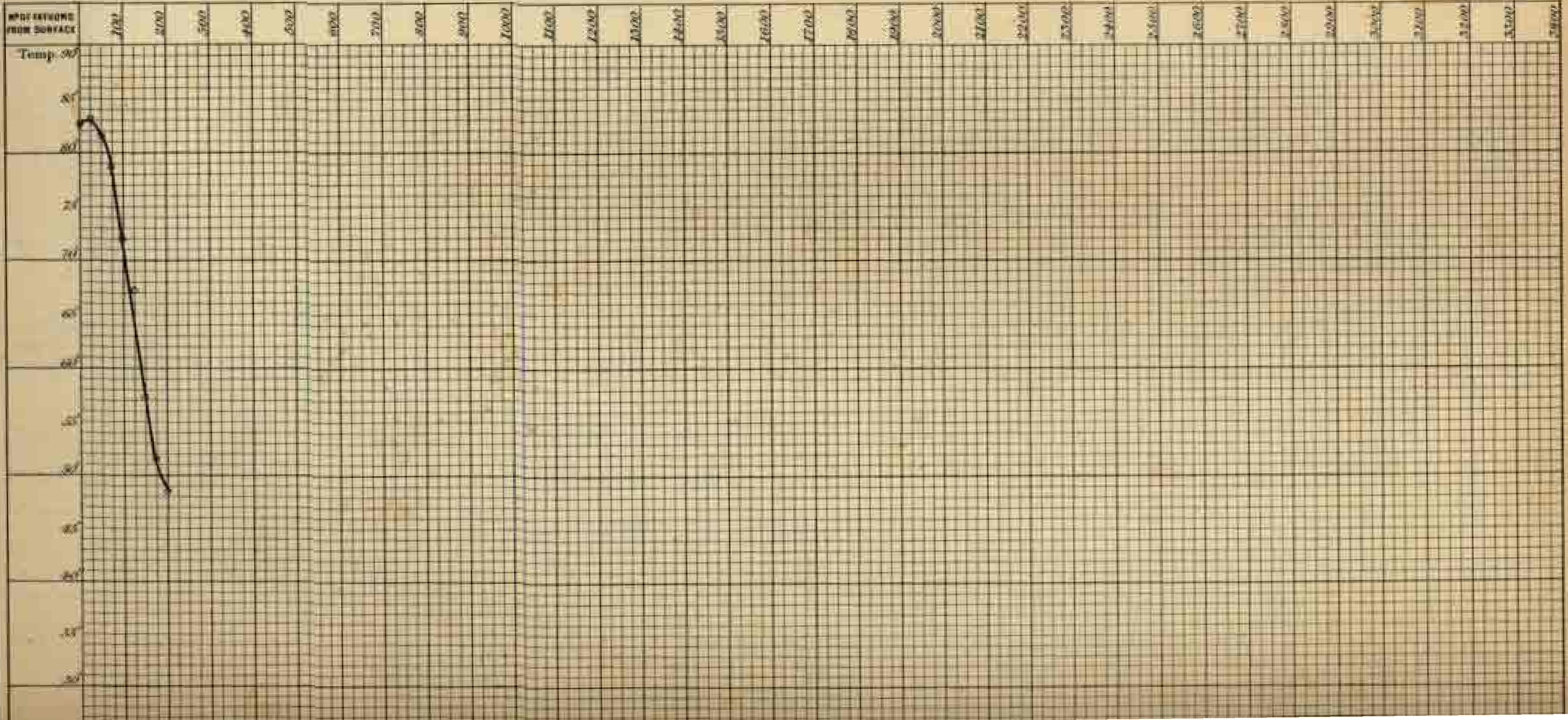
N.º of Sounding 354.
Station 216 a.

Depth 2000 fathoms.

Latitude 2° 56′ *N.*
Longitude 134° 11′ *E.*

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER	77		77			68		94			77		82			81		85			89
TEMPERATURE SHEWN BY THERMOMETER	82.6		83.0			81.5		78.8			71.8		67.2			57.2		51.2			48.2
ERROR OF THERMOMETER	+0.2		+0.2			0.0		−0.1			+0.2		0.0			0.0		+0.2			+0.1
CORRECTED TEMPERATURE	82.8		83.2			81.5		78.7			72.0		67.2			57.2		51.4			48.3
TEMPERATURE FROM CURVE	82.8		83.2			81.5		78.8			71.8		65.0			57.8		51.5			48.7

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																								84 94
TEMPERATURE SHEWN BY THERMOMETER																								36.3 34.5
ERROR OF THERMOMETER																								0.0 −0.1
CORRECTED TEMPERATURE																								36.3 34.4
TEMPERATURE FROM CURVE																								35.4



SECTION. MEANGIS ISLANDS TO ADMIRALTY ISLANDS.

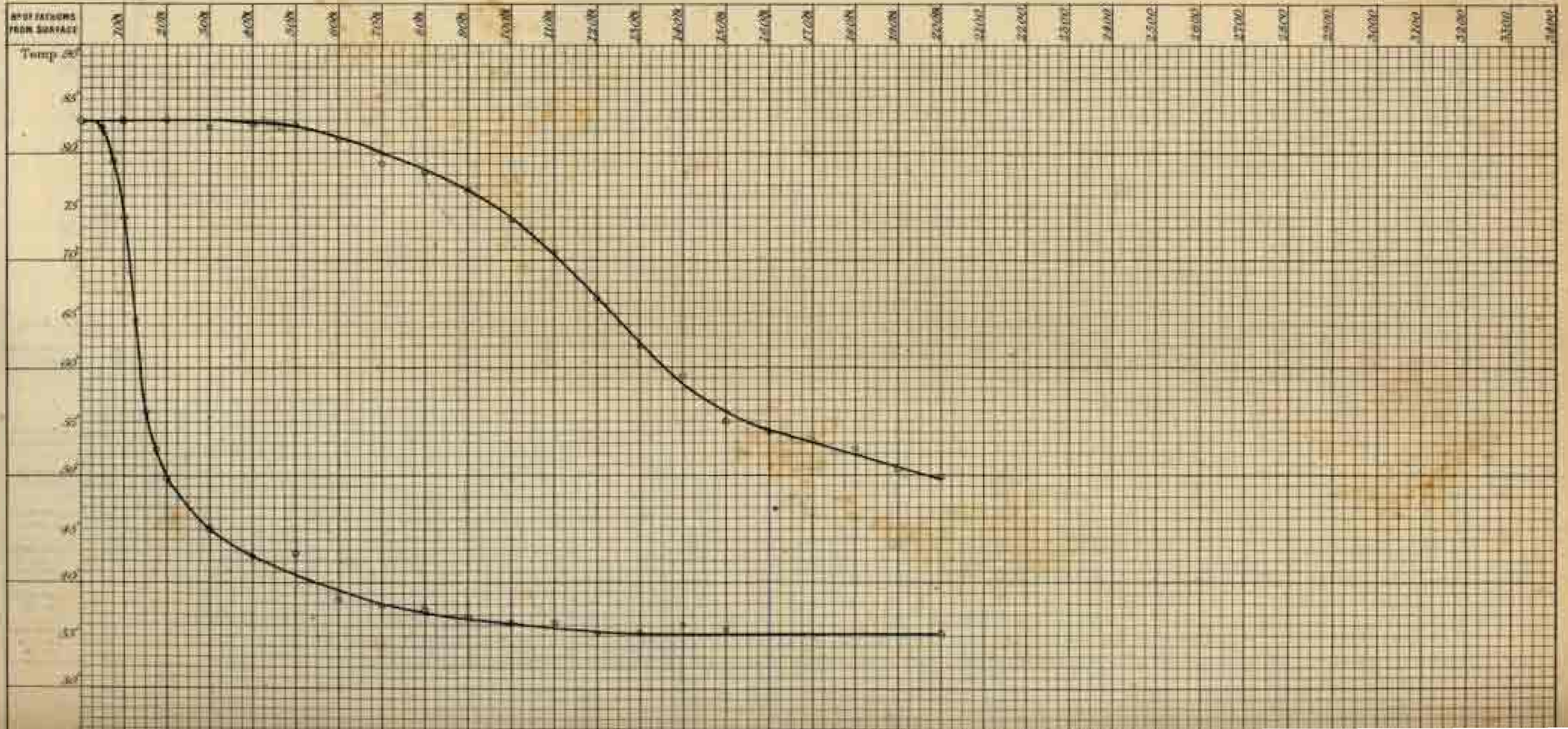
22 February 1875.

Nº of Sounding 355.
Station 217

Depth 2000 fathoms.

Latitude 0° 39′ S.
Longitude 138° 55′ E.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer		87	77	68	69	81	84	94	74	76	82	87	77	68	69	81	84	94	74	76	82				87	89	84	94	74	76	80	81	84	94	74	76	82								68 69
Temperature shewn by Thermometer	83.0	83.0	82.8	82.5	82.8	82.5	81.2	79.2	78.2	76.5	72.8	70.5	66.4	62.0	59.2	55.0	54.2	53.1	52.2	50.5	49.8				45.0	42.2	41.8	38.5	37.9	37.6	36.9	36.2	36.2	35.5	35.2	36.0	35.5								35.2 35.2
Error of Thermometer	0.0	+0.1	+0.2	0.0	0.0	0.0	0.0	−0.1	0.0	0.0	0.0	+0.1	+0.2	0.0	0.0	0.0	0.0	−0.1	+0.2	0.0	0.0				+0.1	+0.2	0.0	−0.1	0.0	0.0	0.0	0.0	0.0	−0.1	0.0	0.0	0.0								0.0 0.0
Corrected Temperature	83.0	83.1	83.0	82.5	82.8	82.5	81.2	79.1	78.2	76.5	72.8	70.6	66.6	62.0	59.2	55.0	54.2	53.0	52.4	50.5	49.8				45.1	42.4	41.8	38.4	37.9	37.6	36.9	36.2	36.2	35.4	35.2	36.0	35.5								35.2 35.2
Temperature from Curve	83.0	83.0	83.0	83.0	82.9	82.5	81.4	80.0	78.3	76.4	74.0	70.5	66.5	62.3	58.6	56.0	54.2	53.0	51.9	50.8	49.7				45.7	42.5	40.7	39.0	38.1	37.3	36.7	36.2	35.7	35.3	35.2	35.2	35.2								35.2



SECTION. MEANGIS ISLANDS TO ADMIRALTY ISLANDS

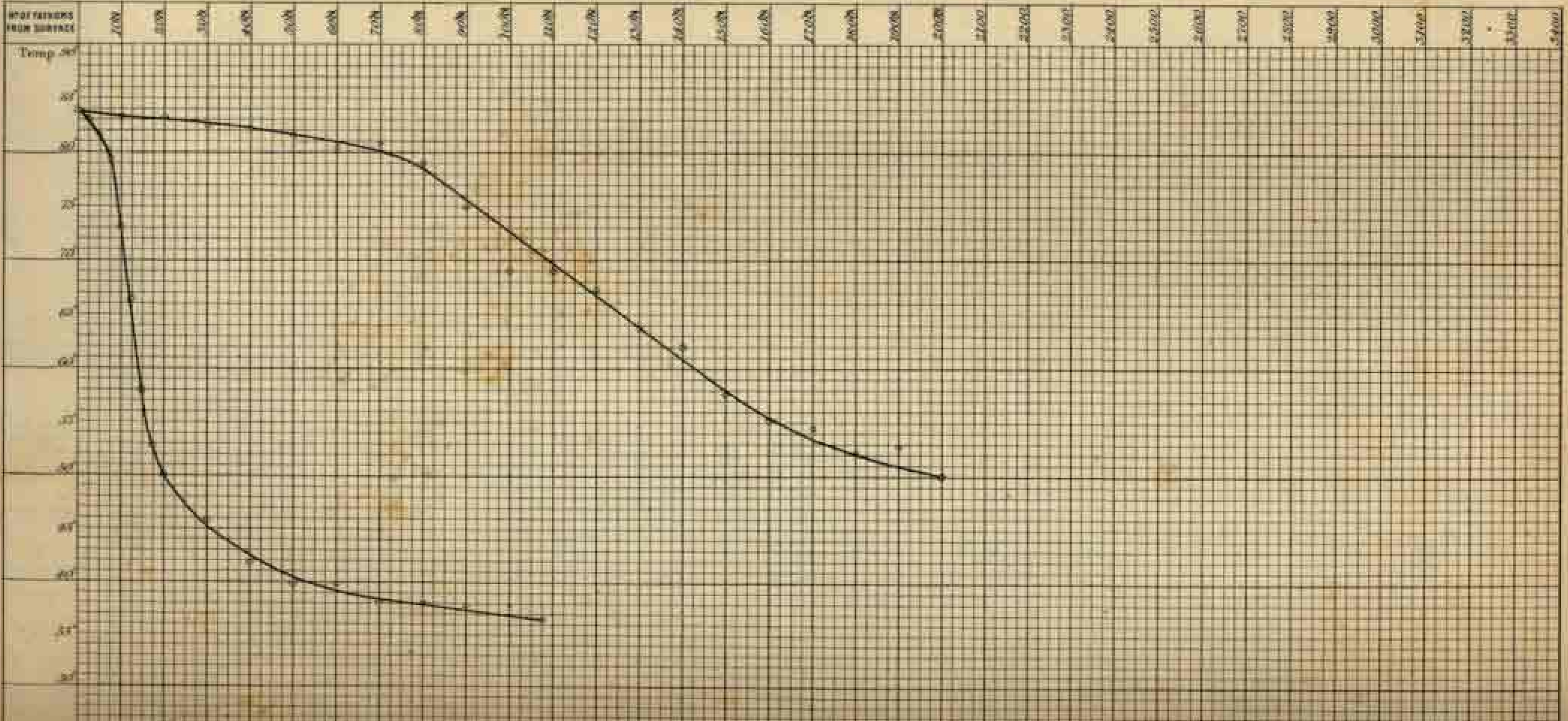
1 March 1875.

No. of Sounding 356.
Station 218.

Depth 1070 fathoms.

Latitude 2° 33′ S.
Longitude 144° 4′ E.

No. of Fathoms from Surface	No. of Thermometer	Temperature shown by Thermometer	Error of Thermometer	Corrected Temperature	Temperature from Curve
Surface		84.0	0.0	84.0	84.0
10	89	83.0	+0.2	83.2	83.2
20	69	83.2	0.0	83.2	83.0
30	94	82.5	−0.1	82.4	82.5
40	87	82.0	+0.1	82.1	82.1
50	84	81.6	0.0	81.6	81.5
60	68	80.3	0.0	80.3	80.3
70	89	80.5	+0.2	80.7	80.0
80	69	79.0	0.0	79.0	78.4
90	81	75.0	0.0	75.0	75.8
100	94	69.1	−0.1	69.0	72.8
110	84	69.0	0.0	69.0	69.7
120	87	67.2	+0.1	67.3	66.8
130	68	63.9	0.0	63.9	63.8
140	89	61.8	+0.2	62.0	60.8
150	81	57.6	0.0	57.6	57.8
160	94	55.7	−0.1	55.6	55.5
170	81	54.5	0.0	54.5	53.8
180	87	52.0	+0.1	52.1	52.1
190	84	52.8	0.0	52.8	51.0
200	68	50.0	0.0	50.0	50.0
225					
250					
275					
300	89	45.5	+0.2	45.7	45.2
400	82	41.8	0.0	41.8	42.4
500	87	39.8	+0.1	39.9	40.5
600	76	39.8	0.0	39.8	39.2
700	94	38.5	−0.1	38.4	38.4
800	84	38.0	0.0	38.0	37.9
900	68	37.8	0.0	37.8	37.4
1000					
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
Bottom	68 69	36.3 36.3	0.0 0.0	36.3 36.3	36.4



SECTION. ADMIRALTY ISLANDS TO JAPAN.

11 March 1875.

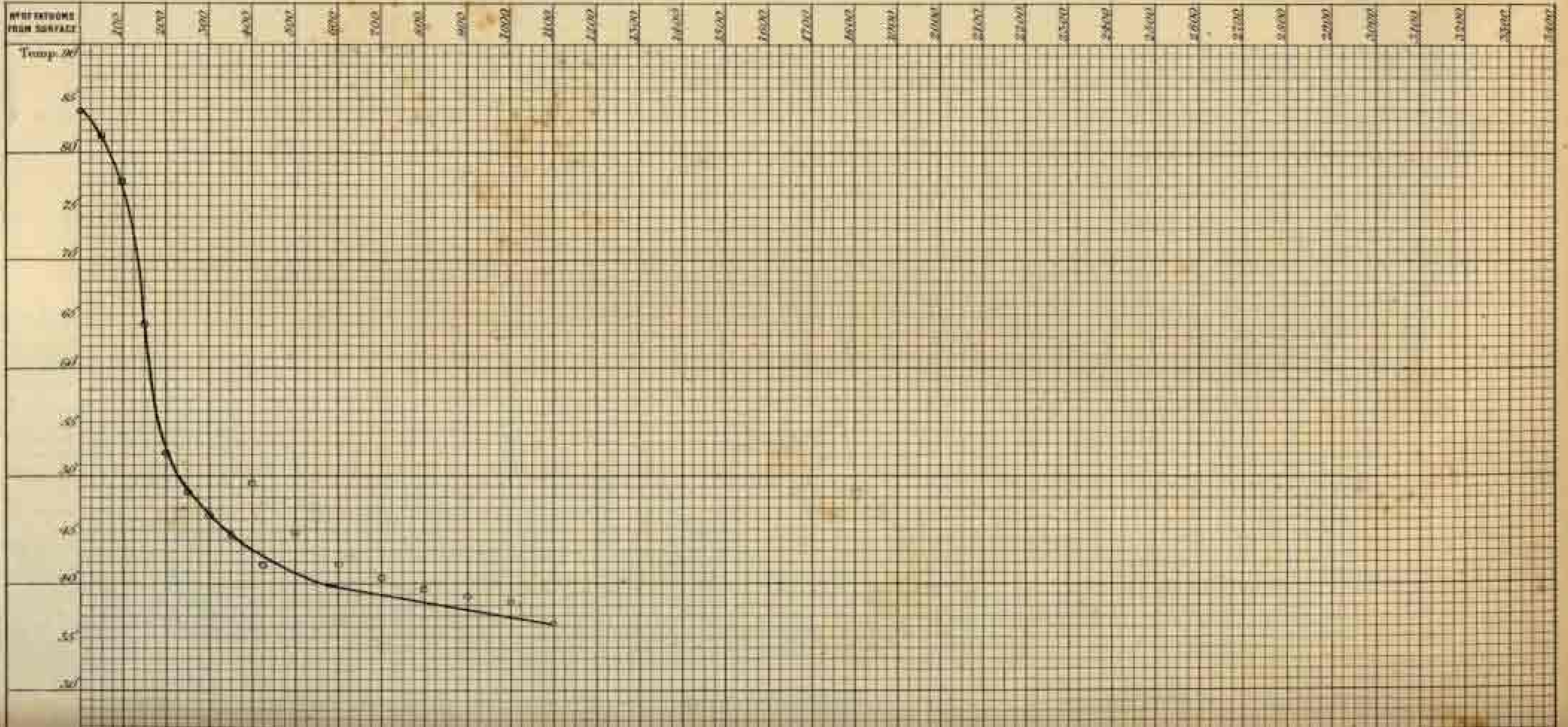
Nº of Sounding 358.
Station 220.

Depth 1100 fathoms.

Latitude 0° 42′ S.
Longitude 147° 0′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER						76					81					84					94
TEMPERATURE SHEWN BY THERMOMETER	83.8					82.6					77.1					64.0					52.1
ERROR OF THERMOMETER	0.0					0.0					0.0					0.0					−0.1
CORRECTED TEMPERATURE	83.8					82.6					77.1					64.0					52.0
TEMPERATURE FROM CURVE	83.8					82.6					77.1					64.0					52.0

Nº OF FATHOMS FROM SURFACE	225	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		87	89	68	89	87	94	74	84	89	68													88 89
TEMPERATURE SHEWN BY THERMOMETER		48.4	46.0	44.8	49.0	44.8	42.0	40.4	39.5	38.3	38.2													36.1 36.2
ERROR OF THERMOMETER		+0.1	+0.2	0.0	+0.2	+0.1	−0.1	0.0	0.0	0.0	0.0													0.0 0.0
CORRECTED TEMPERATURE		48.5	46.2	44.8	49.2	44.9	41.9	40.4	39.5	38.3	38.2													36.1 36.2
TEMPERATURE FROM CURVE		48.5	46.2	44.8	43.1	41.0	39.7	39.0	38.4	37.3	36.8													36.2



13 March 1875.

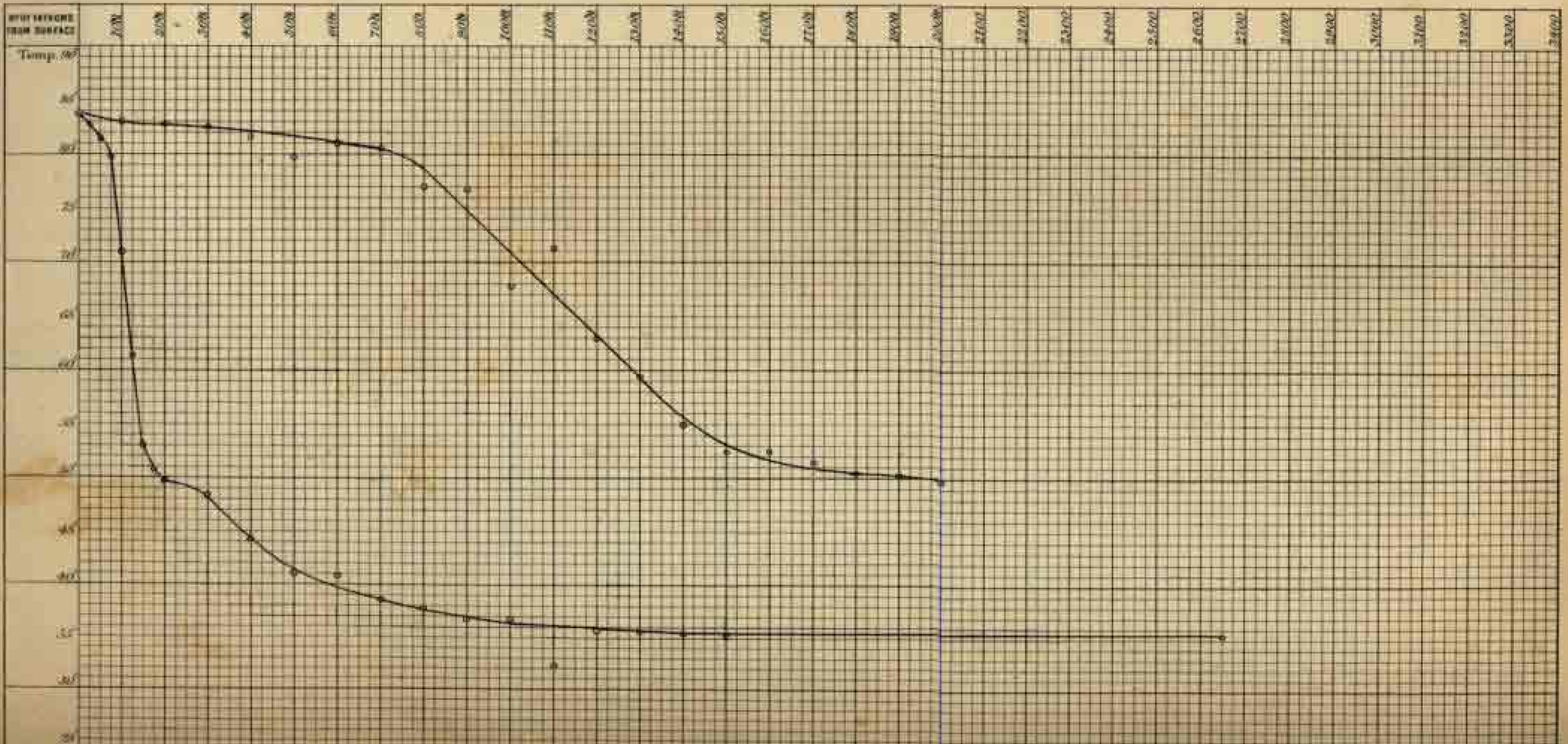
Nº of Sounding 350.
Station 221.

Depth 2650 fathoms

Latitude 0° 40′ N.
Longitude 148° 41′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Nº OF THERMOMETER		74	89	82	76	94	77	94	76	82	89	74	81	84	77	68	74	94	87	76	82
TEMPERATURE SHOWN BY THERMOMETER	83.8	83.0	82.6	82.4	81.5	80.0	80.8	80.5	77.0	76.8	67.5	71.2	63.0	59.5	54.8	52.5	52.4	51.5	50.3	50.1	49.8
ERROR OF THERMOMETER	0.0	0.0	+0.2	0.0	0.0	−0.1	+0.2	−0.1	0.0	0.0	+0.2	0.0	0.0	0.0	+0.2	0.0	0.0	−0.1	+0.1	0.0	0.0
CORRECTED TEMPERATURE	83.8	83.0	82.8	82.4	81.5	79.9	81.0	80.4	77.0	76.8	67.7	71.2	63.0	59.5	55.0	52.5	52.4	51.4	50.4	50.1	49.8
TEMPERATURE FROM CURVE	83.8	83.0	82.8	82.4	82.0	81.5	81.0	80.4	78.5	75.0	71.2	67.2	63.4	59.4	55.6	53.1	52.8	51.2	50.6	50.2	49.9

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1125	1225	1325	1425	1525	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER				84	87	81	69	84	81	94	68	89	94	81	84	68								89 68
TEMPERATURE SHOWN BY THERMOMETER				48.3	44.1	41.0	40.8	38.5	37.0	37.0	36.8	36.0	35.8	35.6	35.4	35.2								35.0 35.5
ERROR OF THERMOMETER				0.0	+0.1	0.0	0.0	0.0	0.0	−0.1	0.0	+0.2	−0.1	0.0	0.0	0.0								+0.2 0.0
CORRECTED TEMPERATURE				48.3	44.2	41.0	40.8	38.5	37.0	36.9	36.8	36.2	35.7	35.6	35.4	35.2								35.2 35.5
TEMPERATURE FROM CURVE				48.3	44.2	41.3	39.8	38.6	37.8	37.1	36.7	36.3	36.0	35.7	35.4	35.4								35.4



SECTION. ADMIRALTY ISLANDS TO JAPAN.

16 March 1875.

Nº of Sounding 360.
– – Station 222.

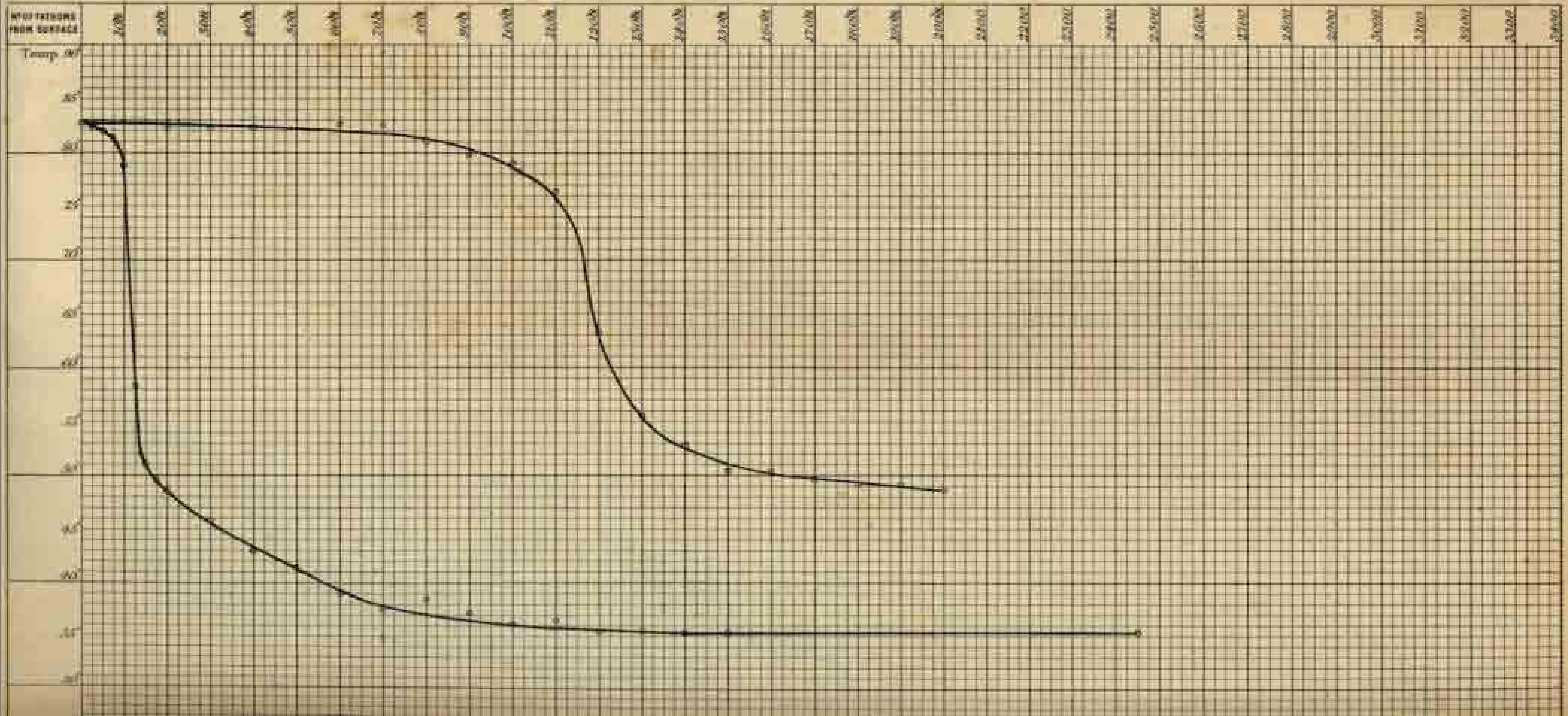
Depth 2450 *fathoms.*

Latitude 2° 15′ N.
Longitude 146° 16′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Nº OF THERMOMETER		84	89	81	82		84	81	82	68	74	87	74	89	76
TEMPERATURE SHEWN BY THERMOMETER	82.8	82.8	82.2	82.0	82.2		82.8	82.5	81.0	79.8	79.0	76.0	63.2	55.4	52.9
ERROR OF THERMOMETER	0.0	0.0	+0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	+0.3	0.0	+0.2	0.0
CORRECTED TEMPERATURE	82.8	82.8	82.4	82.0	82.2		82.8	82.5	81.0	79.8	79.0	76.3	63.2	55.6	52.9
TEMPERATURE FROM CURVE	82.8	82.8	82.6	82.4	82.2	82.0	81.8	81.7	81.2	80.3	78.9	76.0	63.2	55.6	52.7

Nº OF FATHOMS FROM SURFACE	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800
Nº OF THERMOMETER	80	77	87	84	81	94				80	84	76	69	68	89
TEMPERATURE SHEWN BY THERMOMETER	50.3	50.0	49.6	49.2	49.0	48.6				43.8	43.0	41.2	39.0	37.3	38.5
ERROR OF THERMOMETER	0.0	+0.2	+0.1	0.0	0.0	−0.1				0.0	0.0	0.0	0.0	0.0	0.0
CORRECTED TEMPERATURE	50.3	50.2	49.7	49.2	49.0	48.5				43.8	43.0	41.2	39.0	37.3	38.5
TEMPERATURE FROM CURVE	51.0	50.2	49.7	49.3	48.9	48.5				43.5	43.2	41.1	39.3	38.0	37.1

Nº OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	84	87	77	82	76	89	74								58 69
TEMPERATURE SHEWN BY THERMOMETER	37.2	36.0	36.4	35.6	35.4	35.0	35.7								35.2 35.2
ERROR OF THERMOMETER	0.0	+0.1	+0.0	0.0	0.0	+0.2	0.0								0.0 0.0
CORRECTED TEMPERATURE	37.2	36.1	36.4	35.6	35.4	35.2	35.7								35.2 35.2
TEMPERATURE FROM CURVE	36.5	36.1	35.9	35.7	35.3	35.2	35.0								35.0



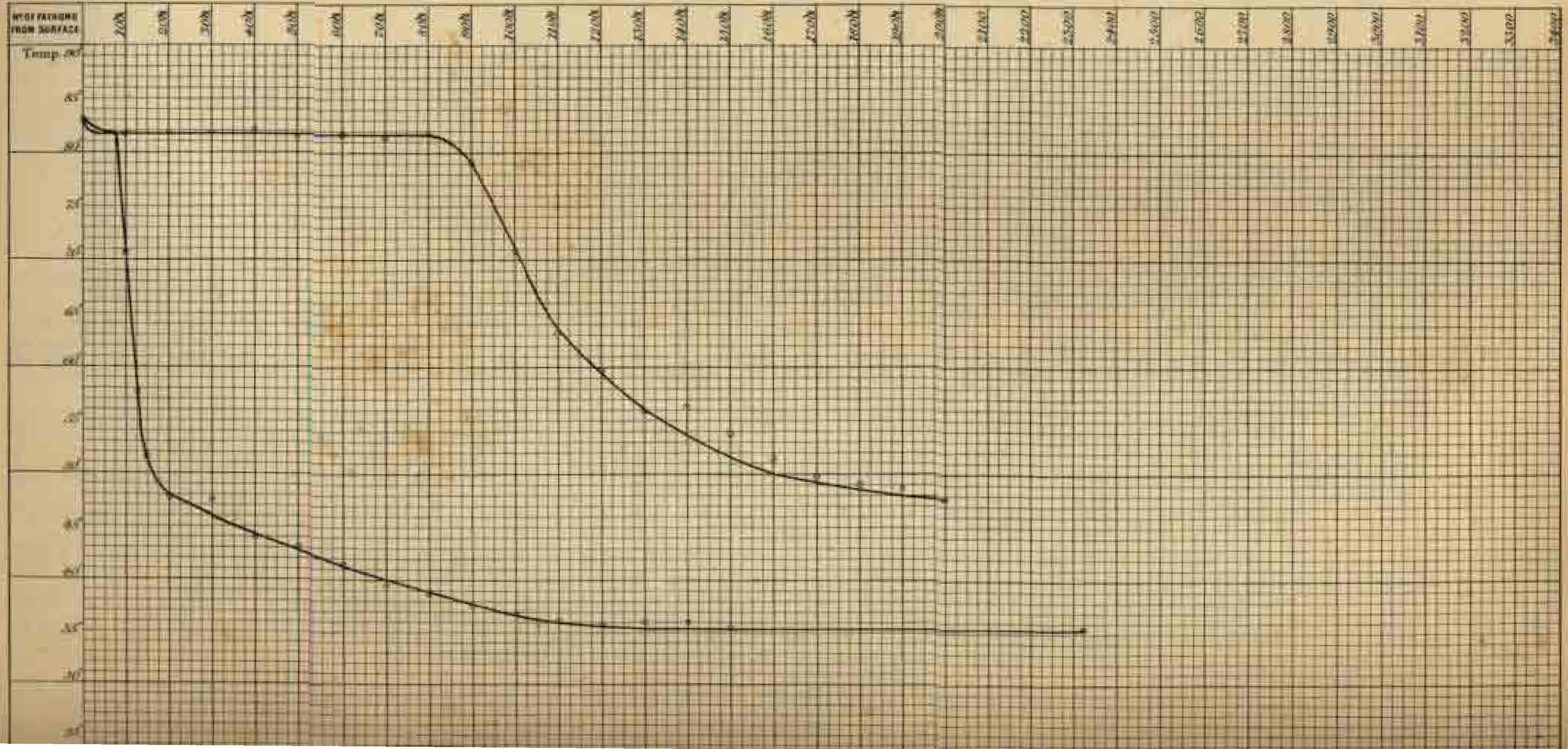
19 March 1875.

Nº of Sounding 261.
Station 223.

Depth 2325 fathoms

Latitude 5° 31′ N.
Longitude 145° 13′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		87	89	94	84	82	82	82	82	84	94	89	77	74	89	87	74	82	81	84	94				87	94	89	84	68	69	81	94	87	89	84	69	68								68 69
TEMPERATURE SHEWN BY THERMOMETER	82.0	81.6	81.5	81.9	82.0	81.5	81.7	81.5	81.8	79.0	71.0	63.0	59.5	56.0	56.0	53.8	51.8	49.8	49.0	48.7	47.8				47.4	44.0	42.6	41.1	39.5	38.8	37.6	37.0	36.1	35.5	36.0	36.0	35.5								35.5 35.5
ERROR OF THERMOMETER	0.0	+0.1	+0.2	−0.1	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	+0.2	+0.2	0.0	+0.4	+0.1	0.0	0.0	0.0	0.0	−0.1				+0.1	−0.1	+0.2	0.0	0.0	0.0	0.0	−0.1	+0.1	+0.2	0.0	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	82.0	81.7	81.7	81.8	82.0	81.5	81.7	81.5	81.8	79.0	70.9	63.2	59.7	56.0	56.4	53.9	51.8	49.8	49.0	48.7	47.7				47.5	43.9	42.8	41.1	39.5	38.8	37.6	36.9	36.2	35.7	36.0	36.0	35.5								35.5 35.5
TEMPERATURE FROM CURVE	82.0	81.7	81.7	81.7	81.7	81.7	81.7	81.7	81.7	79.0	70.9	63.5	59.1	56.5	53.8	52.6	50.0	49.3	48.5	48.2	47.7				45.8	44.3	42.5	41.1	40.0	38.8	37.7	36.8	36.1	35.7	35.5	35.5	35.5								35.5



SECTION. ADMIRALTY ISLANDS TO JAPAN.

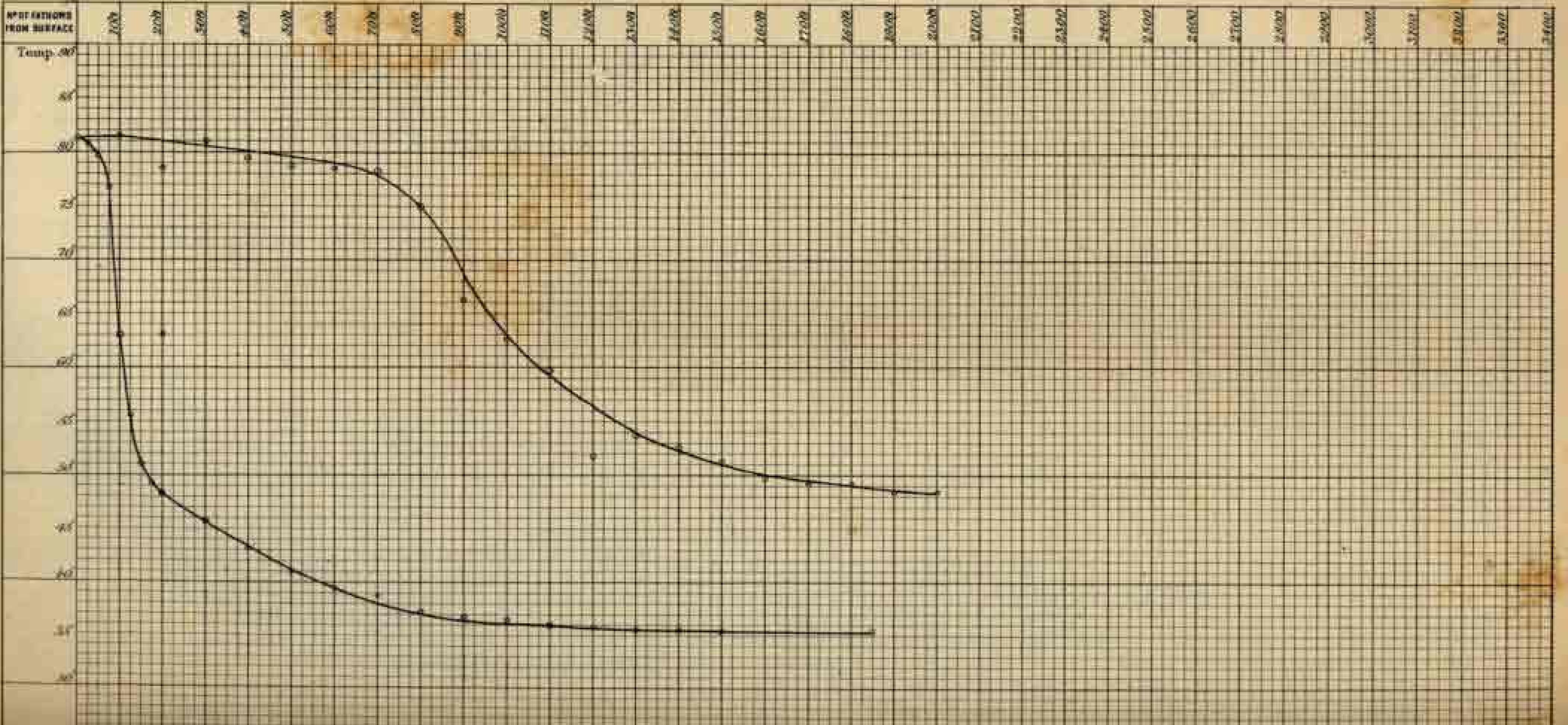
21 March 1875.

Nº of Sounding 362.
" Station 224.

Depth 1850 fathoms.

Latitude . 7° 45′ N.
Longitude 144° 20′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		68	69	84	87	94	81	74	82	89	87	84	77	94	81	74	82	89	87	84	77				87	84	89	68	69	81	82	89	81	89	74	68	69								68 69
TEMPERATURE SHEWN BY THERMOMETER	81.2	81.5	78.5	81.0	79.4	79.0	78.5	78.2	75.0	65.0	62.6	59.8	51.5	54.0	52.6	51.2	49.8	49.0	49.0	48.5	48.2				45.6	43.1	40.8	39.5	38.8	37.1	36.9	36.6	35.9	35.7	35.6	35.5	35.5								35.2 35.3
ERROR OF THERMOMETER	0.0	0.0	0.0	0.0	+0.1	-0.1	0.0	0.0	0.0	+0.2	+0.1	0.0	+0.2	-0.1	0.0	0.0	0.0	+0.2	+0.1	0.0	+0.2				+0.1	0.0	+0.2	0.0	0.0	0.0	0.0	0.0	0.0	+0.2	0.0	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	81.2	81.5	78.5	81.0	79.5	78.9	78.5	78.2	75.0	65.2	62.7	59.8	51.7	53.9	52.6	51.2	49.8	49.2	49.1	48.5	48.4				45.7	43.1	41.0	39.5	38.8	37.1	36.9	36.6	35.9	35.9	35.6	35.5	35.5								35.2 35.3
TEMPERATURE FROM CURVE	81.2	81.5	81.1	80.6	80.0	79.5	79.0	78.1	75.0	68.5	63.0	59.0	56.7	54.3	52.5	51.0	49.9	49.3	48.9	48.6	48.3				45.7	43.4	41.3	39.5	38.4	37.2	36.7	36.3	36.0	35.8	35.6	35.4	35.4								35.4



SECTION. ADMIRALTY ISLANDS TO JAPAN.

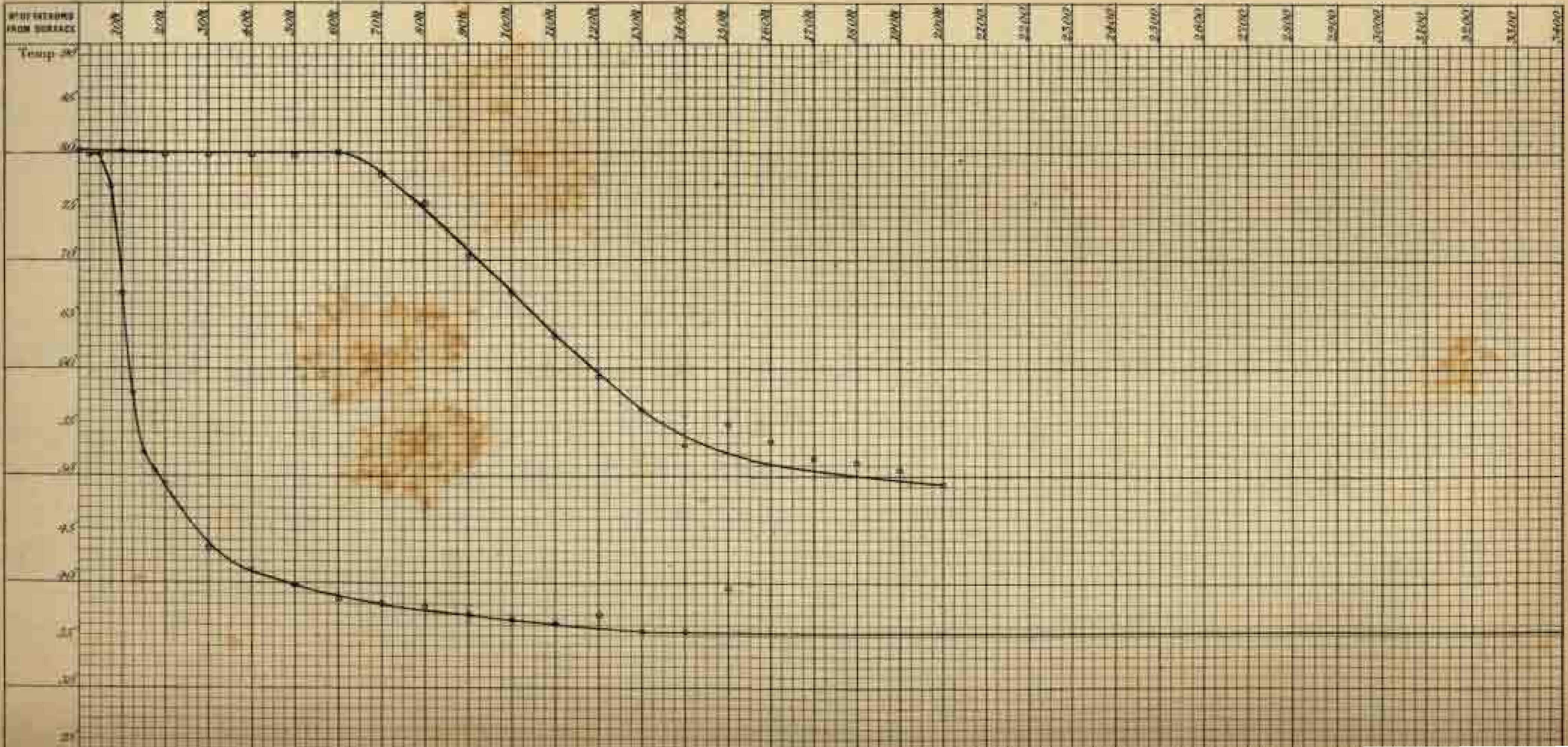
23 March 1875.

N° of Sounding 363.
Station. 225

Depth 4475 fathoms.

Latitude 11° 24′ N.
Longitude 143° 16′ E.

Nº OF FATHOMS FROM SURFACE	Nº OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		80.2	0.0	80.2	80.0
10	94	80.3	−0.1	80.2	80.0
20	81	79.8	0.0	79.8	80.0
30	87	79.7	+0.1	79.8	80.0
40	82	79.8	0.0	79.8	80.0
50	89	79.6	+0.2	79.8	80.0
60	84	80.0	0.0	80.0	80.0
70	71	78.0	0.0	78.0	78.0
80	85	74.7	+0.5	75.2	74.8
90	87	70.2	+0.1	70.3	70.6
100	82	67.0	0.0	67.0	67.0
110	81	63.0	0.0	63.0	63.0
120	77	59.2	+0.2	59.4	59.4
130	84	56.1	0.0	56.1	56.1
140	91	53.0	−0.1	52.9	53.7
150	87	54.6	+0.1	54.7	52.0
160	82	53.1	0.0	53.1	51.5
170	81	51.6	0.0	51.6	50.7
180	77	50.9	+0.2	51.1	50.1
190	84	50.5	0.0	50.5	49.7
200	94	49.3	−0.1	49.2	49.2
225					
250					
275					
300	87	43.1	+0.1	43.2	43.2
400	80	41.2	0.0	41.2	41.2
500	89	39.9	0.0	39.9	39.9
600	85	38.0	+0.5	38.5	38.6
700	87	37.8	+0.2	38.0	37.9
800	65	37.8	0.0	37.8	37.3
900	97	36.9	+0.1	37.0	36.9
1000	80	36.5	0.0	36.5	36.5
1100	89	36.0	+0.2	36.2	36.1
1200	84	37.0	0.0	37.0	35.7
1300	71	35.5	0.0	35.5	35.5
1400	81	35.5	0.0	35.5	35.5
1500	94	35.5	−0.1	35.4	35.5
1600					
1700					
1800					
1900					
2000					
BOTTOM	69	35.2	0.0	35.2	35.2



SECTION. ADMIRALTY ISLANDS TO JAPAN.

25 March 1875.

Nº of Sounding 364.
Station 226

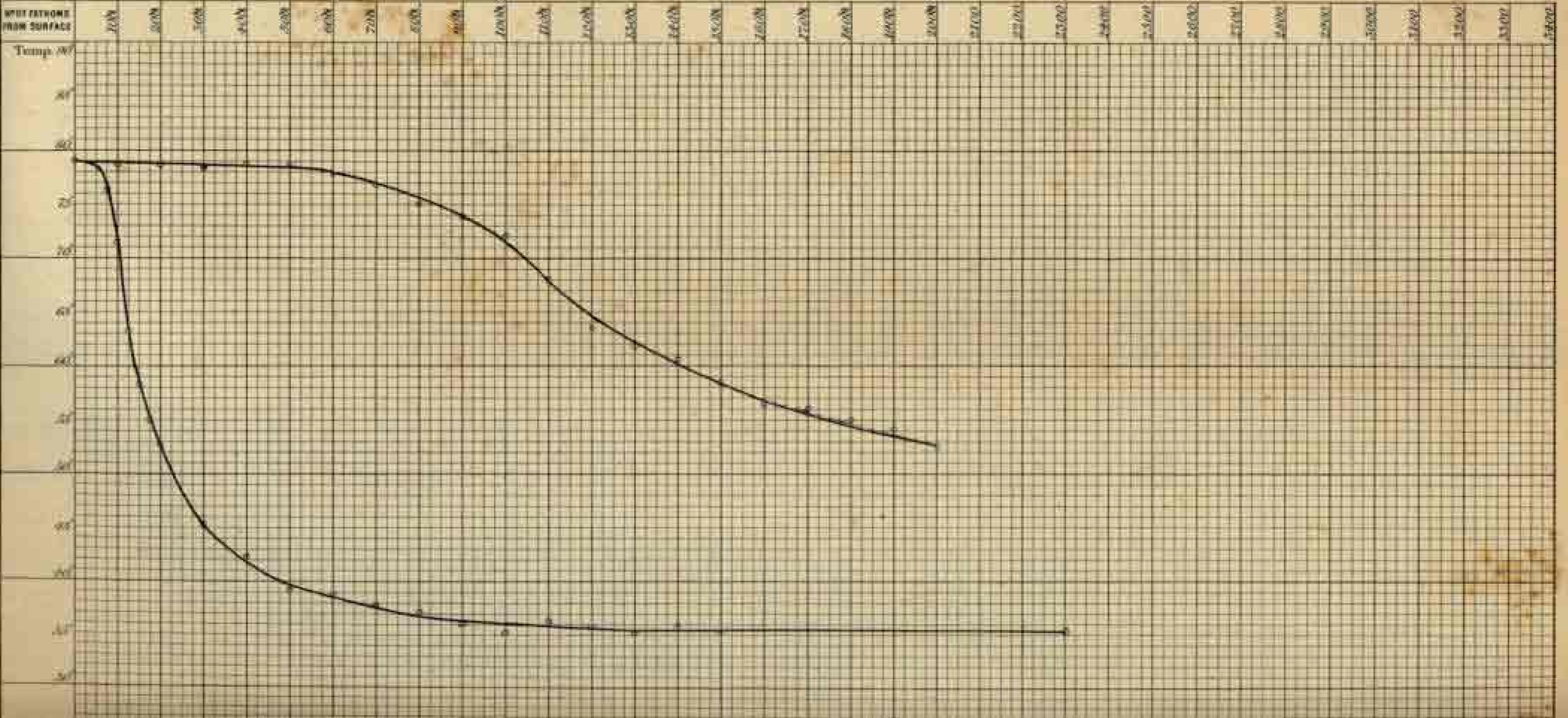
Depth 2300 fathoms.

Latitude 14° 44′ N.
Longitude 142° 13′ E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Nº of thermometer		43	94	84	85	87	82	74	76	77	71	62	94	84	89	87
Temperature shewn by thermometer	79.0	78.2	78.8	78.5	78.6	78.5	77.9	76.8	75.0	73.6	72.0	68.0	63.7	61.8	60.3	58.0
Error of thermometer	0.0	+0.6	−0.1	0.0	+0.2	+0.1	0.0	0.0	0.0	+0.2	0.0	0.0	−0.1	0.0	+0.2	+0.1
Corrected temperature	79.0	78.8	78.7	78.5	78.8	78.6	77.9	76.8	75.0	73.8	72.0	68.0	63.6	61.8	60.5	58.1
Temperature from curve	79.0	78.9	78.8	78.7	78.6	78.5	77.9	77.0	75.1	73.8	71.3	68.0	64.0	62.1	60.0	58.2

Nº of fathoms from surface	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900
Nº of thermometer	81	74	76	77	82				77 69	67	82	84	69	74	84
Temperature shewn by thermometer	56.6	56.0	55.0	54.0	52.5				45.0 45.0	42.0	39.2	38.9	37.8	37.2	36.0
Error of thermometer	0.0	0.0	0.0	+0.2	0.0				+0.2 0.0	+0.1	0.0	0.0	+0.0	0.0	0.0
Corrected temperature	56.6	56.0	55.0	54.2	52.5				45.2 45.0	42.1	39.2	38.9	37.8	37.2	36.0
Temperature from curve	56.8	55.6	54.5	53.3	52.8				45.1	41.8	39.7	38.7	37.7	36.9	36.3

Nº of fathoms from surface	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	94	87	82	89	69	43 41 80								69 85
Temperature shewn by thermometer	35.2	36.0	35.8	35.0	35.9	34.8 35.0 35.4								35.3 35.0
Error of thermometer	−0.1	+0.1	0.0	+0.2	0.0	+0.6 0.0 0.0								0.0 +0.5
Corrected temperature	35.1	36.1	35.8	35.2	35.9	35.4 35.0 35.4								35.3 35.5
Temperature from curve	36.0	35.7	35.5	35.3	35.5	35.5								35.5



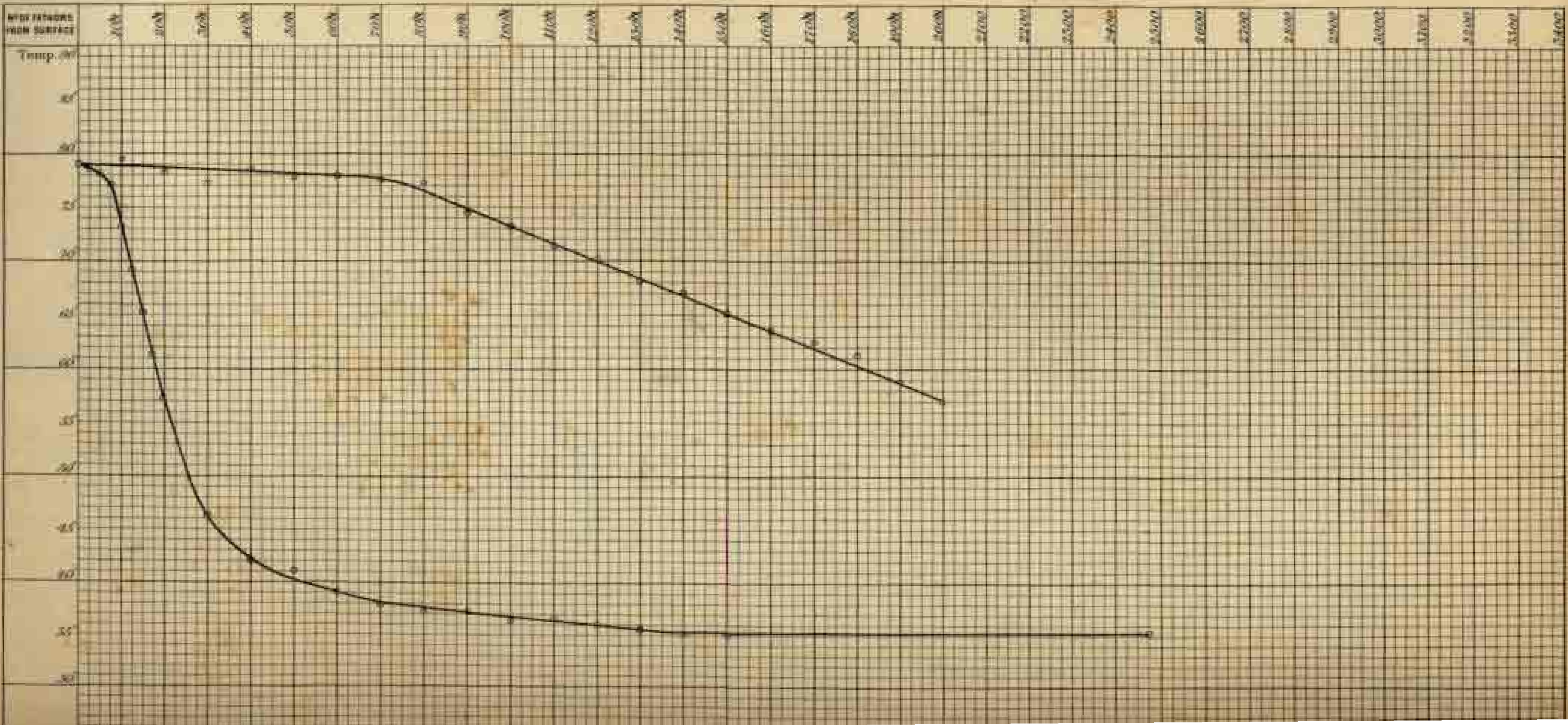
27 March 1875.

Nº of Sounding 365.
Station 227.

Depth 2475 fathoms.

Latitude 17° 29′ N.
Longitude 141° 21′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		84	87	89	85	94	80	87	84	43	81	74	83	71	77	94	41	43	84	82	87				84	81	87	89	85	67	77	74	81	71	82	94	41								89 89
TEMPERATURE SHEWN BY THERMOMETER	79.2	79.6	78.0	77.1	78.0	78.0	78.0	77.5	77.2	74.0	73.2	71.6	69.6	68.2	66.8	65.3	63.4	62.0	61.1	58.8	57.0				46.2	42.0	40.9	38.8	37.3	37.0	37.0	36.6	36.6	35.8	35.3	35.2	35.0								35.1 35.0
ERROR OF THERMOMETER	0.0	0.0	+0.1	+0.2	+0.5	−0.1	0.0	+0.1	0.0	+0.6	0.0	0.0	+0.5	0.0	+0.2	−0.1	0.0	+0.6	0.0	0.0	+0.1				0.0	0.0	+0.1	+0.2	+0.5	+0.1	+0.2	0.0	0.0	0.0	0.0	−0.1	0.0								0.0 +0.2
CORRECTED TEMPERATURE	79.2	79.6	78.1	77.3	78.5	77.9	78.0	77.6	77.2	74.6	73.2	71.6	70.1	68.2	67.0	65.2	63.4	62.6	61.1	58.8	57.1				46.2	42.0	41.0	39.0	38.0	37.1	37.2	36.6	36.6	35.8	35.3	35.1	35.0								35.1 35.2
TEMPERATURE FROM CURVE	79.2	79.0	78.8	78.6	78.4	78.2	78.0	77.6	76.5	75.0	73.3	71.5	70.0	68.3	66.7	65.4	63.5	62.0	60.4	58.8	57.0				46.2	42.0	40.3	39.0	38.1	37.8	37.3	36.8	36.4	35.9	35.5	35.4	35.2								35.1



SECTION. ADMIRALTY ISLANDS TO JAPAN.

29 March 1875.

N.^o of Sounding 306.
Station 228.

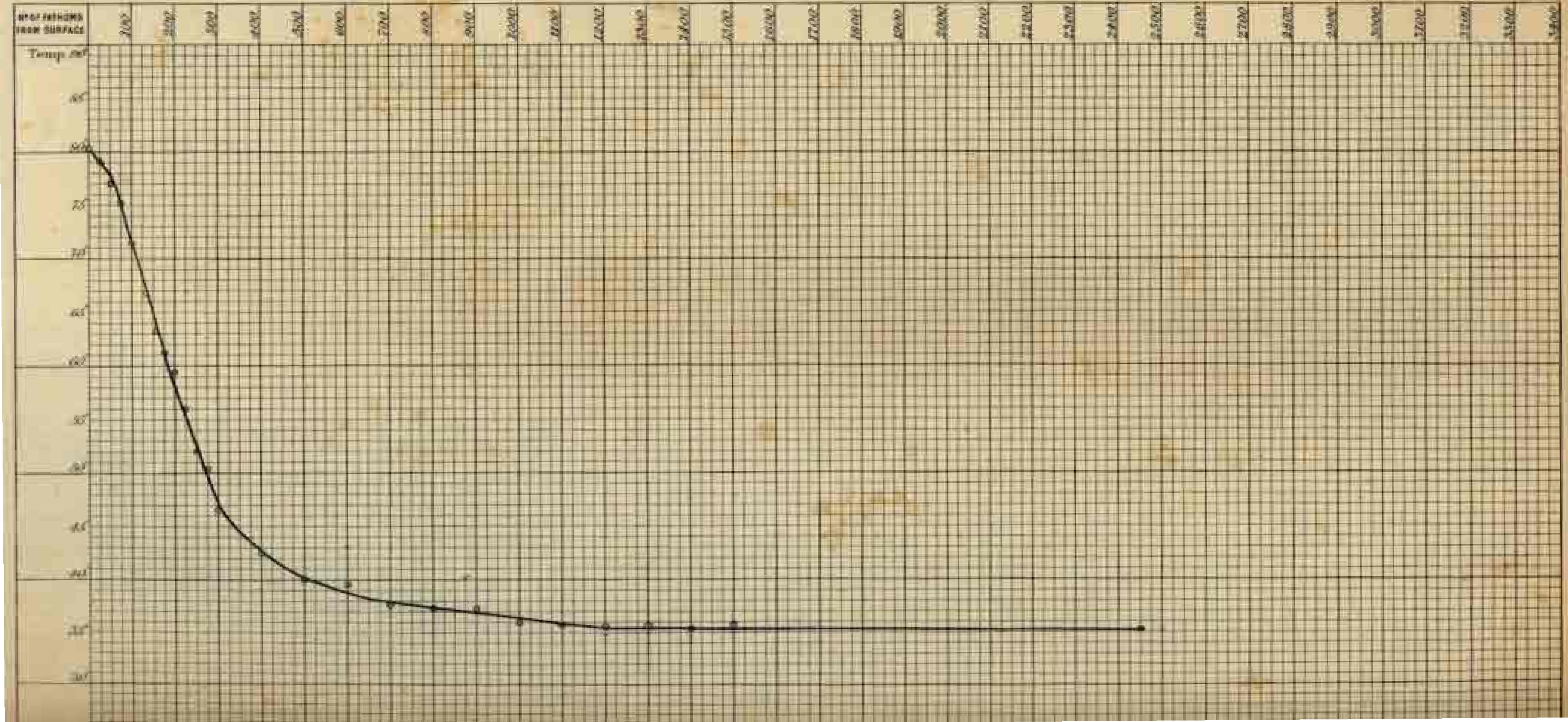
Depth 2450 *fathoms.*

Latitude 19° 24′ N.
Longitude 141° 13′ E.

Nº of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140
Nº of Thermometer			74			77		94			81		83		
Temperature shewn by Thermometer	80.2		79.0			77.0		75.2			71.5		66.2		
Error of Thermometer	0.0		0.0			0.0		-0.1			0.0		+0.6		
Corrected Temperature	80.2		79.0			77.0		75.1			71.5		66.8		
Temperature from Curve	80.2		79.0			77.4		75.0			71.5		68.3		

Nº of Fathoms from Surface	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
Nº of Thermometer	87		43			71	87	84	77	81	87	82	64	91	80
Temperature shewn by Thermometer	63.0		60.6			59.4	55.9	52.0	50.0	47.4	42.2	40.0	39.6	37.2	36.9
Error of Thermometer	+0.1		+0.6			0.0	+0.1	0.0	+0.2	0.0	+0.1	0.0	0.0	+0.5	+0.2
Corrected Temperature	63.1		61.2			59.4	56.0	52.0	50.2	47.4	42.3	40.0	39.6	37.7	37.1
Temperature from Curve	64.8		61.3			58.0	55.4	52.4	49.8	47.7	42.8	40.1	38.9	38.0	37.4

Nº of Fathoms from Surface	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	69	81	84	82	83	89	89								68 69
Temperature shewn by Thermometer	37.1	36.0	35.8	35.6	35.1	35.2	35.2								35.4 35.0
Error of Thermometer	0.0	0.0	0.0	0.0	+0.5	+0.2	0.0								0.0 0.0
Corrected Temperature	37.1	36.0	35.8	35.6	35.6	35.4	35.2								35.4 35.0
Temperature from Curve	36.9	36.4	35.9	35.4	35.3	35.2	35.2								35.2



SECTION. ADMIRALTY ISLANDS TO JAPAN.

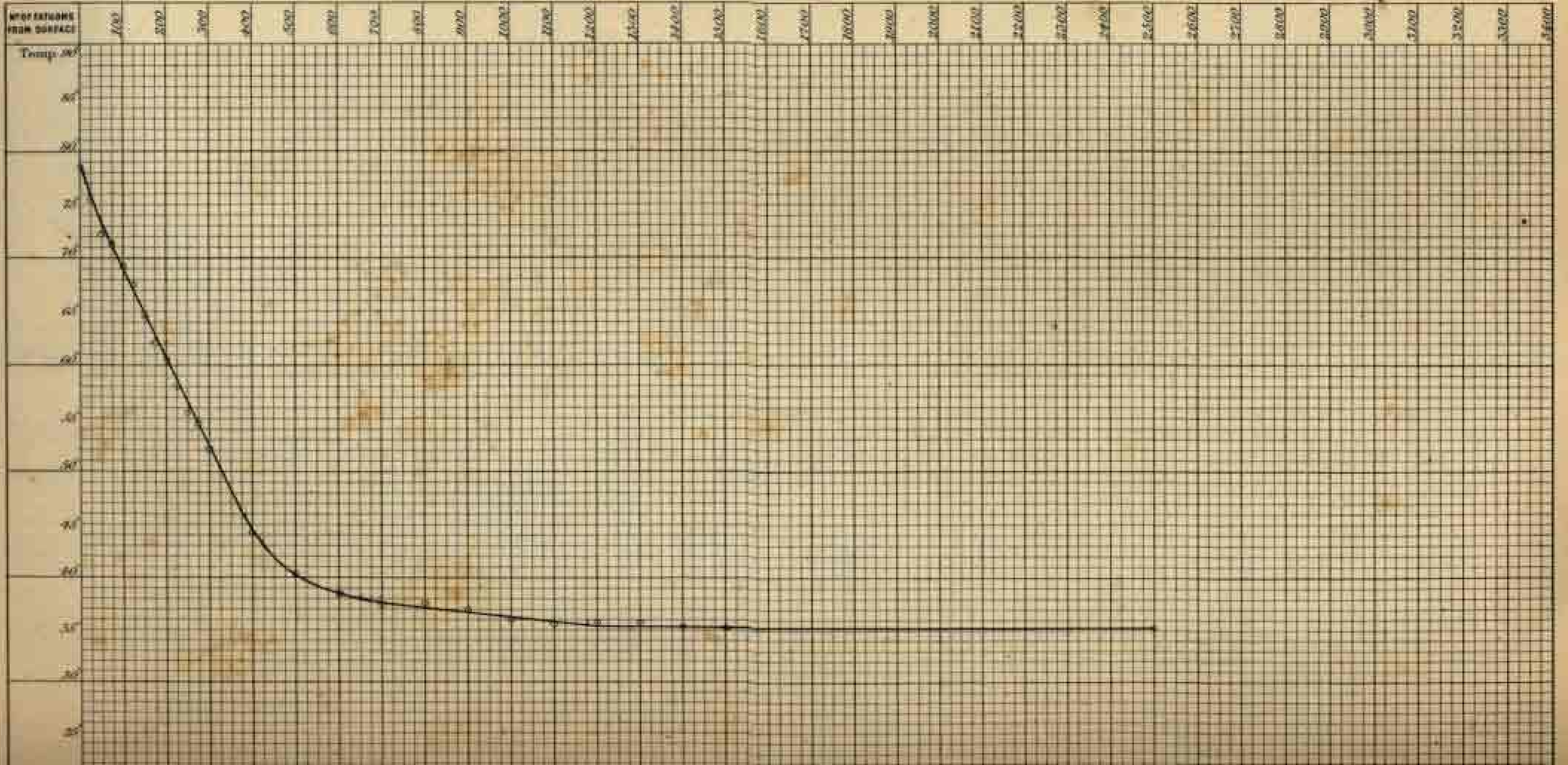
1 April 1875.

Nº of Sounding 367.
Station 229.

Depth 2500 fathoms.

Latitude 22° 1′ N.
Longitude 140° 27′ E.

Nº OF FATHOMS FROM SURFACE	Nº OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		78.5	0.0	78.5	78.5
10					
25	94	73.3	−0.1	73.4	73.7
30					
40					
50	77	72.0	+0.2	72.2	73.3
60					
75	87	71.0	+0.1	71.1	71.0
80					
90					
100	77	68.6	+0.8	69.4	69.0
110					
125	69	67.5	0.0	67.5	66.9
130					
140					
150	43	64.0	+0.6	64.6	64.8
160					
175	81	62.0	0.0	62.0	62.3
180					
190					
200	71	60.5	0.0	60.5	60.4
225	74	58.0	0.0	58.0	58.3
250	70	55.5	0.0	55.5	56.0
275	77	54.2	+0.2	54.4	54.1
300	84	52.0	0.0	52.0	52.0
400	80	44.1	0.0	44.1	44.2
500	94	40.4	−0.1	40.3	40.3
600	85	38.0	+0.5	38.5	38.5
700	87	37.4	+0.1	37.5	37.7
800	87	37.5	+0.1	37.6	37.2
900	85	36.5	+0.5	37.0	36.7
1000	41	36.0	0.0	36.0	36.3
1100	94	35.6	−0.1	35.5	35.8
1200	80	35.8	0.0	35.8	35.5
1300	84	35.8	0.0	35.8	35.2
1400	74	35.4	0.0	35.4	35.1
1500	89	35.0	+0.3	35.3	35.0
1600					
1700					
1800					
1900					
2000					
BOTTOM	72 69	35.2 35.2	0.0 0.0	35.2 35.2	35.2



SECTION. ADMIRALTY ISLANDS TO JAPAN.

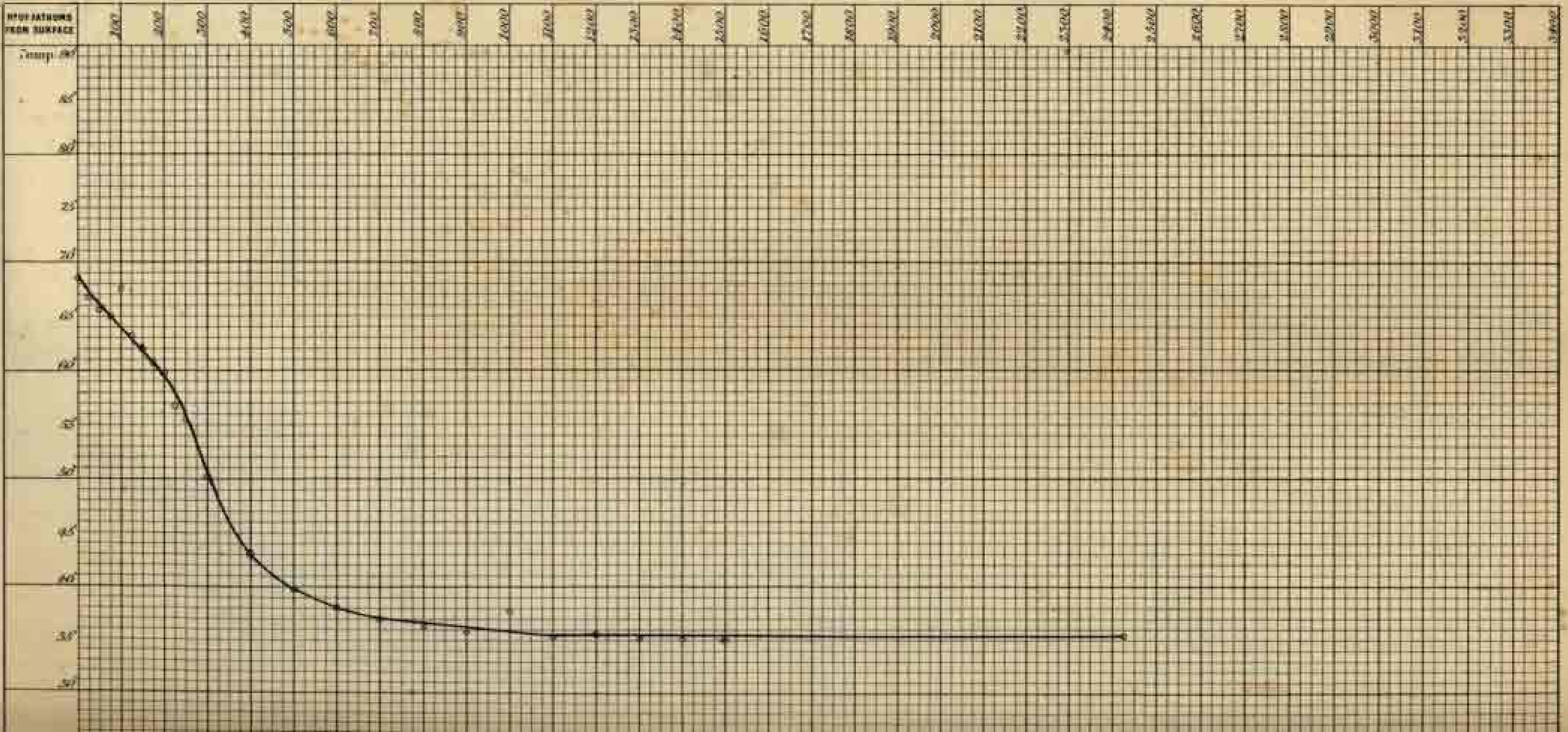
5 April 1875.

Nº of Sounding 308.
Station 230.

Depth 2425 *fathoms*

Latitude 26° 29′ N.
Longitude 137° 57′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			82			89		72			77		82			89		71			69	43	84		87	81	85	94	74	85	43	84	89	77	94	81	74								69 72
TEMPERATURE SHEWN BY THERMOMETER	68.5		67.0			65.4		65.0			63.5		63.2			61.8		60.8			59.8	56.2	55.5		50.6	43.0	39.2	38.0	37.0	35.8	35.2	38.0	35.2	35.5	35.2	35.2	35.0								35.5 35.5
ERROR OF THERMOMETER	0.0		0.0			+0.2		0.0			+0.2		0.0			+0.2		0.0			0.0	+0.6	0.0		+0.1	0.0	+0.5	-0.1	0.0	+0.5	+0.6	0.0	+0.2	+0.2	-0.1	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	68.5		67.0			65.6		65.0			63.7		63.2			62.0		60.8			59.8	56.8	55.5		50.7	43.0	39.7	37.9	37.0	36.3	35.8	38.0	35.4	35.7	35.1	35.2	35.0								35.5 35.5
TEMPERATURE FROM CURVE	68.5		67.0			66.0		65.0			63.9		62.8			61.7		60.7			59.7	58.2	56.0	53.3	50.5	43.0	39.2	38.6	37.2	36.7	36.3	35.9	35.5	35.5	35.5	35.5	35.5								35.5



SECTION. ADMIRALTY ISLANDS TO JAPAN.

9 April 1875.

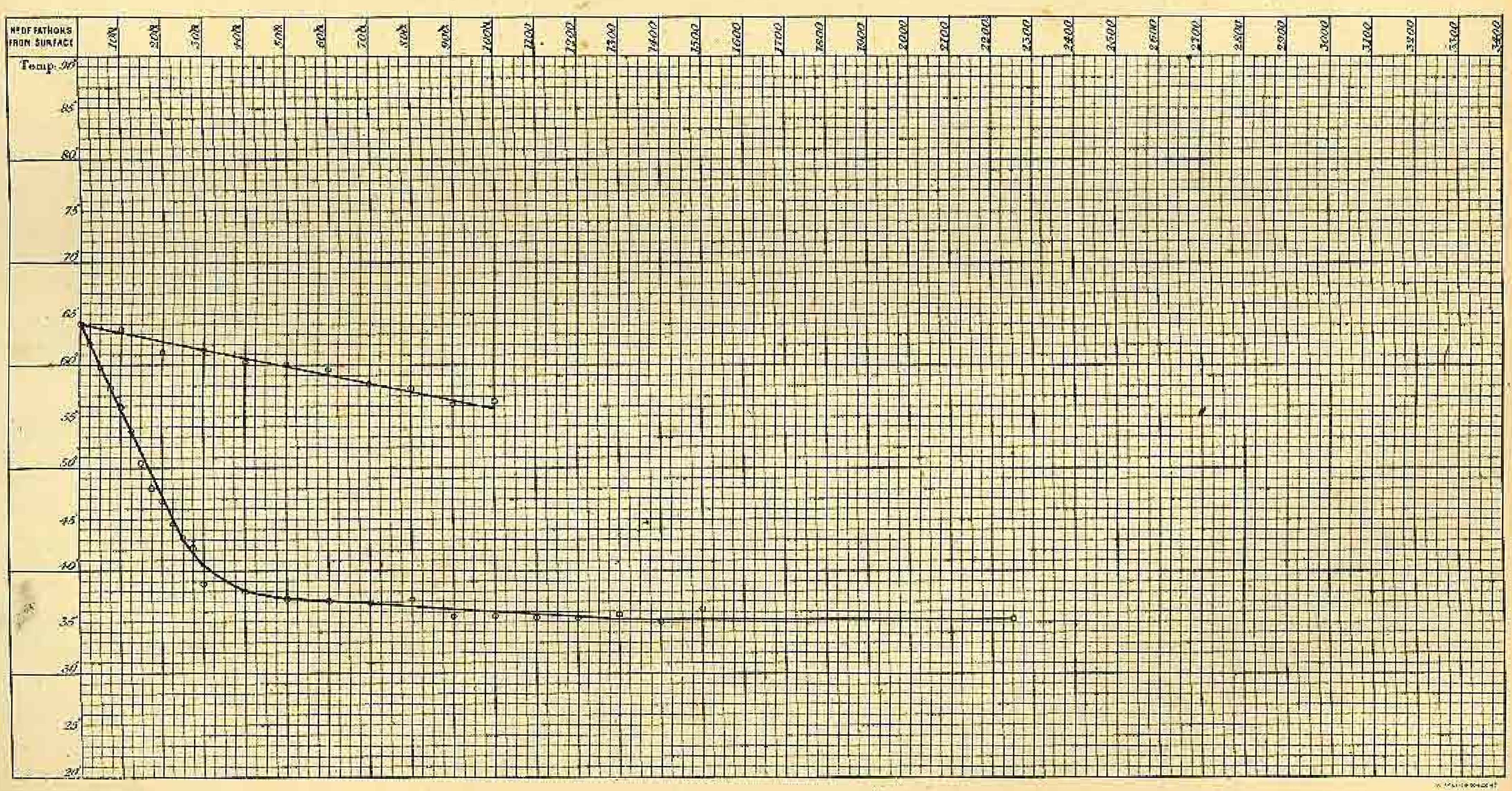
No. of Sounding 369.
" Station 231.

Depth 2250 fathoms.

Latitude 31° 8′ N.
Longitude 137° 8′ E.

No. OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	125	130	140	150	160	175	180	190
No. OF THERMOMETER		86	21	23	94	74	69	71	87	81	94		81			82		89		
TEMPERATURE SHEWN BY THERMOMETER	64.0	63.5	61.2	61.0	60.5	60.0	59.6	58.2	57.6	56.2	56.7		53.6			50.5		47.8		
ERROR OF THERMOMETER	0.0	0.0	0.0	+0.6	−0.1	0.0	0.0	0.0	+0.2	0.0	−0.1		0.0			0.0		+0.2		
CORRECTED TEMPERATURE	64.0	63.5	61.2	61.6	60.4	60.0	59.6	58.2	57.7	56.2	56.6		53.6			50.5		48.0		
TEMPERATURE FROM CURVE	64.0	63.2	62.4	61.6	60.8	59.9	59.1	58.3	57.5	56.6	55.8		53.4			52.2		49.2		

No. OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	84	87	77	23	23	82	89	77	84	85	21	94	81	87	77	89	84								71 59
TEMPERATURE SHEWN BY THERMOMETER	46.8	44.2	43.0	41.5	38.2	38.0	37.0	36.8	36.8	36.6	35.5	35.5	35.5	35.2	35.6	34.8	36.2								37.0 35.2
ERROR OF THERMOMETER	0.0	+0.1	+0.2	+0.6	+0.6	0.0	+0.2	+0.2	0.0	+0.5	0.0	−0.1	0.0	+0.1	+0.2	+0.2	0.0								0.0 0.0
CORRECTED TEMPERATURE	46.8	44.3	43.2	42.1	38.8	38.0	37.2	37.0	36.8	37.1	35.5	35.4	35.5	35.3	35.8	35.0	36.2								37.0 35.2
TEMPERATURE FROM CURVE	47.0	45.0	43.0	41.8	40.7	38.2	37.3	37.0	36.7	36.4	36.2	36.0	35.8	35.6	35.4	35.2	35.2								35.2



SECTION. OFF JAPAN.

12 May 1875.

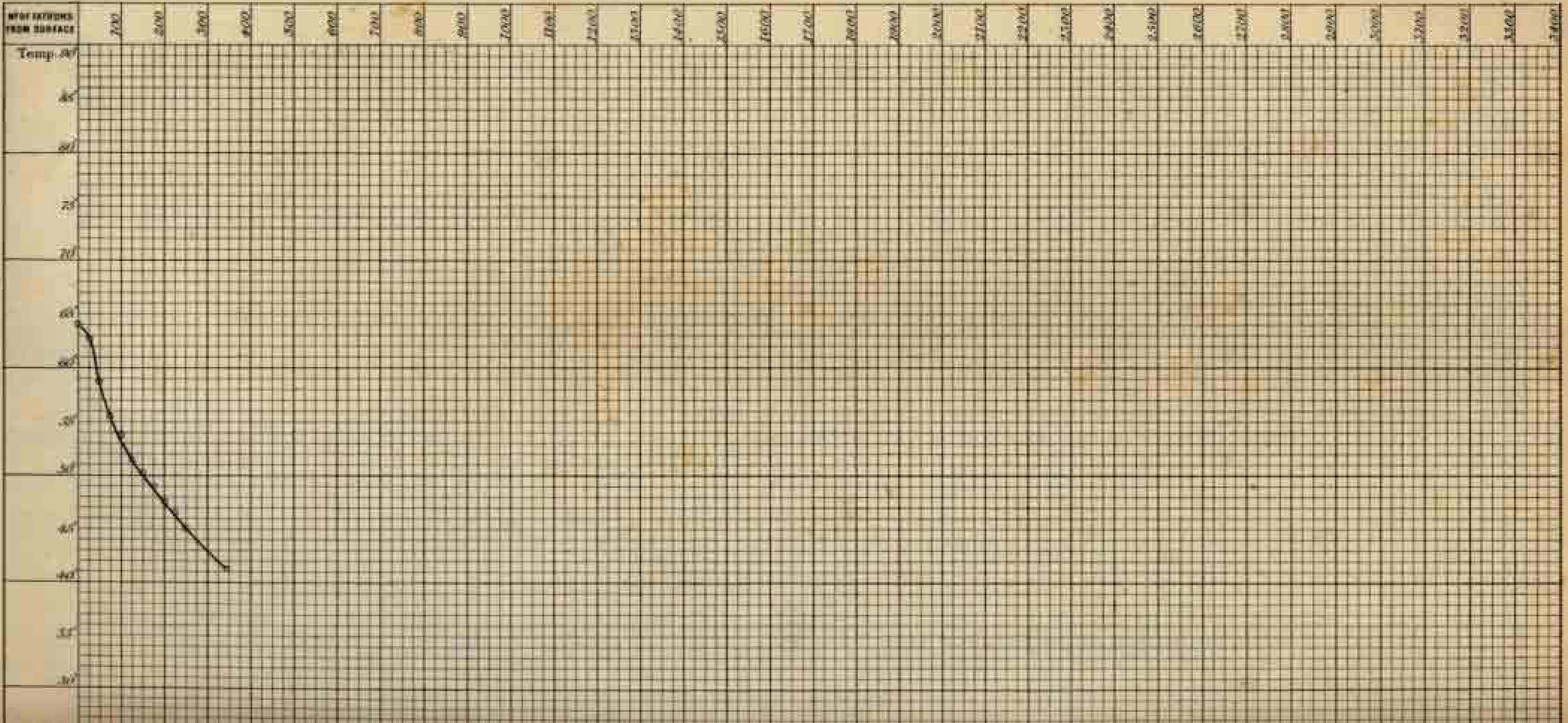
Nº of Sounding 370.
Station 232.

Depth 345 fathoms.

Latitude 35° 11′ N.
Longitude 139° 28′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250
Nº OF THERMOMETER			45			43		74			94		89			87		82			84	82	83
TEMPERATURE SHEWN BY THERMOMETER	64.2		62.2			58.2		55.4			53.8		51.2			50.0		49.0			47.4	46.5	44.5
ERROR OF THERMOMETER	0.0		+0.6			+0.6		0.0			−0.1		+0.2			+0.1		0.0			0.0	0.0	+0.5
CORRECTED TEMPERATURE	64.2		62.8			58.8		55.4			53.7		51.4			50.1		49.0			47.4	46.5	45.0
TEMPERATURE FROM CURVE	64.2		62.8			58.8		55.4			53.6		51.4			50.0		48.7			47.4	46.1	45.0

Nº OF FATHOMS FROM SURFACE	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																						84 81
TEMPERATURE SHEWN BY THERMOMETER																						41.0 41.2
ERROR OF THERMOMETER																						0.0 0.0
CORRECTED TEMPERATURE																						41.0 41.2
TEMPERATURE FROM CURVE																						41.1



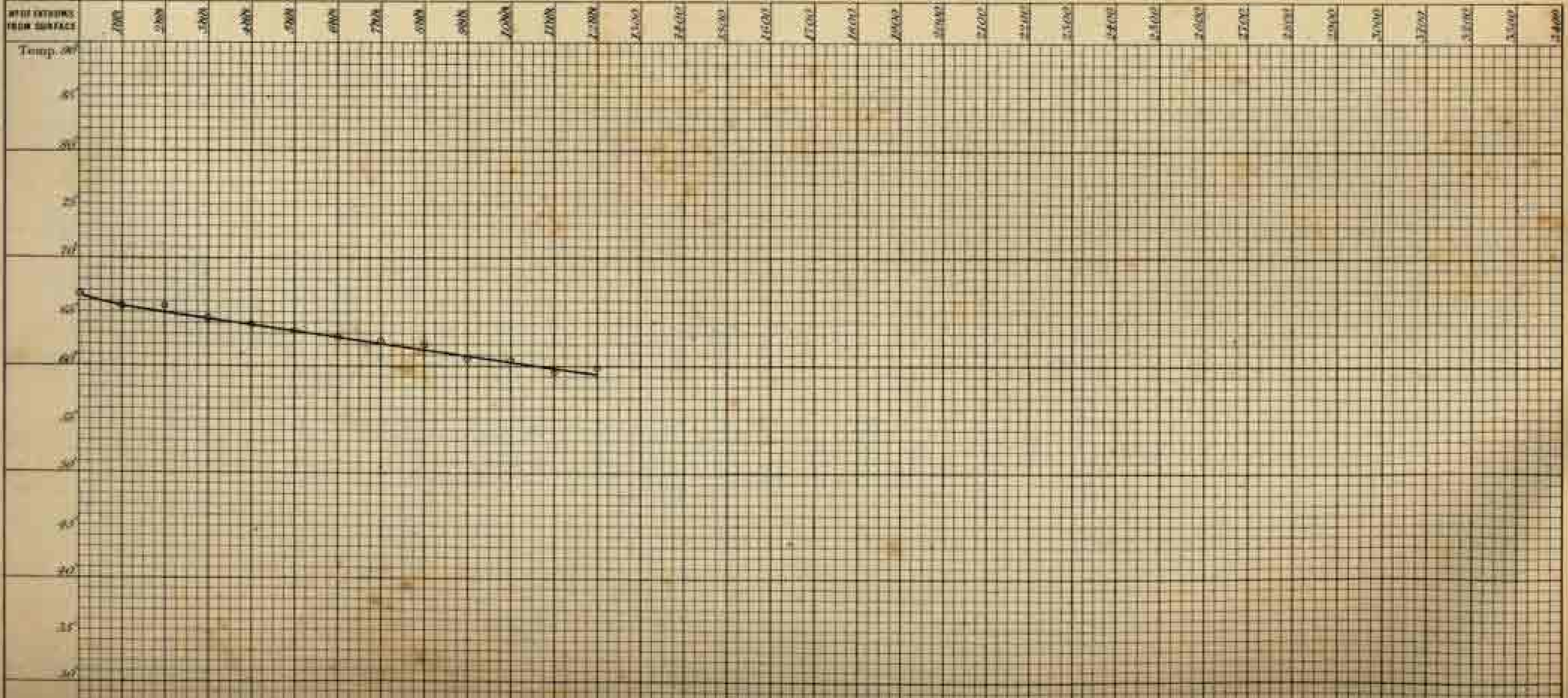
28 May 1875.

N° of Sounding 874.
Station 233 c.

Depth 12 *fathoms.*

Latitude 34° 18′ N.
Longitude 133° 21′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	1	2	3	4	5	6	7	8	9	10	11	12	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		94	84	74	83	89	82	94	84	74	83	89																																		82
TEMPERATURE SHEWN BY THERMOMETER	66.8	65.6	65.6	64.4	63.1	63.0	62.7	62.3	62.0	61.8	60.0	59.1																																		59.9
ERROR OF THERMOMETER	0.0	−0.1	0.0	0.0	+0.6	+0.2	0.0	−0.1	0.0	0.0	+0.6	+0.2																																		0.0
CORRECTED TEMPERATURE	66.8	65.5	65.6	64.4	63.8	63.2	62.7	62.4	62.0	61.8	60.6	59.3																																		59.9
TEMPERATURE FROM CURVE	66.8	65.3	64.9	64.4	63.8	63.2	62.7	62.1	61.5	60.9	60.3	59.7																																		59.2



SECTION. ADMIRALTY ISLANDS TO JAPAN.

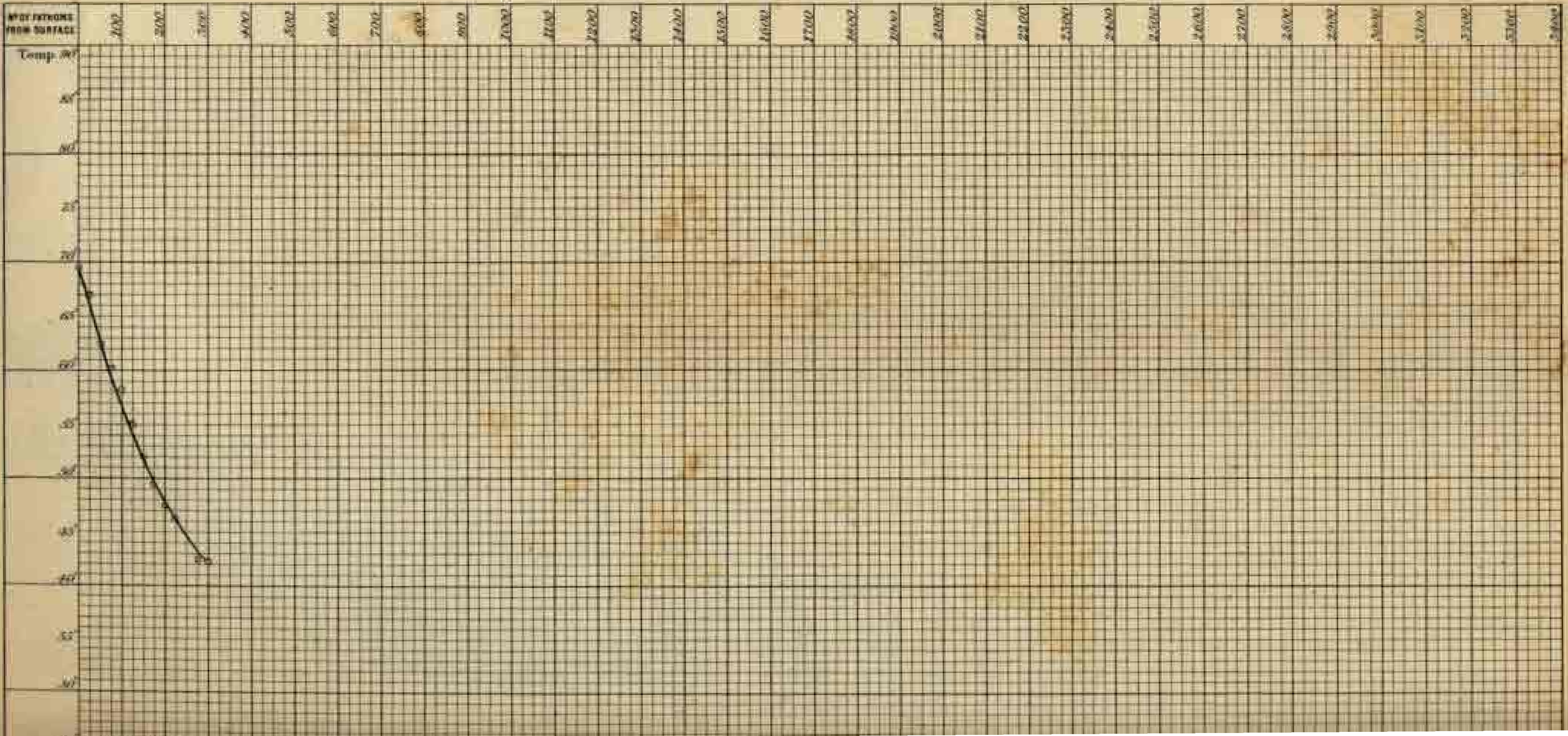
3 June 1875.

Nº of Sounding 275.
Station 234.

Depth 2675 *fathoms*

Latitude 32° 31′ N.
Longitude 135° 39′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			77			83		82			87		81			78		72			94	41	84	89	69																				82 83
TEMPERATURE SHEWN BY THERMOMETER	69.5		66.8			61.7		60.1			58.0		55.0			50.0		49.4			47.6	46.2	45.0	42.3	42.2																				36.2 35.5
ERROR OF THERMOMETER	0.0		+0.2			+0.6		0.0			+0.1		0.0			0.0		0.0			−0.1	0.0	0.0	+0.2	0.0																				0.0 0.0
CORRECTED TEMPERATURE	69.5		67.0			62.3		60.1			58.1		55.0			50.0		49.4			47.5	46.2	45.0	42.5	42.2																				36.2 35.5
TEMPERATURE FROM CURVE	69.3		66.8			63.0		60.0			57.0		54.2			50.0		49.7			48.0	46.2	44.0	43.5	42.2																				35.8



SECTION. OFF JAPAN.

4 June 1875.

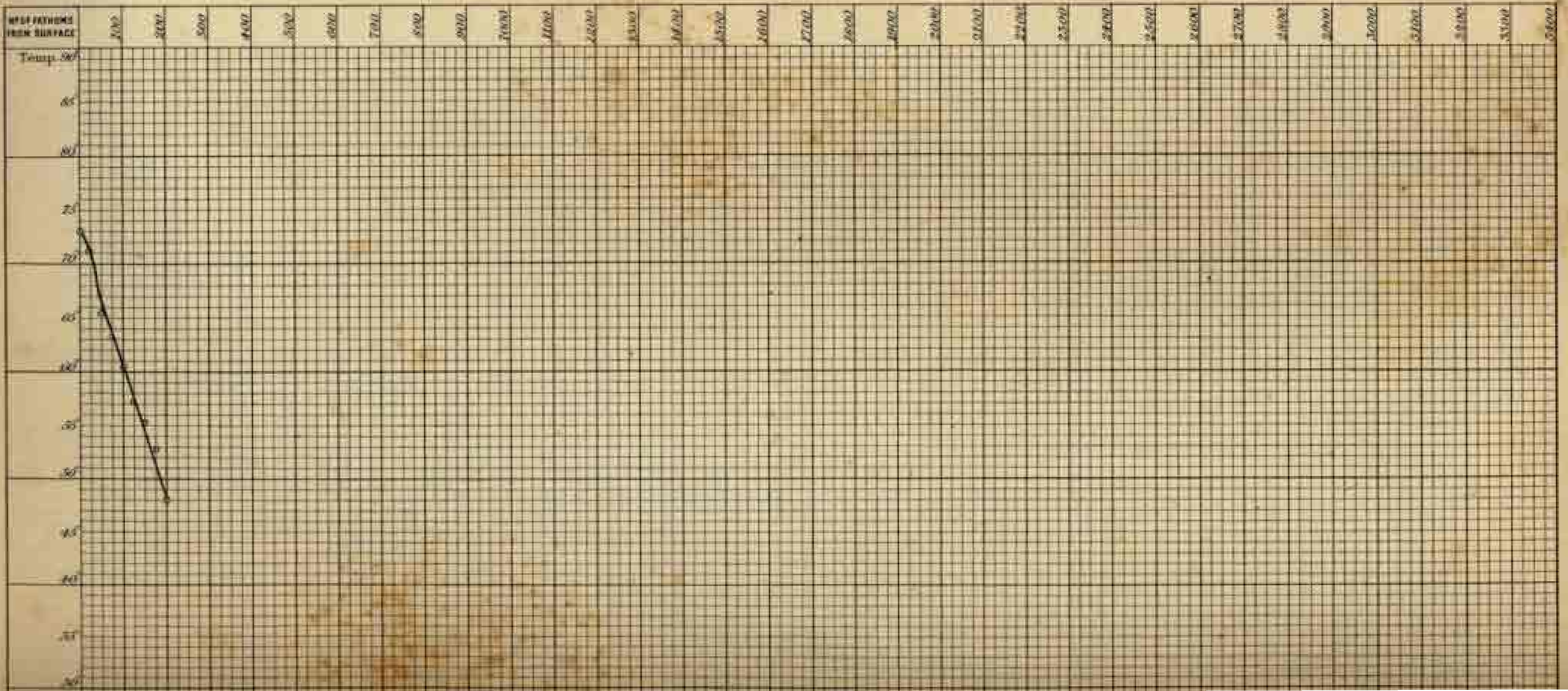
No. of Sounding 376.
Station 235.

Depth 565 *fathoms.*

Latitude 34° 7′ N.
Longitude 138° 0′ E.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
No. of Thermometer			77			81		84			71		89			74		87			41
Temperature shewn by Thermometer	73.0		71.0			65.4		63.2			60.5		57.0			55.7		52.8			48.0
Error of Thermometer	0.0		+0.2			0.0		0.0			0.0		+0.2			0.0		+0.1			-0.1
Corrected Temperature	73.0		71.2			65.4		63.2			60.5		57.2			55.7		52.9			47.9
Temperature from Curve	73.0		71.2			65.4		63.5			60.5		57.7			54.7		51.5			48.0

No. of Fathoms from Surface	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer																								89 69
Temperature shewn by Thermometer																								37.8 38.2
Error of Thermometer																								+0.2 0.0
Corrected Temperature																								38.0 38.2
Temperature from Curve																								38.1



SECTION. OFF JAPAN.

5 June 1875.

Nº of Sounding 378.
Station 236 a.

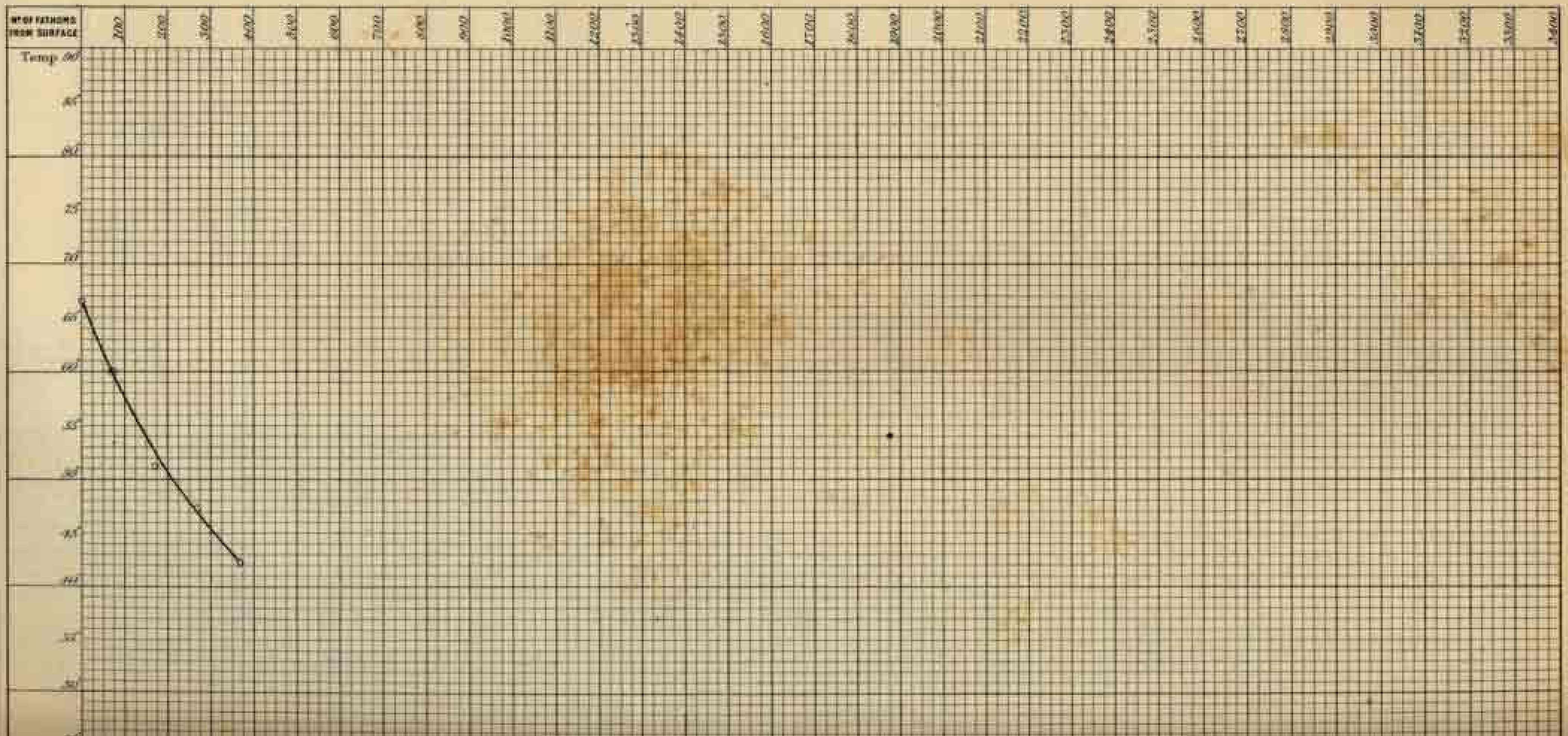
Depth 420 fathoms.

Latitude 34° 59′ N.
Longitude 139° 31′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Nº OF THERMOMETER								85								
TEMPERATURE SHEWN BY THERMOMETER	66.5							59.5								
ERROR OF THERMOMETER	0.0							+0.5								
CORRECTED TEMPERATURE	66.5							60.0								
TEMPERATURE FROM CURVE	66.5							60.0								

Nº OF FATHOMS FROM SURFACE	160	170	180	190	200	225	250	270	300	370	500	600
Nº OF THERMOMETER		67						84		82		
TEMPERATURE SHEWN BY THERMOMETER		51.0						47.2		42.8		
ERROR OF THERMOMETER		+0.1						0.0		0.0		
CORRECTED TEMPERATURE		51.1						47.2		42.8		
TEMPERATURE FROM CURVE		51.2						47.2		42.8		

Nº OF FATHOMS FROM SURFACE	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		BOTTOM
Nº OF THERMOMETER																
TEMPERATURE SHEWN BY THERMOMETER																
ERROR OF THERMOMETER																
CORRECTED TEMPERATURE																
TEMPERATURE FROM CURVE																



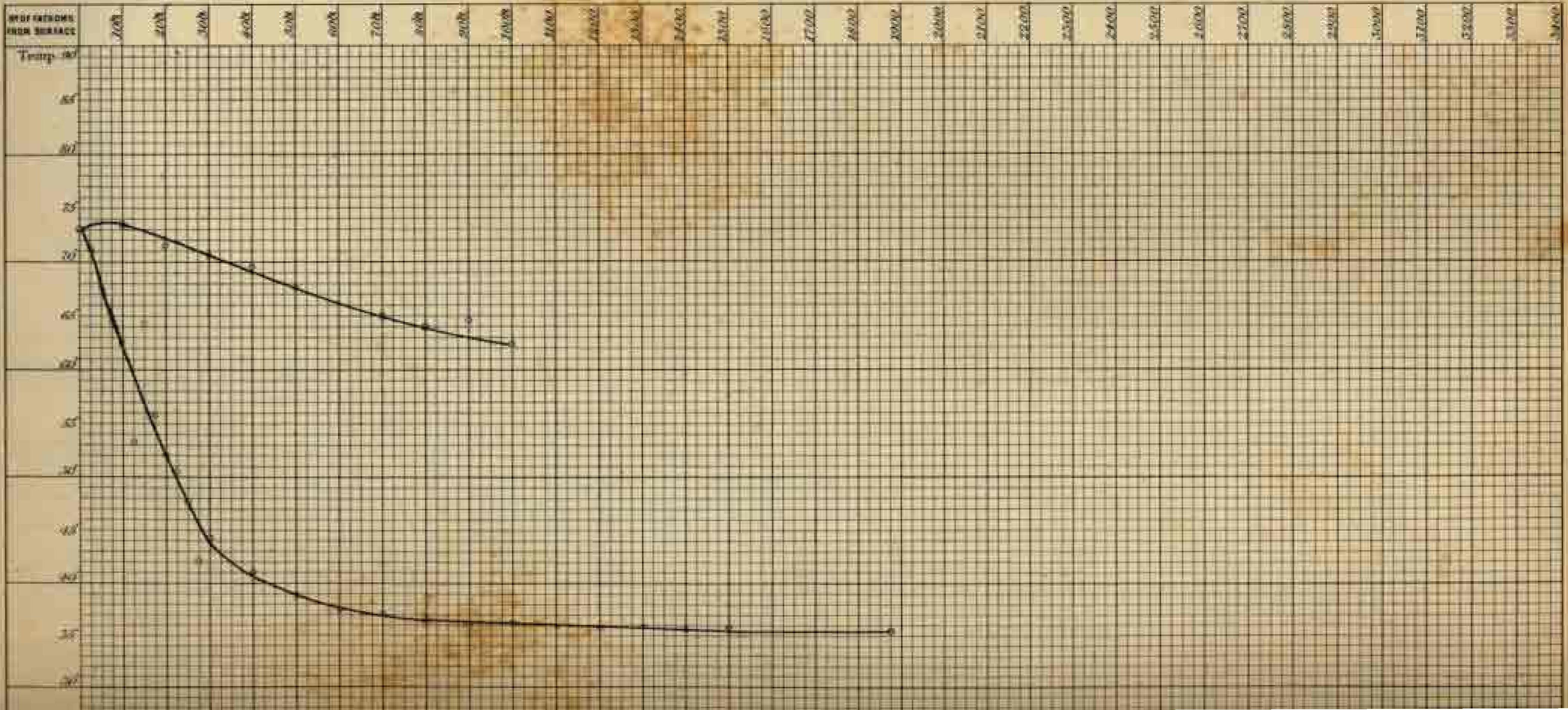
17 June 1875.

Nº of Sounding 379.
" " Station 237.

Depth 1875 fathoms.

Latitude 34° 37' N.
Longitude 140° 32' E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer		80	89	43	94	81	71	74	89	43	89		77			71		94			74	89	89	81	81	69	94	43	87	80	81	43	94	80	87	81	69								69 84
Temperature shewn by thermometer	73.0	73.4	71.5	70.0	69.8	67.6		65.0	63.8	64.2	62.6		54.0			64.0		56.0			52.0	50.2	47.5	42.0	44.1	41.0	38.8	37.2	37.0	36.5	36.1	35.5	36.0	35.8	35.8	35.0	35.3								35.3 35.0
Error of thermometer	0.0	0.0	+0.1	+0.8	-0.1	0.0	0.0	0.0	+0.2	+0.6	-0.2		+0.2			0.0		-0.1			0.0	+0.1	+0.2	0.0	0.0	0.0	-0.1	+0.3	+0.1	0.0	0.0	+0.6	-0.1	0.0	+0.1	+0.3	0.0								0.0 0.0
Corrected temperature	73.0	73.4	71.6	70.8	69.7	67.6		65.0	64.0	64.8	62.4		54.2			64.0		55.9			52.0	50.3	47.7	42.0	44.1	41.0	38.7	37.5	37.1	36.5	36.1	36.1	35.9	35.8	35.9	35.3	35.3								35.3 35.0
Temperature from curve	73.0	73.4	72.0	70.5	69.0	67.5	66.1	65.0	64.0	63.2	62.4		59.8			57.0		54.5			52.0	50.0	48.0	46.0	44.1	40.8	38.8	37.7	37.0	36.6	36.4	36.2	36.0	35.8	35.5	35.4	35.3								35.3



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49′ N. Long. 179° 57′ W.

18 June 1875.

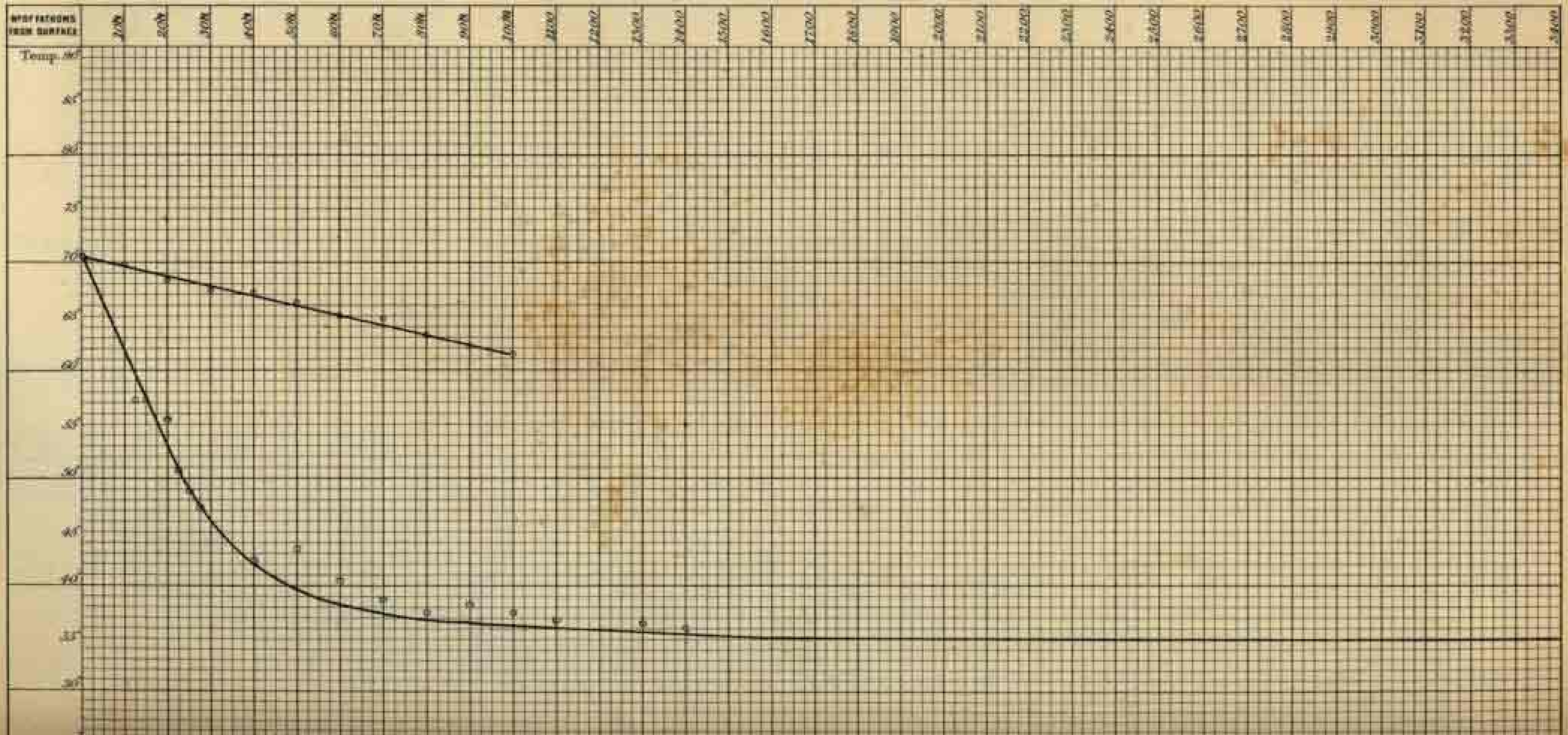
Nº of Sounding 380.
Station 238.

Depth 3950 fathoms.

Latitude 35° 18′ N.
Longitude 144° 8′ E.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	125	130	140	150	160	175	180	190
Nº of thermometer		71	81	87	90	89	94	43	85	69	[illegible]		77			87		71		
Temperature shewn by thermometer	70.5	69.8	68.3	67.5	67.2	66.2	65.2	64.2	63.8	62.2	61.2		57.0			57.2				
Error of thermometer	0.0	0.0	0.0	+0.1	0.0	+0.2	−0.1	+0.5	−0.5	0.0	+0.2		+0.2			+0.1		0.0		
Corrected temperature	70.5	69.8	68.3	67.6	67.2	66.4	65.1	64.8	63.3	62.2	61.4		57.2			57.3				
Temperature from curve	70.5	69.6	68.7	67.8	66.9	66.0	65.1	64.2	63.3	62.4	61.5		59.3			57.0		54.9		

Nº of fathoms from surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	83	94	89	90	84	69	81	83	74	85	83	87	34	41	85	84									69 83
Temperature shewn by thermometer	53.8	51.0	48.5	47.2		42.0	43.5	41.0	38.9	37.0	37.5	37.2	37.0		35.8	36.0									35.2 35.4
Error of thermometer	+0.6	−0.1	+0.2	0.0	0.0	0.0	0.0	−0.3	0.0	+0.5	+0.6	+0.1	−0.1	0.0	+0.5	0.0									0.0 −0.5
Corrected temperature	54.4	50.9	48.7	47.2		42.0	43.5	40.7	38.9	37.5	38.1	37.3	36.9		36.3	36.0									35.2 34.9
Temperature from curve	52.7	50.7	48.8	47.1	45.9	42.2	39.7	38.3	37.5	37.0	36.6	36.4	36.2	36.0	35.7	35.5	35.3								35.0



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49' N. Long. 179° 57' W.

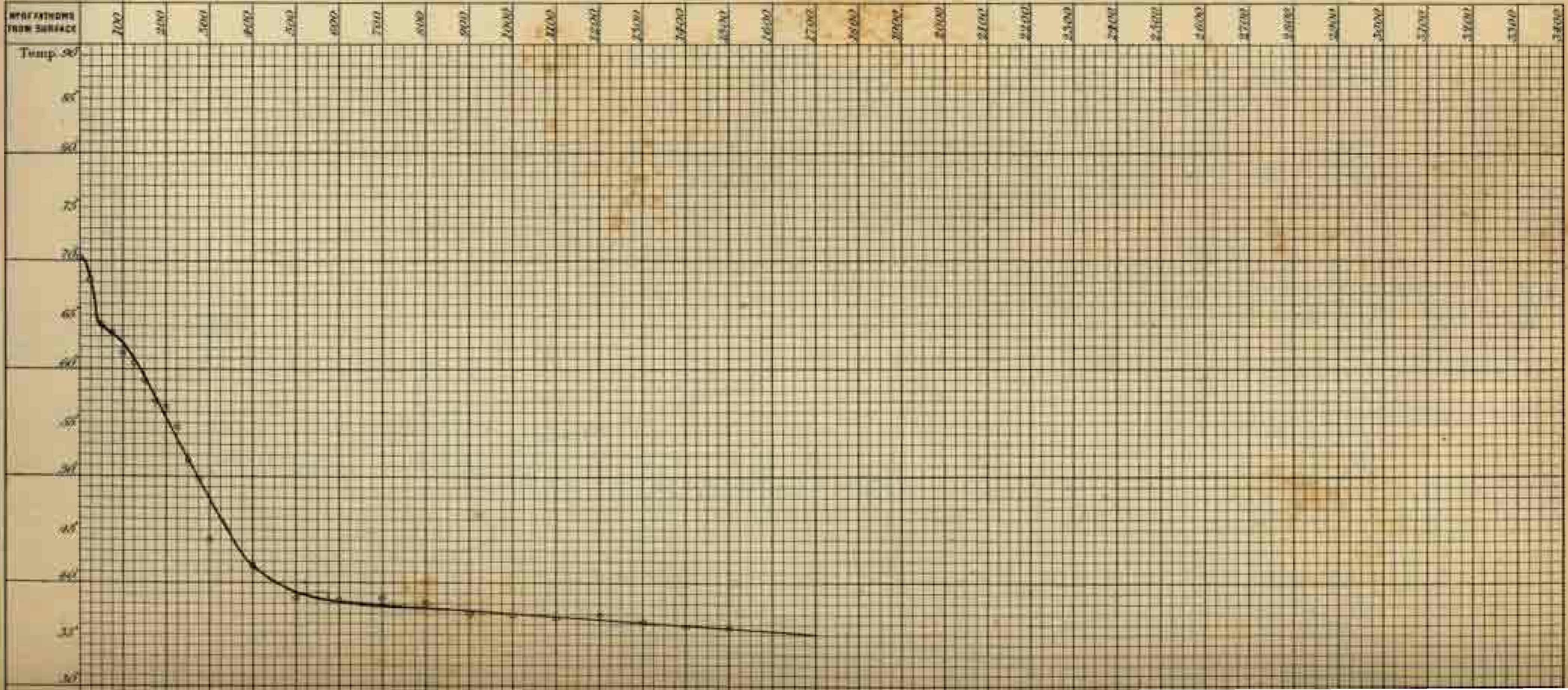
19 June 1875.

N° of Sounding 381.
Station 239.

Depth 3025 fathoms.

Latitude 35° 18' N.
Longitude 147° 9' E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			43			94		77			87		74			81		89			43	71	74	94	77	87	81	89	43	90	71	74	94	77	87	81	89								83 69
TEMPERATURE SHEWN BY THERMOMETER	70.2		67.5			64.2		63.2			61.5		60.5			59.0		56.8			56.0	54.8	51.4	50.0	43.8	41.5	38.5	38.0	37.8	38.0	37.0	36.8	36.5	36.6	36.0	35.8	35.5								35.4 35.4
ERROR OF THERMOMETER	0.0		+0.6			−0.1		+0.2			+0.1		0.0			0.0		+0.2			+0.6	0.0	0.0	−0.1	+0.2	+0.1	0.0	+0.2	+0.6	0.0	0.0	0.0	−0.1	+0.2	+0.1	0.0	+0.2								−0.5 0.0
CORRECTED TEMPERATURE	70.2		68.1			64.1		63.4			61.6		60.5			59.0		57.0			56.6	54.8	51.4	49.9	44.0	41.6	38.5	38.2	38.4	38.0	37.0	36.8	36.4	36.8	36.1	35.8	35.7								34.9 35.4
TEMPERATURE FROM CURVE	70.2		68.1			64.3		63.4			60.3		60.8			59.1		57.1			55.1	53.0	51.3	49.5	47.7	41.6	39.0	38.1	37.7	37.4	37.1	36.9	36.7	36.4	36.1	35.9	35.7								35.1



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49' N. Long. 179° 57' W.

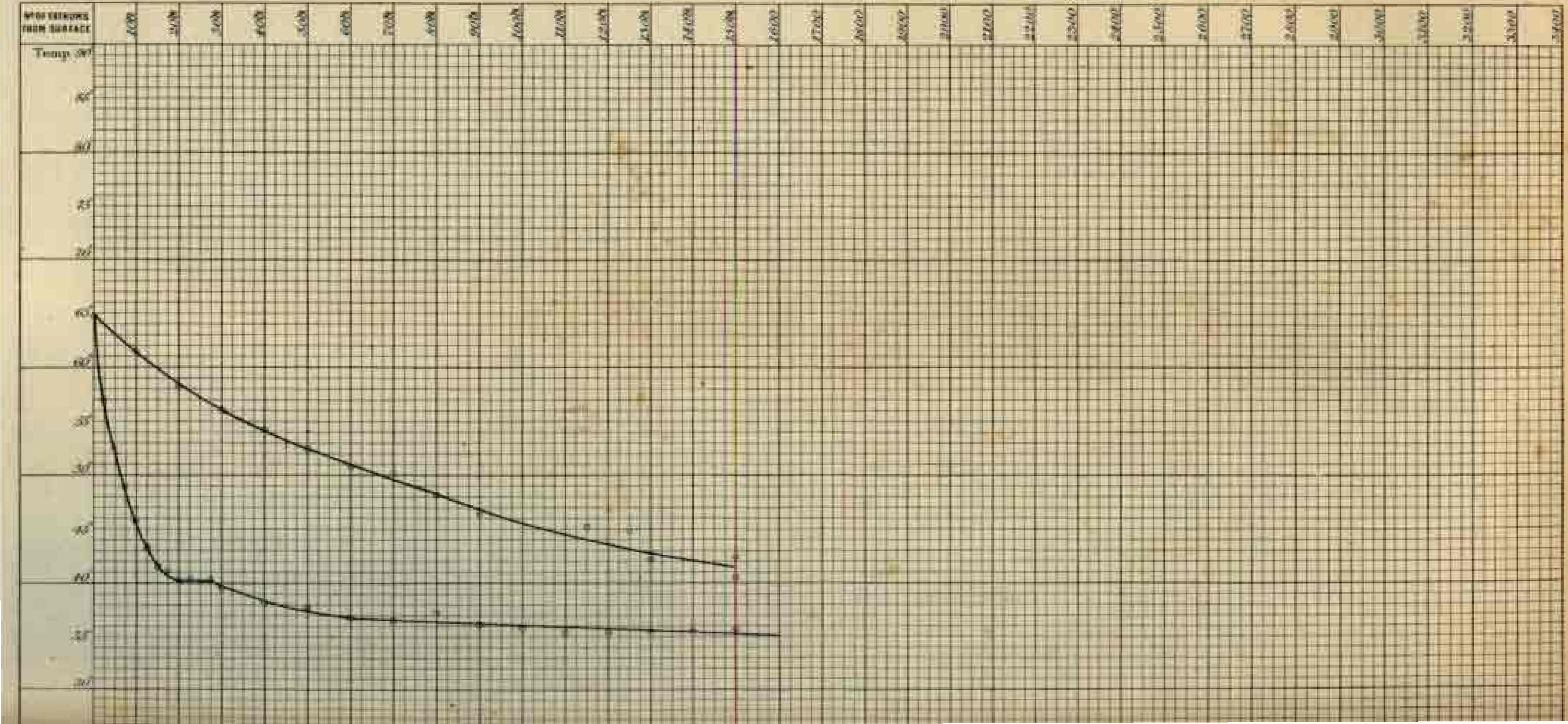
21 June 1875.

No. of Sounding 382.
Station 240.

Depth 2900 fathoms.

Latitude 35° 20' N.
Longitude 153° 39' E.

No. of fathoms from surface	No. of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		64.8	0.0	64.8	64.8
10	81	61.3	0.0	61.3	61.4
20	90	58.2	0.0	58.2	58.5
30	69	56.0	0.0	56.0	56.0
40	85	53.8	+0.6	54.4	54.2
50	83	53.0	−0.5	52.5	52.4
60	89	50.6	+0.2	50.8	51.0
70	77	49.9	+0.2	50.1	49.8
80	94	48.2	−0.1	48.1	48.3
90	74	46.5	0.0	46.5	47.0
100			0.0		45.8
110	81	45.0	0.0	45.0	44.0
120	71	44.9	0.0	44.9	43.7
130	87	40.0	+0.1	40.1	42.8
140					
150	90 94	40.8 42.4	0.0 −0.1	40.8 42.3	41.4
160					
170	61 87	39.2 41.0	+3.0 +0.1	42.2 41.1	40.8
180					
190					
200	77 85	40.1 40.8	+0.2 0.0	40.3 40.8	40.2
225	87 89	40.0 40.0	+0.1 +0.8	40.1 40.8	40.1
250	81 84	40.0 40.5	0.0 −0.5	40.0 40.0	40.0
275	74 84	40.2 40.0	0.0 0.0	40.2 40.0	40.0
300	89 93 90	39.5 40.0 38.8	+0.2 −0.5 0.0	39.7 39.5 38.8	39.8
400	94	38.2	−0.1	38.1	38.2
500	83	37.4	+0.3	37.7	37.4
600	99	36.9	0.0	36.9	36.9
700	90	36.5	0.0	36.5	36.4
800	77	37.2	0.0	37.2	36.3
900	83	35.8	+0.3	36.1	36.0
1000	80	35.5	+0.2	35.7	36.0
1100	94	35.5	−0.1	35.4	35.9
1200	74	35.5	0.0	35.5	35.7
1300	81	35.5	0.0	35.5	35.5
1400	87	35.4	+0.1	35.5	35.3
1500	77	35.2	+0.2	35.4	35.1
1600					
1700					
1800					
1900					
2000					
Bottom	66 85	34.7 35.5	0.0 −0.5	34.7 35.0	34.9



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49' N / Long. 179° 57' W.

23 June 1875.

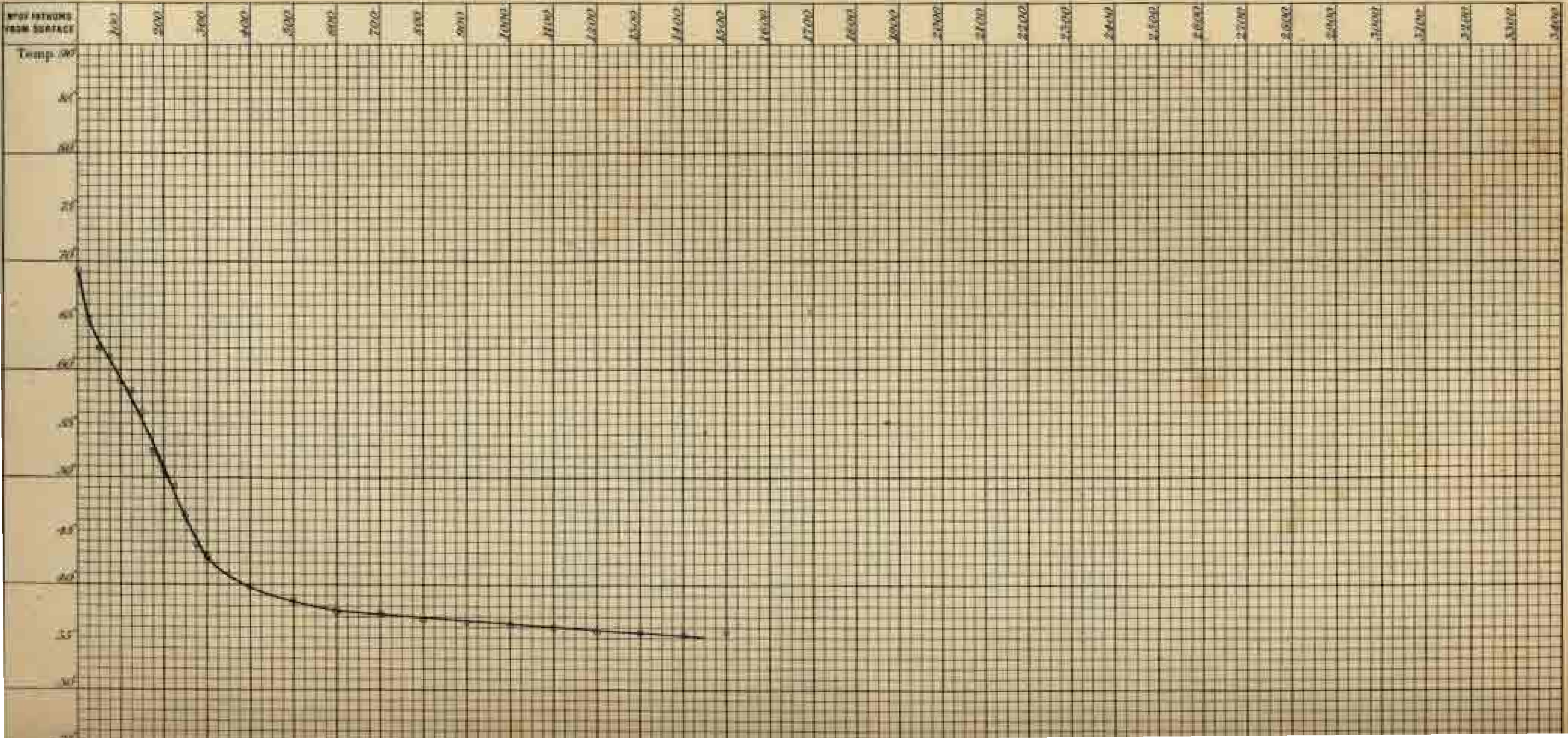
Nº of Sounding 383.
Station 241.

Depth 2300 fathoms.

Latitude 35° 41' N.
Longitude 157° 42' E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
Nº OF THERMOMETER			94			81		71			89		87			90		90		
TEMPERATURE SHEWN BY THERMOMETER	69.0		64.8			62.0		61.1			58.7		58.0			56.0		53.5		
ERROR OF THERMOMETER	0.0		−0.1			0.0		0.0			+0.2		+0.1			0.0		0.0		
CORRECTED TEMPERATURE	69.0		64.7			62.0		61.1			58.9		58.1			56.0		53.5		
TEMPERATURE FROM CURVE	69.0		64.7			62.5		60.8			59.3		57.5			55.5		53.1		

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	89	77	74	87	77	94	91	85	74	77	87	71	81	89	94	90	85								33 85
TEMPERATURE SHEWN BY THERMOMETER	50.5	49.2	46.4	43.8	42.2	40.0	38.5	37.1	37.2	36.5	36.4	36.2	36.0	35.4	35.5	35.1	35.0								35.3 35.2
ERROR OF THERMOMETER	+0.2	0.0	0.0	+0.1	+0.2	−0.1	0.0	+0.5	0.0	+0.2	+0.1	0.0	0.0	+0.2	−0.1	0.0	+0.5								−0.3 0.0
CORRECTED TEMPERATURE	50.7	49.2	46.4	43.9	42.4	39.9	38.5	37.6	37.2	36.7	36.5	36.2	36.0	35.6	35.4	35.1	35.5								35.0 35.2
TEMPERATURE FROM CURVE	50.7	48.7	46.3	44.0	42.4	39.8	38.4	37.7	37.1	36.9	36.6	36.3	36.0	35.7	35.4	35.1	35.1								35.1



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49′ N. / Long. 179° 57′ W.

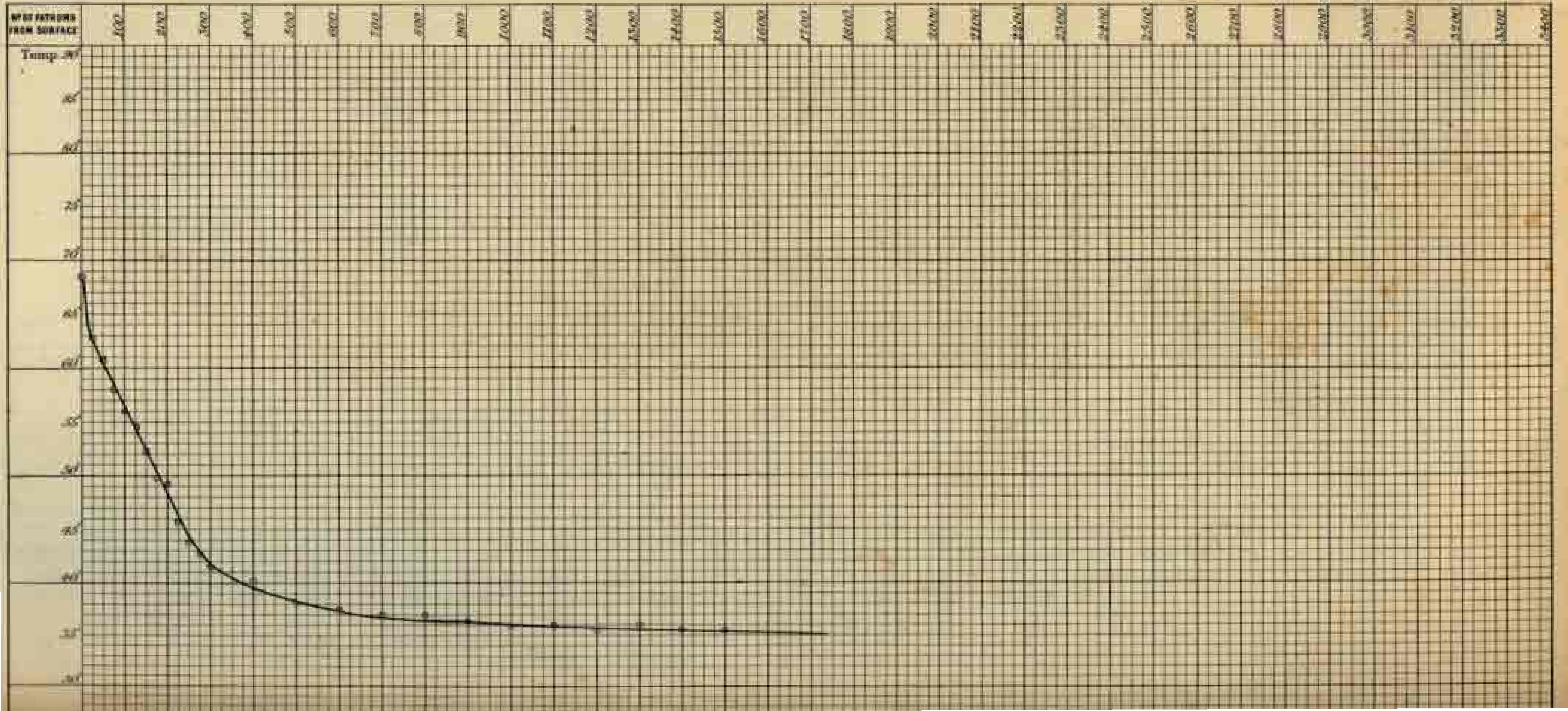
24 June 1875.

Nº of Sounding 384.
Station 242.

Depth 2675 fathoms.

Latitude 35° 29′ N.
Longitude 161° 52′ E.

Nº of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer			94			71		81			43		78			90		89			77	44	87	81	43	74	90	71	89	85	87	90	89	81	84	74	71								69 85
Temperature shewn by Thermometer	68.5		63.0			60.8		58.0			55.4		54.3			52.2		49.6			49.0	45.8	43.8	42.8	41.0	40.2	38.2	37.6	36.8	36.5	36.4	36.0	35.8	35.8	36.1	35.7	35.5								35.2 35.5
Error of Thermometer	0.0		−0.1			0.0		0.0			+0.6		0.0			0.0		+0.2			+0.2	−0.1	+0.1	0.0	+0.6	0.0	0.0	0.0	+0.2	+0.5	+0.1	0.0	+0.2	0.0	0.0	0.0	0.0								0.0 −0.5
Corrected Temperature	68.5		62.9			60.8		58.0			56.0		54.3			52.2		49.8			49.2	45.7	43.9	42.8	41.6	40.2	38.2	37.6	37.0	37.0	36.5	36.0	36.0	35.8	36.1	35.7	35.5								35.2 35.0
Temperature from Curve	68.5		62.9			60.7		58.3			56.0		54.1			52.2		50.3			48.3	46.4	44.4	42.8	41.8	39.6	38.2	37.4	36.9	36.5	36.3	36.1	35.9	35.8	35.7	35.5	35.3								35.1



SECTION. FROM JAPAN TO A POSITION IN { Lat. [illegible]
{ Long. 179° 57′ W.

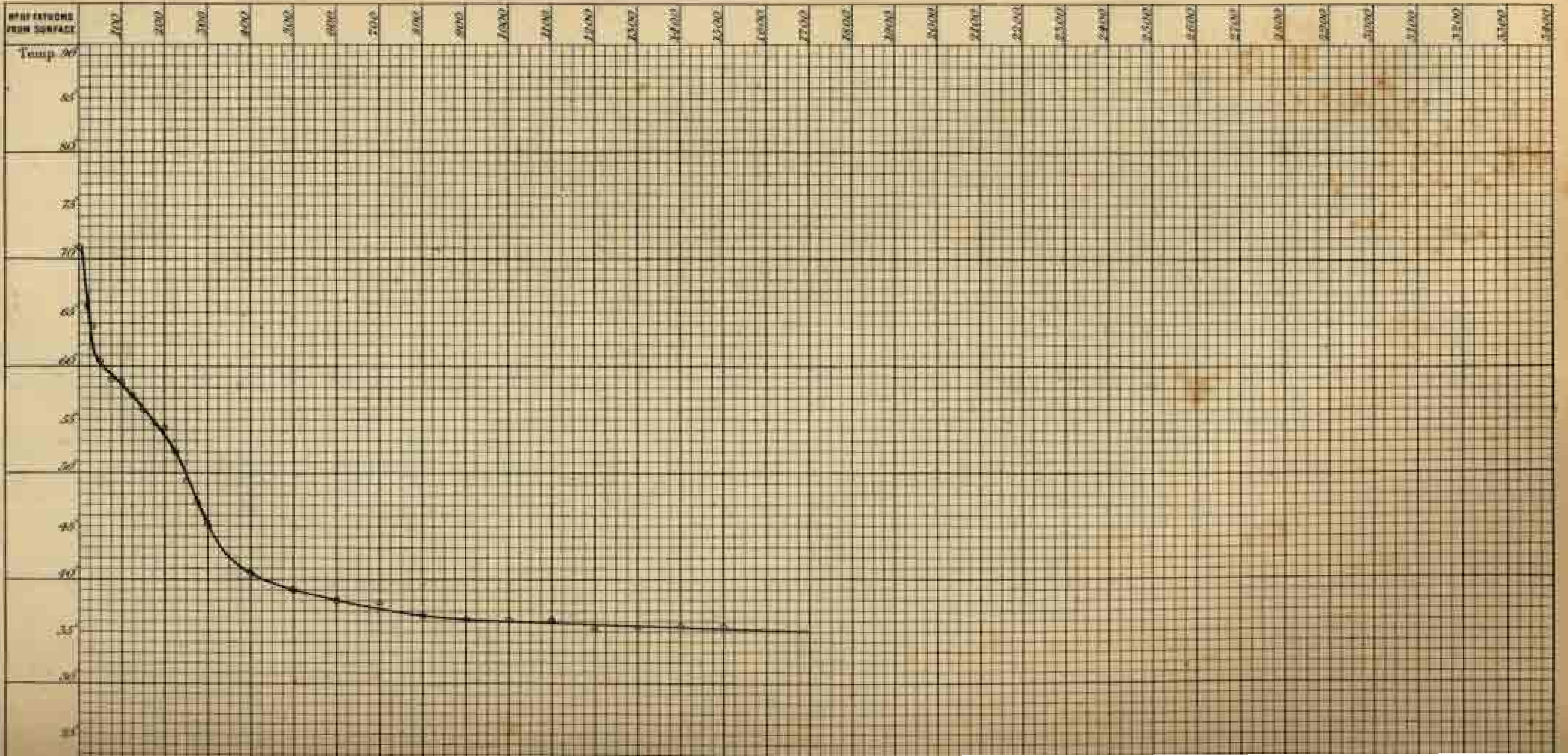
26 June 1875.

N.^o of Sounding 385.
" Station 243.

Depth 2800 fathoms

Latitude 35° 24′ N.
Longitude 166° 35′ E.

No. of fathoms from surface	No. of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		71.0	0.0	71.0	71.0
10	83	70.8	−0.5	70.3	70.3
20	90	65.6	0.0	65.6	65.6
30	69	63.8	0.0	63.8	63.9
40					
50	77	60.2	+0.2	60.4	60.4
60					
75	94	59.0	−0.1	58.9	59.3
80					
90					
100	69	58.8	0.0	58.8	58.3
110					
125	89	57.0	+0.2	57.2	57.2
130					
140					
150	84	56.0	0.0	56.0	56.2
160					
175	90	54.8	0.0	54.8	55.1
180					
190					
200	90	54.2	0.0	54.2	53.5
225	84	52.0	0.0	52.0	52.0
250	89	49.0	+0.2	49.2	49.6
275	94	47.4	0.0	47.4	47.0
300	77	45.0	+0.9	45.9	45.0
400	93	40.0	+0.6	40.6	40.5
500	87	39.0	+0.1	39.1	39.1
600	81	38.1	0.0	38.1	38.1
700	71	37.9	0.0	37.9	37.2
800	94	36.8	−0.1	36.7	36.6
900	89	36.0	+0.2	36.2	36.1
1000	84	36.0	0.0	36.0	35.9
1100	77	35.8	+0.2	36.0	35.8
1200	93	34.5	+0.6	35.1	35.7
1300	87	35.2	+0.1	35.3	35.5
1400	81	35.4	0.0	35.4	35.4
1500	71	35.4	0.0	35.4	35.3
1600					
1700					
1800					
1900					
2000					
Bottom	83 69	35.4 35.0	−0.5 0.0	34.9 35.0	35.0



SECTION. FROM JAPAN TO A POSITION IN { Lat. 35° 49′ N. Long. 179° 57′ W.

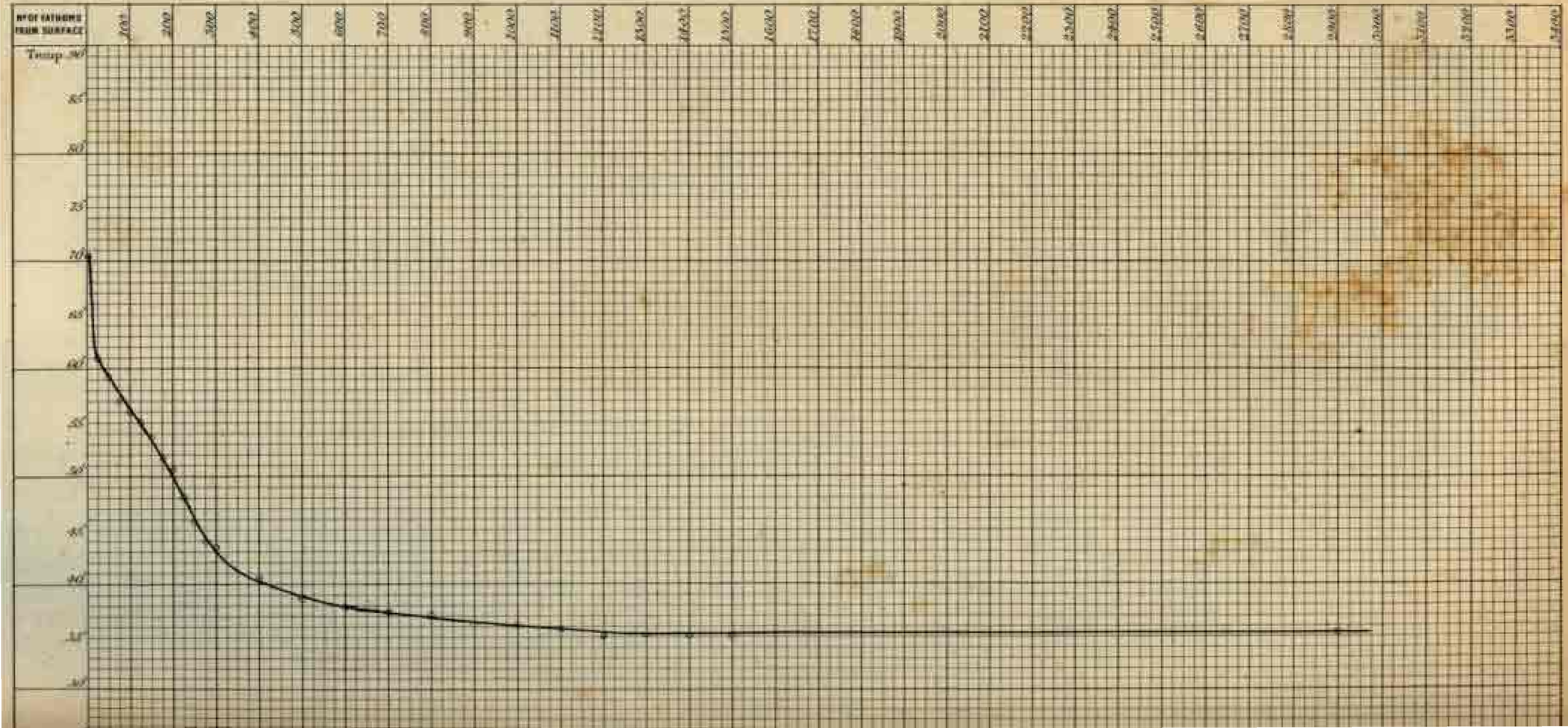
28 June 1875.

N° of Sounding 386.
Station 244.

Depth 2900 *fathoms.*

Latitude 35° 22′ N.
Longitude 169° 53′ E.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	273	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			71			69		90			83		82			43		94			85	81	74	94	74	87	75	90	84	72	41	87	77	90	89	94	84								83 89
TEMPERATURE SHEWN BY THERMOMETER	70.5		61.0			59.2		57.0			56.5		55.0			53.0		51.8			50.0	48.0	45.8	44.0	43.8	40.3	38.5	38.0	37.4	37.1	35.0	35.9	35.6	35.4	35.2	35.2	35.0								35.6 35.3
ERROR OF THERMOMETER	0.0		0.0			0.0		0.0			−0.5		0.0			+0.6		−0.1			+0.5	0.0	0.0	−0.1	0.0	+0.1	+0.2	0.0	0.0	0.0	+1.2	+0.1	+0.2	0.0	+0.2	−0.1	0.0								−0.5 0.0
CORRECTED TEMPERATURE	70.5		61.0			59.2		57.0			56.0		55.0			53.6		51.7			50.5	48.0	45.8	43.9	43.8	40.4	38.7	38.0	37.4	37.1	36.2	36.0	35.8	35.4	35.4	35.1	35.0								35.1 35.3
TEMPERATURE FROM CURVE	70.5		61.0			59.2		57.6			56.2		54.9			53.3		51.7			49.8	48.0	46.0	44.3	43.1	40.4	38.9	38.0	37.4	36.9	36.4	36.0	35.7	35.5	35.3	35.3	35.3								35.2



SECTION. FROM JAPAN TO A POSITION IN { Lat. [illegible] N. / Long. 179° 57′ W.

30 June 1875.

No. of Sounding 387.
Station 245.

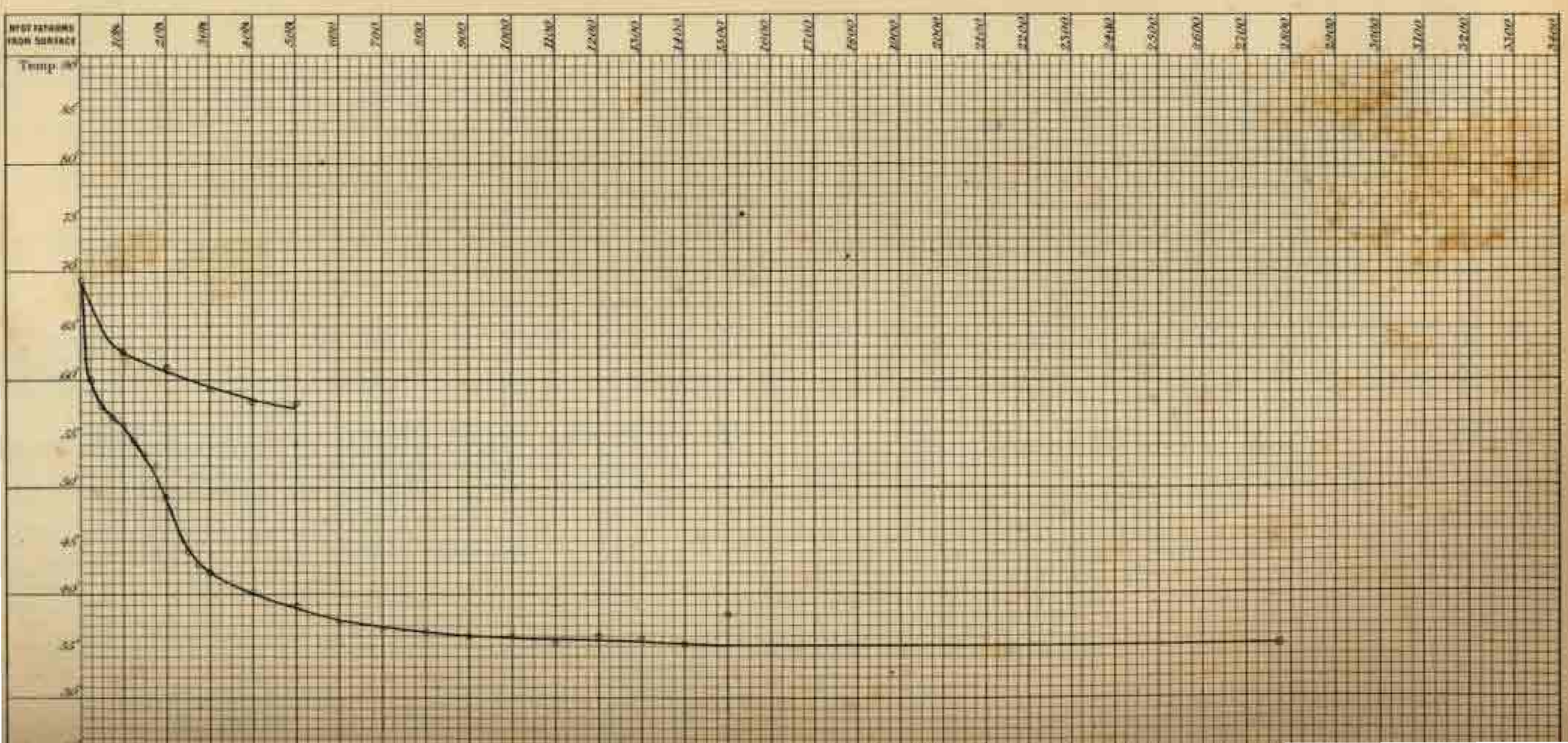
Depth 2775 *fathoms*

Latitude 36° 23′ N.
Longitude 174° 31′ E.

No. of fathoms from surface	Surface	10	20	30	40	50	60	75	80	90	100	110	125	130	140
No. of thermometer		216	84	43	91	215		83			43		91		
Temperature shewn by thermometer	69.0	62.8	61.0	58.5	58.0	58.0		56.1			55.0		54.5		
Error of thermometer	0.0	−0.2	+0.2	+0.6	−0.1	−0.2		+0.2			+0.6		−0.1		
Corrected temperature	69.0	62.6	61.2	59.1	57.9	57.8		56.3			55.6		54.4		
Temperature from curve	69.0	62.6	60.8	59.3	58.3	57.1		56.4			55.6		54.4		

No. of fathoms from surface	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
No. of thermometer	83		69			84		43	94	87	74	71	83	216	87
Temperature shewn by thermometer	53.5		52.0			49.0		43.3	43.0	41.0	40.2	38.8	37.0	37.0	36.0
Error of thermometer	−0.5		0.0			0.0		+0.8	−0.1	+0.1	0.0	0.0	+0.3	−0.2	+0.4
Corrected temperature	53.0		52.0			49.0		44.1	42.9	41.1	40.2	38.8	37.3	36.8	36.4
Temperature from curve	53.0		51.0			48.8	46.4	44.0	43.0	42.0	40.2	38.8	37.6	36.8	36.4

No. of fathoms from surface	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer	91	83	216	71	74	87	84								83 61
Temperature shewn by thermometer	36.1	35.8	35.5	36.0	35.8	35.0	36.0								35.2 35.2
Error of thermometer	−0.1	+0.2	−0.2	0.0	0.0	+0.1	0.0								−0.5 0.0
Corrected temperature	36.0	36.0	35.3	36.0	35.8	35.1	36.0								34.7 35.2
Temperature from curve	36.1	35.9	35.7	35.5	35.3	35.1	34.9								34.9



SECTION. FROM JAPAN TO A POSITION IN { *Lat. 35° 49′ N.* / *Long. 179° 57′ W.*

2 July 1875.

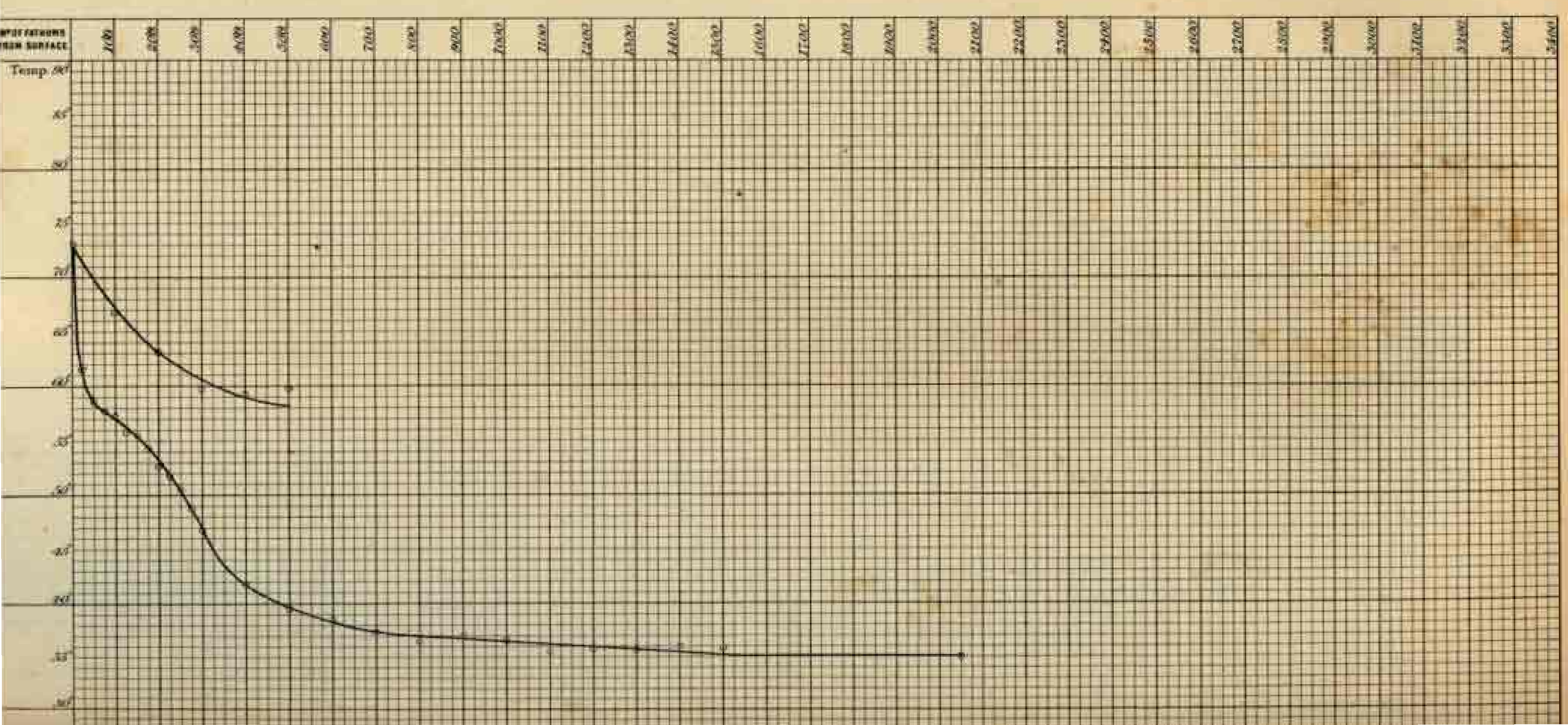
N° of Sounding 388.
Station 246.

Depth 2050 fathoms.

Latitude 36° 10′ N.
Longitude 178° 0′ E.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER		94	74	43	87	77		81			71		94			74		43			87
TEMPERATURE SHEWN BY THERMOMETER	73.0	66.8	63.0	59.2	59.0	59.5		57.8			57.2		55.8			55.4		53.5			52.5
ERROR OF THERMOMETER	0.0	−0.1	0.0	+0.6	+0.1	+0.2		0.0			0.0		−0.1			0.0		+0.6			+0.1
CORRECTED TEMPERATURE	73.0	66.7	63.0	59.8	59.1	59.7		57.8			57.2		55.7			55.4		54.1			52.6
TEMPERATURE FROM CURVE	73.0	67.0	63.0	60.4	59.2	58.4		57.8			57.0		56.2			55.3		54.2			53.0

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	87	43	74	94	71	81	77	85	106	71	81	89	43	87	77	84								69 83
TEMPERATURE SHEWN BY THERMOMETER	51.8	49.6	48.8	46.8	41.8	39.5	38.4	36.8	36.6	37.0	36.0	35.4	35.0	35.5	35.7	35.7								35.2 35.5
ERROR OF THERMOMETER	+0.1	+0.8	0.0	−0.1	0.0	0.0	+0.2	+0.5	−0.2	0.0	+0.5	+0.2	+0.6	+0.1	+0.2	0.0								0.0 −0.5
CORRECTED TEMPERATURE	51.9	50.4	48.8	46.7	41.8	39.5	38.6	37.3	36.4	37.0	36.5	35.6	35.6	35.6	35.9	35.7								35.3 35.0
TEMPERATURE FROM CURVE	52.0	50.4	48.9	46.9	41.8	39.7	38.3	37.4	37.0	36.7	36.4	36.1	35.9	35.6	35.3	35.1								35.1



SECTION. FROM A POSITION IN {Lat. 35° 49′ N. Long. 179° 57′ W.} TO A POSITION IN {Lat. 38° 9′ N. Long. 166° 25′ W.}

3 July 1875.

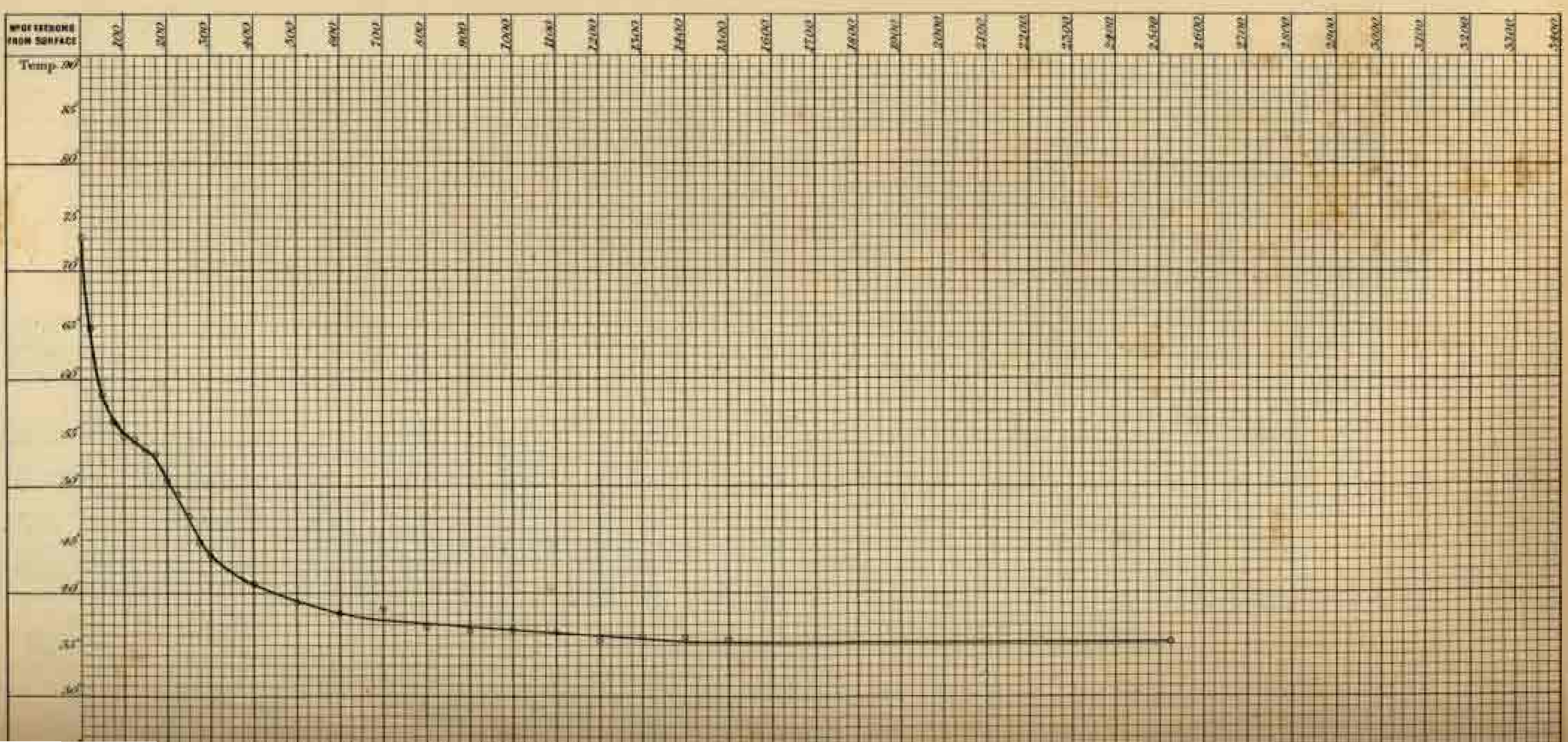
Nº of Sounding 389.
Station 247.

Depth 2530 *fathoms*

Latitude 35° 49′ N.
Longitude 179° 57′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER			77			71		216			81		74			87		71			216
TEMPERATURE SHEWN BY THERMOMETER	73.0		63.6			58.4		56.2			54.8		54.4			53.3		53.0			50.6
ERROR OF THERMOMETER	0.0		+0.2			0.0		−0.2			0.0		0.0			+0.1		0.0			−0.2
CORRECTED TEMPERATURE	73.0		63.8			58.4		56.0			54.8		54.4			53.4		53.0			50.4
TEMPERATURE FROM CURVE	73.0		63.8			58.4		56.0			54.8		54.1			53.5		52.5			50.5

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	83	81	71	89	77	87	85	71	216	83	81	74	89	77	87	85								69 83
TEMPERATURE SHEWN BY THERMOMETER	48.5	47.1	44.0	43.3	40.6	39.0	37.6	36.6	37.0	35.9	36.5	36.1	35.3	35.3	35.6	35.1								35.5 35.5
ERROR OF THERMOMETER	+0.6	0.0	0.0	+0.2	+0.2	+0.1	+0.5	0.0	−0.2	+0.6	0.0	0.0	+0.2	+0.4	+0.1	+0.5								0.0 −0.5
CORRECTED TEMPERATURE	49.1	47.1	44.0	43.5	40.8	39.1	38.1	36.6	36.8	36.5	36.5	36.1	35.5	35.7	35.7	35.6								35.5 35.0
TEMPERATURE FROM CURVE	48.7	46.9	45.0	43.5	40.7	39.1	38.0	37.7	37.2	36.9	36.6	36.2	35.9	35.6	35.3	35.2								35.2



SECTION. FROM A POSITION IN { Lat. 35° 49' N. Long. 179° 57' W. } TO A POSITION IN { Lat. 38° 9' N. Long. 156° 25' W.

6 July 1875.

Nº of Sounding 390.
Station 248.

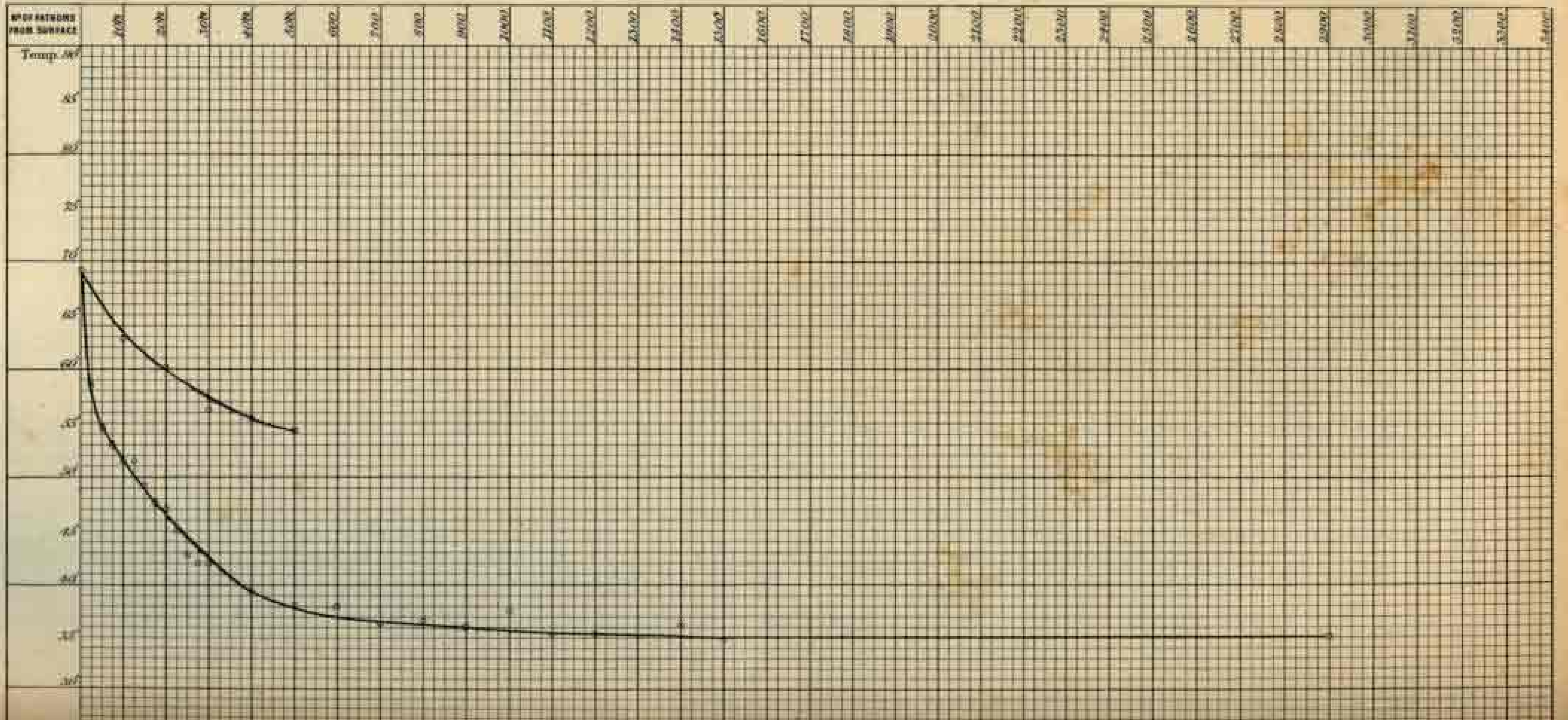
Depth 2900 fathoms

Latitude 37° 41' N.
Longitude 177° 4' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	125	130	140
Nº OF THERMOMETER		87	77	89	81	79		63			116		77		
TEMPERATURE SHEWN BY THERMOMETER	69.2	62.5	59.8	58.0	55.5	54.5		52.4			51.8		51.2		
ERROR OF THERMOMETER	0.0	+0.1	+0.2	+0.2	0.0	0.0		+0.6			−0.2		+0.2		
CORRECTED TEMPERATURE	69.2	62.6	60.0	58.2	55.5	54.5		53.0			51.6		51.4		
TEMPERATURE FROM CURVE	69.4	62.9	60.0	57.5	55.5	54.7		53.0			51.8		50.2		

Nº OF FATHOMS FROM SURFACE	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
Nº OF THERMOMETER	83		81			71	74	63	116	77	89	81	71	89	77
TEMPERATURE SHEWN BY THERMOMETER	49.0		47.8			47.0	45.0	42.2	42.8	41.8	39.5	38.2	38.0	36.0	36.4
ERROR OF THERMOMETER	+0.1		0.0			0.0	0.0	+0.6	−0.8	+0.2	+0.1	0.0	0.0	+0.4	+0.2
CORRECTED TEMPERATURE	49.1		47.8			47.0	45.0	42.8	42.0	42.0	39.6	38.2	38.0	36.4	36.6
TEMPERATURE FROM CURVE	49.0		47.8			46.9	45.2	44.0	43.0	42.0	39.6	38.0	37.1	36.5	36.2

Nº OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	74	71	116	83	94	84	63								69 73
TEMPERATURE SHEWN BY THERMOMETER	36.0	37.5	35.5	35.0	35.5	35.1	34.7								35.2 35.3
ERROR OF THERMOMETER	0.0	0.0	−0.1	+0.5	−0.1	0.0	+0.1								0.0 −0.3
CORRECTED TEMPERATURE	36.0	37.5	35.4	35.5	35.4	35.1	34.8								35.2 35.0
TEMPERATURE FROM CURVE	36.0	35.8	35.6	35.4	35.2	35.1	35.1								35.1



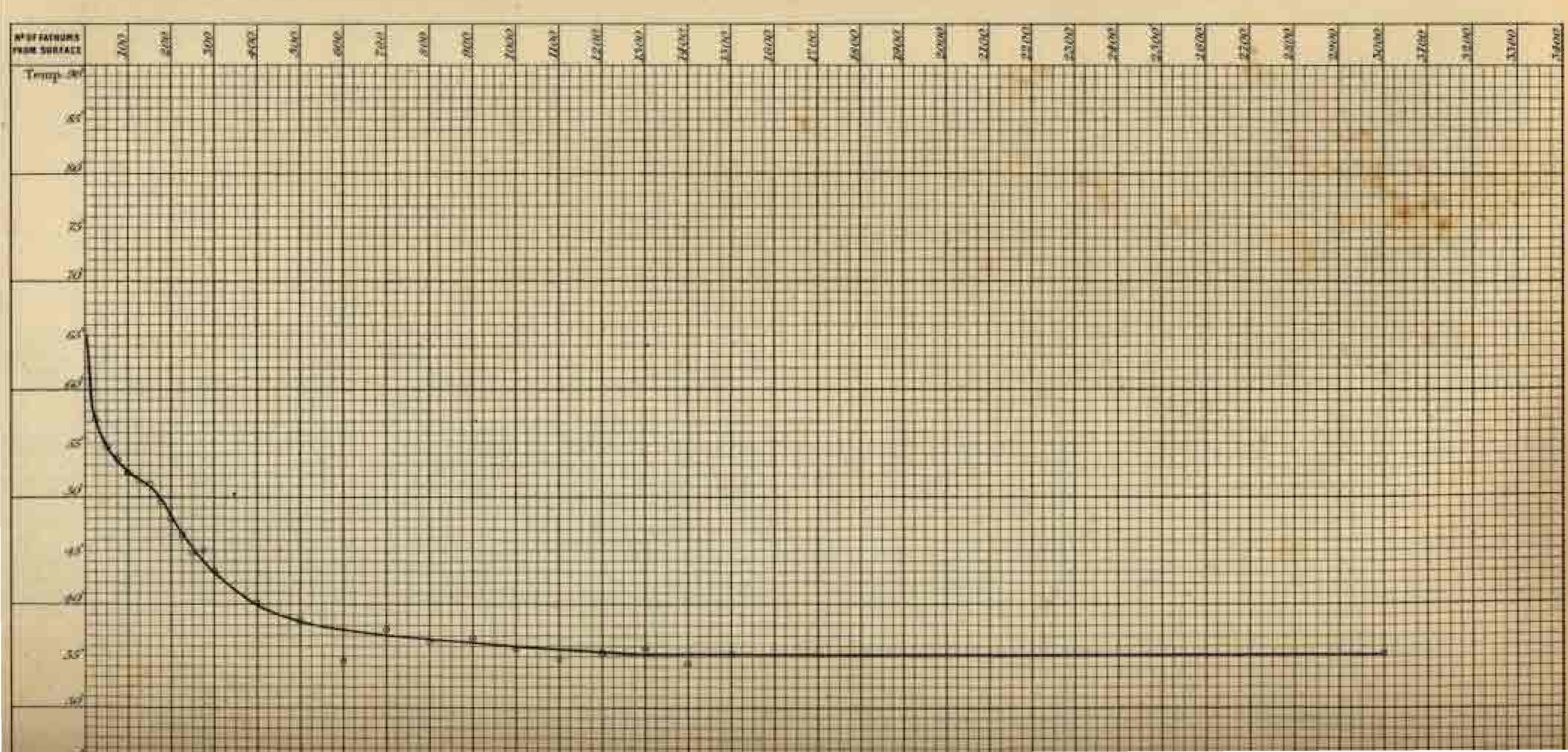
7 July 1875.

Nº of Sounding 391.
Station 249.

Depth 3000 fathoms.

Latitude 37° 59' N.
Longitude 171° 48' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			84			84		82			87		a16			87		85			81	89	94	71	84	83	83	74	69	a16	71	89	94	81	77	83	87								73 84
TEMPERATURE SHEWN BY THERMOMETER	65.0		57.0			54.5		53.9			52.0		51.8			51.0		49.2			48.0	46.0	45.0	45.0	43.0	39.5	39.0	34.5	37.5	36.6	36.8	35.6	35.0	35.2	35.5	33.8	35.0								35.5 35.0
ERROR OF THERMOMETER	0.0		0.0			+0.2		0.0			+0.1		−0.2			+0.1		+0.5			0.0	+0.2	−0.1	0.0	0.0	+0.8	−0.5	0.0	0.0	−0.2	0.0	+0.2	−0.1	0.0	+0.2	+0.5	+0.1								0.0 0.0
CORRECTED TEMPERATURE	65.0		57.0			54.7		53.9			52.1		51.6			51.1		49.7			48.0	46.2	44.9	45.0	43.0	40.3	38.5	34.3	37.5	36.4	36.8	35.8	34.9	35.2	35.7	34.3	35.1								35.5 35.0
TEMPERATURE FROM CURVE	65.0		57.5			54.8		53.3			52.5		52.0			51.2		49.8			48.0	46.4	45.0	43.7	42.7	40.1	38.5	37.7	37.0	36.5	36.2	35.9	35.6	35.3	35.2	35.2	35.2								35.2



SECTION. FROM A POSITION IN { Lat. 35° 49′ N. / Long. 179° 57′ W. } TO A POSITION IN { Lat. 38° 9′ N. / Long. 156° 25′ W.

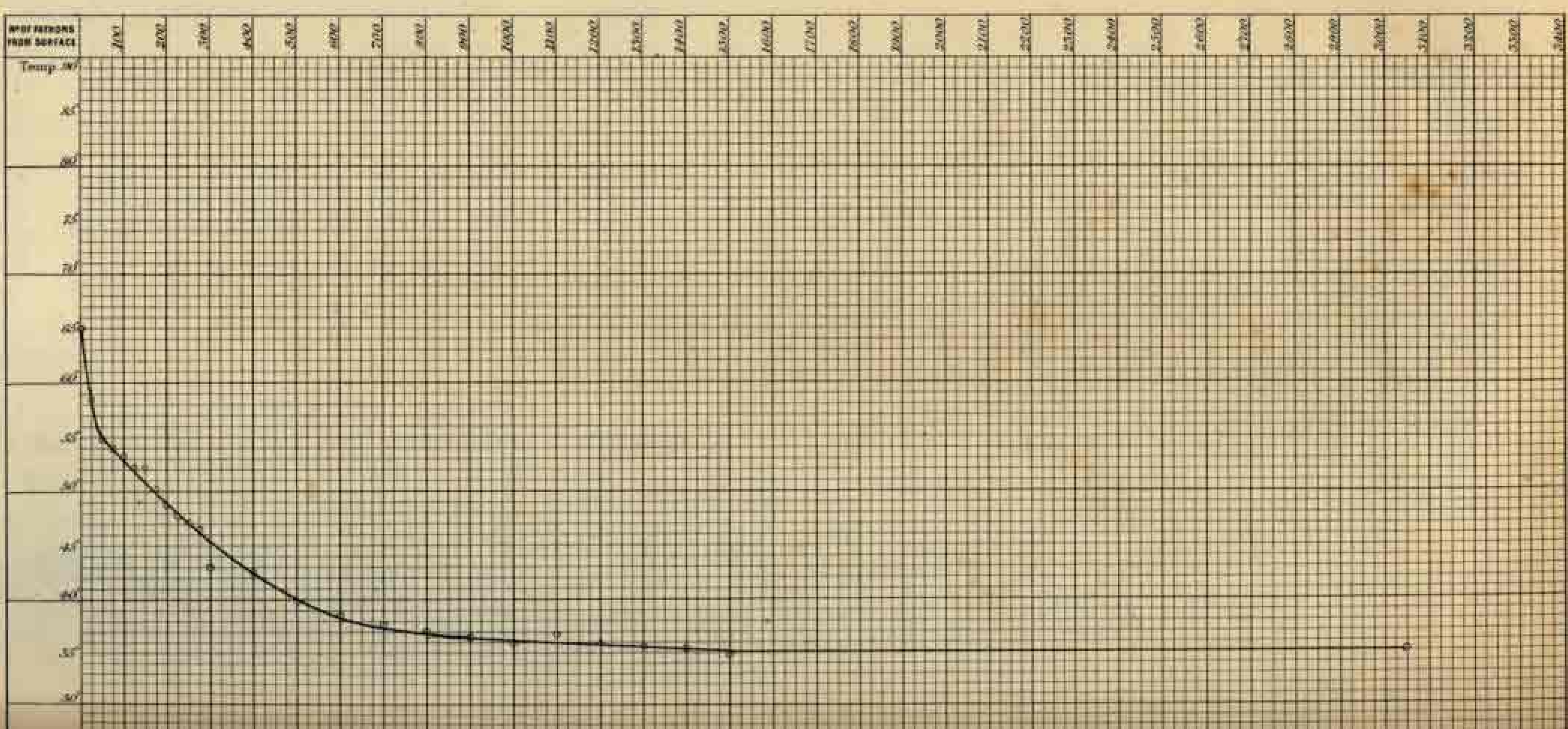
9 July 1875.

N.º of Sounding 392.
Station 250.

Depth 3050 fathoms.

Latitude 37° 49′ N.
Longitude 166° 47′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			69			94		72			77		116			77		74			87	75	43	84	81	45	81	74	85	94	77	83	84	81	43	65	116								89 83
TEMPERATURE SHEWN BY THERMOMETER	65.0		58.5			55.0		54.0			53.0		52.4			52.0		50.8			48.8	47.6	46.5	46.6	43.0	42.0	39.8	38.5	37.7	37.0	36.2	35.5	36.8	35.8	35.0	34.8	35.0								35.2 35.4
ERROR OF THERMOMETER	0.0		0.0			−0.1		0.0			+0.2		−0.2			+0.2		0.0			+0.1	+0.2	+0.6	0.0	0.0	+0.6	0.0	0.0	+0.2	+0.1	+0.2	+0.5	0.0	0.0	+0.6	+0.5	−0.2								0.0 −0.5
CORRECTED TEMPERATURE	65.0		58.5			54.9		54.0			53.2		52.2			52.2		50.8			48.9	47.8	47.1	46.6	43.0	42.6	39.8	38.5	37.9	37.1	36.4	36.0	36.8	35.8	35.6	35.3	34.8								35.2 34.9
TEMPERATURE FROM CURVE	65.0		58.5			55.0		54.0			53.0		52.0			51.0		50.1			49.1	48.1	47.1	46.2	45.3	42.6	40.0	38.5	37.6	36.9	36.4	36.2	36.0	35.8	35.6	35.4	35.2								35.0



SECTION. FROM A POSITION IN Long. 179° 57′ W. TO A POSITION IN Long. 158° 25′ W.

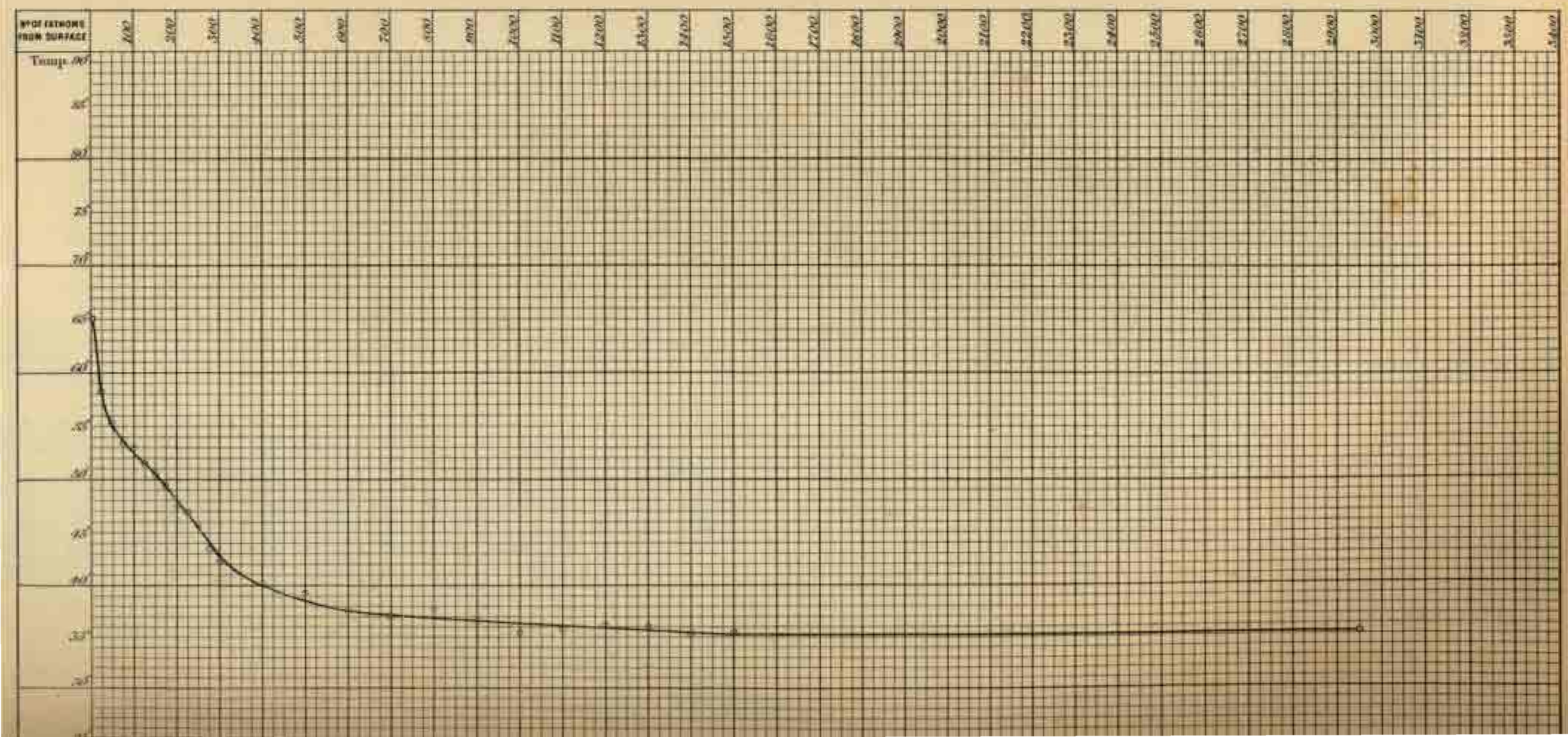
10 July 1875.

N.º of Sounding 393.
Station 251.

Depth 2950 *fathoms.*

Latitude 37° 37′ N.
Longitude 163° 26′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			71			77		71			87		89			81		43			74	71	87	94	116	77	80	81	74	71	87	94	116	77	89	85	81								69 83
TEMPERATURE SHEWN BY THERMOMETER	65.0		58.2			55.0		53.4			52.9		51.2			50.5		48.8			47.4	46.9	45.6	43.6	42.5	40.0	39.0	37.6	37.0	36.9	36.5	35.6	35.9	35.9	35.8	34.6	35.3								35.2 35.5
ERROR OF THERMOMETER	0.0		0.0			+0.2		0.0			+0.1		+0.2			0.0		+0.6			0.0	0.0	+0.1	−0.1	−0.2	+0.2	+0.2	0.0	0.0	0.0	+0.1	−0.1	−0.2	+0.2	+0.2	+0.5	0.0								0.0 −0.5
CORRECTED TEMPERATURE	65.0		58.2			55.2		53.4			53.0		51.4			50.5		49.4			47.4	46.9	45.7	43.5	42.3	40.2	39.2	37.6	37.0	36.9	36.6	35.5	35.7	36.1	36.0	35.1	35.3								35.2 35.0
TEMPERATURE FROM CURVE	65.0		58.2			55.2		53.5			52.5		51.5			50.5		49.4			48.2	46.9	45.4	43.7	42.8	40.0	38.5	37.6	37.0	36.8	36.6	36.3	36.1	35.9	35.6	35.3	35.1								35.1



SECTION. FROM A POSITION IN { Lat. 35° 49′ N. / Long. 179° 57′ W. } **TO A POSITION IN** { Lat. 38° 9′ N. / Long. 156° 25′ W. }

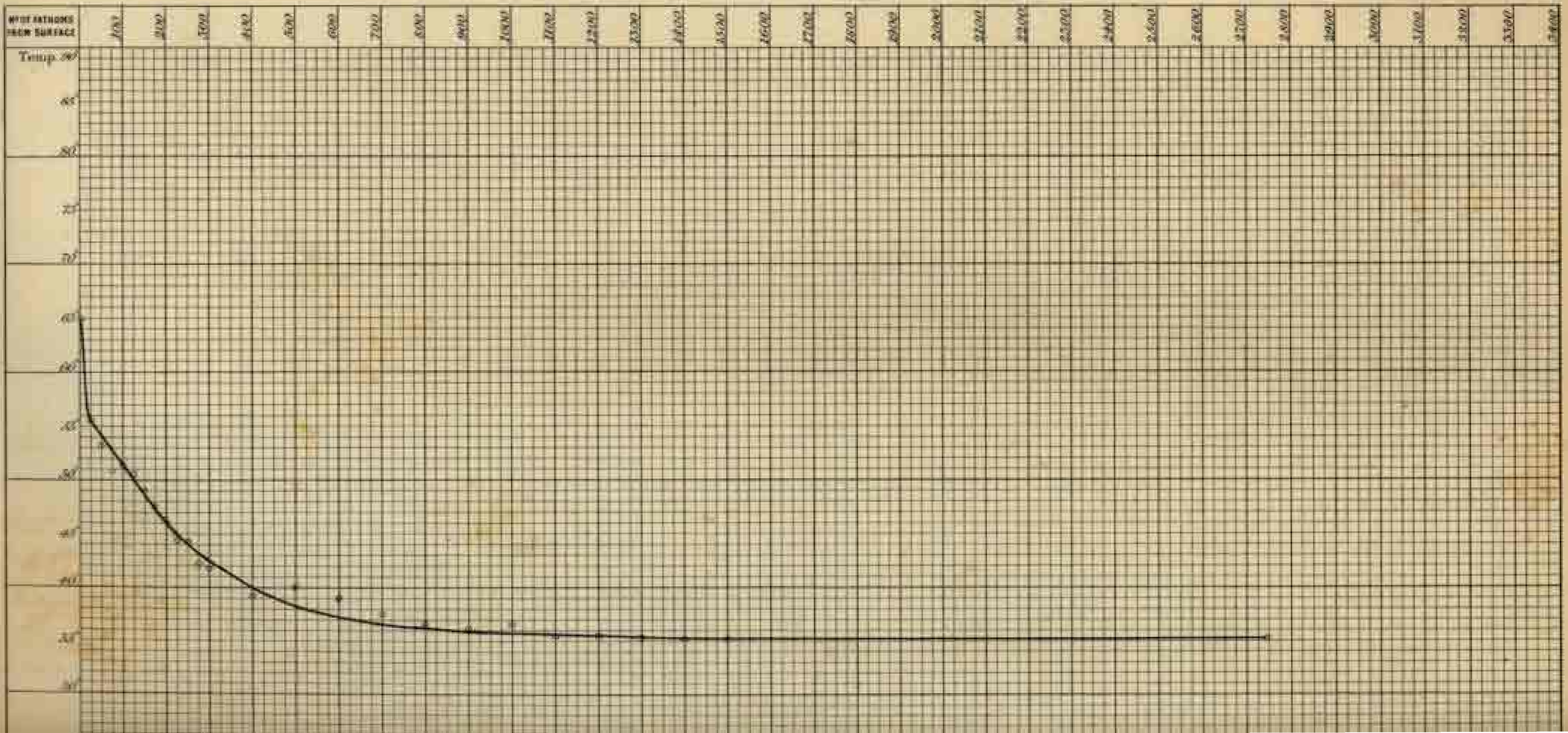
12 July 1875.

Nº of Sounding 394.
Station 252.

Depth 2740 fathoms.

Latitude 37° 52′ N.
Longitude 160° 17′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			81			94		77			83		74			a16		43			74	85	82	77	91	81	72	71	84	43	82	74	83	77	a16	81	94								83 85
TEMPERATURE SHEWN BY THERMOMETER	63.0		55.6			53.2		50.7			51.0		50.5			49.7		47.0			45.1	44.0	44.0	42.0	41.9	39.2	40.0	39.0	37.4	36.1	36.0	36.4	35.0	35.2	35.4	35.1	35.2								35.8 35.1
ERROR OF THERMOMETER	0.0		0.0			−0.1		+0.2			+0.1		0.0			−0.2		+0.6			0.0	+0.5	+0.1	+0.2	−0.1	0.0	0.0	0.0	0.0	+0.6	+0.1	0.0	+0.5	+0.2	−0.2	0.0	−0.1								−0.5 +0.2
CORRECTED TEMPERATURE	63.0		55.6			53.1		50.9			51.1		50.5			49.5		47.6			45.1	44.5	44.1	42.2	41.8	39.2	40.0	39.0	37.4	36.7	36.1	36.4	35.5	35.4	35.2	35.1	35.1								35.3 35.3
TEMPERATURE FROM CURVE	63.0		55.6			54.0		52.3			51.1		49.9			48.7		47.4			46.1	45.0	44.0	43.1	42.3	39.8	38.3	37.3	36.7	36.2	35.9	35.8	35.6	35.5	35.4	35.1	35.3								35.3



SECTION. FROM A POSITION IN { Lat. 38° 9' N. / Long. 156° 25' W. } TO HONOLULU.

14 July 1875.

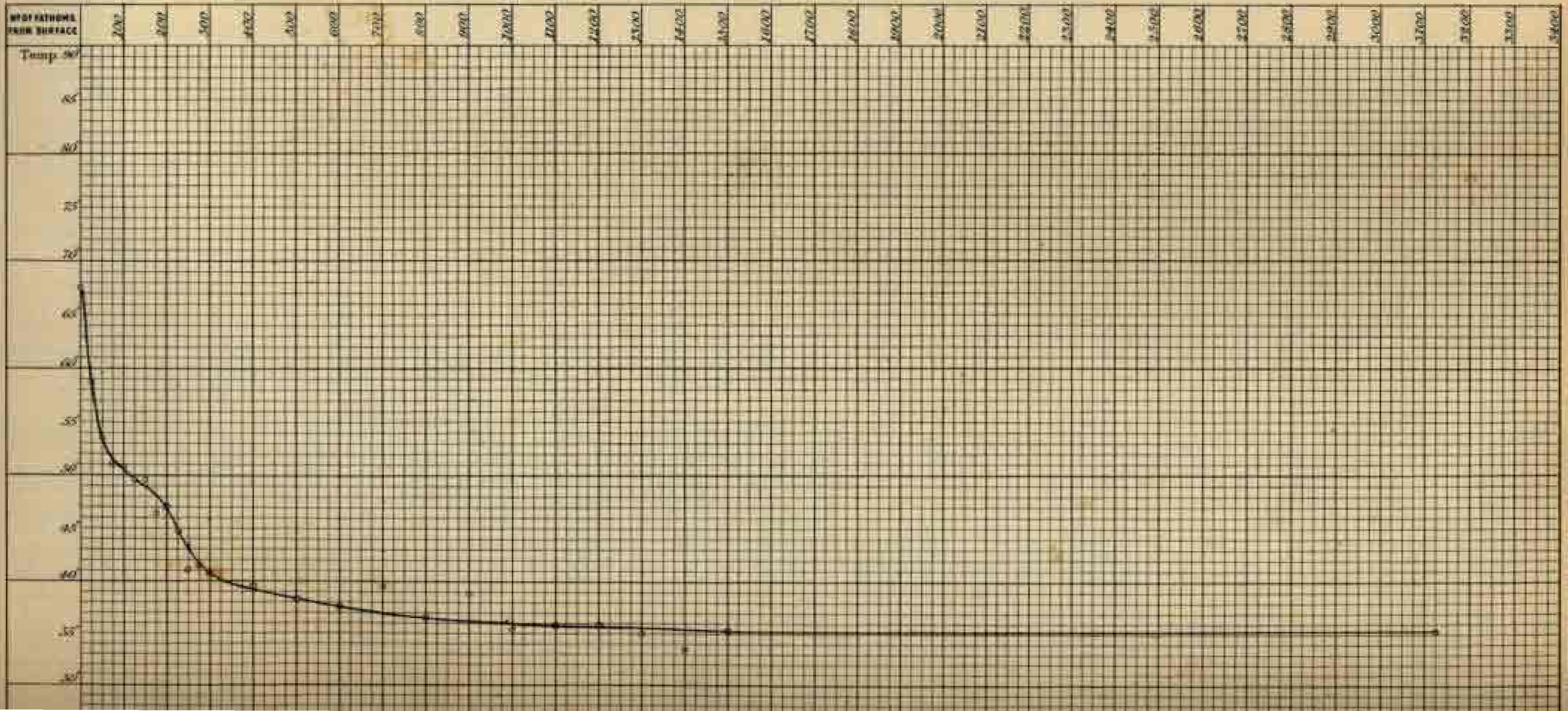
N° of Sounding 395.
Station 253.

Depth 3125 fathoms.

Latitude 38° 9' N.
Longitude 156° 25' W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
N° OF THERMOMETER			83			a16		a16			82		83			71		87		
TEMPERATURE SHEWN BY THERMOMETER	67.7		56.2			53.6		51.2			50.2		49.0			49.6		48.2		
ERROR OF THERMOMETER	0.0		+0.6			−0.2		−0.2			+0.5		+0.6			0.0		+0.1		
CORRECTED TEMPERATURE	67.7		56.8			53.4		51.0			50.7		49.6			49.6		48.3		
TEMPERATURE FROM CURVE	67.7		56.8			53.4		51.2			50.4		49.6			49.1		48.2		

N° OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER	84	73	94	a16	81	94	77	87	71	81	71	85	77	87	74	94	83								89 83
TEMPERATURE SHEWN BY THERMOMETER	47.0	44.7	41.1	41.5	40.9	39.5	38.0	37.5	37.4	36.4	36.8	34.9	35.5	35.8	35.0	33.7	35.6								34.9 35.6
ERROR OF THERMOMETER	0.0	0.0	−0.1	−0.2	0.0	−0.1	+0.2	+0.1	0.0	0.0	0.0	+0.5	+0.2	+0.1	0.0	−0.1	−0.5								+0.2 −0.5
CORRECTED TEMPERATURE	47.0	44.7	41.0	41.3	40.9	39.4	38.2	37.6	37.4	36.4	36.8	35.4	35.7	35.9	35.0	33.6	35.1								35.1 35.1
TEMPERATURE FROM CURVE	46.9	44.8	43.0	41.5	40.8	39.2	38.3	37.6	36.9	36.4	36.2	36.0	35.8	35.7	35.5	35.3	35.2								35.1



SECTION. FROM A POSITION IN { Lat. 38° 9′ N. / Long. 156° 25′ W. } TO HONORURU

17 July 1875.

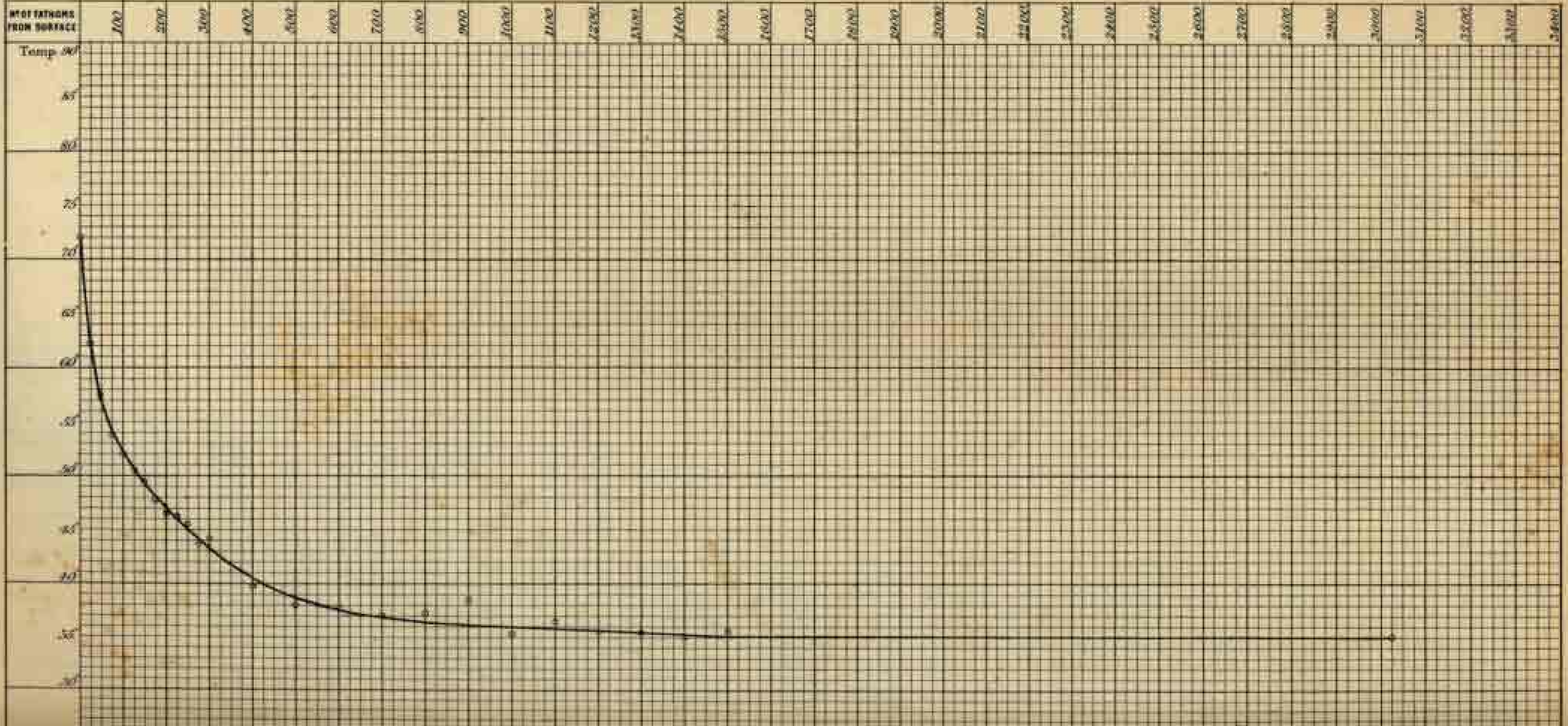
Nº of Sounding 396.
Station 254.

Depth 3025 fathoms.

Latitude 35° 13′ N.
Longitude 154° 43′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
Nº OF THERMOMETER			74			84		87			81		89			94		93		
TEMPERATURE SHEWN BY THERMOMETER	72.0		62.2			57.4		53.8			52.0		50.4			49.4		48.0		
ERROR OF THERMOMETER	0.0		0.0			0.0		+0.1			0.0		+0.2			−0.1		−0.2		
CORRECTED TEMPERATURE	72.0		62.2			57.4		53.9			52.0		50.6			49.3		47.8		
TEMPERATURE FROM CURVE	72.0		62.2			57.0		53.9			52.0		50.5			49.3		48.0		

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	92	77	81	87	84	216	74	89	94	77	84	94	89	74	216	87	81								97 93
TEMPERATURE SHEWN BY THERMOMETER	46.7	45.9	45.4	43.5	44.2	40.0	38.0	37.5	37.2	37.0	36.5	35.4	36.4	35.4	35.6	35.0	35.5								35.2 35.2
ERROR OF THERMOMETER	−0.2	+0.2	0.0	+0.1	0.0	−0.2	0.0	+0.2	−0.1	+0.2	0.0	−0.1	+0.2	0.0	−0.2	+0.1	0.0								−0.2 −0.2
CORRECTED TEMPERATURE	46.5	46.1	45.4	43.6	44.2	39.8	38.0	37.7	37.1	37.2	36.5	35.3	36.6	35.4	35.4	35.1	35.5								35.0 35.0
TEMPERATURE FROM CURVE	46.8	45.9	45.0	44.1	43.3	40.6	38.8	37.7	37.0	36.5	36.2	36.0	35.8	35.6	35.4	35.2	35.0								35.0



SECTION. FROM A POSITION IN { Lat. [illegible] N. / Long. 156° 25′ W. } TO HONOLULU.

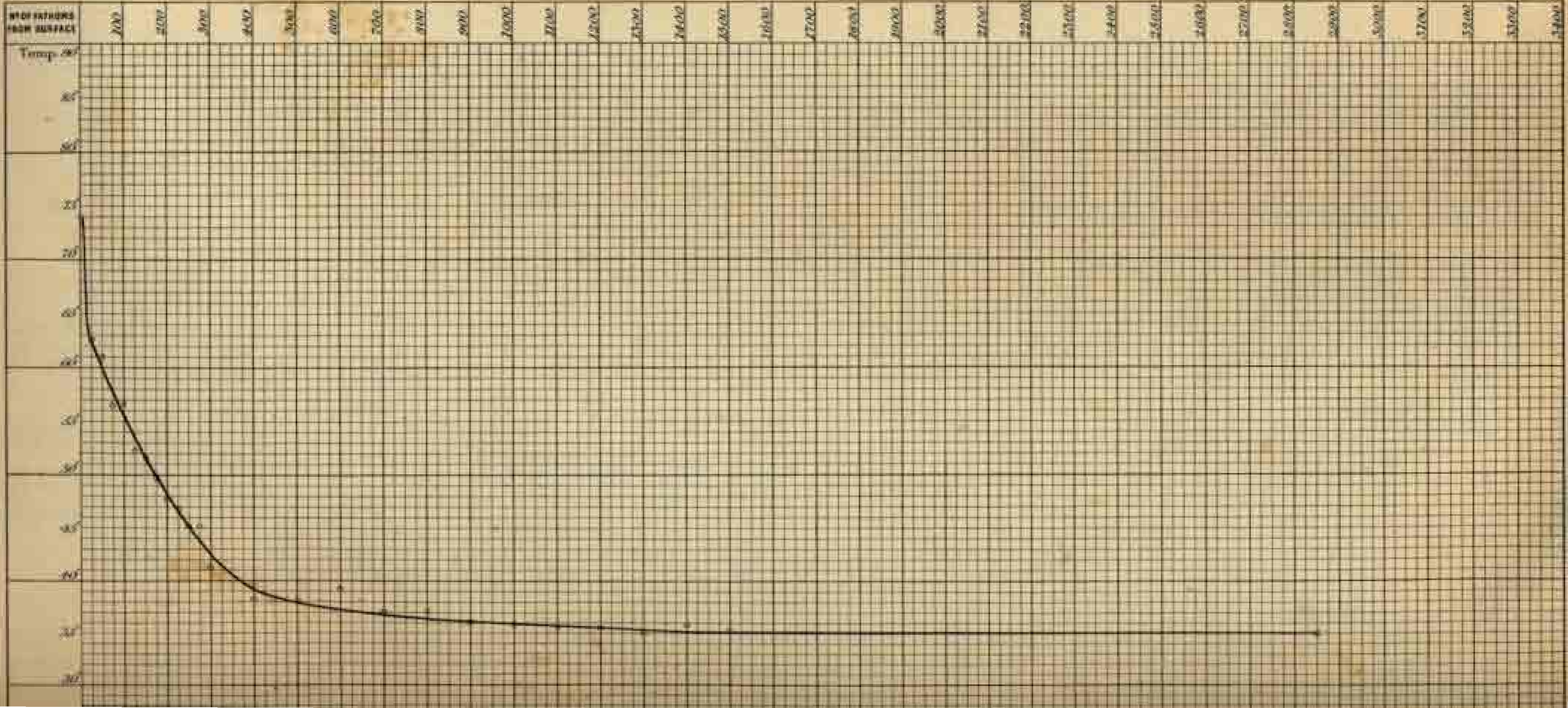
19 July 1875.

N.° of Sounding 397.
Station 255.

Depth 2850 fathoms.

Latitude 32° 28′ N.
Longitude 154° 33′ W.

N.° of fathoms from surface	N.° of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		74.0	0.0	74.0	74.0
10					
25	85	62.0	+0.3	62.3	62.3
30					
40					
50	87	60.8	+0.1	60.9	60.3
60					
75	84	56.6	0.0	56.6	55.6
80					
90					
100	43	53.0	+0.6	53.6	53.4
110					
125	74	52.7	0.0	52.7	52.3
130					
140					
150	89	51.2	+0.2	51.4	51.4
160					
175	94	50.0	−0.1	49.9	49.8
180					
190					
200	94	48.0	−0.1	47.9	47.9
225	80	46.6	+0.2	46.8	46.6
250	74	45.0	0.0	45.0	45.0
275	43	44.8	+0.5	45.3	43.5
300	77	41.0	+0.2	41.2	41.4
400	94	38.2	−0.1	38.1	39.8
500	81	38.1	0.0	38.1	38.1
600	84	36.2	0.0	36.2	37.4
700	216	37.2	−0.2	37.0	36.8
800	77	36.8	+0.2	37.0	36.4
900	89	35.8	+0.2	36.0	36.1
1000	74	35.8	0.0	35.8	35.8
1100	43	34.8	+0.6	35.4	35.6
1200	85	34.8	+0.5	35.3	35.4
1300	81	35.0	0.0	35.0	35.2
1400	84	35.8	0.0	35.8	35.0
1500	216	35.4	−0.2	35.2	35.0
1600					
1700					
1800					
1900					
2000					
Bottom	93 90	35.2 35.2	−0.2 −0.2	35.0 35.0	35.0



SECTION. FROM A POSITION IN { Lat. 38° 9′ N. Long. 156° 25′ W. } TO HONORURU.

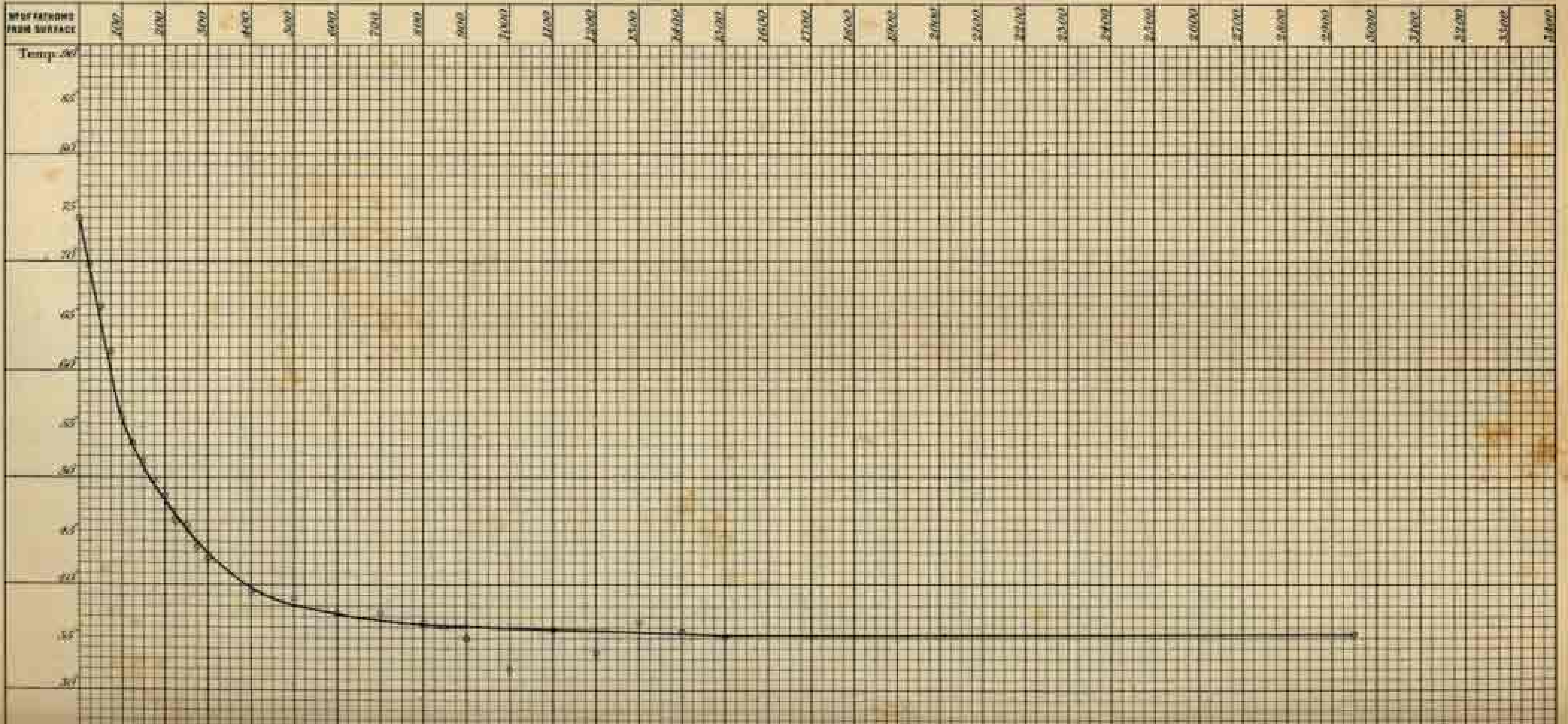
21 July 1875.

No. of Sounding 398.
Station 256.

Depth 2950 fathoms.

Latitude 30° 22′ N.
Longitude 154° 56′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER			77			89		94			216		89			77		75			81	83	213	94	213	89	94	216	87	85	216	81	74	77	213	84	94								92 97
TEMPERATURE SHEWN BY THERMOMETER	74.0		69.5			65.5		61.5			55.8		53.0			51.2		49.8			48.2	45.3	45.0	43.6	41.8	39.2	39.0	37.5	37.2	35.8	36.2	36.0	35.8	35.5	35.8	35.5	35.2								35.4 35.3
ERROR OF THERMOMETER	0.0		+0.2			+0.2		-0.1			-0.2		+0.3			+0.2		0.0			0.0	+0.5	+0.6	-0.1	+0.6	+0.2	-0.1	-0.2	+0.1	+0.5	-0.2	0.0	0.0	+0.2	+0.6	+0.2	-0.1								-0.2 -0.2
CORRECTED TEMPERATURE	74.0		69.7			65.7		61.4			55.6		53.3			51.4		49.8			48.2	45.8	45.6	43.5	42.4	39.4	38.9	37.3	37.3	36.3	36.0	36.0	35.8	35.7	36.4	35.7	35.1								35.2 35.1
TEMPERATURE FROM CURVE	74.0		70.0			65.0		60.0			55.6		53.2			51.2		49.5			48.0	46.5	45.2	43.8	42.8	39.7	38.4	37.3	36.7	36.3	36.1	35.9	35.8	35.7	35.5	35.4	35.3								35.2



SECTION. FROM A POSITION IN { Lat. 28° 9' N. Long. 156° 25' W. } TO HONORURU.

23 July 1875.

No. of Sounding 399.
Station 257.

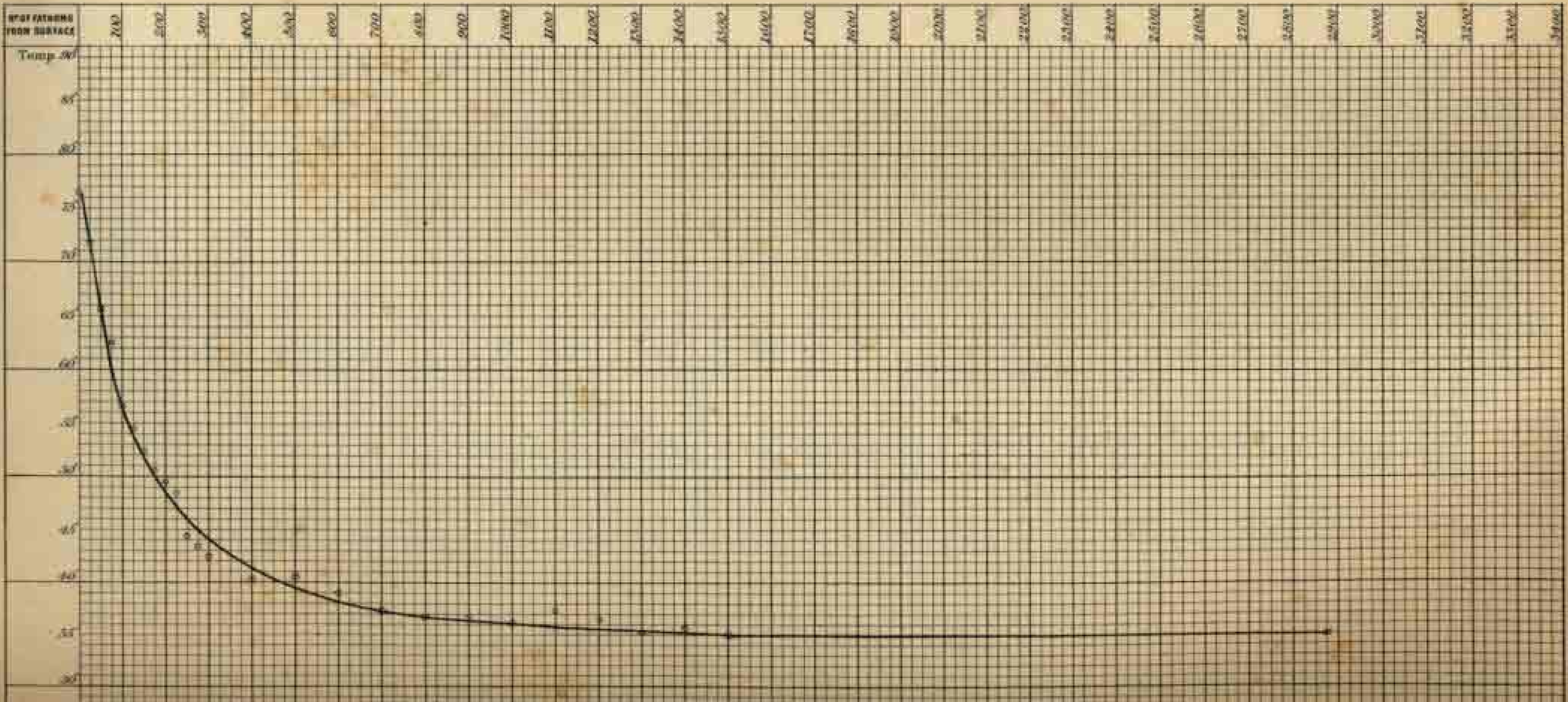
Depth 2875 fathoms.

Latitude 27° 33' N.
Longitude 154° 55' W.

No. of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140
No. of thermometer			77			83		74			216		89		
Temperature shewn by thermometer	76.5		71.5			65.0		60.5			56.5		54.2		
Error of thermometer	0.0		+0.2			+0.8		0.0			−0.2		+0.2		
Corrected temperature	76.5		71.7			65.8		60.5			56.3		54.4		
Temperature from curve	76.5		71.3			65.0		60.0			56.5		53.8		

No. of fathoms from surface	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
No. of thermometer	94		87			43	74	216	89	91	87	77	84	85	94
Temperature shewn by thermometer	52.2		50.5			49.0	48.4	44.5	43.2	40.5	40.0	40.5	39.0	36.8	36.8
Error of thermometer	−0.1		+0.1			+0.6	0.0	−0.2	+0.2	−0.1	+0.1	+0.2	0.0	+0.5	−0.1
Corrected temperature	52.1		50.6			49.6	48.4	44.3	43.4	40.4	40.1	40.7	39.0	37.3	36.7
Temperature from curve	51.8		50.2			48.8	47.4	46.2	45.0	44.0	41.3	39.5	38.3	37.3	36.7

No. of fathoms from surface	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer	87	74	77	84	89	43	218								93 90
Temperature shewn by thermometer	36.3	36.0	37.2	36.3	35.0	34.8	35.2								35.2 35.0
Error of thermometer	+0.1	0.0	+0.2	0.0	+0.2	+0.6	−0.2								−0.2 −0.2
Corrected temperature	36.4	36.0	37.4	36.3	35.2	35.4	35.0								35.0 34.8
Temperature from curve	36.3	36.0	35.8	35.6	35.4	35.2	35.0								34.9



SECTION. FROM A POSITION IN { *Lat. 38° 9′ N.* / *Long. 156° 25′ W.* } TO HONORURU.

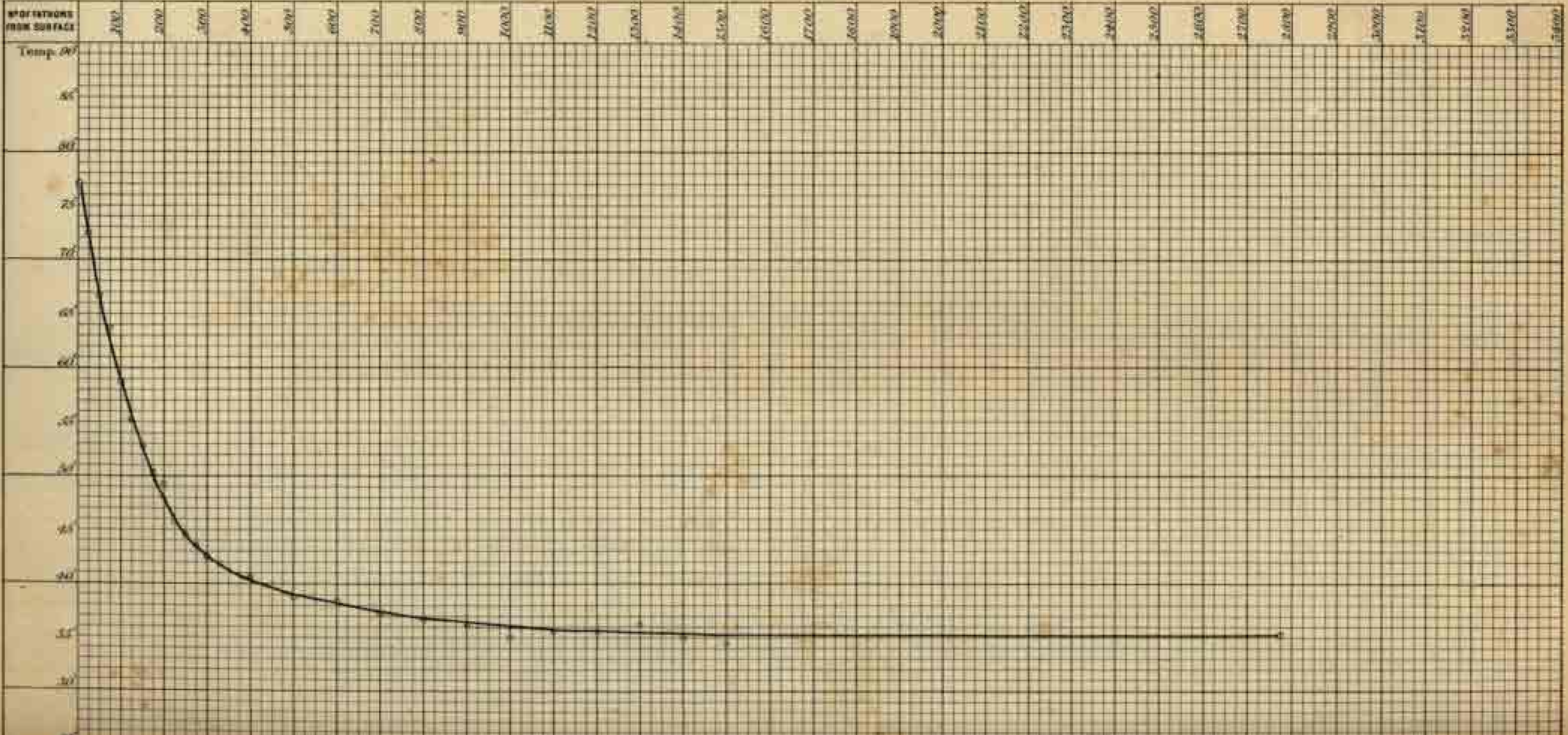
24 July 1875.

N° of Sounding 400.
" Station 258.

Depth 2775 fathoms.

Latitude 26° 11′ N.
Longitude 155° 12′ W.

N° OF FATHOMS FROM SURFACE	N° OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		77.0	0.0	77.0	77.0
10					
25	43	72.0	+0.6	72.6	72.6
30					
40					
50	216	67.0	−0.7	66.3	66.6
60					
75	87	63.8	−0.1	63.7	62.5
80					
90					
100	81	58.8	0.0	58.8	58.8
110					
125	89	55.0	+0.1	55.1	55.3
130					
140					
150	74	50.9	0.0	50.9	52.5
160					
175	216	50.5	−0.2	50.3	49.8
180					
190					
200	43	48.6	+0.6	49.2	47.6
225	94	45.8	−0.1	45.7	45.7
250	81	44.6	0.0	44.6	44.5
275	87	43.1	+0.3	43.4	43.4
300	80	42.2	+0.2	42.4	42.6
400	77	40.5	+0.2	40.7	40.4
500	74	38.9	0.0	38.9	39.0
600	85	38.0	+0.5	38.5	38.2
700	216	37.5	−0.2	37.3	37.6
800	43	36.4	+0.4	36.8	37.0
900	94	36.2	−0.1	36.1	36.5
1000	81	35.0	0.0	35.0	36.1
1100	87	35.6	+0.1	35.7	35.8
1200	80	35.4	+0.2	35.6	35.6
1300	77	36.0	+0.2	36.2	35.4
1400	74	35.0	0.0	35.0	35.2
1500	85	34.0	+0.5	34.5	35.2
1600					
1700					
1800					
1900					
2000					
BOTTOM	98 93	35.5 35.4	−0.2 +0.3	35.3 35.7	35.2



SECTION. FROM A POSITION IN { Lat. [illegible] N. / Long. 156° 25' W. } TO HONORURU.

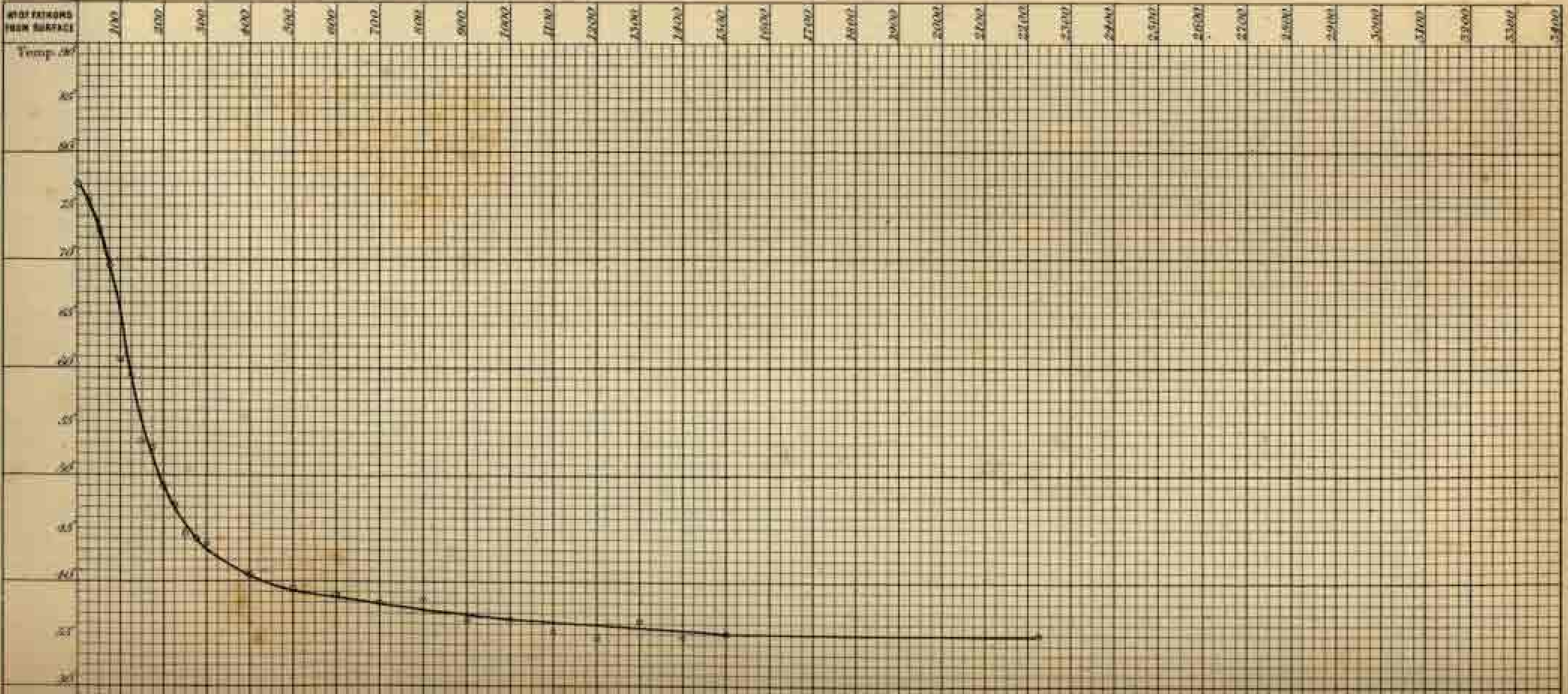
26 July 1875.

N° of Sounding 401.
Station 259.

Depth 2225 fathoms

Latitude 23° 3' N.
Longitude 156° 6' W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			81			87		87			126		74			89		83			82	94	77	85	84	90	81	94	93	77	81	43	74	33	87	97	81								93 92
TEMPERATURE SHEWN BY THERMOMETER	77.0		75.8			73.6		69.4			61.0		59.2			53.0		52.0			49.0	47.8	44.3	43.8	43.5	40.7	39.5	39.0	38.2	38.0	36.5	35.8	35.2	34.9	36.0	35.0	35.0								35.0 35.1
ERROR OF THERMOMETER	0.0		0.0			+0.1		+0.1			−0.2		0.0			+0.2		+0.6			0.0	−0.1	+0.1	+0.1	0.0	−0.2	0.0	−0.1	−0.2	+0.2	0.0	+0.6	0.0	−0.2	+0.1	−0.2	0.0								−0.2 −0.2
CORRECTED TEMPERATURE	77.0		75.8			73.7		69.5			60.8		59.2			53.2		52.6			49.0	47.7	44.4	43.9	43.5	40.5	39.5	38.9	38.0	38.2	36.5	36.4	35.2	34.7	36.1	34.8	35.0								34.8 34.9
TEMPERATURE FROM CURVE	77.0		75.6			73.7		69.5			61.1		59.2			53.0		52.5			48.8	46.5	45.0	43.8	42.0	40.5	40.3	38.8	37.9	37.4	36.9	36.5	36.2	35.9	35.6	35.1	35.0								34.9



SECTION. FROM A POSITION IN { Lat. 38° 9′ N. Long. 156° 25′ W. } TO HONORURU.

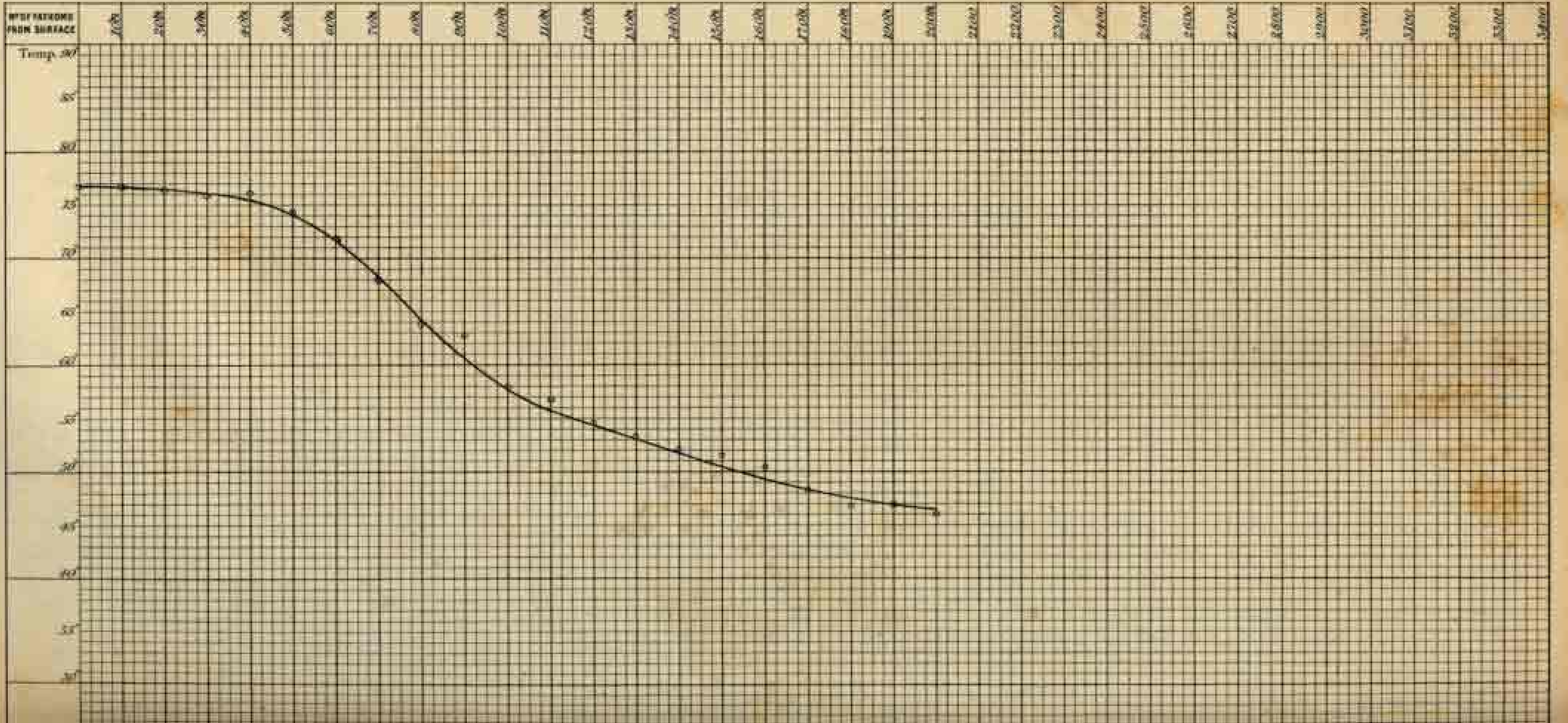
27 July 1875.

N^o. of Sounding 402.
Station 260.

Depth 310 fathoms.

Latitude 21° 11′ N.
Longitude 157° 27′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		81	89	76	77	84	94	83	87	90	216	93	81	89	74	77	84	94	83	87	90																								92 93
TEMPERATURE SHOWN BY THERMOMETER	76.8	76.8	76.2	76.0	75.8	74.0	72.0	68.5	63.6	63.0	58.0	57.0	54.6	53.0	52.2	51.2	50.6	48.5	46.2	46.8	46.2																								44.4 44.7
ERROR OF THERMOMETER	0.0	0.0	+0.2	0.0	+0.2	0.0	−0.1	−0.5	+0.1	−0.2	−0.2	−0.2	0.0	+0.2	0.0	+0.2	0.0	−0.1	+0.6	+0.1	−0.2																								−0.2 −0.3
CORRECTED TEMPERATURE	76.8	76.8	76.4	76.0	76.0	74.0	71.9	68.0	63.7	62.8	57.8	56.8	54.6	53.2	52.2	51.4	50.6	48.4	46.8	46.9	46.0																								44.2 43.9
TEMPERATURE FROM CURVE	76.8	76.8	76.4	76.0	75.7	73.9	71.5	68.2	63.7	60.4	57.8	55.8	54.1	53.0	51.8	50.5	49.4	48.3	47.6	46.9	46.3																								44.0



12 August 1875.

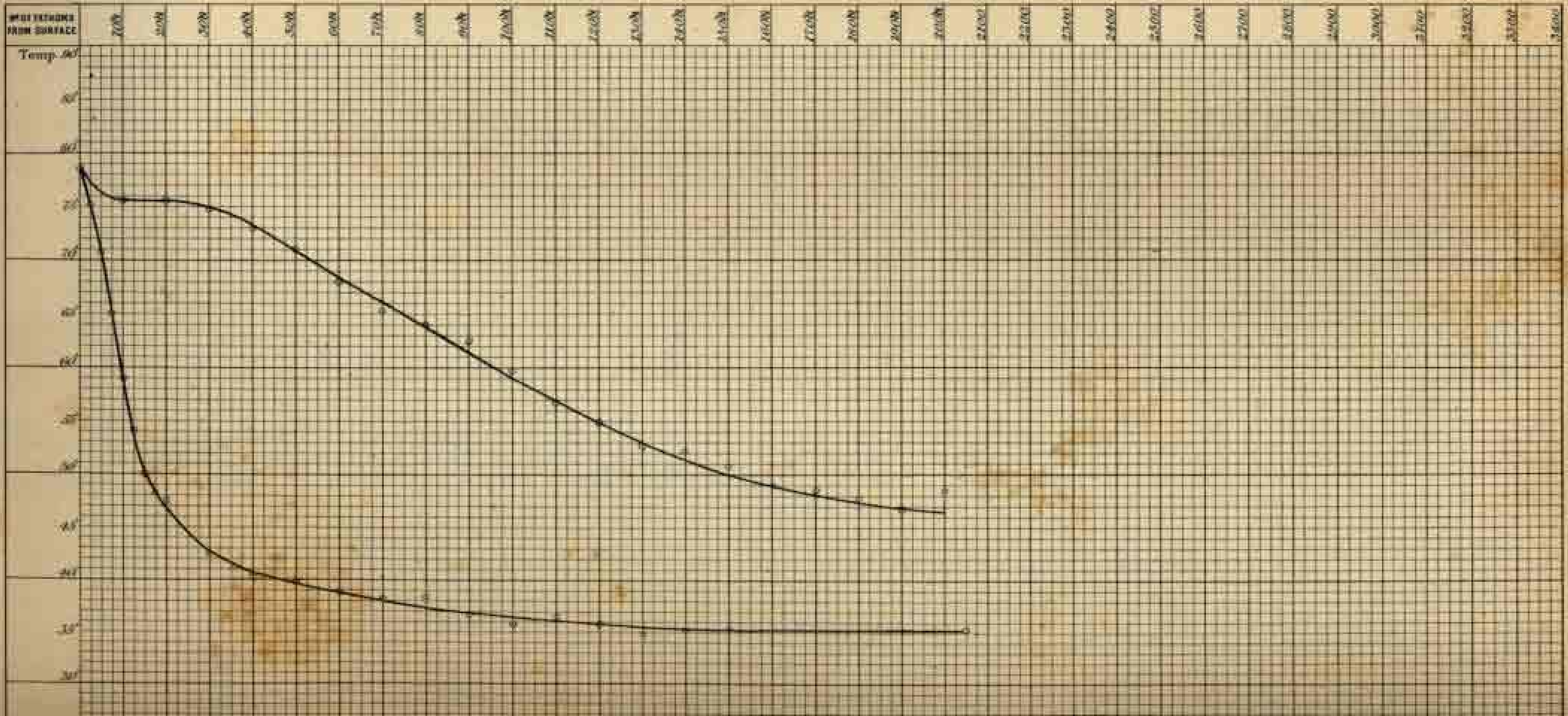
Nº of Sounding 403.
Station 261.

Depth 2050 fathoms.

Latitude 20° 18′ N
Longitude 157° 14′ W

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275
Nº of thermometer		93	97	A89	94	A96	89	A16	81	85	97	93	94	A96	89	A16	89	87	90	93	A89			
Temperature shewn by thermometer	78.1	75.8	75.3	74.9	73.0	71.0	68.0	65.5	64.0	62.2	60.0	57.1	55.0	52.8	52.0	51.0	49.0	48.8	48.0	47.1	46.6			
Error of thermometer	0.0	−0.2	−0.2	0.0	−0.1	0.0	+0.2	−0.2	0.0	+0.1	−0.2	−0.2	−0.1	0.0	+0.2	−0.2	+0.2	−0.1	−0.2	−0.2	0.0			
Corrected temperature	78.1	75.6	75.1	74.9	72.9	71.0	68.2	65.3	64.0	62.3	59.8	56.9	54.9	52.8	52.2	50.8	49.2	48.7	47.8	46.9	46.6			
Temperature from curve	78.1	75.8	75.3	74.9	73.1	70.9	68.3	66.0	63.7	61.4	59.0	56.9	55.0	53.0	51.3	50.0	49.1	48.2	47.4	47.0	46.6			

Nº of fathoms from surface	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	81	94	A89	A16	87	89	87	A16	74	A89	94	A96	81								98 93
Temperature shewn by thermometer	42.3	40.6	39.9	39.0	38.0	37.0	36.6	36.0	36.5	36.0	35.0	35.3	35.4								35.4 35.5
Error of thermometer	0.0	−0.1	0.0	−0.2	+0.1	+0.2	+0.1	+0.2	0.0	0.0	−0.1	0.0	0.0								−0.2 −0.2
Corrected temperature	42.3	40.5	39.9	38.8	38.1	37.2	36.7	36.2	36.5	36.0	34.9	35.3	35.4								35.2 35.3
Temperature from curve	42.6	40.8	39.7	38.8	38.0	37.2	36.9	36.4	36.1	35.9	35.7	35.4	35.2								35.2



SECTION. HONORURU TO TAHITI.

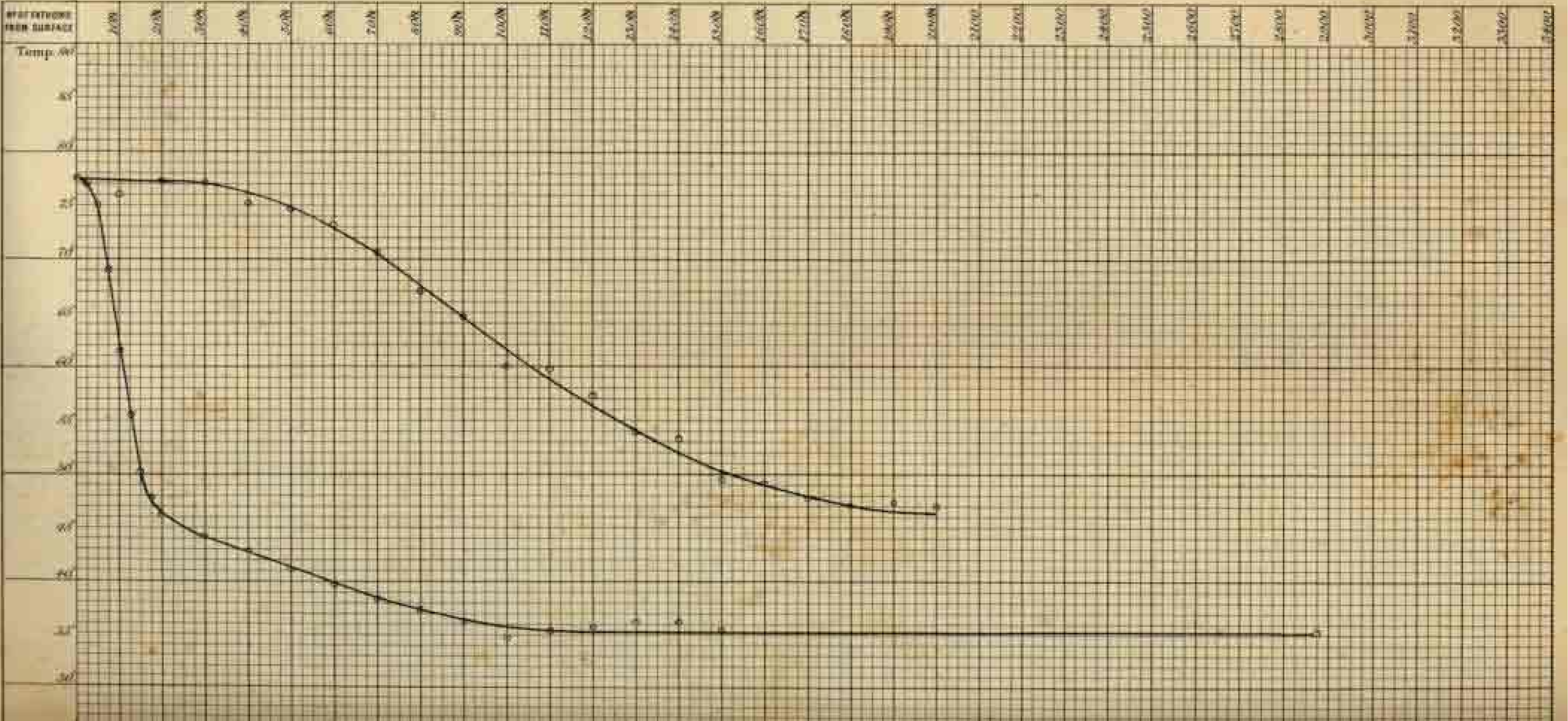
20 August 1875.

Nº of Sounding 404.
" Station 262.

Depth 2875 fathoms.

Latitude 19° 12′ N.
Longitude 154° 14′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		77	116	93	82	94	84	87	81	74	88	84	77	87	89	81	74	94	416	88	84				84	94	77	89	74	416	81	93	87	84	87	77	89								92 93
TEMPERATURE SHEWN BY THERMOMETER	77.5	75.8	77.2	77.1	75.0	75.0	73.2	70.5	67.0	64.5	60.0	59.5	56.9	53.8	52.6	49.8	49.2	48.0	47.3	47.2	47.0				44.8	43.0	41.0	39.5	38.4	37.3	36.2	35.0	35.2	35.8	36.1	36.0	35.2								35.4 35.4
ERROR OF THERMOMETER	0.0	+0.2	−0.2	−0.1	+0.2	−0.1	0.0	+0.1	0.0	0.0	0.0	+0.2	+0.2	+0.2	+0.5	0.0	0.0	−0.1	−0.2	0.0	0.0				0.0	+0.1	+0.2	+0.2	0.0	−0.2	0.0	−0.2	+0.1	0.0	+0.1	+0.2	+0.2								+0.3 −0.2
CORRECTED TEMPERATURE	77.5	76.0	77.3	77.0	75.2	74.9	73.2	70.6	67.0	64.5	60.0	59.7	57.1	54.0	53.1	49.8	49.2	47.9	47.1	47.2	47.0				44.8	43.0	41.2	39.7	38.4	37.3	36.2	34.8	35.3	35.8	36.2	36.2	35.4								35.7 35.2
TEMPERATURE FROM CURVE	77.5	77.4	77.4	77.0	76.3	75.0	73.0	70.5	67.5	64.3	61.5	58.8	56.5	54.2	52.2	50.7	49.0	48.0	47.2	46.7	46.2				44.1	42.9	41.3	39.9	38.3	37.3	36.5	35.9	35.4	35.2	35.2	35.2	35.2								35.2



SECTION. HONORURU TO TAHITI.

21 August 1875.

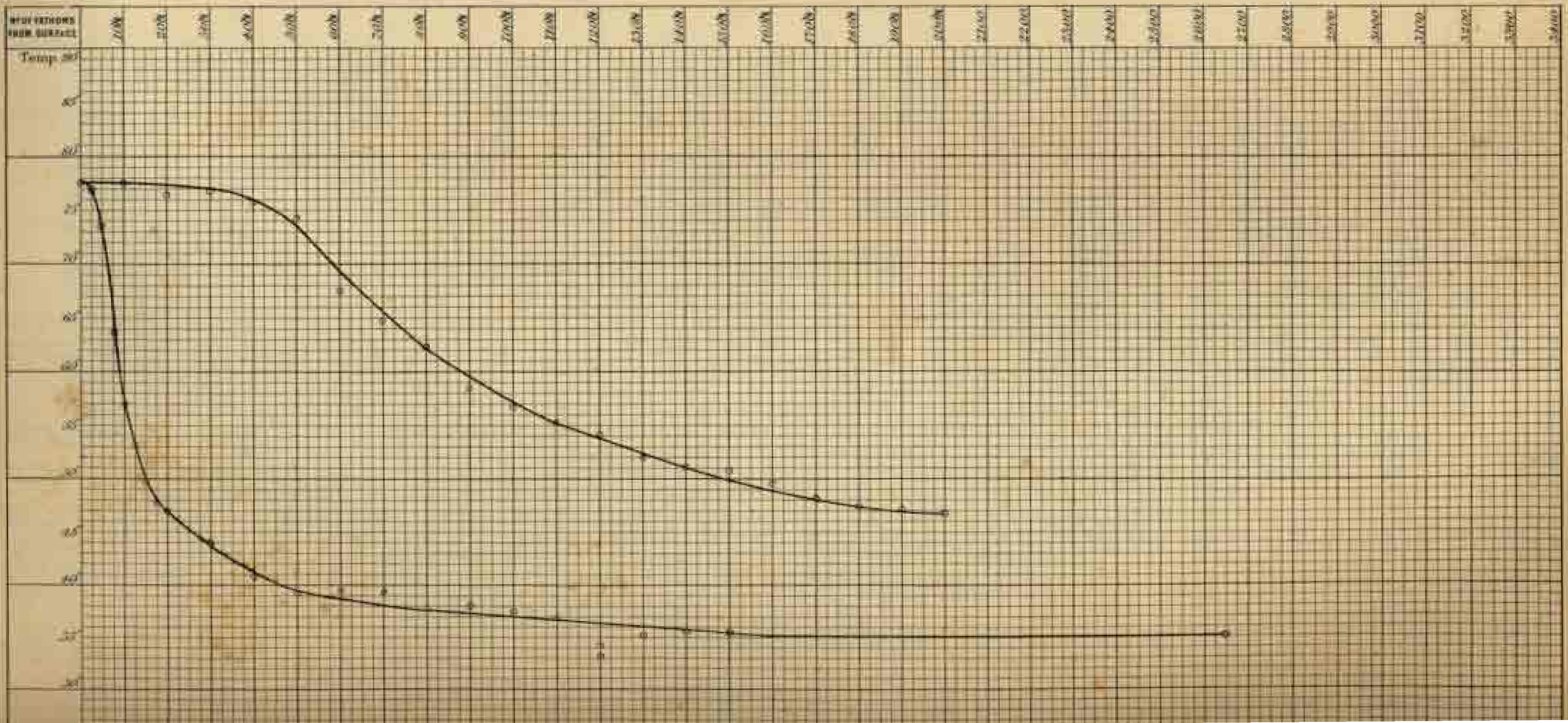
No. of Sounding 405.
Station 263.

Depth 2650 *fathoms.*

Latitude 17° 33′ N.
Longitude 153° 36′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225
No. of thermometer		84	93	98	94	A89	a26	A95	87	89	94	89	87	A98	a28	A89	94	92	93	84	85	
Temperature shewn by thermometer	77·5	77·5	76·8	77·0	76·0	74·9	67·6	64·8	60·2	56·2	56·8	55·2	54·2	52·0	51·9	50·6	49·3	48·2	47·5	47·1	46·2	
Error of thermometer	0·0	0·0	−0·2	−0·5	−0·1	0·0	−0·2	0·0	+0·1	+0·2	−0·1	+0·0	+0·1	0·0	−0·9	0·0	+0·1	−0·2	−0·3	0·0	−0·5	
Corrected temperature	77·5	77·5	76·6	76·5	75·9	74·9	67·4	64·8	60·3	56·4	56·7	55·2	54·3	52·0	51·0	50·6	49·4	48·0	47·2	47·1	45·7	
Temperature from curve	77·5	77·5	77·2	76·9	76·0	73·5	69·3	63·3	61·2	59·3	57·2	55·5	53·8	52·2	51·1	49·9	48·9	48·0	47·3	47·0	46·7	

No. of fathoms from surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer			A89	a28	A96	87	89	94	85	A89	a26	A98	81	87	89								98 93
Temperature shewn by thermometer			44·0	41·0	39·4	39·4	39·2	38·0	37·5	37·3	37·1	35·2	35·4	35·3	35·2								35·4 35·2
Error of thermometer			0·0	−0·2	0·0	+0·1	+0·2	−0·1	+0·5	0·0	−0·2	0·0	0·0	+0·1	+0·2								+0·2 −0·2
Corrected temperature			44·0	40·8	39·4	39·5	39·4	37·9	38·0	37·3	36·9	35·2	35·4	35·5	35·4								35·6 35·0
Temperature from curve			43·7	41·1	39·5	38·7	38·2	37·8	37·4	37·0	36·8	36·3	35·6	35·7	35·4								35·5



SECTION. HONORURU TO TAHITI.

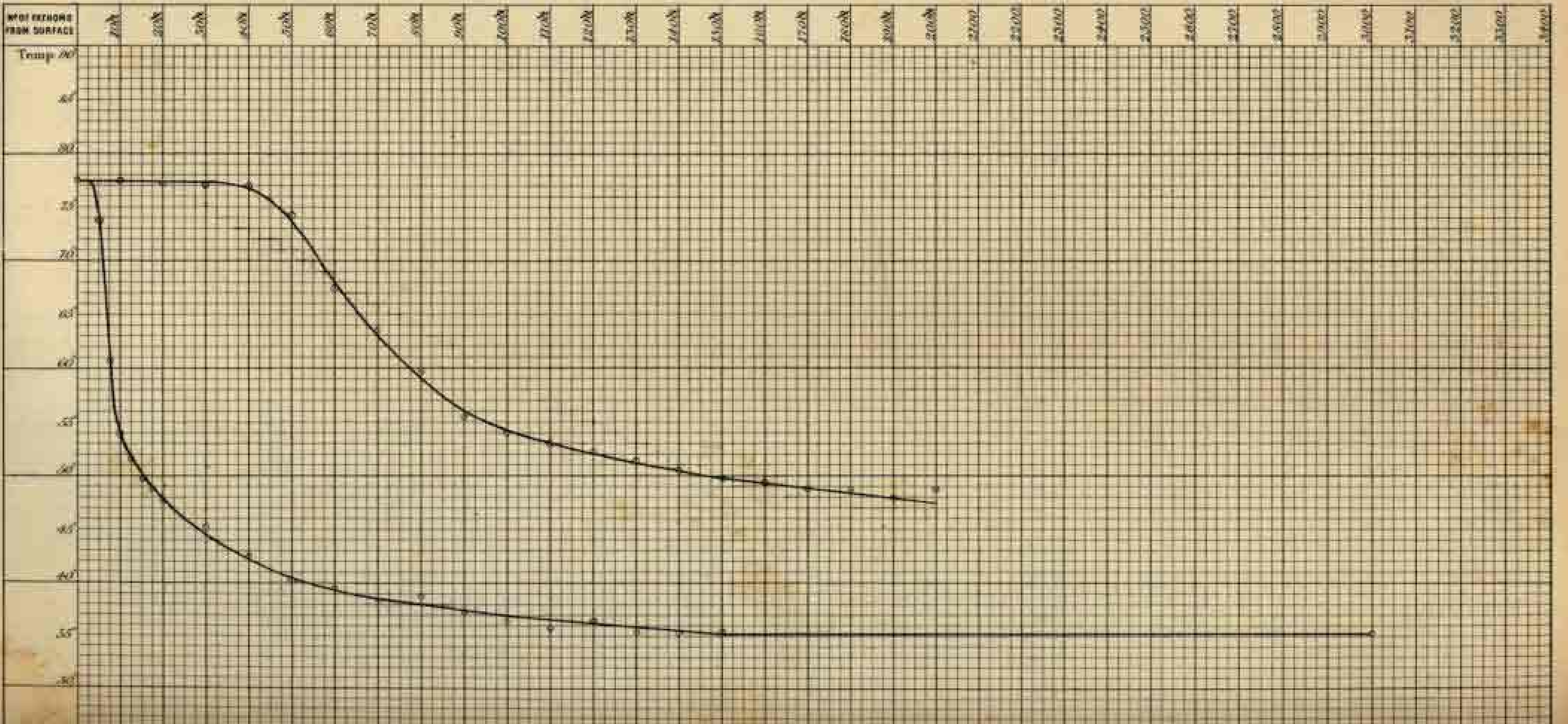
23 August 1875.

N.º of Sounding 406.
Station 264.

Depth 3000 fathoms.

Latitude 14° 19′ N.
Longitude 152° 37′ W.

N.º OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.º OF THERMOMETER		696	418	92	93	89	889	87	94	81	889	74	889	87	89	94	416	696	83	82	87				89	94	696	65	81	889	87	69	94	85	416	690	82								88 93
TEMPERATURE SHEWN BY THERMOMETER	77·5	77·3	77·4	77·2	77·2	74·0	67·3	63·2	59·0	55·3	54·0	53·0	52·2	51·5	50·4	50·0	49·5	48·9	48·4	48·0	48·3				45·0	42·5	40·3	39·1	38·6	38·8	37·0	36·1	36·0	35·9	35·6	35·4	35·4								35·4 35·4
ERROR OF THERMOMETER	0·0	0·0	−0·2	−0·2	−0·2	+0·2	0·0	+0·1	−0·2	0·0	0·0	0·0	0·0	+0·1	+0·2	−0·1	−0·2	0·0	+0·5	0·0	+0·1				+0·2	−0·1	0·0	+0·5	0·0	0·0	+0·1	+0·2	−0·1	+0·5	−0·2	0·0	0·0								−0·2 −0·2
CORRECTED TEMPERATURE	77·5	77·3	77·2	77·0	77·0	74·2	67·3	63·3	58·8	55·3	54·0	53·0	52·2	51·6	50·6	49·9	49·3	48·9	48·9	48·0	48·4				45·2	42·4	40·3	39·6	38·6	38·8	37·1	36·3	35·9	36·4	35·4	35·4	35·4								35·2 35·2
TEMPERATURE FROM CURVE	77·5	77·5	77·4	77·0	76·8	73·0	67·5	63·0	59·1	56·0	54·1	53·0	52·0	51·3	50·3	49·8	49·3	48·9	48·5	48·0	47·6				44·5	42·4	40·6	39·5	38·7	38·0	37·4	36·9	36·6	36·3	35·9	35·5	35·3								35·2



SECTION. HONOLULU TO TAHITI

25 August 1875.

N.º of Sounding 407.
Station 265.

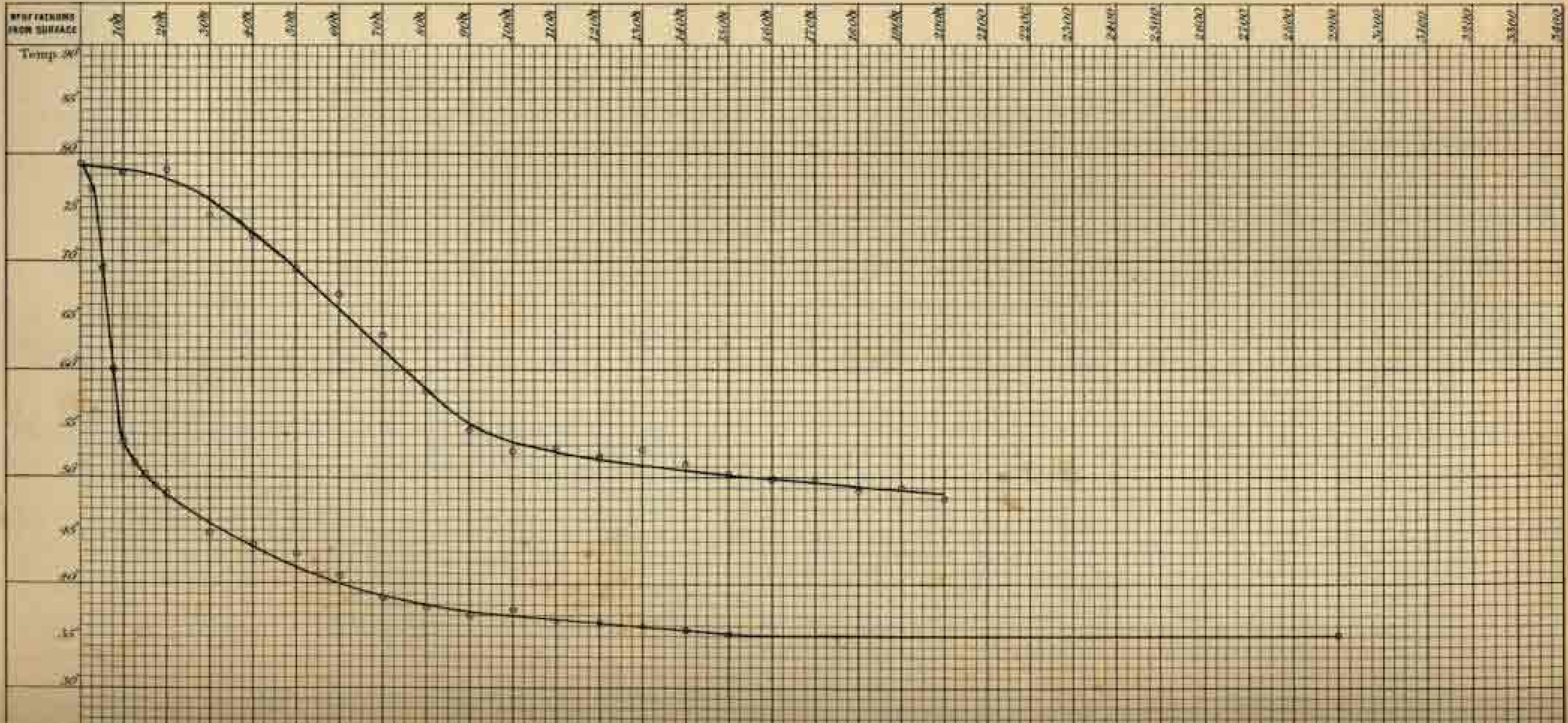
Depth 2900 fathoms

Latitude 12° 42′ N.
Longitude 152° 1′ W.

Nº of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Nº of Thermometer		416	91	87	94	89	81	83	498	389	93	416	91	87	94	89
Temperature shewn by Thermometer	79.1	78.9	78.8	74.0	70.6	69.1	67.0	62.6	58.0	54.4	52.8	53.0	52.2	52.5	51.2	50.0
Error of Thermometer	0.0	−0.3	−0.2	+0.1	−0.1	+0.2	0.0	+0.5	0.0	0.0	−0.2	−0.2	−0.2	+0.3	−0.1	+0.2
Corrected Temperature	79.1	78.6	78.6	74.1	70.5	69.3	67.0	63.1	58.0	54.4	52.6	52.8	52.0	52.8	51.1	50.2
Temperature from Curve	79.2	78.6	77.8	75.8	72.6	69.2	65.6	62.0	58.3	55.2	53.3	52.3	51.7	51.1	50.6	50.2

Nº of Fathoms from Surface	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000
Nº of Thermometer	81	83	498	389	93				93	389	84	77	92	416	498	85
Temperature shewn by Thermometer	49.8	49.2	48.7	48.3	48.2				45.0	43.6	42.8	40.5	39.0	38.0	37.0	36.8
Error of Thermometer	0.0	+0.5	0.0	0.0	−0.2				−0.8	0.0	0.0	+0.2	−0.2	−0.2	0.0	+0.5
Corrected Temperature	49.8	49.7	48.7	48.3	48.0				44.2	43.6	42.8	40.7	38.8	37.8	37.0	37.3
Temperature from Curve	49.8	49.5	49.1	48.8	48.5				45.4	43.3	41.5	40.1	39.0	38.1	37.4	37.0

Nº of Fathoms from Surface	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	74	67	94	89	81								74 93
Temperature shewn by Thermometer	36.5	36.2	36.0	35.5	35.4								34.9 35.3
Error of Thermometer	0.0	+0.1	−0.1	+0.2	0.0								0.0 −0.2
Corrected Temperature	36.5	36.3	35.9	35.7	35.4								34.9 35.1
Temperature from Curve	36.6	36.1	36.0	35.7	35.4								35.0



SECTION. HONORURU TO TAHITI.

26 August 1875.

N.º of Sounding 408.
Station 266.

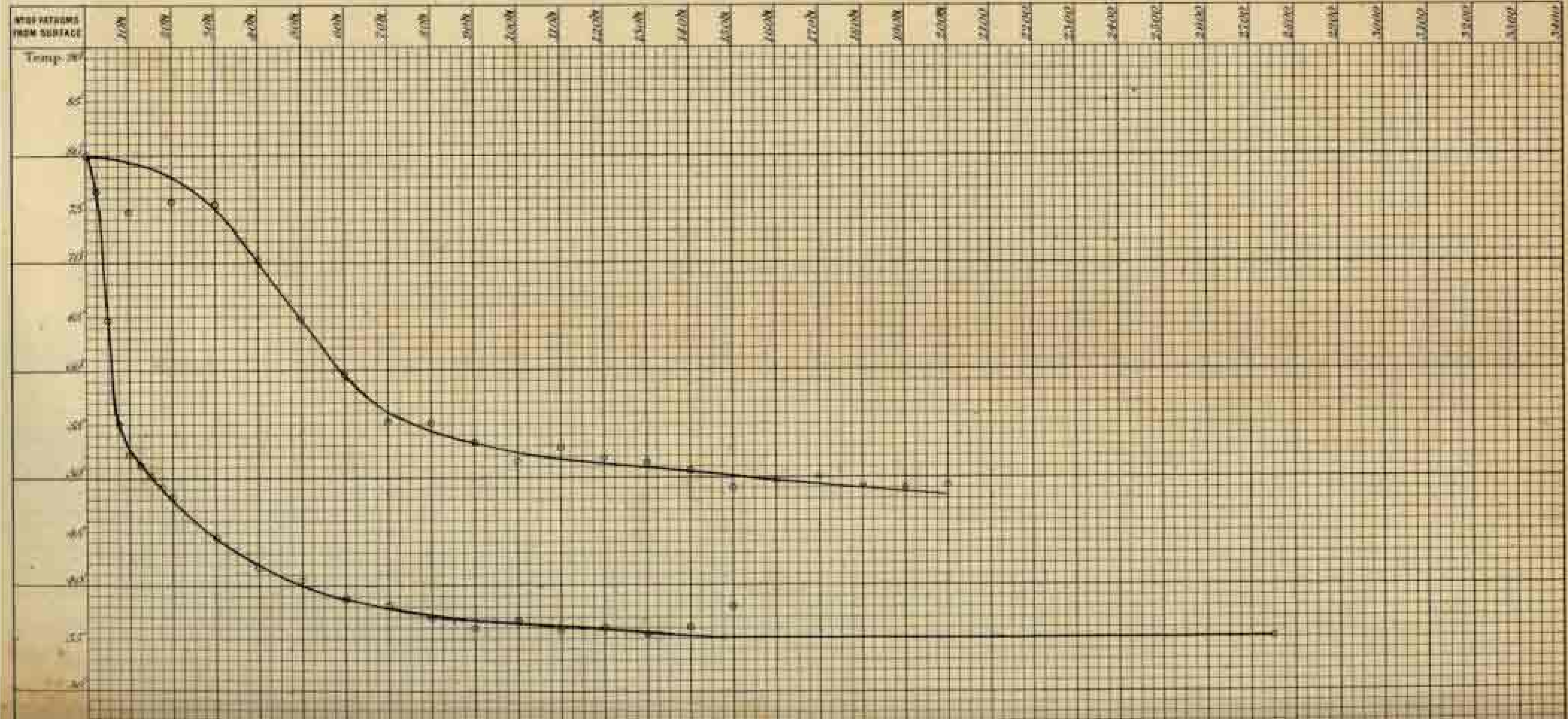
Depth 2750 fathoms.

Latitude 11° 7′ N.
Longitude 152° 3′ W.

N.º OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
N.º OF THERMOMETER		94	77	216	91	77	87	89	88	896	73	84	85	77	216	898	91	87	890	74	87
TEMPERATURE SHEWN BY THERMOMETER	80.0	75.0	75.8	73.8	70.3	64.5	58.5	55.0	55.0	53.0	51.2	51.9	51.2	51.2	50.8	49.0	50.0	49.9	49.3	49.0	49.0
ERROR OF THERMOMETER	0.0	−0.1	+0.2	−0.2	−0.2	+0.2	+0.1	+0.2	0.0	0.0	+0.2	0.0	+0.5	+0.2	−0.2	0.0	−0.2	+0.1	0.0	0.0	+0.1
CORRECTED TEMPERATURE	80.0	74.9	76.0	73.6	70.1	64.7	58.6	55.2	55.0	53.0	51.4	51.9	51.7	51.4	50.6	49.0	49.8	50.0	49.3	49.0	49.1
TEMPERATURE FROM CURVE	80.0	79.5	78.0	73.3	70.3	64.7	58.6	56.2	54.3	53.0	52.2	51.8	51.3	51.0	50.6	50.2	49.8	49.4	49.0	48.6	48.2

N.º OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
N.º OF THERMOMETER				92	216	77	85	77	216	91	87	896	74	94	85	84
TEMPERATURE SHEWN BY THERMOMETER				44.8	42.0	40.3	38.4	38.0	37.2	36.2	36.5	35.8	36.2	35.6	35.5	36.0
ERROR OF THERMOMETER				−0.2	−0.2	+0.1	+0.5	+0.2	−0.2	−0.2	+0.1	0.0	0.0	−0.1	+0.5	0.0
CORRECTED TEMPERATURE				44.6	41.8	40.4	38.9	38.2	37.0	36.0	36.6	35.8	36.2	35.5	36.0	36.0
TEMPERATURE FROM CURVE				44.6	42.0	40.2	38.9	37.9	37.3	36.9	36.5	36.2	35.9	35.6	35.3	35.1

N.º OF FATHOMS FROM SURFACE	1600	1700	1800	1900	2000			BOTTOM
N.º OF THERMOMETER								81 93
TEMPERATURE SHEWN BY THERMOMETER								35.5 35.0
ERROR OF THERMOMETER								0.0 −0.2
CORRECTED TEMPERATURE								35.5 34.8
TEMPERATURE FROM CURVE								35.1



28 August 1875.

No. of Sounding 409.
Station 267.

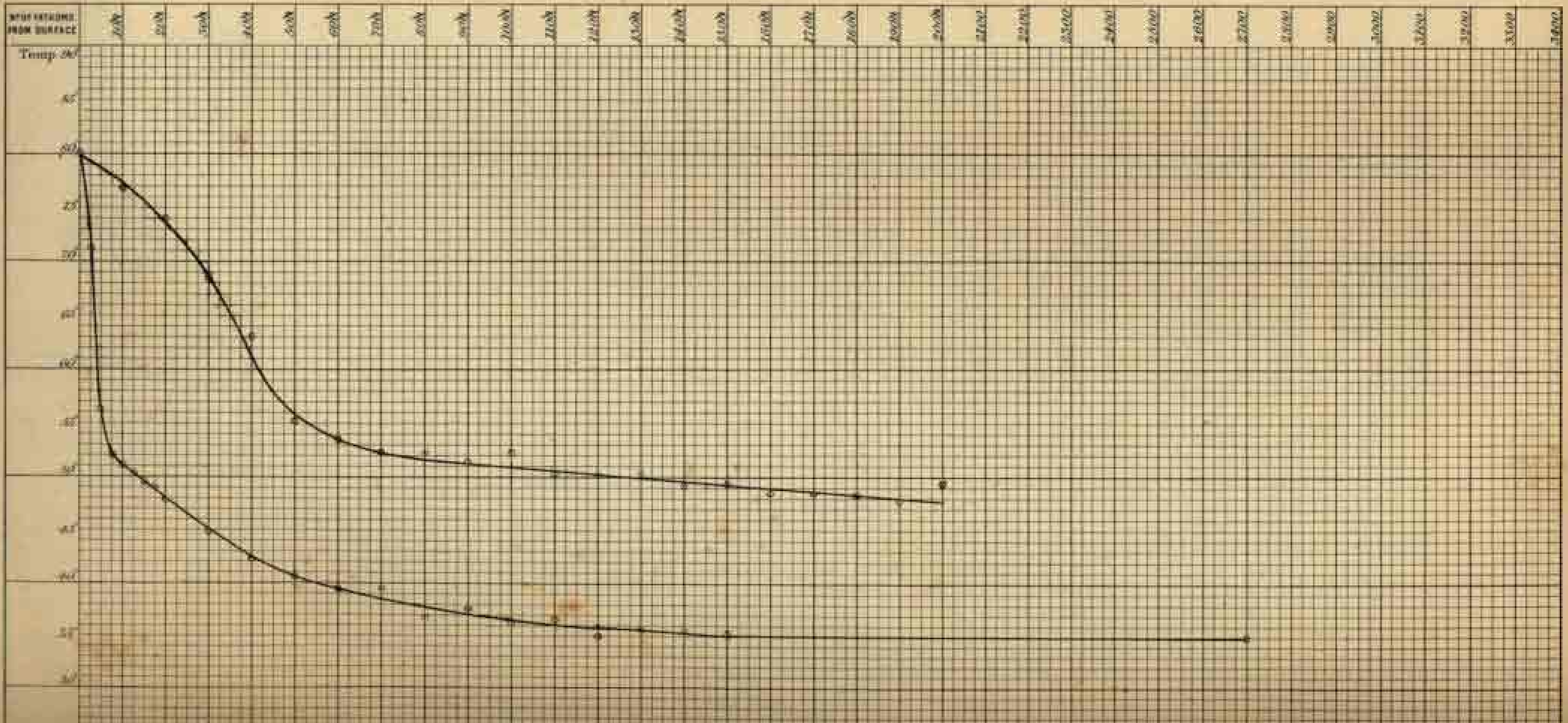
Depth 2700 *fathoms.*

Latitude 9° 28′ N.
Longitude 150° 49′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140
No. of Thermometer		89	92	94	889	94	416	93	81	92	889	896	94	889	416
Temperature shewn by Thermometer	80.0	76.5	74.2	68.5	63.0	55.2	53.8	52.5	52.0	51.8	52.2	50.4	50.2	50.0	49.5
Error of Thermometer	0.0	+0.2	−0.2	−0.1	0.0	−0.1	−0.2	−0.2	0.0	−0.2	0.0	0.0	−0.1	0.0	−0.2
Corrected Temperature	80.0	76.7	74.0	68.4	63.0	55.1	53.6	52.3	52.0	51.6	52.2	50.4	50.1	50.0	49.3
Temperature from Curve	80.0	77.0	73.5	68.4	61.3	56.0	53.8	52.3	51.7	51.4	51.0	50.7	50.3	50.0	49.7

No. of Fathoms from Surface	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800
No. of Thermometer	416	81	85	89	87	81				93	85	89	87	896	94
Temperature shewn by Thermometer	49.6	48.8	48.2	48.2	48.0	49.5				45.0	41.8	40.5	39.2	39.8	36.8
Error of Thermometer	−0.2	0.0	+0.5	+0.2	+0.1	0.0				−0.2	+0.5	+0.2	+0.1	0.0	−0.1
Corrected Temperature	49.4	48.8	48.7	48.4	48.1	49.5				44.8	42.3	40.7	39.3	39.8	36.7
Temperature from Curve	49.4	49.1	48.8	48.4	48.1	47.8				45.0	42.5	40.8	39.5	38.5	37.8

No. of Fathoms from Surface	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	889	416	81	93	85	89	87								77 97
Temperature shewn by Thermometer	37.6	36.4	36.6	35.2	35.0	35.2	35.2								34.8 35.0
Error of Thermometer	0.0	−0.2	0.0	−0.2	+0.3	+0.2	+0.1								+0.2 +0.1
Corrected Temperature	37.6	36.2	36.6	35.0	35.3	35.4	35.3								35.0 35.1
Temperature from Curve	37.1	36.6	36.1	35.7	35.4	35.2	35.0								35.0



SECTION. HONORURU TO TAHITI.

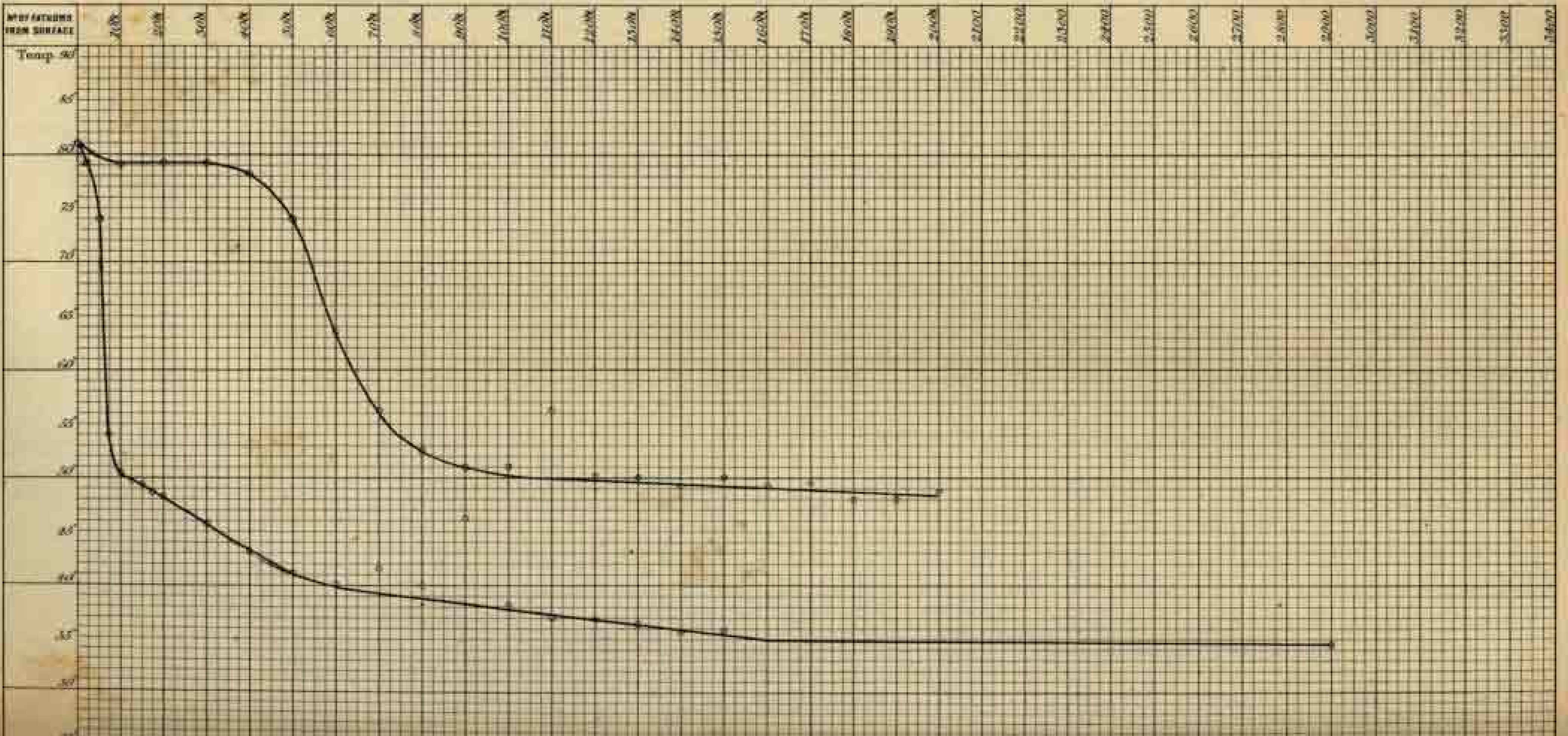
30 August 1875.

Nº of Sounding 410.
Station 268.

Depth 2900 fathoms.

Latitude 7° 35′ N.
Longitude 149° 49′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		216	93	87	77	74	83	84	92	93	81	89	77	85	80	86	74	81	74	85	89				216	87	94	77	83	81	269	89	74	216	87	94	77								92 93
TEMPERATURE SHEWN BY THERMOMETER	81.0	79.6	79.5	79.2	78.0	74.0	63.2	56.2	52.8	51.2	51.0	56.0	50.0	49.5	49.0	50.0	49.8	49.5	48.0	47.6	48.6				46.0	43.8	41.4	40.0	41.2	40.0	46.2	38.0	37.0	36.9	36.2	35.8	35.6								35.0 35.0
ERROR OF THERMOMETER	0.0	−0.3	−0.2	+0.1	+0.2	0.0	+0.2	0.0	−0.2	−0.2	0.0	+0.1	+0.2	+0.5	+0.2	0.0	0.0	0.0	0.0	+0.4	+0.2				−0.2	+0.1	−0.3	+0.2	+0.5	0.0	0.0	+0.2	0.0	−0.2	+0.1	−0.1	+0.2								−0.2 −0.2
CORRECTED TEMPERATURE	81.0	79.3	79.3	79.3	78.2	74.0	63.4	56.2	52.6	51.0	51.0	56.1	50.2	50.0	49.2	50.0	49.8	49.5	48.0	48.0	48.8				45.8	43.9	41.1	40.2	41.7	40.0	46.2	38.2	37.0	36.7	36.3	35.7	35.8								34.8 34.8
TEMPERATURE FROM CURVE	81.0	79.3	79.3	79.3	78.2	74.0	63.4	56.2	52.6	51.0	50.3	50.0	49.8	49.6	49.4	49.2	49.0	48.8	48.6	48.4	48.2				45.8	43.9	41.1	40.0	39.2	38.7	38.2	37.7	37.2	36.7	36.3	35.8	35.3								34.8



2 September 1875.

N.° of Sounding 411.
Station. 269.

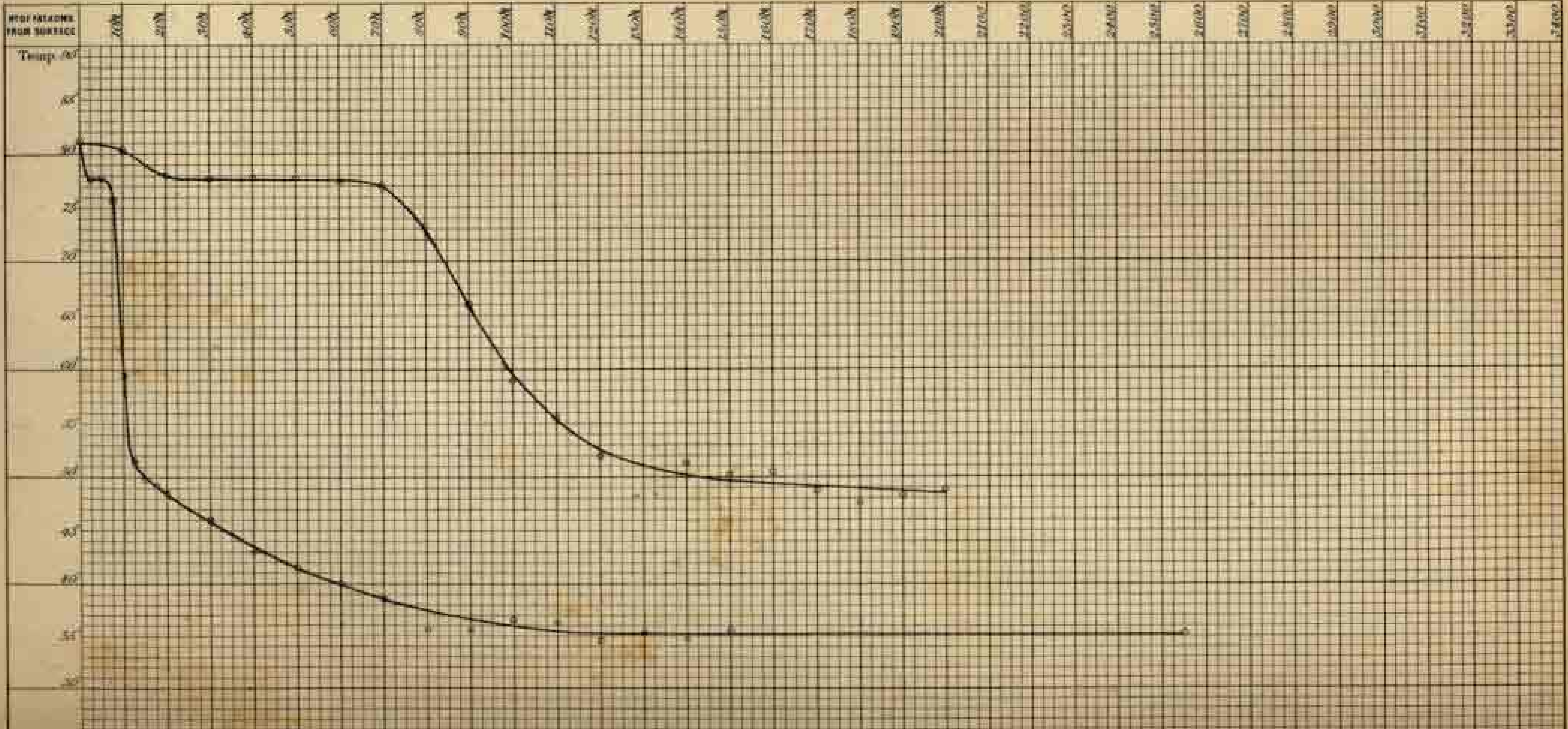
Depth 2550 fathoms

Latitude 5° 54′ N.
Longitude 147° 2′ W.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
N.° OF THERMOMETER		89	89	87	97	418	82	83	94	74	496	87	81		416	93
TEMPERATURE SHEWN BY THERMOMETER	81.2	80.1	77.8	77.6	78.0	78.0	77.3	76.5	73.2	66.0	55.0	53.5	52.0		51.4	50.4
ERROR OF THERMOMETER	0.0	+0.3	+0.2	+0.1	−0.2	−0.2	0.0	+0.5	−0.1	0.0	0.0	+0.3	0.0	0.0	−0.2	−0.2
CORRECTED TEMPERATURE	81.2	80.4	78.0	77.7	77.8	77.8	77.3	77.0	73.1	66.0	55.0	53.8	52.0		51.2	50.2
TEMPERATURE FROM CURVE	81.2	80.4	78.0	77.8	77.7	77.8	77.8	77.0	73.1	66.0	55.3	53.4	52.3	51.1	50.2	49.7

N.° OF FATHOMS FROM SURFACE	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900
N.° OF THERMOMETER	83	496	94	89	83				416	84	89	94	93	92	496
TEMPERATURE SHEWN BY THERMOMETER	50.0	48.8	47.8	48.2	48.2				46.2	43.0	41.2	40.0	38.8	35.8	35.5
ERROR OF THERMOMETER	+0.3	0.0	−0.1	+0.2	+0.5				−0.2	0.0	+0.2	−0.1	−0.2	−0.2	0.0
CORRECTED TEMPERATURE	50.3	48.8	47.7	48.4	48.7				46.0	43.0	41.4	39.9	38.6	35.6	35.5
TEMPERATURE FROM CURVE	49.4	48.9	49.0	48.8	48.5				46.0	43.7	41.4	39.9	38.6	37.3	36.7

N.° OF FATHOMS FROM SURFACE	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER	83	89	94	87	93	92								93
TEMPERATURE SHEWN BY THERMOMETER	36.0	36.0	34.8	35.0	35.0	35.8								35.4
ERROR OF THERMOMETER	+0.5	+0.2	−0.1	+0.1	−0.2	−0.1								−0.2
CORRECTED TEMPERATURE	36.5	36.2	34.7	35.1	34.8	35.8								35.2
TEMPERATURE FROM CURVE	36.0	35.8	35.3	35.2	35.2	35.2								35.2



SECTION. HONORURU TO TAHITI.

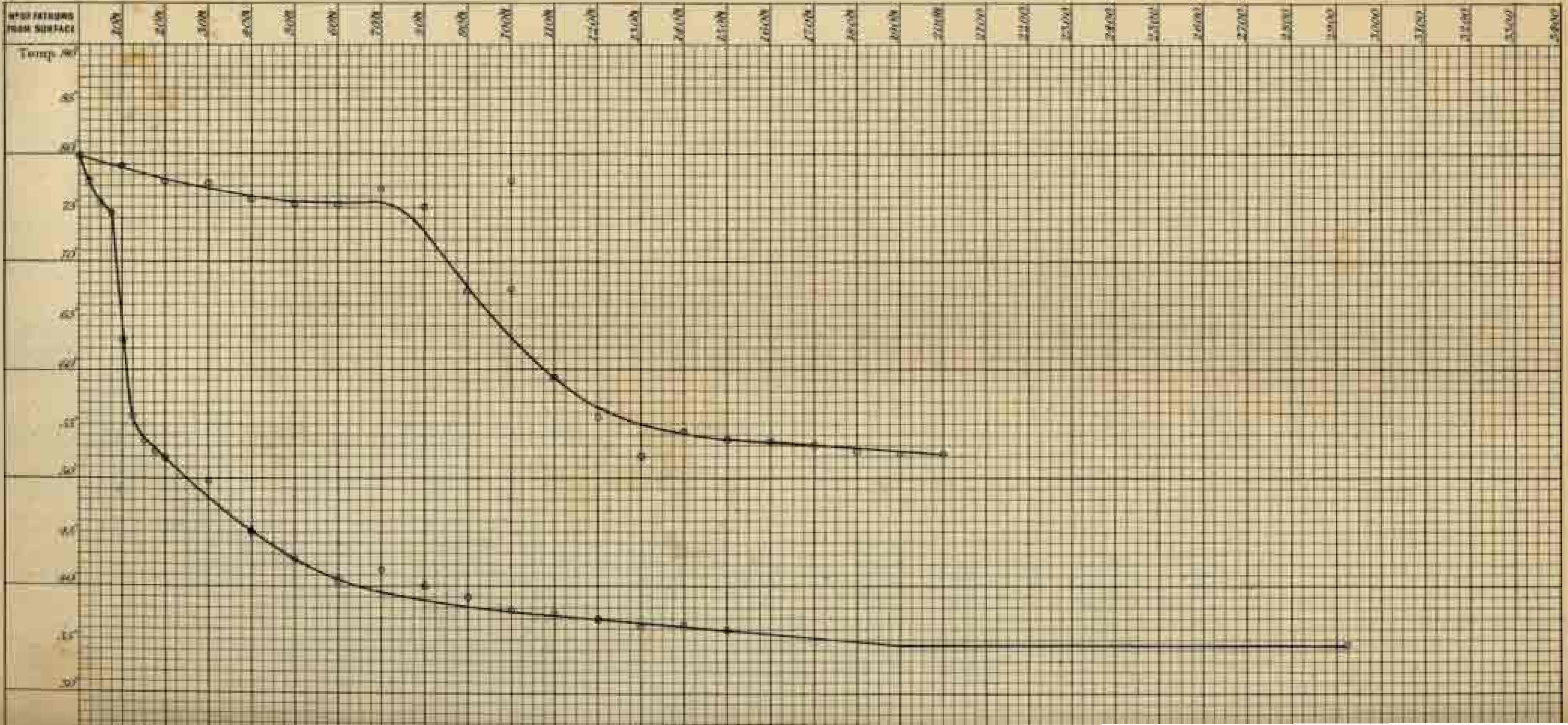
4 September 1875.

No. of Sounding 412.
Station 270.

Depth 2925 *fathoms.*

Latitude 2° 34′ N.
Longitude 149° 9′ W.

No. OF FATHOMS FROM SURFACE	No. OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		79.5	0.0	79.5	79.5
10	93	79.0	−0.2	78.8	78.7
20	74	77.3	0.0	77.3	77.7
30	85	76.8	+0.5	77.3	77.0
40	77	75.5	+0.2	75.7	76.2
50	696	75.2	0.0	75.2	75.5
60	87	75.2	+0.1	75.3	75.3
70	94	77.0	−0.1	76.9	75.3
80	216	73.2	−0.2	73.0	72.8
90	83	67.0	+0.2	67.2	67.3
100	89	77.2	+0.2	77.4	62.8
110	85	58.6	+0.5	59.1	59.1
120	74	53.6	0.0	53.6	56.2
130	92	52.2	−0.2	52.0	55.0
140	77	54.5	+0.3	54.8	54.8
150	696	53.5	0.0	53.5	53.5
160	87	53.1	+0.1	53.2	53.0
170	94	53.0	−0.4	52.6	52.9
180	216	52.6	−0.2	52.4	52.6
190	89	52.0	+0.2	52.2	52.3
200	94	52.2	−0.1	52.1	52.0
225					
250					
275					
300	216	50.0	−0.2	49.8	48.3
400	696	45.0	0.0	45.0	45.0
500	87	42.6	+0.1	42.7	42.7
600	85	40.1	+0.5	40.6	40.6
700	77	41.3	+0.2	41.5	39.5
800	74	40.0	0.0	40.0	38.7
900	89	38.8	+0.2	39.0	38.0
1000	94	38.0	−0.1	37.9	37.7
1100	216	37.8	−0.2	37.6	37.3
1200	81	37.0	0.0	37.0	37.0
1300	696	36.0	0.0	36.0	36.7
1400	85	35.8	+0.5	36.3	36.3
1500	87	36.0	+0.1	36.1	36.0
1600					
1700					
1800					
1900					
2000					
BOTTOM	90 93	35.2 34.8	−0.2 −0.2	35.0 34.6	34.6



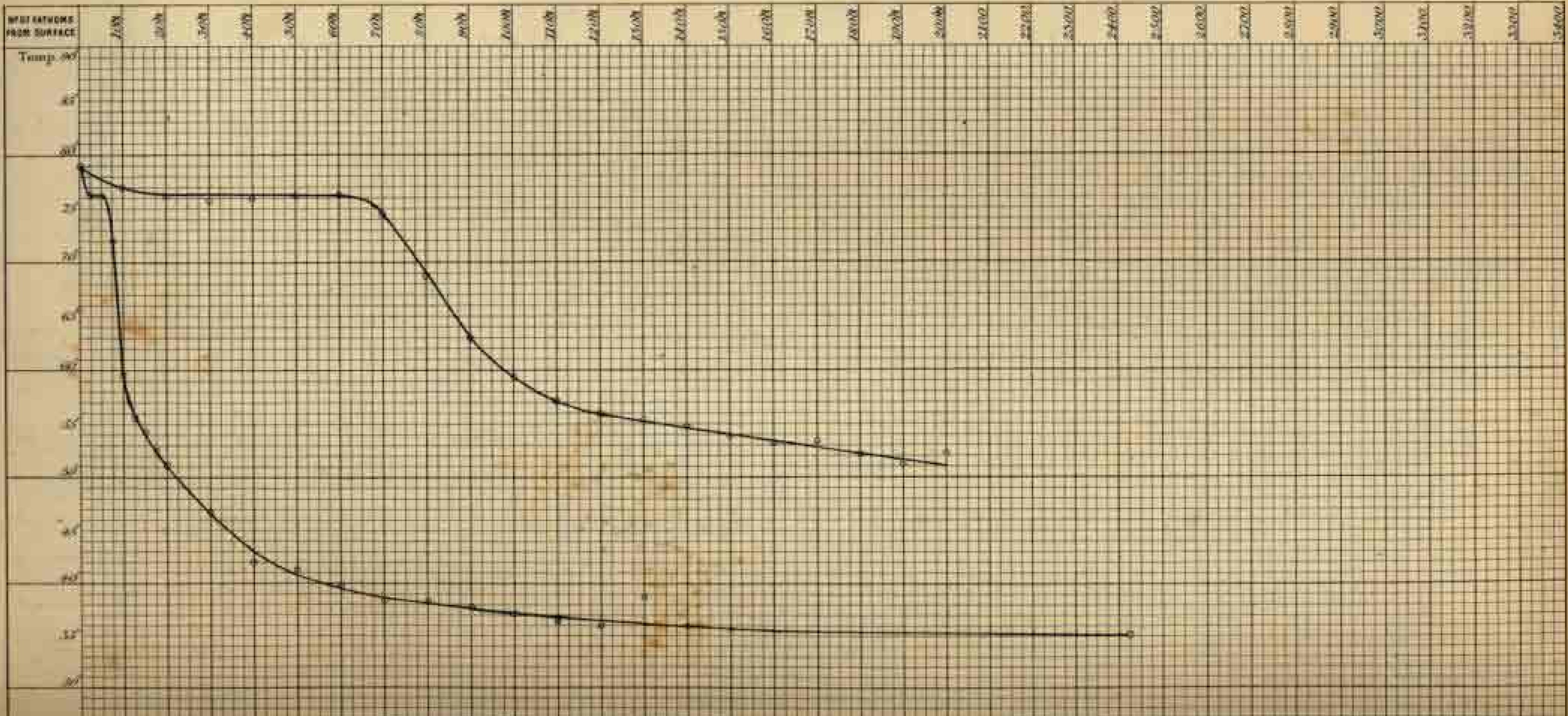
6 September 1875.

Nº of Sounding 413.
Station 271.

Depth 2425 fathoms

Latitude 0° 33′ S.
Longitude 151° 34′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		89	94	87	216	196	77	85	74	95	74	74	93	85	77	196	216	87	98	89	196				77	216	89	87	94	85	98	77	93	216	89	85	87								93
TEMPERATURE SHOWN BY THERMOMETER	78.7	76.8	76.2	75.8	76.2	76.2	76.0	74.0	68.8	63.2	59.4	57.0	56.2	55.0	54.6	53.9	53.5	53.3	52.2	51.0	50.1				46.5	42.2	41.0	39.8	38.6	37.8	38.0	37.0	36.5	36.2	36.6	35.5	35.5								35.4
ERROR OF THERMOMETER	0.0	+0.2	−0.1	+0.1	−0.2	0.0	+0.2	+0.5	0.0	−0.2	0.0	0.0	−0.2	+0.5	+0.2	0.0	−0.2	+0.1	−0.1	+0.2	0.0				+0.2	−0.2	+0.2	+0.1	−0.3	+0.5	−0.1	+0.4	−0.2	−0.2	+0.2	+0.5	+0.1								−0.4
CORRECTED TEMPERATURE	78.7	77.0	76.1	75.9	76.0	76.2	76.2	74.5	68.8	63.0	59.4	57.0	56.0	55.5	54.8	53.9	53.3	53.4	52.1	51.2	50.1				46.7	42.0	41.2	39.9	38.3	38.3	37.9	37.4	36.3	36.0	36.8	36.0	35.6								35.0
TEMPERATURE FROM CURVE	78.7	77.0	76.1	75.9	76.0	76.2	76.2	74.5	68.8	63.0	59.4	57.0	56.0	55.3	54.7	54.1	53.4	52.8	52.2	51.6	51.0				46.5	42.0	40.7	39.6	38.7	38.0	37.7	37.2	36.7	36.3	36.1	35.9	35.7								35.0



SECTION. HONORURU TO TAHITI.

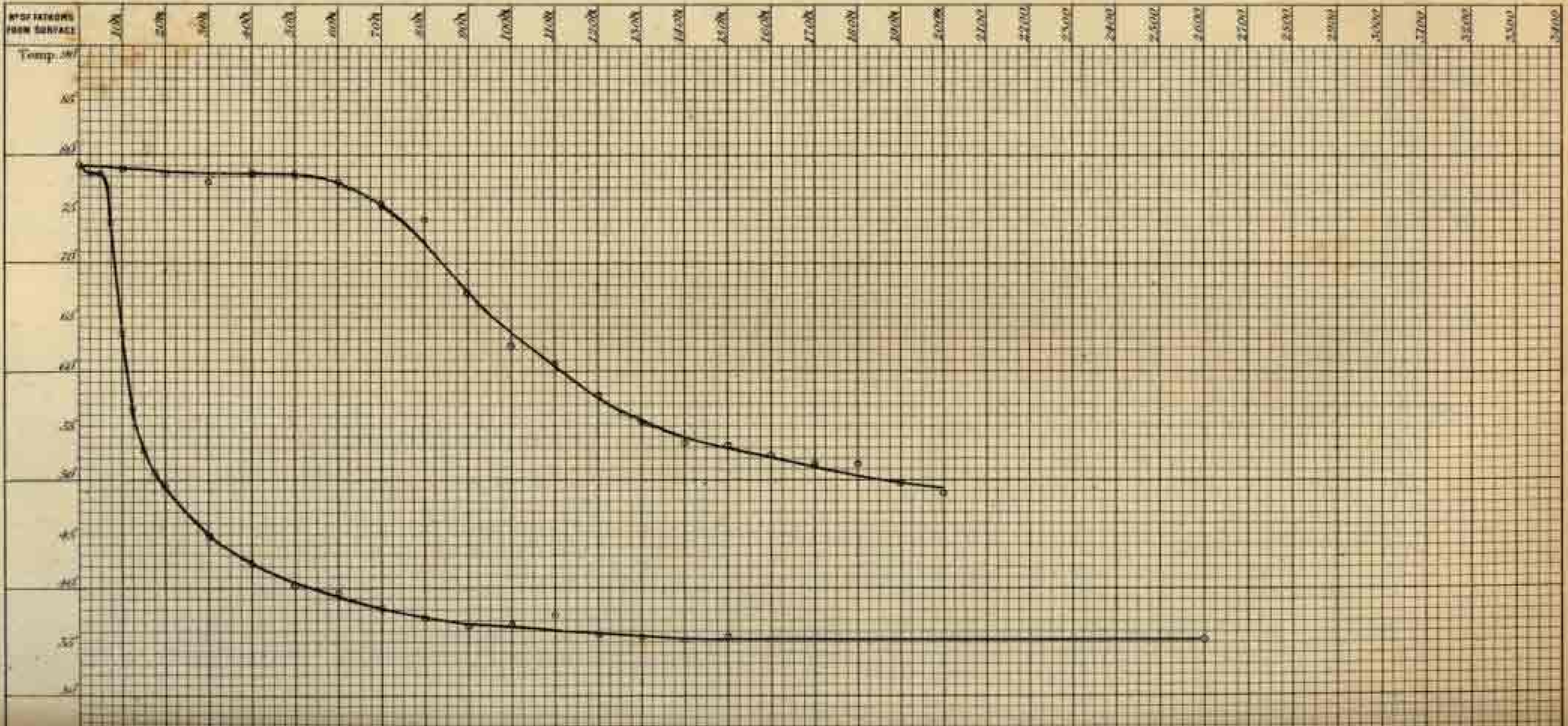
8 September 1875.

Nº of Sounding 414.
Station 272.

Depth 2600 fathoms.

Latitude 3° 48′ S.
Longitude 152° 56′ W.

Nº OF FATHOMS FROM SURFACE	Nº OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		79.0	0.0	79.0	79.0
10	216	79.0	−0.2	78.8	78.8
20	77	78.0	+0.2	78.2	78.5
30	74	77.5	0.0	77.5	78.4
40	89	78.0	+0.2	78.2	78.2
50	87	78.0	+0.1	78.1	78.1
60	94	77.8	−0.3	77.5	77.5
70	77	73.2	+0.2	73.4	75.4
80	74	74.0	0.0	74.0	71.9
90	87	67.1	+0.1	67.2	67.3
100	87	62.0	+0.1	62.1	63.6
110	A96	60.6	0.0	60.6	60.4
120	216	58.0	−0.2	57.8	57.5
130	89	55.2	+0.2	55.4	55.4
140	94	53.6	−0.1	53.5	54.0
150	85	52.6	+0.5	53.1	52.9
160	77	52.0	+0.2	52.2	52.0
170	74	50.8	0.0	50.8	51.2
180	89	50.4	−0.1	50.3	50.5
190	91	50.0	−0.2	49.8	49.8
200	94	49.0	−0.1	48.9	49.0
225					
250					
275					
300	85	44.2	+0.5	44.7	44.7
400	77	42.0	+0.2	42.2	42.2
500	74	40.2	0.0	40.2	40.4
600	87	39.3	+0.3	39.6	39.2
700	93	38.4	−0.2	38.2	38.2
800	216	37.4	−0.2	37.2	37.3
900	74	36.8	0.0	36.8	36.8
1000	77	36.6	+0.2	36.8	36.4
1100	A96	37.4	0.0	37.4	36.0
1200	216	35.8	−0.2	35.6	35.7
1300	89	35.3	+0.2	35.5	35.5
1400	94	34.1	−0.2	33.9	33.7
1500	85	33.0	+0.3	33.3	33.2
1600					
1700					
1800					
1900					
2000					
BOTTOM	93 89	35.2 35.2	+0.2 +0.1	35.4 35.3	35.4



SECTION. HONORURU TO TAHITI

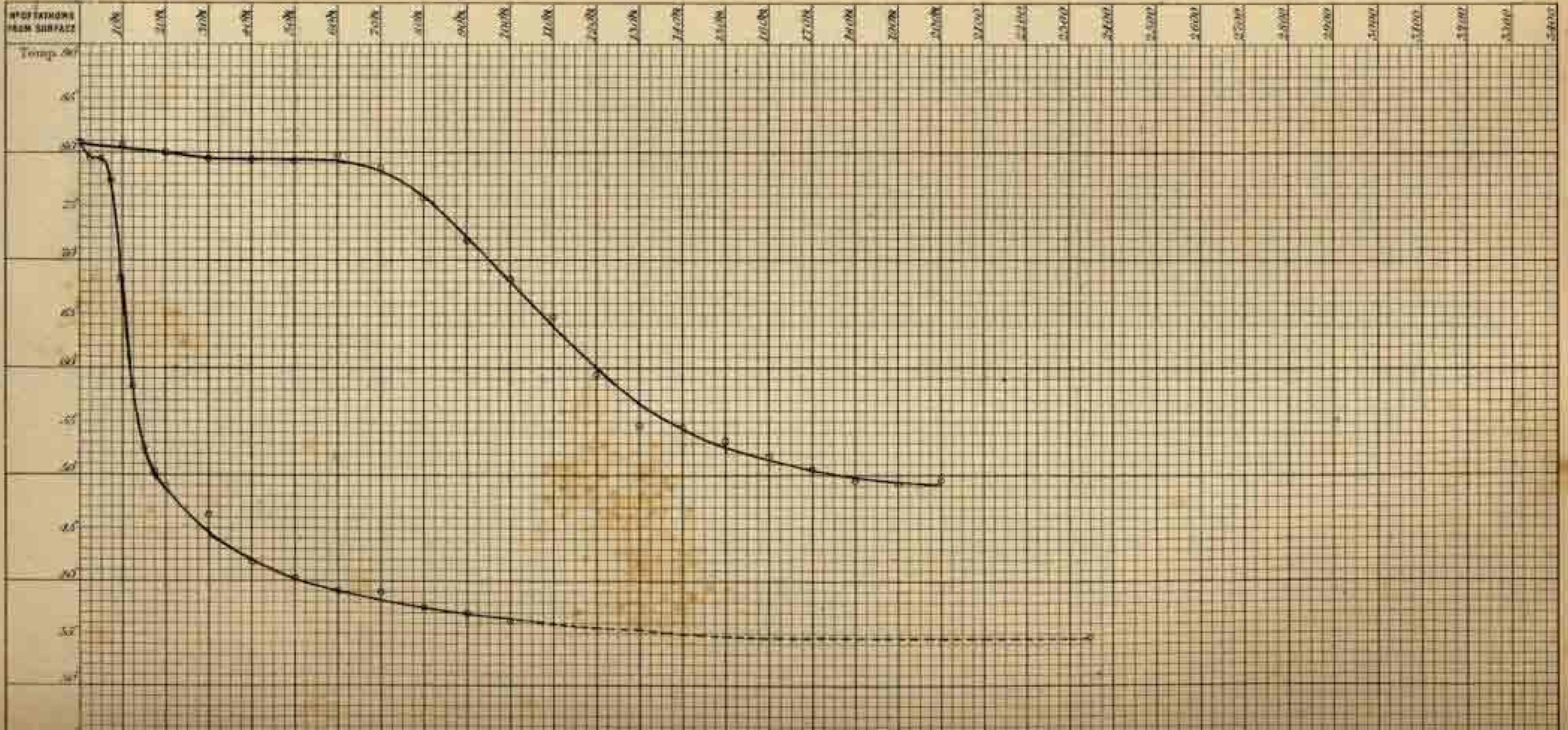
9 September 1875.

Nº of Sounding 415.
Station 273.

Depth 2350 fathoms.

Latitude 5° 11′ S.
Longitude 152° 56′ W.

Nº OF FATHOMS FROM SURFACE	Nº OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		80.7	0.0	80.7	80.7
10	77	80.5	+0.2	80.7	80.4
20	73	79.8	+0.2	80.0	80.0
30	85	79.0	+0.5	79.5	79.5
40	70	79.2	+0.2	79.4	79.4
50	88	78.8	+0.5	79.3	79.3
60	74	79.3	0.0	79.3	79.2
70	94	78.8	−0.1	78.7	78.2
80	416	76.0	−0.2	75.8	75.8
90	85	71.8	+0.1	71.9	71.9
100	696	68.2	0.0	68.2	68.2
110	77	64.5	+0.2	64.7	64.0
120	83	59.0	+0.3	59.3	59.8
130	75	54.5	+0.2	54.7	56.5
140	85	53.8	+0.5	54.3	54.3
150	77	53.0	+0.2	53.2	52.6
160	696	51.8	0.0	51.8	51.7
170	87	50.5	+0.1	50.6	50.7
180	416	49.8	−0.2	49.6	49.8
190	94	49.2	−0.1	49.1	49.3
200	71	49.4	0.0	49.4	49.0
225					
250					
275					
300	87	46.0	+0.1	46.1	44.2
400	416	42.0	−0.2	41.8	41.8
500	73	40.0	+0.2	40.2	40.1
600	94	39.0	−0.1	38.9	38.9
700	74	39.0	0.0	39.0	38.1
800	72	37.4	+0.2	37.6	37.5
900	88	36.5	+0.5	37.0	37.0
1000	696	36.2	0.0	36.2	36.3
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
BOTTOM	89 93	34.6 34.8	+0.2 −0.2	34.8 34.6	34.5



SECTION. HONORURU TO TAHITI.

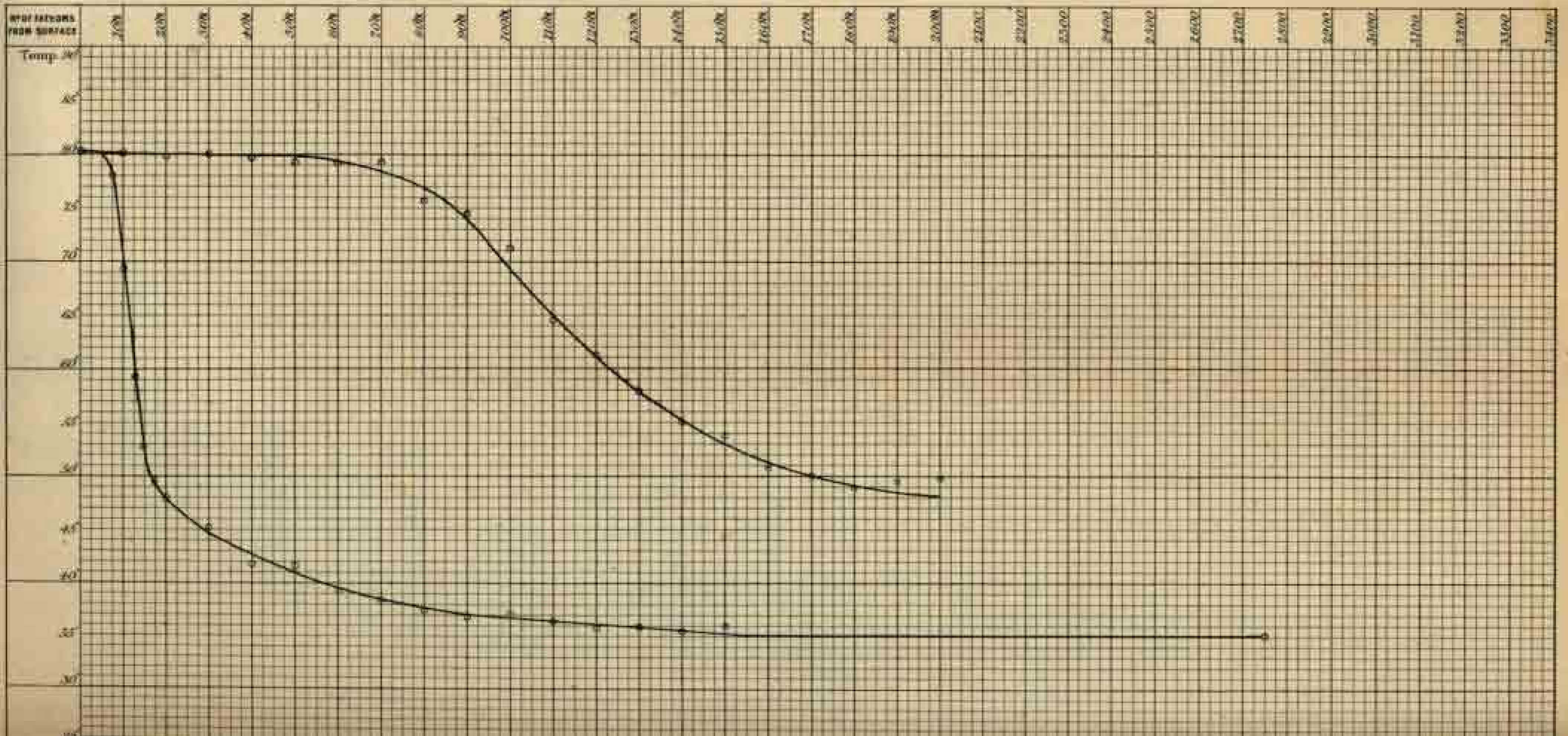
11 September 1875.

Nº of Sounding 416.
Station 274.

Depth 2750 fathoms

Latitude 7° 25′ S
Longitude 152° 15′ W

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		75	94	72	89	92	87	85	416	88	496	87	89	94	79	75	75	496	93	74	72				94	94	72	75	496	93	89	87	83	416	77	88	74								93 74
TEMPERATURE SHEWN BY THERMOMETER	80.2	79.8	79.8	79.9	79.5	79.5	79.0	78.8	76.0	74.0	71.0	64.2	61.0	58.0	54.8	53.6	50.5	50.0	49.2	49.5	49.6				45.2	42.0	41.5	39.2	38.6	37.6	36.8	37.0	36.0	35.9	35.9	35.1	36.0								35.2 35.2
ERROR OF THERMOMETER	0.0	+0.2	−0.1	+0.2	+0.2	−0.2	+0.1	+0.5	−0.2	+0.5	0.0	+0.1	+0.2	−0.1	+0.2	+0.2	+0.2	0.0	−0.2	0.0	+0.2				−0.1	−0.1	+0.2	+0.2	0.0	−0.2	+0.2	+0.1	+0.5	−0.2	+0.2	+0.5	0.0								−0.2 0.0
CORRECTED TEMPERATURE	80.2	80.0	79.7	80.1	79.7	79.3	79.1	79.3	75.8	74.5	71.0	64.3	61.2	57.9	55.0	53.8	50.7	50.0	49.0	49.5	49.8				45.1	41.9	41.7	39.4	38.6	37.4	37.0	37.1	36.5	35.7	36.1	35.6	36.0								35.0 35.2
TEMPERATURE FROM CURVE	80.2	80.0	80.0	80.0	80.0	79.8	79.5	78.6	77.0	73.7	69.3	64.7	60.9	57.8	55.1	52.9	51.3	49.9	49.2	48.5	48.0				44.6	42.5	41.0	39.5	38.5	37.6	37.1	36.7	36.4	36.1	35.9	35.6	35.3								35.1



SECTION. HONOLULU TO TAHITI.

14 September 1875.

Nº of Sounding 417.
Station 275.

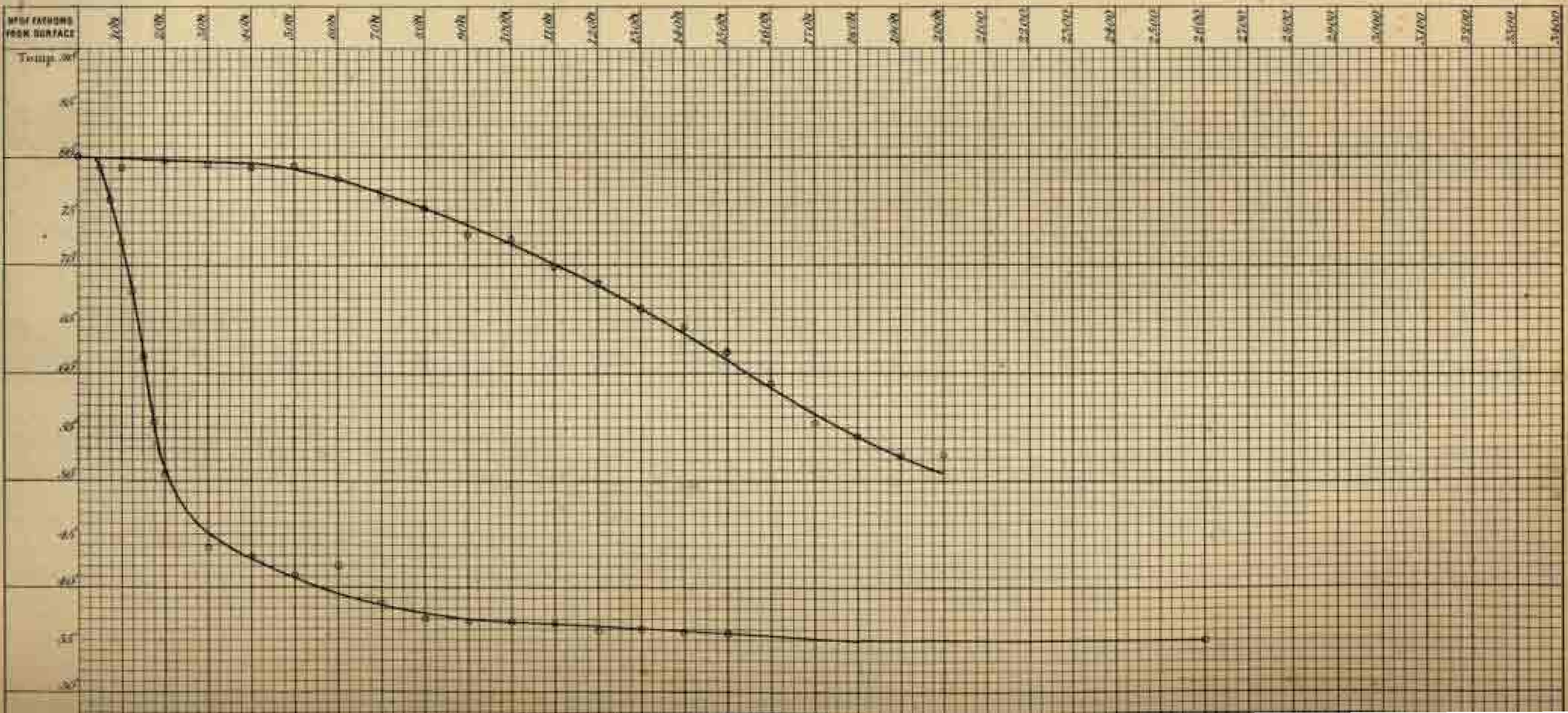
Depth 2610 *fathoms.*

Latitude 11° 20′ S.
Longitude 150° 30′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Nº OF THERMOMETER		74	77	496	95	89	416	85	88	94	416	87	416	89	95
TEMPERATURE SHEWN BY THERMOMETER	80.0	79.0	79.5	79.2	79.2	79.0	78.2	76.0	74.6	72.8	72.6	69.8	68.5	66.0	64.3
ERROR OF THERMOMETER	0.0	0.0	+0.2	0.0	−0.2	+0.2	−0.2	+0.3	+0.5	−0.1	−0.2	+0.1	−0.2	+0.2	−0.2
CORRECTED TEMPERATURE	80.0	79.0	79.7	79.2	79.0	79.2	78.0	76.3	75.1	72.7	72.4	69.9	68.3	66.2	64.1
TEMPERATURE FROM CURVE	80.0	79.9	79.8	79.6	79.4	79.0	78.0	76.7	75.3	73.7	72.0	70.1	68.3	66.2	64.0

Nº OF FATHOMS FROM SURFACE	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800
Nº OF THERMOMETER	496	77	74	77	75	78				94	88	85	496	77	74
TEMPERATURE SHEWN BY THERMOMETER	62.0	59.0	55.5	54.0	52.2	52.2				44.0	42.2	40.8	40.0	38.2	37.0
ERROR OF THERMOMETER	0.0	+0.2	0.0	+0.2	+0.2	+0.2				−0.1	+0.5	+0.3	0.0	+0.2	0.0
CORRECTED TEMPERATURE	62.0	59.2	55.5	54.2	52.4	52.4				43.9	42.7	41.1	40.0	38.4	37.0
TEMPERATURE FROM CURVE	61.4	58.9	56.4	54.2	52.4	50.8				45.0	42.6	40.9	39.5	38.4	37.5

Nº OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	73	416	77	94	88	89	85								87 92
TEMPERATURE SHEWN BY THERMOMETER	36.6	37.0	36.4	36.0	35.5	35.6	35.2								35.1 35.1
ERROR OF THERMOMETER	+0.2	−0.2	+0.2	−0.1	+0.5	+0.2	+0.5								+0.1 −0.2
CORRECTED TEMPERATURE	36.8	36.8	36.6	35.9	36.0	35.8	35.7								35.2 34.9
TEMPERATURE FROM CURVE	37.0	36.7	36.5	36.2	36.0	35.8	35.6								35.0



SECTION. HONORURU TO TAHITI.

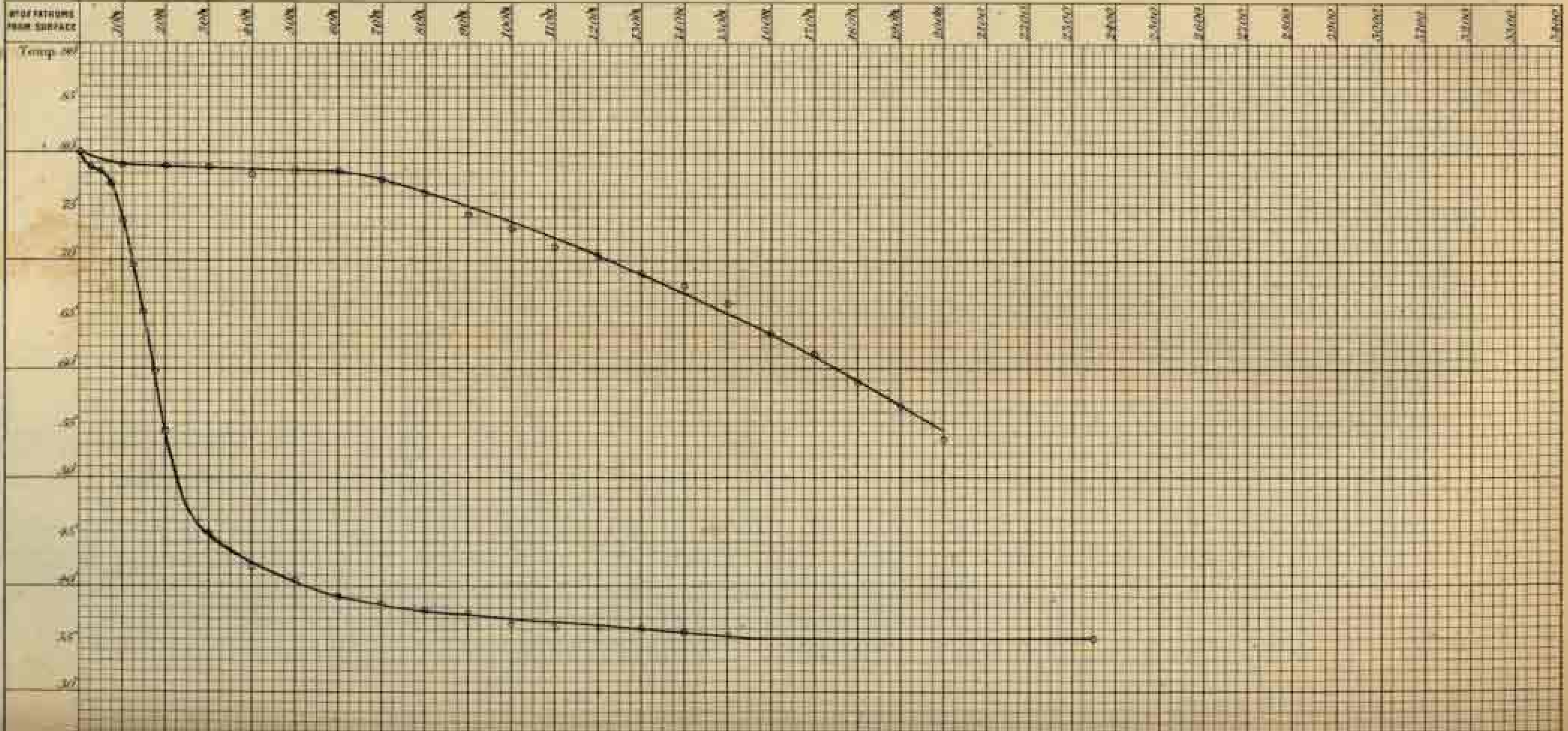
16 September 1875.

Nº of Sounding 418.
Station 276.

Depth 2350 *fathoms*.

Latitude 13° 28′ S.
Longitude 149° 30′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		93	96	87	116	94	89	73	77	83	79	83	33	81	74	77	89	85	94	116	77				94	89	83	116	79	77	96	94	89	85	88	74	116								87 93
TEMPERATURE SHEWN BY THERMOMETER	80.0	79.1	78.8	78.6	78.2	78.2	78.0	77.3	76.0	73.8	72.8	71.0	70.4	69.0	67.5	65.8	63.0	60.8	58.8	56.8	53.0				45.0	41.5	40.2	39.2	38.0	37.6	37.5	36.6	36.0	35.8	35.5	35.8	35.3								35.0 35.1
ERROR OF THERMOMETER	0.0	−0.2	0.0	+0.1	−0.2	−0.1	+0.2	+0.4	+0.2	+0.3	+0.2	+0.1	+0.2	−0.2	+0.2	+0.2	+0.2	+0.5	−0.1	−0.2	+0.4				−0.1	+0.2	+0.5	−0.2	+0.4	+0.2	0.0	−0.1	+0.1	+0.3	+0.5	0.0	0.0								+0.1 −0.2
CORRECTED TEMPERATURE	80.0	78.9	78.8	78.7	78.0	78.1	78.2	77.7	76.2	74.1	73.0	71.1	70.6	68.8	67.7	66.0	63.2	61.3	58.7	56.6	53.4				44.9	41.7	40.7	39.0	38.4	37.8	37.5	36.5	36.1	36.1	36.0	35.8	35.3								35.2 34.9
TEMPERATURE FROM CURVE	80.0	78.9	78.8	78.7	78.6	78.4	78.2	77.7	76.4	75.1	73.7	72.2	70.6	68.8	67.0	65.1	63.1	61.0	58.8	56.6	54.5				44.8	41.9	40.3	39.1	38.3	37.8	37.3	36.9	36.6	36.3	36.0	35.7	35.4								35.1



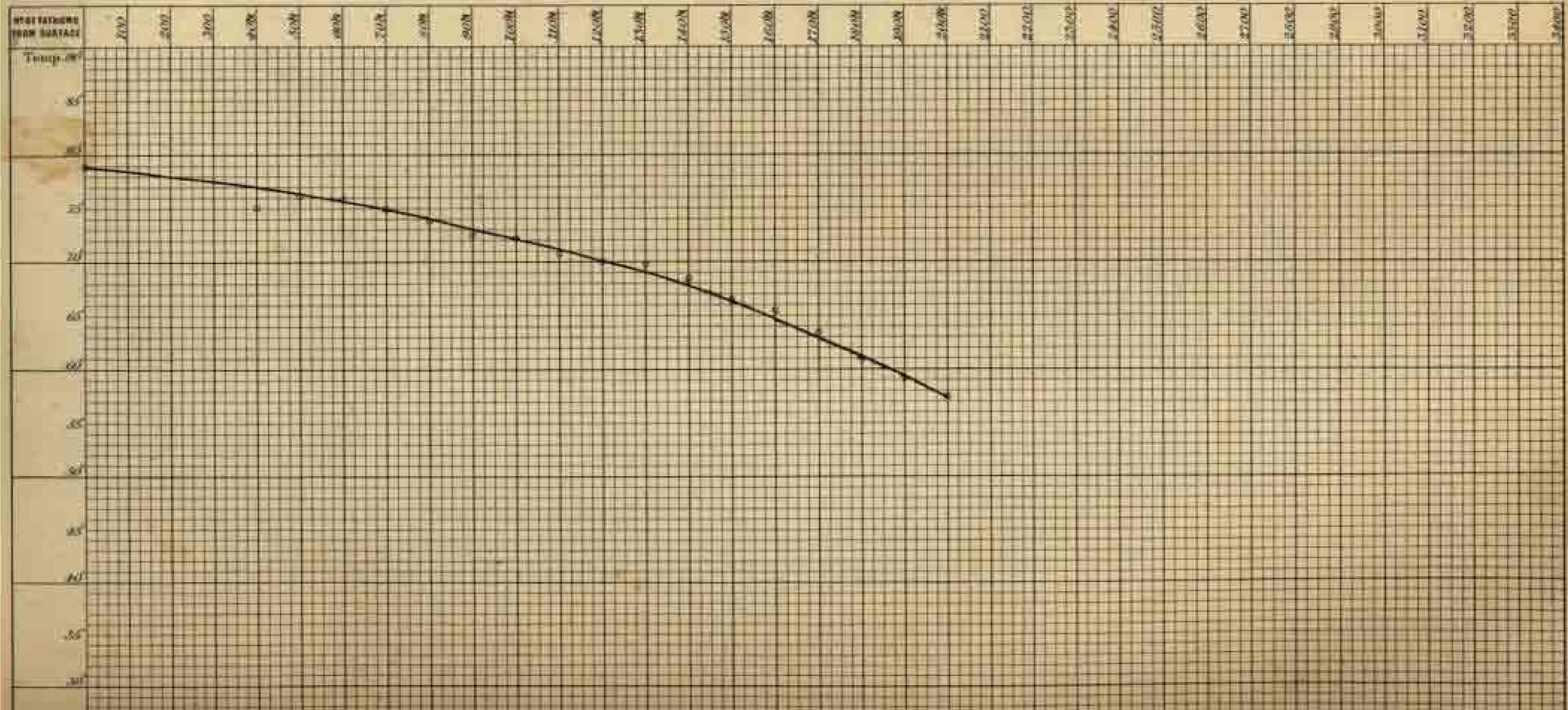
17 September 1875.

Nº of Sounding 419.
Station 277.

Depth 2325 fathoms.

Latitude 15° 51′ S.
Longitude 149° 41′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER					89	88	a16	79	75	85	77	896	a16	89	94	82	88	72	75	85	77																								74 93
TEMPERATURE SHEWN BY THERMOMETER	79.0				74.8	75.7	76.0	74.8	73.6	72.9	72.0	71.0	70.2	69.5	68.7	66.2	65.0	63.2	60.8	58.6	57.2																								35.5 35.0
ERROR OF THERMOMETER	0.0				+0.2	+0.5	-0.2	+0.2	+0.2	+0.8	+0.2	0.0	-0.2	+0.2	-0.1	+0.1	+0.5	+0.2	+0.2	+0.5	+0.2																								0.0 -0.2
CORRECTED TEMPERATURE	79.0				75.0	76.2	75.8	75.0	73.8	73.7	72.2	71.0	70.0	69.7	68.6	66.3	65.5	63.4	61.0	59.1	57.4																								35.5 34.8
TEMPERATURE FROM CURVE	79.0	78.5	78.0	77.5	77.0	76.4	75.8	74.9	74.0	73.1	72.2	71.2	70.2	69.2	68.3	66.4	64.8	63.0	61.2	59.5	57.4																								35.1



SECTION. HONORURU TO TAHITI.

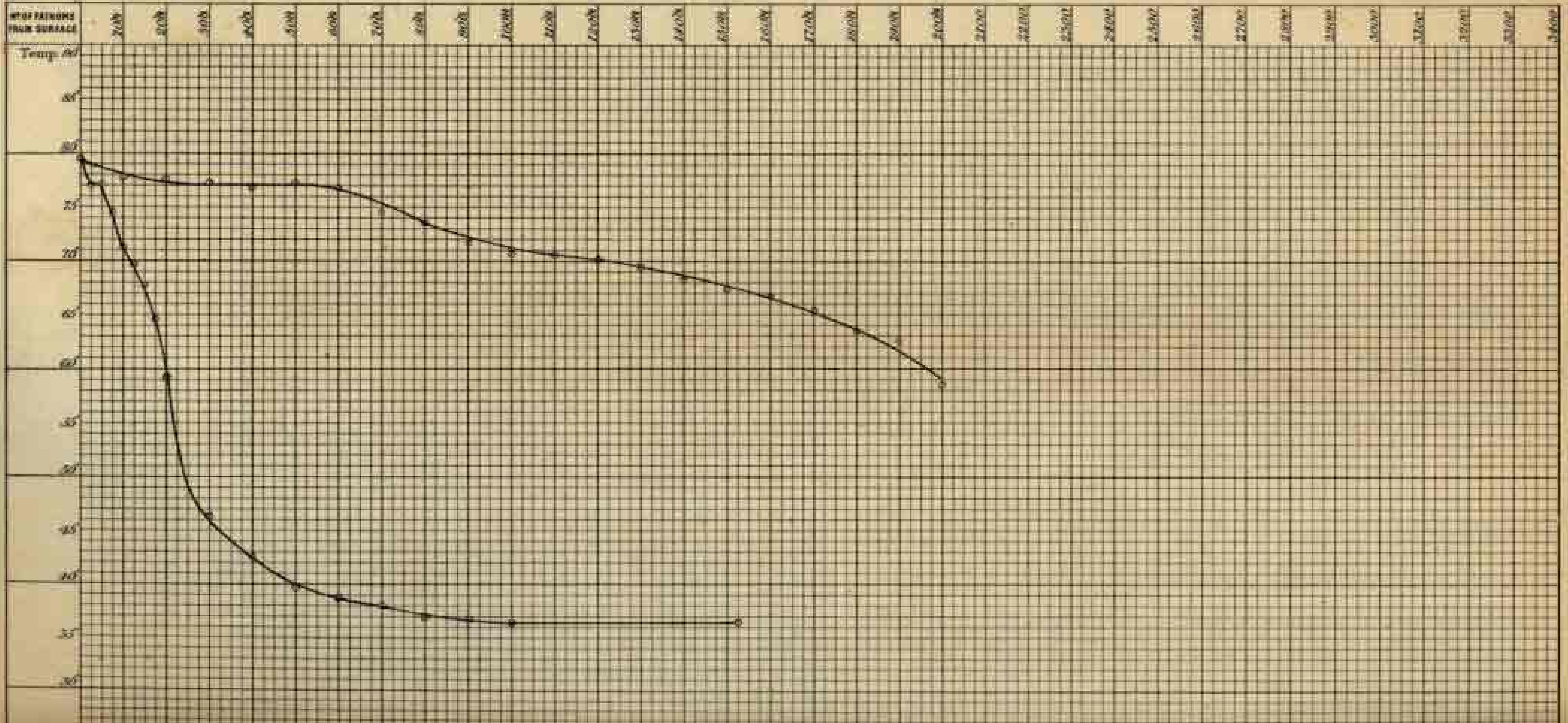
18 September 1875.

Nº of Sounding 420.
Station 278.

Depth 1525 fathoms.

Latitude 17° 12′ S.
Longitude 149° 43′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		74	88	89	216	72	77	94	83	75	896	896	71	83	94	77	72	216	89	88	74				71	77	94	72	896	216	83	89													83 87
TEMPERATURE SHEWN BY THERMOMETER	79.5	77.8	77.2	77.0	77.0	77.0	76.6	74.6	73.0	71.6	70.8	70.5	69.8	69.0	68.2	67.2	66.0	65.5	63.4	62.0	58.6				46.0	42.5	39.8	38.5	38.0	37.2	36.4	36.1													36.0 37.0
ERROR OF THERMOMETER	0.0	0.0	+0.5	+0.2	−0.2	+0.2	+0.2	−0.1	+0.5	+0.2	0.0	0.0	+0.2	+0.5	−0.1	+0.2	+0.2	−0.2	+0.2	+0.5	0.0				+0.2	+0.2	−0.1	+0.2	0.0	−0.2	+0.5	+0.3													−0.2 +0.1
CORRECTED TEMPERATURE	79.5	77.8	77.7	77.2	76.8	77.2	76.8	74.5	73.5	71.8	70.8	70.5	70.0	69.5	68.1	67.4	66.2	65.3	63.6	62.5	58.6				46.2	42.7	39.7	38.7	38.0	37.0	36.9	36.4													35.8 37.1
TEMPERATURE FROM CURVE	79.5	78.0	77.3	77.0	77.0	77.0	76.4	75.2	73.5	72.0	71.2	70.5	70.0	69.5	68.5	67.7	66.7	65.3	63.8	61.8	59.2				46.2	42.6	40.0	38.7	37.7	37.1	36.8	36.5													36.5



2 October 1875.

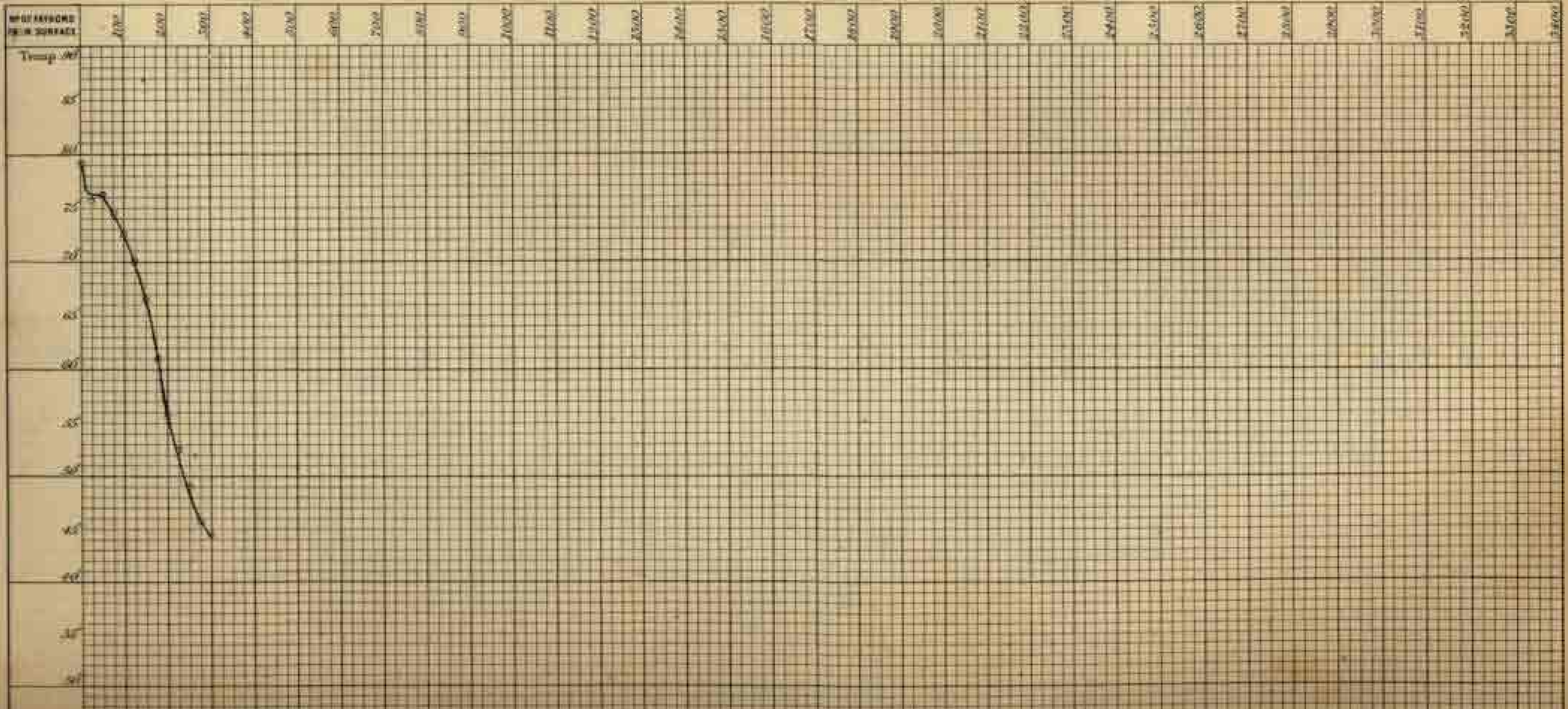
N.° of Sounding 424.
Station. 279 c.

Depth 675 *fathoms.*

Latitude 17° 29' 11" S.
Longitude 149° 34' 32" W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300
Nº OF THERMOMETER			93			77		94			72		75			74		88			87	116	85	89	91
TEMPERATURE SHEWN BY THERMOMETER	79.0		76.0			76.0		74.5			74.2		69.8			66.5		60.5			55.1	52.5	48.5	45.5	44.5
ERROR OF THERMOMETER	0.0		-0.2			+0.2		-0.1			+0.2		+0.2			0.0		+0.3			+0.2	-0.2	+0.5	+0.2	-0.2
CORRECTED TEMPERATURE	79.0		75.8			76.2		74.4			74.4		70.0			66.5		60.8			55.3	52.3	49.0	45.7	44.3
TEMPERATURE FROM CURVE	79.0		76.2			75.8		74.4			74.4		69.8			66.3		61.0			55.3	51.8	48.8	46.0	44.3

Nº OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																				
TEMPERATURE SHEWN BY THERMOMETER																				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE																				



SECTION. FROM TAHITI TO A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W.

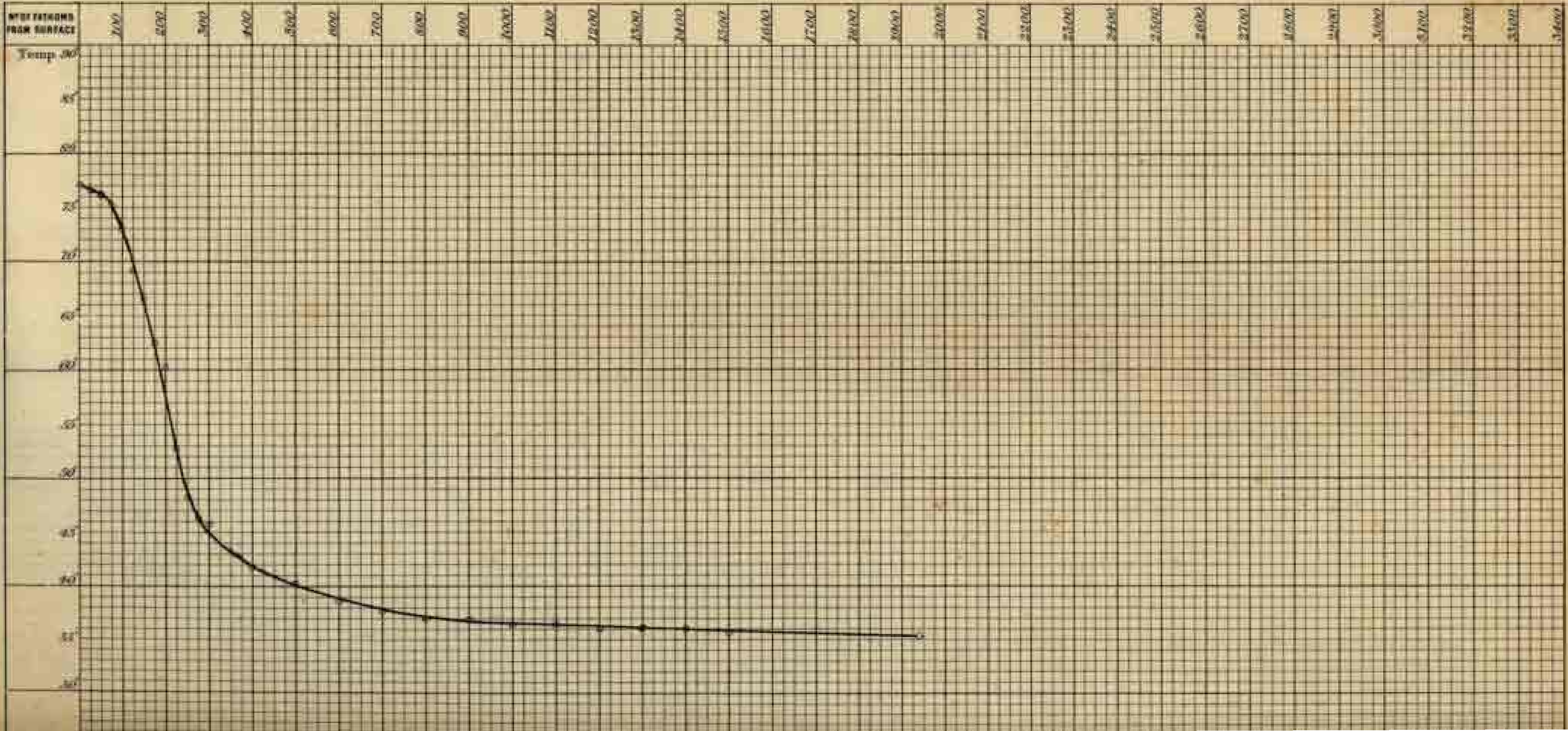
4 October 1875.

N° of Sounding 425.
Station 280.

Depth 1940 fathoms.

Latitude 18° 40′ S.
Longitude 149° 52′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			77			74		216			218		94			75		89			94	72	85	87	75	89	72	85	87	216	94	73	89	98	72	85	87								73 87
TEMPERATURE SHEWN BY THERMOMETER	77.2		76.5			76.2		75.2			73.2		69.2			66.2		60.5			60.2	52.6	47.6	46.0	45.6	41.5	40.0	38.2	37.6	37.2	37.0	36.1	36.1	36.0	35.8	35.3	35.5								35.3 36.5
ERROR OF THERMOMETER	0.0		+0.2			0.0		-0.2			-0.2		-0.1			+0.2		+0.2			-0.1	+0.2	+0.5	+0.1	+0.2	+0.2	+0.2	+0.5	+0.1	-0.2	-0.1	+0.2	+0.2	0.0	+0.2	+0.5	+0.1								-0.2 +0.1
CORRECTED TEMPERATURE	77.2		76.7			76.2		75.0			73.0		69.1			66.4		60.7			60.1	52.8	48.1	46.1	45.8	41.7	40.2	38.7	37.7	37.0	36.9	36.3	36.3	36.0	36.0	36.0	35.6								35.1 36.6
TEMPERATURE FROM CURVE	77.2		76.9			76.2		75.0			73.0		70.0			66.4		60.5			58.0	52.8	48.1	46.1	44.9	41.7	40.2	38.8	37.9	37.2	36.8	36.4	36.2	36.1	36.0	35.9	35.8								35.3



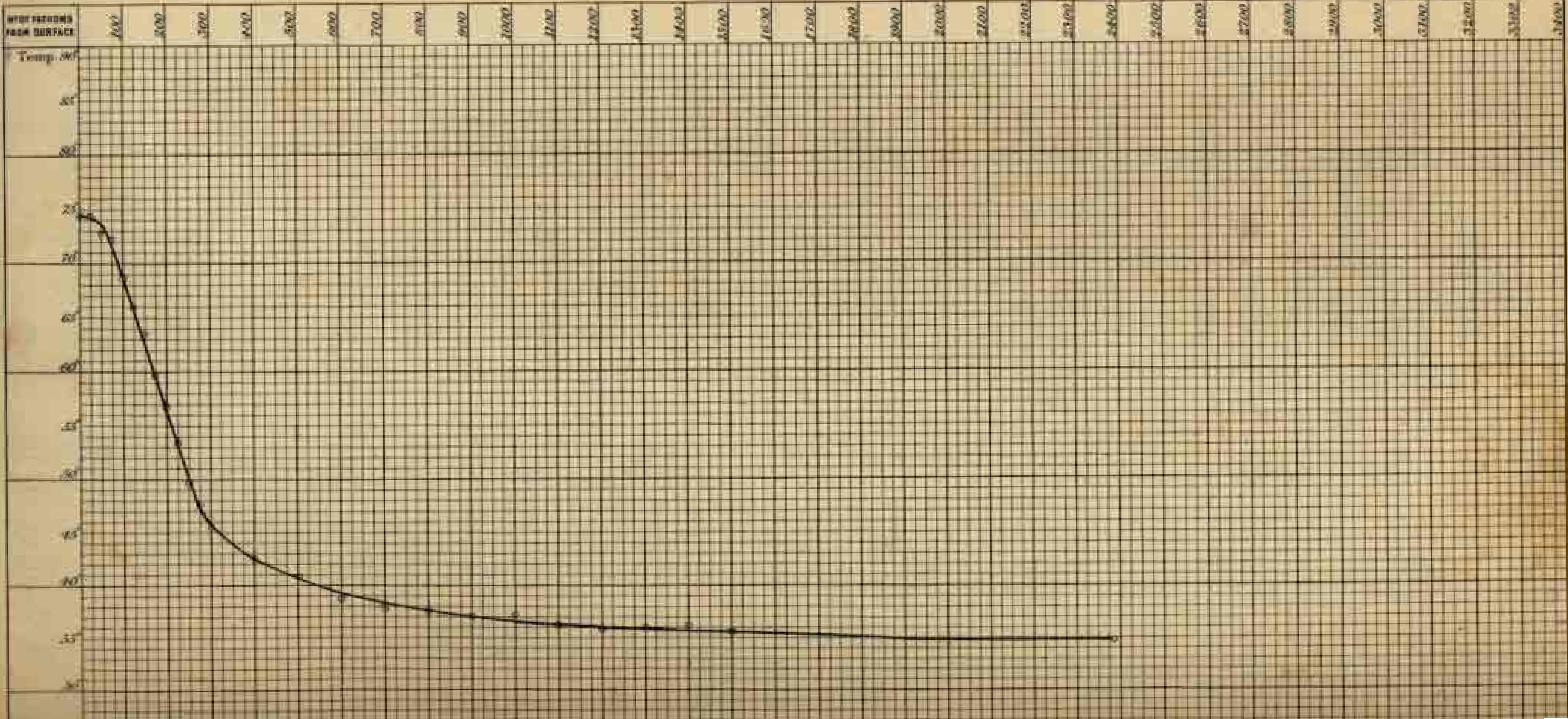
6 October 1875.

N° of Sounding 426.
Station 281.

Depth 2385 fathoms.

Latitude 33° 21′ S.
Longitude 150° 17′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			93			89		77			94		216			75		89			72	85	94	75	216	87	85	89	94	77	75	72	296	216	87	85	89								87 93
TEMPERATURE SHEWN BY THERMOMETER	74.5		74.6			72.6		71.0			69.0		66.2			63.2		59.5			56.7	53.0	50.0	47.2	45.8	42.2	40.3	38.5	38.0	37.2	36.8	37.0	36.2	36.0	36.0	35.6	35.5								35.2 34.7
ERROR OF THERMOMETER	0.0		−0.4			+0.2		+0.2			−0.3		−0.2			+0.2		+0.2			+0.2	+0.5	−0.1	+0.2	−0.2	+0.1	+0.5	+0.2	−0.1	+0.2	+0.2	+0.2	0.0	−0.2	+0.1	+0.5	+0.2								+0.1 −0.2
CORRECTED TEMPERATURE	74.5		74.1			72.8		71.2			68.9		66.0			63.4		59.7			56.9	53.5	49.9	47.4	45.6	42.3	40.8	38.7	37.9	37.4	37.0	37.2	36.2	35.8	36.1	36.1	35.7								35.3 34.5
TEMPERATURE FROM CURVE	74.5		74.1			73.2		72.1			68.9		65.7			60.5		59.3			56.2	53.1	50.0	47.4	45.6	42.3	40.5	39.3	38.4	37.5	37.0	36.5	36.2	36.0	35.8	35.6	35.5								34.9



SECTION. FROM TAHITI TO A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W.

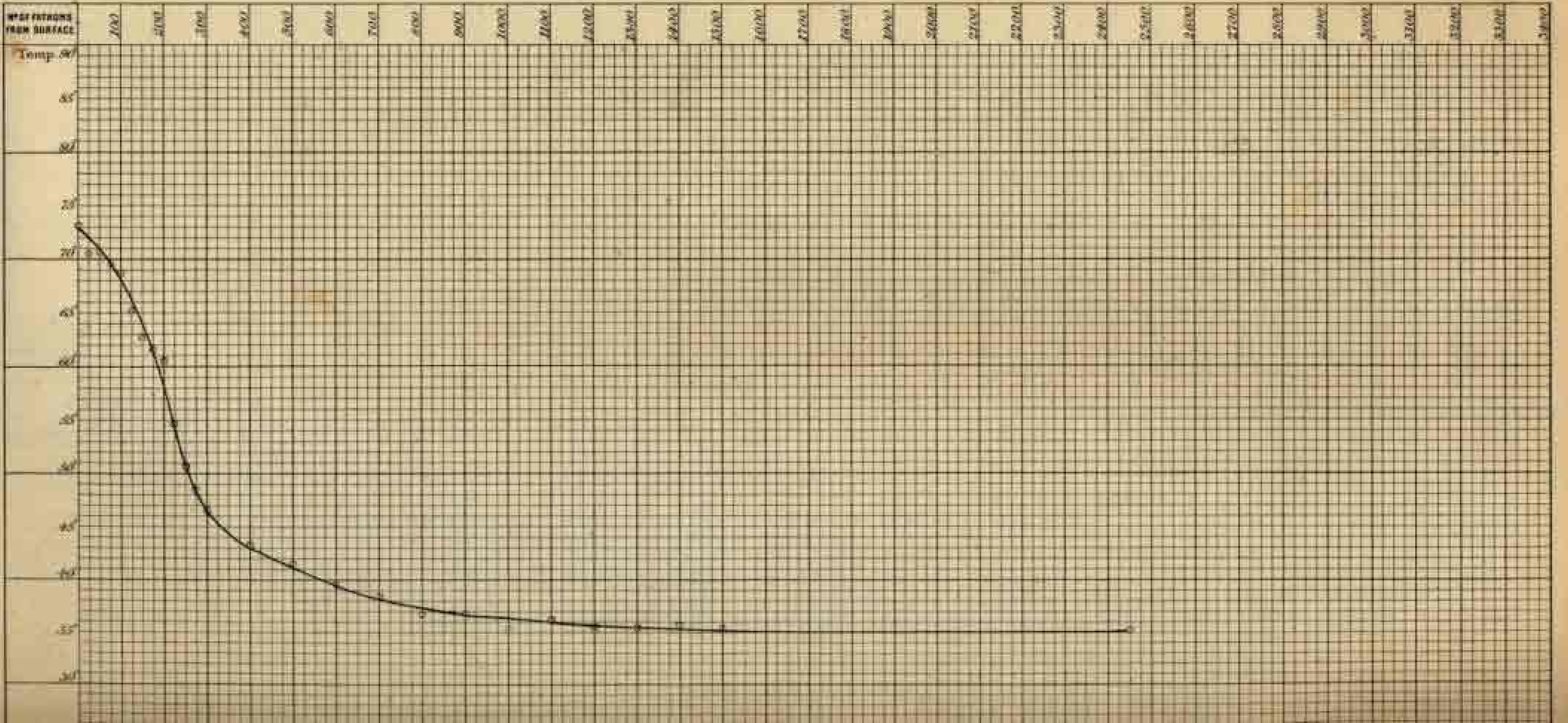
7 October 1875.

Nº of Sounding 427.
Station 282.

Depth 2450 fathoms.

Latitude 23° 46′ S.
Longitude 149° 59′ W.

Nº OF FATHOMS FROM SURFACE	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			74			216		83			93		94			216		89			72	93	216	83	72	73	74	89	88	87	216	93	77	85	88	72	94								84 74
TEMPERATURE SHEWN BY THERMOMETER	73.2		70.5			71.0		69.2			69.0		65.2			63.0		61.2			60.2	55.0	51.0	48.5	46.0	43.0	41.5	39.4	37.8	36.8	37.0	35.5	36.0	35.2	35.2	35.6	35.4								34.9 35.4
ERROR OF THERMOMETER	0.0		0.0			-0.2		+0.5			-0.2		-0.1			-0.2		+0.1			+0.2	-0.2	-0.2	+0.1	+0.2	+0.2	0.0	+0.2	+0.5	+0.1	-0.2	-0.2	+0.2	+0.5	+0.5	+0.2	-0.1								0.0 0.0
CORRECTED TEMPERATURE	73.2		70.5			70.8		69.7			68.8		65.1			62.8		61.3			60.4	54.8	50.8	48.6	46.2	43.2	41.5	39.6	38.3	36.9	36.8	35.3	36.2	35.7	35.7	35.8	35.3								34.9 35.4
TEMPERATURE FROM CURVE	73.2		72.0			71.0		69.8			68.1		66.5			64.3		61.5			58.5	54.7	50.8	48.5	46.2	43.0	41.2	39.6	38.3	37.1	36.7	36.3	36.0	35.8	35.6	35.4	35.2								35.2



SECTION. FROM TAHITI TO A POSITION IN { Lat. 40° 3' S. Long. 132° 58' W.

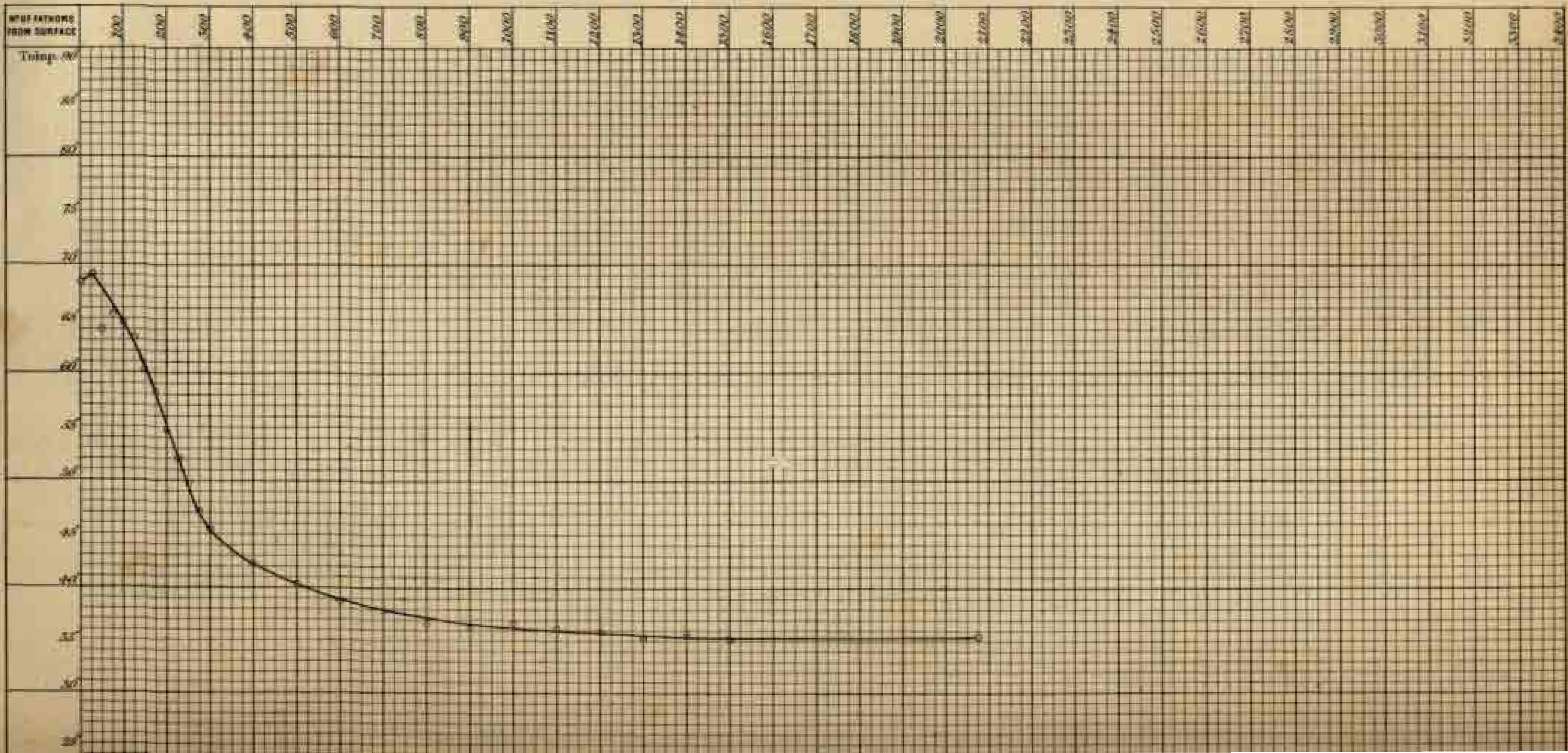
9 October 1875.

No. of Sounding 428.
Station 283.

Depth 2075 fathoms.

Latitude 26° 9' S.
Longitude 145° 17' W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer			72			A96		88			94		72			A96		89			69	A16	77	88	94	89	87	A16	88	89	87	A16	77	88	94	85	75								74 93
Temperature shewn by Thermometer	68.5		69.0			64.0		65.0			65.0		63.0			60.0		57.8			54.8	52.0	49.5	46.5	45.5	42.0	40.2	39.0	37.2	36.5	36.0	37.0	36.2	35.5	35.5	35.0	35.0								35.6 35.3
Error of Thermometer	0.0		+0.2			0.0		+0.5			-0.1		+0.2			0.0		+0.2			+0.1	-0.2	+0.2	+0.5	-0.1	+0.2	+0.1	-0.2	+0.5	+0.2	+0.1	-0.2	+0.2	+0.5	-0.1	+0.5	+0.2								0.0 +0.2
Corrected Temperature	68.5		69.2			64.0		65.5			64.9		63.2			60.0		58.0			54.9	51.8	49.7	47.0	45.4	42.2	40.3	38.8	37.7	36.7	36.1	36.8	36.4	36.0	35.4	35.5	35.2								35.6 35.3
Temperature from Curve	68.5		69.2			68.0		66.5			64.6		62.8			60.3		57.5			54.8	52.0	49.2	46.8	45.4	42.2	40.3	39.0	38.0	37.3	36.7	36.3	36.0	35.8	35.6	35.4	35.4								35.4



SECTION. FROM TAHITI TO A POSITION IN { *Lat. 40° 3′ S.* / *Long. 132° 58′ W.*

11 October 1875.

N.º of Sounding 429.
Station 284.

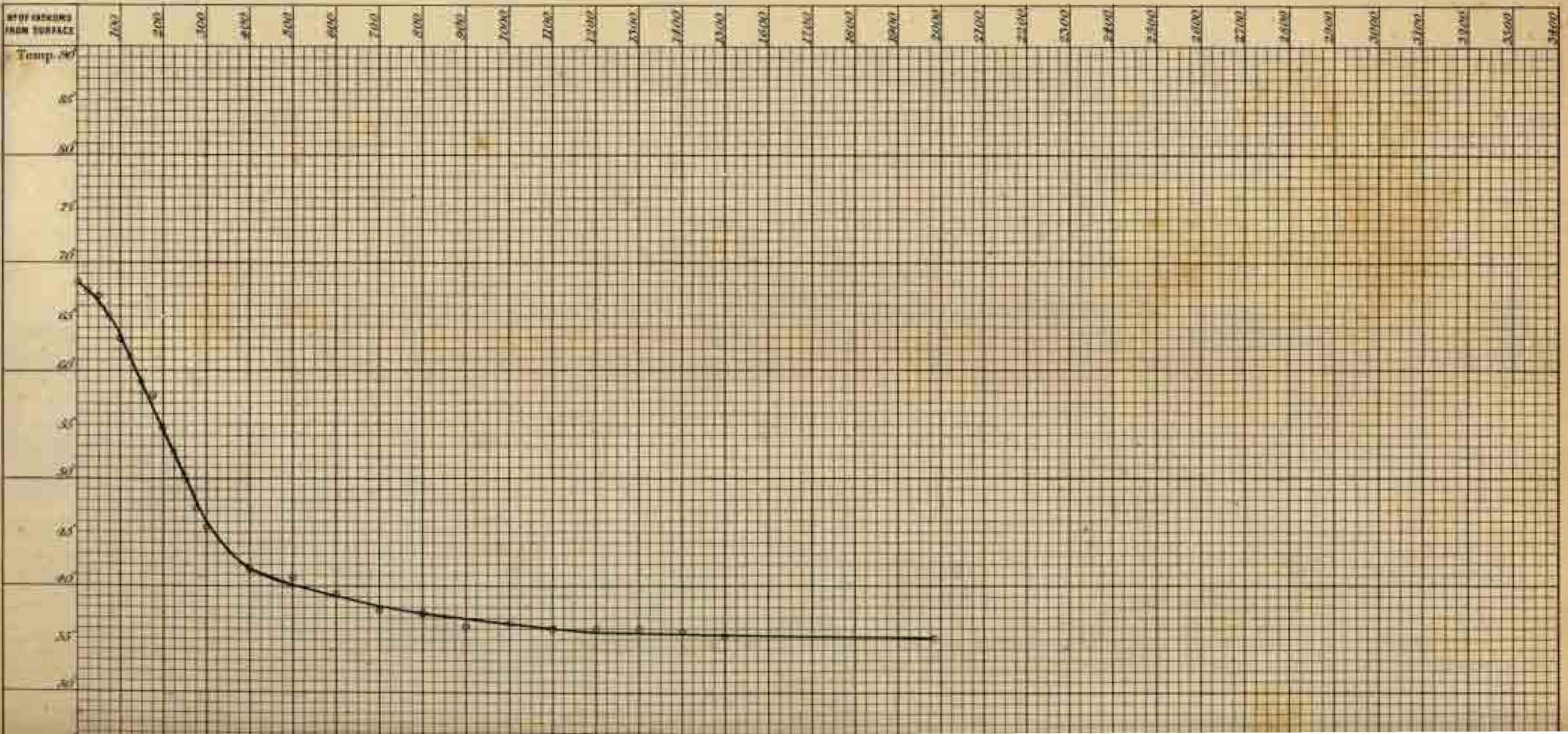
Depth 1985 fathoms.

Latitude 28° 22′ S.
Longitude 141° 22′ W.

Nº of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150
Nº of thermometer			77			89		216			696		75			696
Temperature shewn by thermometer	68.0		67.2			66.6		65.2			63.0		61.0			59.0
Error of thermometer	0.0		+0.2			+0.4		−0.2			0.0		+0.2			0.0
Corrected temperature	68.0		67.4			67.0		65.0			63.0		61.2			59.0
Temperature from curve	68.0		67.4			66.6		65.0			63.2		61.6			59.0

Nº of fathoms from surface	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900
Nº of thermometer		216			89	77	74	87	75	696	89	77	75	93	696
Temperature shewn by thermometer		58.0			54.5	52.2	50.2	47.2	45.2	41.6	40.5	39.0	37.5	37.6	36.2
Error of thermometer		−0.2			+0.2	+0.2	0.0	+0.1	+0.2	0.0	+0.2	+0.2	+0.2	−0.2	0.0
Corrected temperature		57.8			54.7	52.4	50.2	47.3	45.4	41.6	40.7	39.2	37.7	37.4	36.2
Temperature from curve		56.8			54.6	52.5	50.2	48.1	45.8	41.6	40.0	39.0	38.1	37.4	36.9

Nº of fathoms from surface	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer	216	89	77	74	87	75								74 93
Temperature shewn by thermometer	36.5	35.8	35.8	36.0	35.5	35.2								35.1 35.3
Error of thermometer	−0.2	+0.2	+0.2	0.0	+0.1	+0.2								0.0 −0.2
Corrected temperature	36.3	36.0	36.0	36.0	35.6	35.4								35.1 35.1
Temperature from curve	36.4	36.0	35.8	35.7	35.6	35.4								35.1



SECTION: FROM TAHITI TO A POSITION IN Lat. 40° 3' S. Long. 132° 58' W.

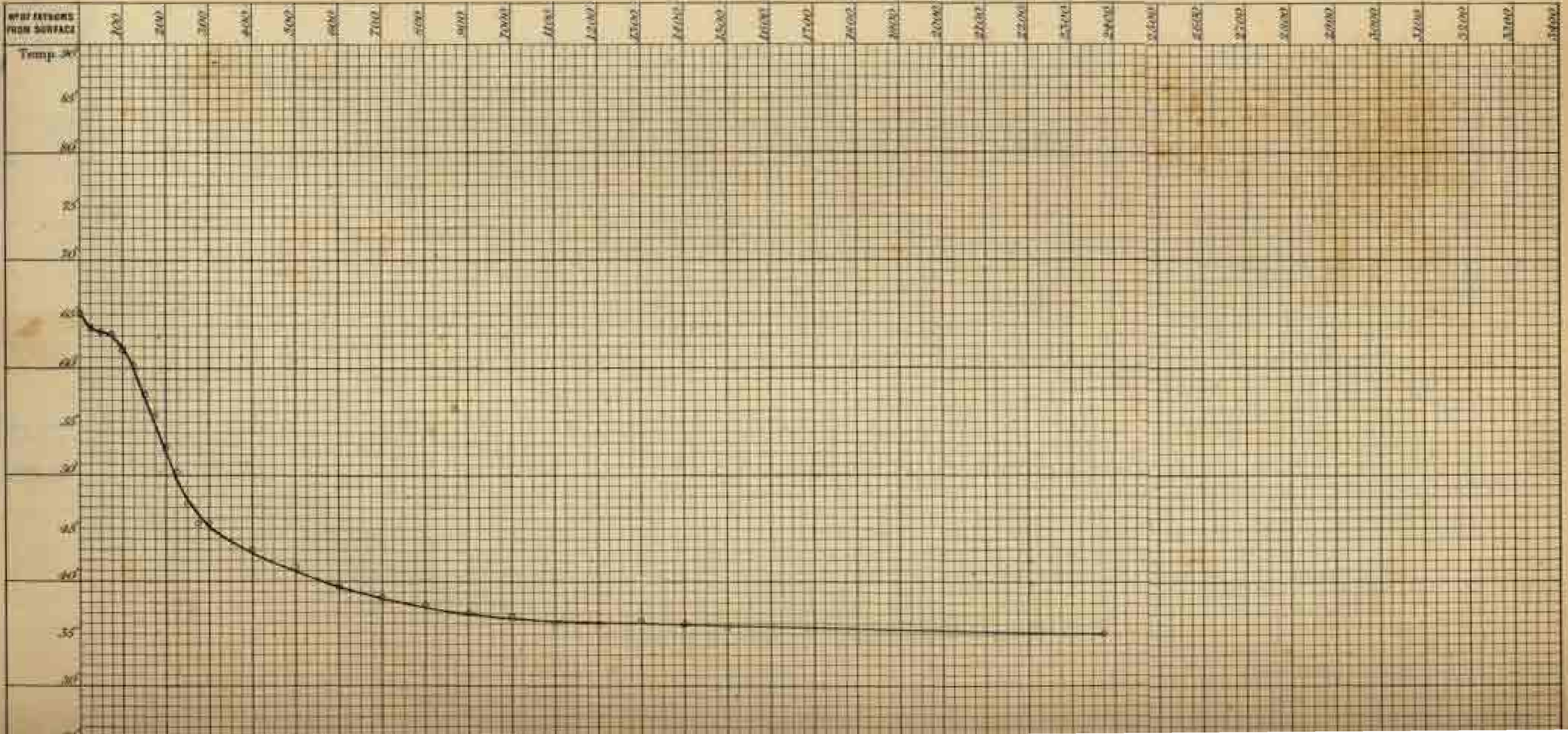
14 October 1875.

Nº of Sounding 430.
Station 285.

Depth 2375 fathoms.

Latitude 32° 36' S.
Longitude 137° 43' W.

Nº of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of thermometer			72			75		88			93		77			216		94			85	87	89	296	77	216	94	85	82	89	296	77	216	94	85	82	89								87 93
Temperature shewn by thermometer	65.0		63.5			63.2		62.5			62.0		60.0			57.8		55.5			52.2	50.0	47.0	45.5	45.2	43.2	41.5	39.0	38.3	37.6	37.1	36.5	36.2	36.0	35.8	35.8	35.5								35.0 35.0
Error of thermometer	0.0		+0.2			+0.2		+0.5			−0.2		+0.2			−0.4		−0.1			+0.5	+0.1	+0.2	0.0	+0.2	−0.2	+0.1	+0.3	+0.1	+0.2	0.0	+0.2	−0.2	−0.1	+0.5	+0.1	+0.2								+0.1 −0.2
Corrected temperature	65.0		63.7			63.4		63.0			61.8		60.2			57.4		55.4			52.7	50.1	47.2	45.5	45.4	43.0	41.6	39.3	38.4	37.8	37.1	36.7	36.0	35.9	36.3	35.9	35.7								35.1 34.8
Temperature from curve	65.0		63.8			63.4		63.0			61.8		60.0			57.3		55.0			52.3	49.8	46.8	44.6	43.9	42.8	41.0	39.2	38.4	37.7	37.0	36.8	36.3	36.1	35.9	35.8	35.7								35.0



SECTION. FROM TAHITI TO A POSITION IN Lat. 40° 3′ S. Long. 132° 58′ W.

18 October 1875.

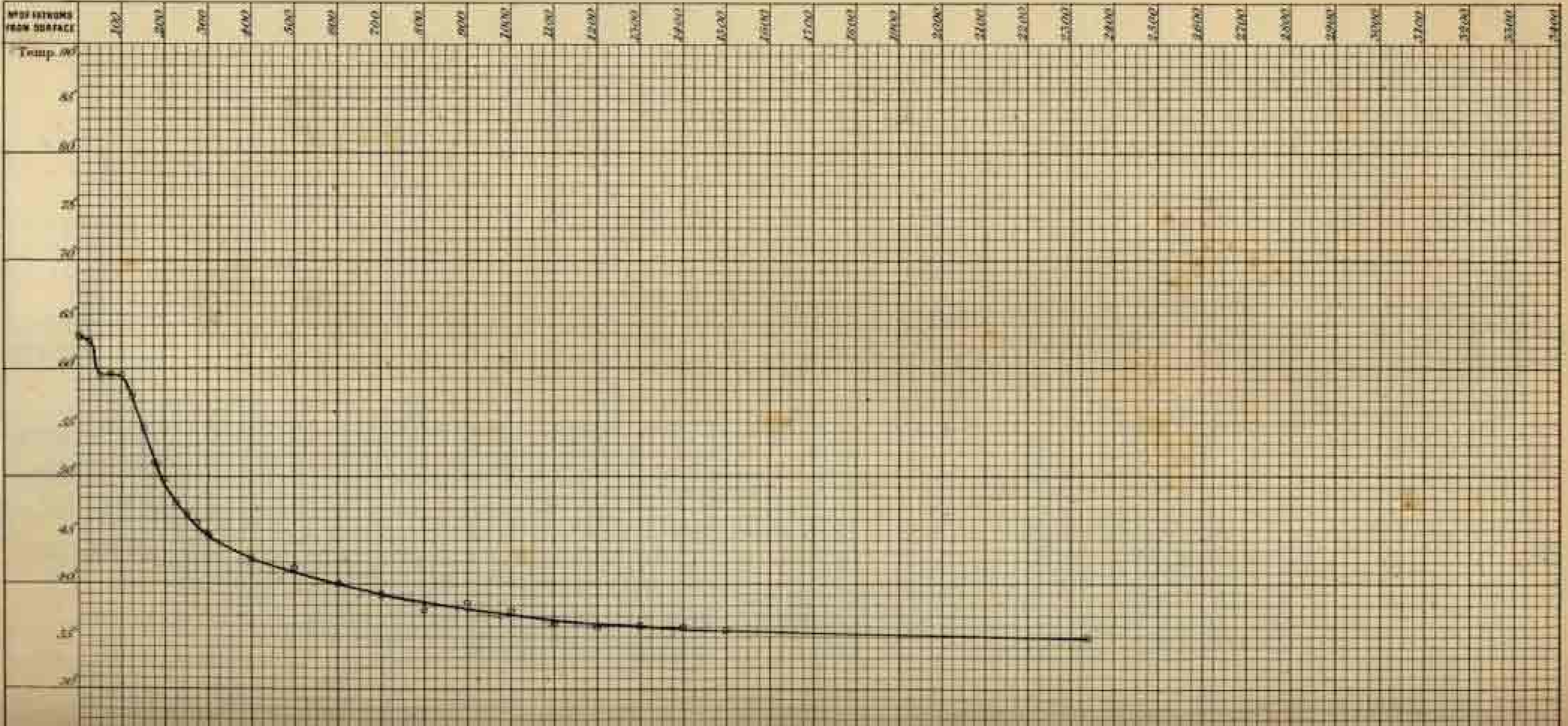
N° of Sounding 431.
Station 286.

Depth 2385 fathoms

Latitude 33° 29′ S.
Longitude 133° 22′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200
Nº OF THERMOMETER			93			94		75			79		216			77		85			85
TEMPERATURE SHEWN BY THERMOMETER	63.0		62.8			59.5		59.0			59.1		57.5			54.2		51.0			49.2
ERROR OF THERMOMETER	0.0		-0.2			-0.1		+0.4			+0.3		-0.2			+0.2		+0.2			+0.5
CORRECTED TEMPERATURE	63.0		62.6			59.4		59.4			59.4		57.3			54.4		51.2			49.7
TEMPERATURE FROM CURVE	63.0		62.6			59.4		59.4			59.4		57.3			54.3		51.3			49.0

Nº OF FATHOMS FROM SURFACE	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	87	73	79	216	77	94	89	84	87	74	296	94	73	77	85	74								87 93
TEMPERATURE SHEWN BY THERMOMETER	47.5	46.2	45.5	44.8	42.2	41.5	39.8	38.5	37.5	38.2	37.6	36.2	35.8	35.8	35.5	35.6								34.9 34.9
ERROR OF THERMOMETER	+0.1	+0.2	+0.2	-0.2	+0.2	-0.1	+0.1	+0.5	+0.3	0.0	0.0	-0.1	+0.2	+0.2	+0.5	+0.2								+0.1 -0.2
CORRECTED TEMPERATURE	47.6	46.4	45.7	44.6	42.4	41.4	39.9	39.0	37.8	38.2	37.6	36.1	36.0	36.0	36.0	35.8								35.0 34.7
TEMPERATURE FROM CURVE	47.5	46.2	45.3	44.5	42.4	41.0	40.0	39.0	38.2	37.7	37.1	36.5	36.2	36.0	35.9	35.8								34.8



SECTION. FROM A POSITION IN { Lat. 40° 3' S. Long. 132° 58' W. } TOWARDS MOCHA ISLAND.

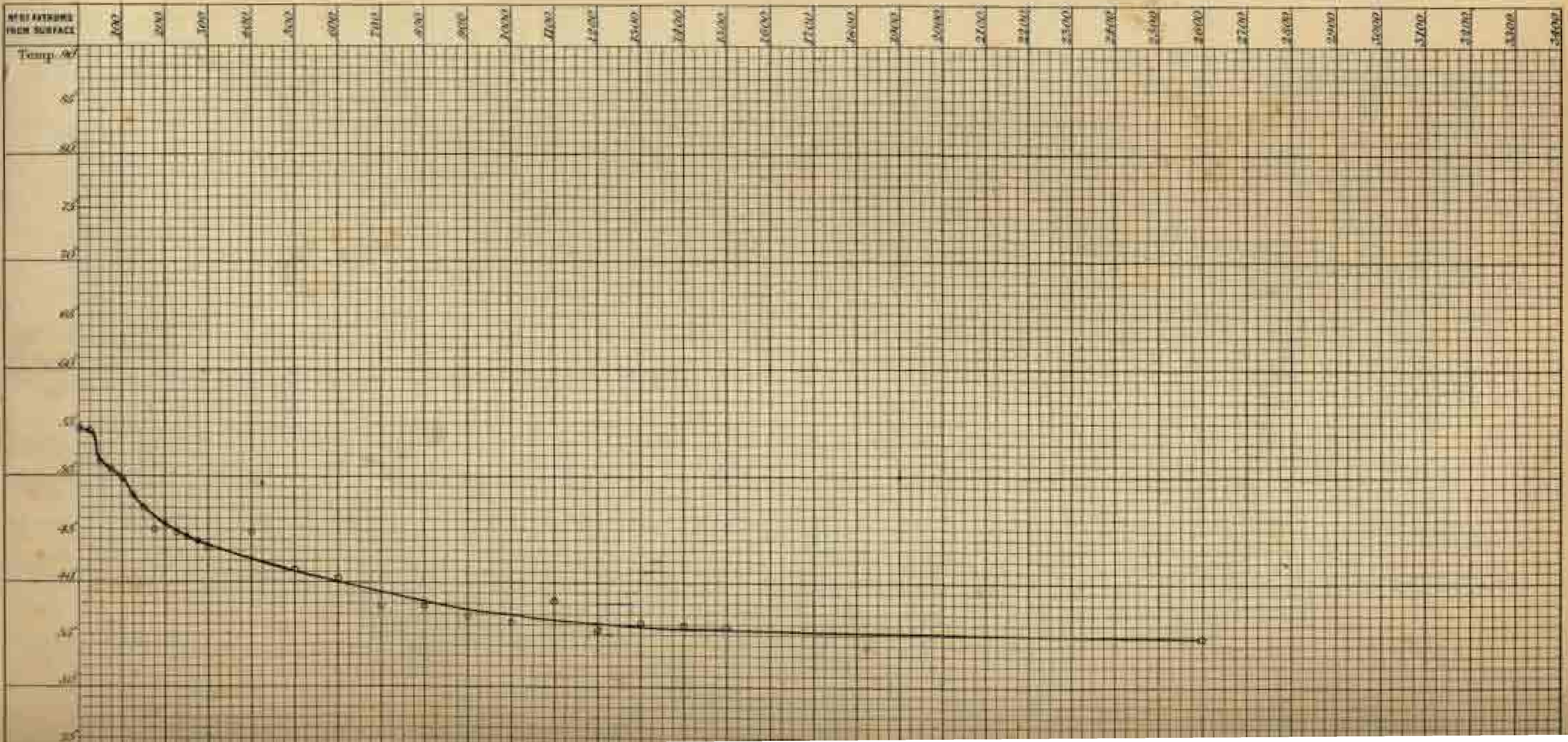
21 October 1875.

Nº of Sounding 433.
Station 288.

Depth 2600 fathoms.

Latitude 40° 3' S.
Longitude 132° 58' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			74			94		75			416		94			88		396			74	94	85	88	396	396	88	85	94	74	75	416	89	93	77	75	89								93 89
TEMPERATURE SHOWN BY THERMOMETER	54.5		54.0			53.2		50.4			50.0		48.4			46.5		45.0			45.2	44.8	43.6	43.4	43.2	41.8	40.5	39.8	38.0	37.8	36.8	36.4	36.0	35.8	36.0	35.8	35.8								35.0 34.6
ERROR OF THERMOMETER	0.0		0.0			−0.1		+0.2			−0.2		−0.1			+0.5		0.0			0.0	−0.1	+0.5	+0.5	0.0	0.0	+0.5	+0.5	−0.1	0.0	+0.2	−0.2	+0.2	−0.2	+0.2	+0.2	+0.1								−0.2 +0.2
CORRECTED TEMPERATURE	54.5		54.0			53.1		50.6			49.8		48.3			47.0		45.0			45.2	44.7	44.1	43.9	43.2	41.8	41.0	40.3	37.9	37.8	36.8	36.2	36.2	35.6	36.2	36.0	35.9								34.8 34.8
TEMPERATURE FROM CURVE	54.5		54.0			53.1		50.6			49.8		48.3			47.1		46.1			45.2	44.7	44.2	43.8	43.1	41.9	41.0	40.0	39.0	38.2	37.5	36.9	36.5	36.1	35.9	35.7	35.5								34.8



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

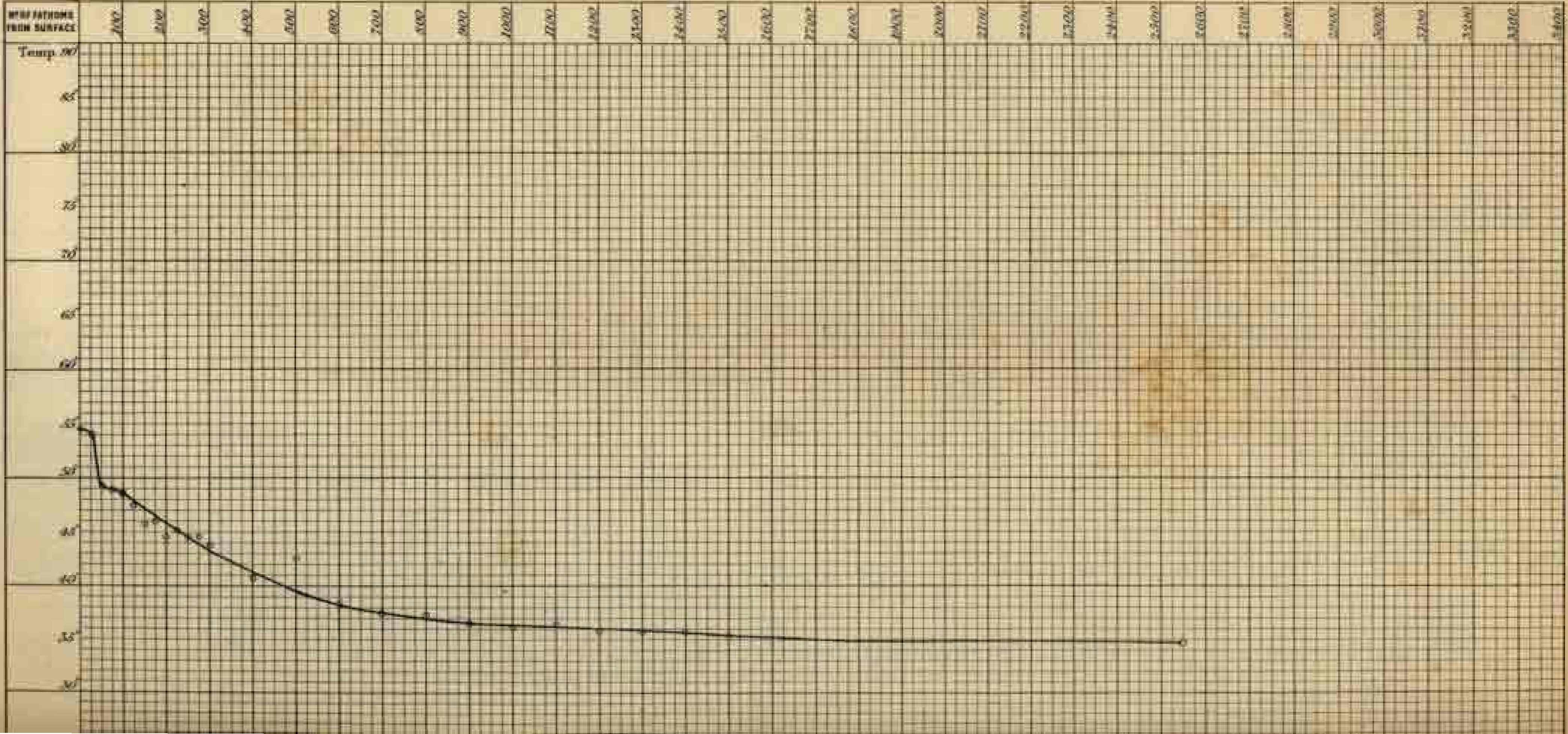
23 October 1875.

N.º of Sounding 434.
Station 289.

Depth 2550 fathoms.

Latitude 39° 41′ S.
Longitude 131° 23′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			89			94		87			116		75			93		74			106	77	88	72	71	92	77	85	94	89	87	73	116	87	94	89	85								87 93
TEMPERATURE SHEWN BY THERMOMETER	54.5		53.8			49.2		48.8			48.5		47.3			46.0		46.0			44.5	44.8	44.0	44.0	43.6	41.0	42.0	37.8	37.8	37.2	36.5	36.0	36.2	35.8	35.8	35.6	35.0								35.0 34.8
ERROR OF THERMOMETER	0.0		+0.2			−0.1		+0.1			−0.2		+0.1			−0.2		0.0			0.0	+0.2	+0.5	+0.4	+0.2	−0.2	+0.2	+0.5	−0.2	+0.2	+0.1	+0.2	−0.2	+0.1	−0.1	+0.2	+0.3								+0.1 −0.2
CORRECTED TEMPERATURE	54.5		54.0			49.1		48.9			48.3		47.4			45.8		46.0			44.5	45.0	44.5	44.4	43.8	40.8	42.2	38.3	37.6	37.4	36.6	36.2	36.0	35.9	35.7	35.8	35.3								35.1 34.6
TEMPERATURE FROM CURVE	54.5		54.0			49.2		48.9			48.3		47.3			46.9		46.2			45.6	45.0	44.4	43.8	43.2	41.2	39.2	38.2	37.5	37.0	36.7	36.4	36.2	36.0	35.8	35.6	35.5								34.8



SECTION. FROM A POSITION IN { Lat. 40° 3' S. Long. 132° 58' W. } TOWARDS MOCHA ISLAND.

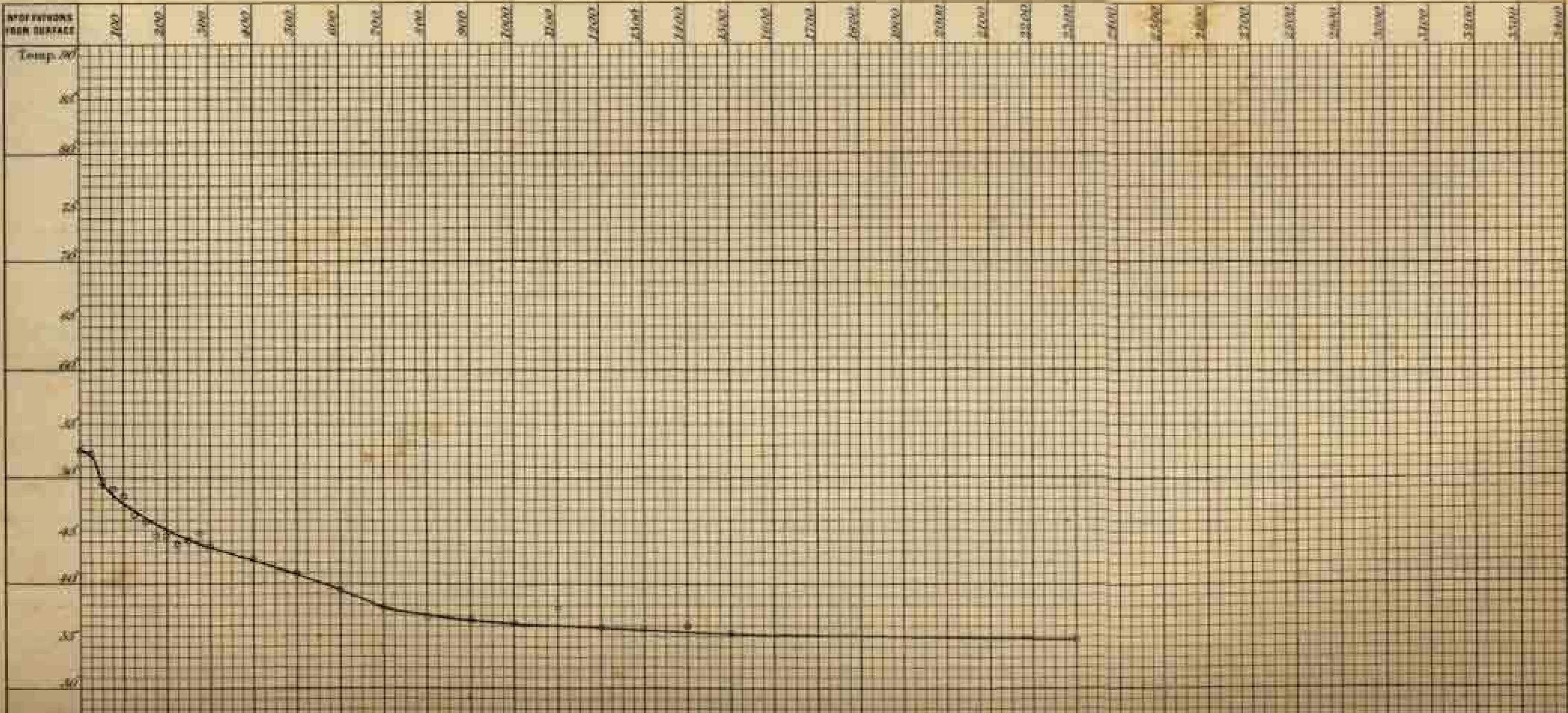
25 October 1875.

N.º of Sounding 435.
Station 290.

Depth 2300 fathoms.

Latitude 39° 16' S.
Longitude 124° 7' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			94			216		85			72		75			77		74			89	94	88	72	73	77	74	72	88	216	85	84	89	94	85	72									87 93
TEMPERATURE SHEWN BY THERMOMETER	52.5		52.2			49.8		48.5			48.0		46.2			45.5		44.8			44.4	43.8	43.5	44.5	43.2	42.0	41.0	39.2	37.2	36.8	36.0	36.0	37.5	36.0	35.9	35.8	35.2								34.8 35.2
ERROR OF THERMOMETER	0.0		-0.1			-0.2		+0.5			+0.2		+0.2			+0.2		0.0			+0.2	-0.1	+0.5	+0.2	+0.2	+0.2	0.0	+0.2	+0.5	-0.2	+0.5	+0.2	+0.2	-0.1	+0.2	+0.2									+0.2 -0.2
CORRECTED TEMPERATURE	52.5		52.1			49.6		49.0			48.2		46.4			45.7		44.8			44.6	43.7	44.0	44.7	43.4	42.2	41.0	39.4	37.7	36.6	36.5	36.2	37.7	35.9	35.7	36.0									35.0 35.0
TEMPERATURE FROM CURVE	52.5		52.0			49.8		48.8			47.6		46.7			46.0		45.3			44.9	44.5	44.1	43.7	43.4	42.0	40.7	39.4	37.8	36.9	36.4	36.2	36.0	35.8	35.6	35.3	35.1									34.9



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

27 October 1875.

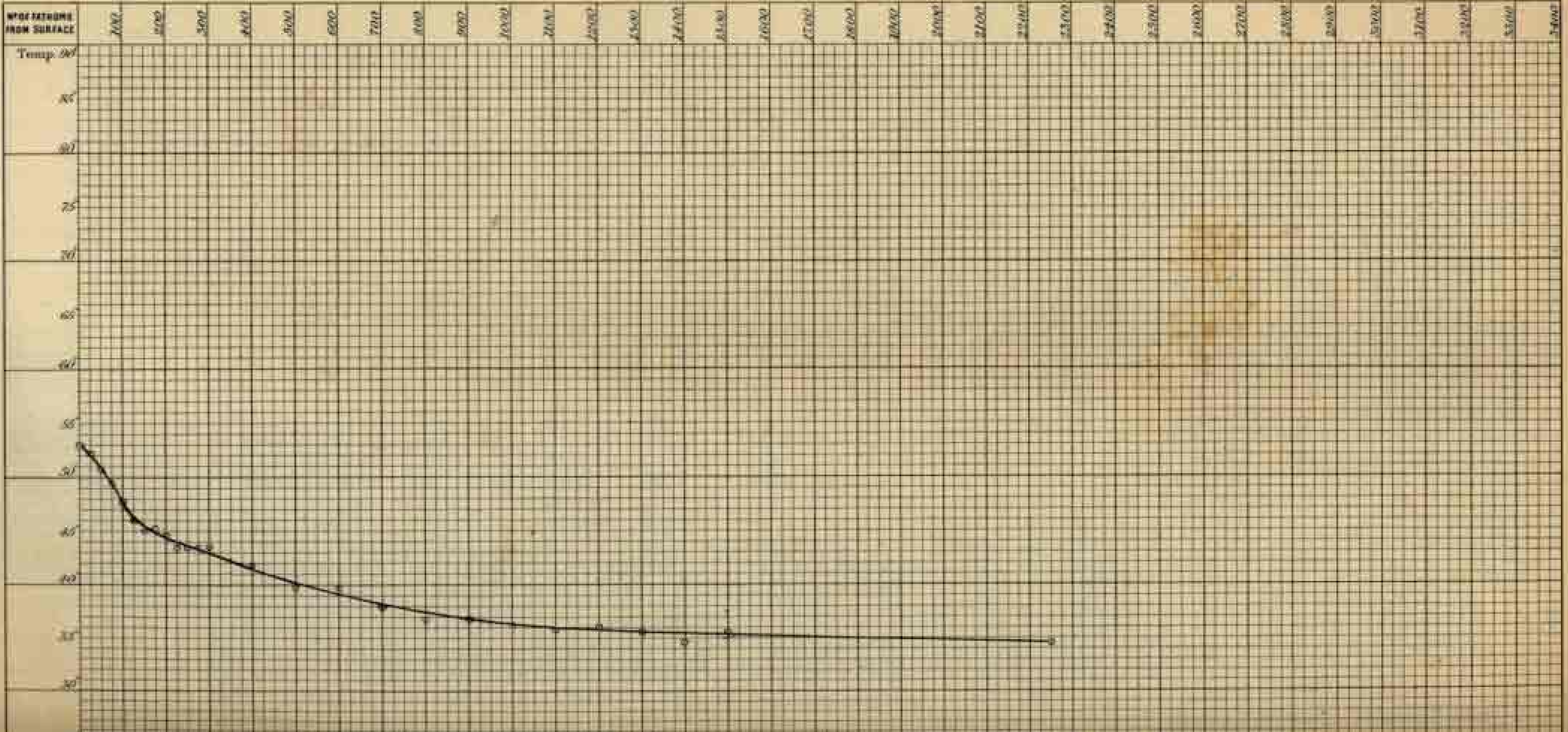
No. of Sounding 436.
Station 291.

Depth 2250 fathoms.

Latitude 39° 13′ S.
Longitude 118° 49′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250
No. OF THERMOMETER			87			496		88			77		75			73		72			88	496	87
TEMPERATURE SHEWN BY THERMOMETER	53.0		52.0			50.8		49.0			47.5		45.8			44.8		45.0			44.0	43.5	43.2
ERROR OF THERMOMETER	0.0		+0.1			0.0		+0.5			+0.2		+0.2			+0.2		+0.2			+0.5	0.0	+0.1
CORRECTED TEMPERATURE	53.0		52.1			50.8		49.5			47.7		46.0			45.0		45.2			44.5	43.5	43.3
TEMPERATURE FROM CURVE	53.0		52.1			50.8		49.5			47.7		46.1			45.4		44.9			44.4	44.0	43.8

No. OF FATHOMS FROM SURFACE	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	85	89	94	83	87	496	88	77	75	94	416	87	83	89								73 87
TEMPERATURE SHEWN BY THERMOMETER	42.8	43.1	41.8	39.4	39.6	38.0	36.2	36.6	36.0	36.0	36.2	35.5	34.2	35.4								34.9 35.0
ERROR OF THERMOMETER	+0.5	+0.2	−0.1	+0.3	+0.1	0.0	+0.5	+0.2	+0.2	−0.1	−0.2	+0.1	+0.5	+0.2								−0.9 +0.1
CORRECTED TEMPERATURE	43.3	43.3	41.7	39.7	39.7	38.0	36.7	36.8	36.2	35.9	36.0	35.6	34.7	35.6								34.0 35.1
TEMPERATURE FROM CURVE	43.3	42.9	41.4	40.1	39.2	38.3	37.3	36.8	36.2	35.9	35.8	35.7	35.5	35.4								34.6



SECTION. FROM A POSITION IN { Lat. 40° 3' S. Long. 132° 58' W. } TOWARDS MOCHA ISLAND.

29 October 1875.

No. of Sounding 487.
Station 292.

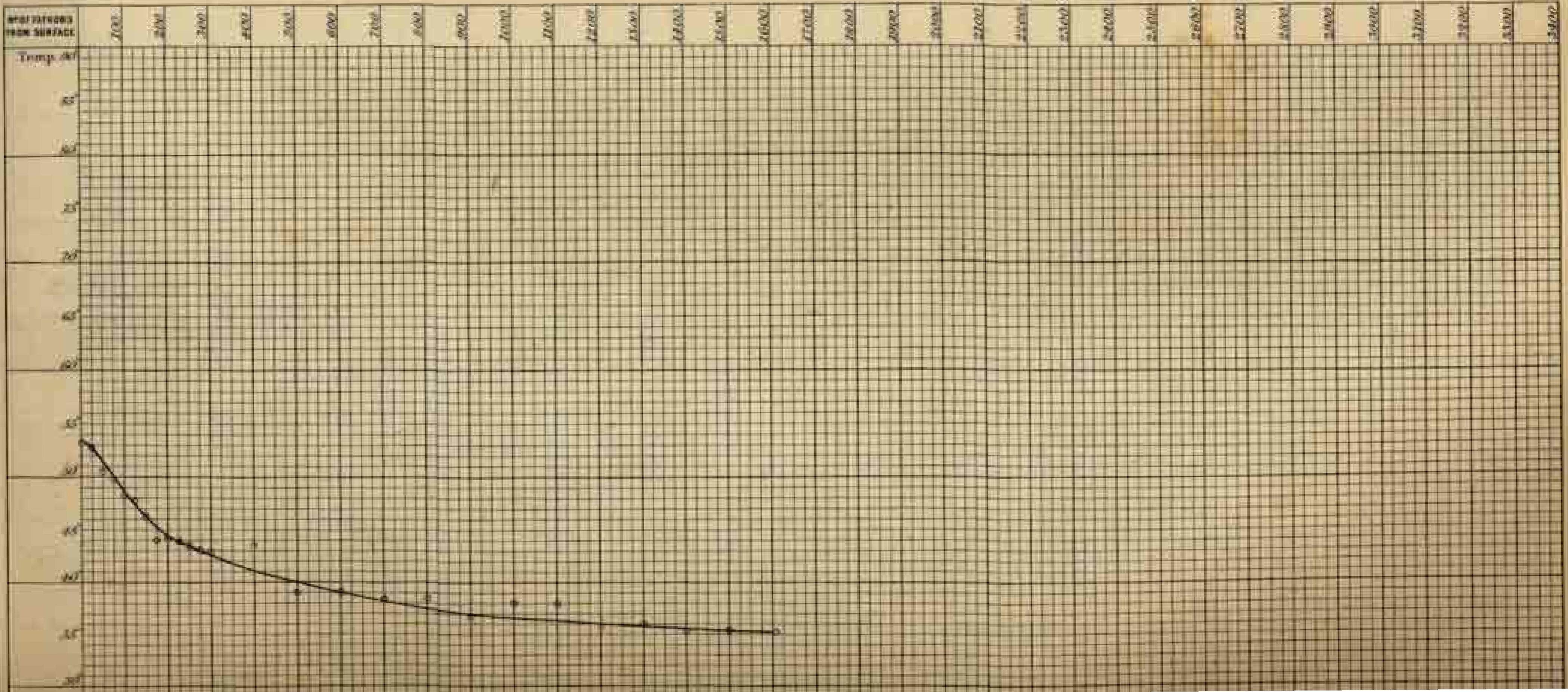
Depth 1600 fathoms

Latitude 38° 43' S.
Longitude 112° 31' W.

No. of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140
No. of thermometer			93			85		87			93		94		
Temperature shewn by thermometer	53.9		53.0			50.0		49.8			48.5		48.0		
Error of thermometer	0.0		-0.2			+0.5		+0.1			-0.2		-0.1		
Corrected temperature	53.9		52.8			50.5		49.9			48.3		47.9		
Temperature from curve	53.9		52.8			51.7		50.0			48.5		47.4		

No. of fathoms from surface	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
No. of thermometer	85		87			116	94	45	116	87	89	74	77	73	696
Temperature shewn by thermometer	45.8		45.8			44.6	44.0	43.6	43.2	40.8	43.2	39.0	38.8	38.3	38.5
Error of thermometer	+0.5		+0.1			-0.2	-0.1	-0.2	-0.2	+0.1	+0.2	0.0	+0.2	+0.2	0.0
Corrected temperature	46.3		45.9			44.4	43.9	43.4	43.0	40.9	43.4	39.0	39.0	38.5	38.5
Temperature from curve	46.2		45.7			44.3	43.9	43.5	43.0	42.5	41.1	40.0	39.0	38.3	37.0

No. of fathoms from surface	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer	88	74	696	88	72	116	94								73 89
Temperature shewn by thermometer	36.2	37.8	36.0	35.2	35.8	35.5	35.4								35.4 35.2
Error of thermometer	+0.5	+0.2	0.0	+0.5	+0.2	-0.2	-0.1								-0.2 +0.1
Corrected temperature	36.7	38.0	36.0	35.7	36.0	35.3	35.3								35.2 35.3
Temperature from curve	37.1	36.6	36.2	36.0	35.8	35.5	35.3								35.2



SECTION. FROM A POSITION IN { *Lat. 40° 3' S.* / *Long. 132° 58' W.* } TOWARDS MOCHA ISLAND.

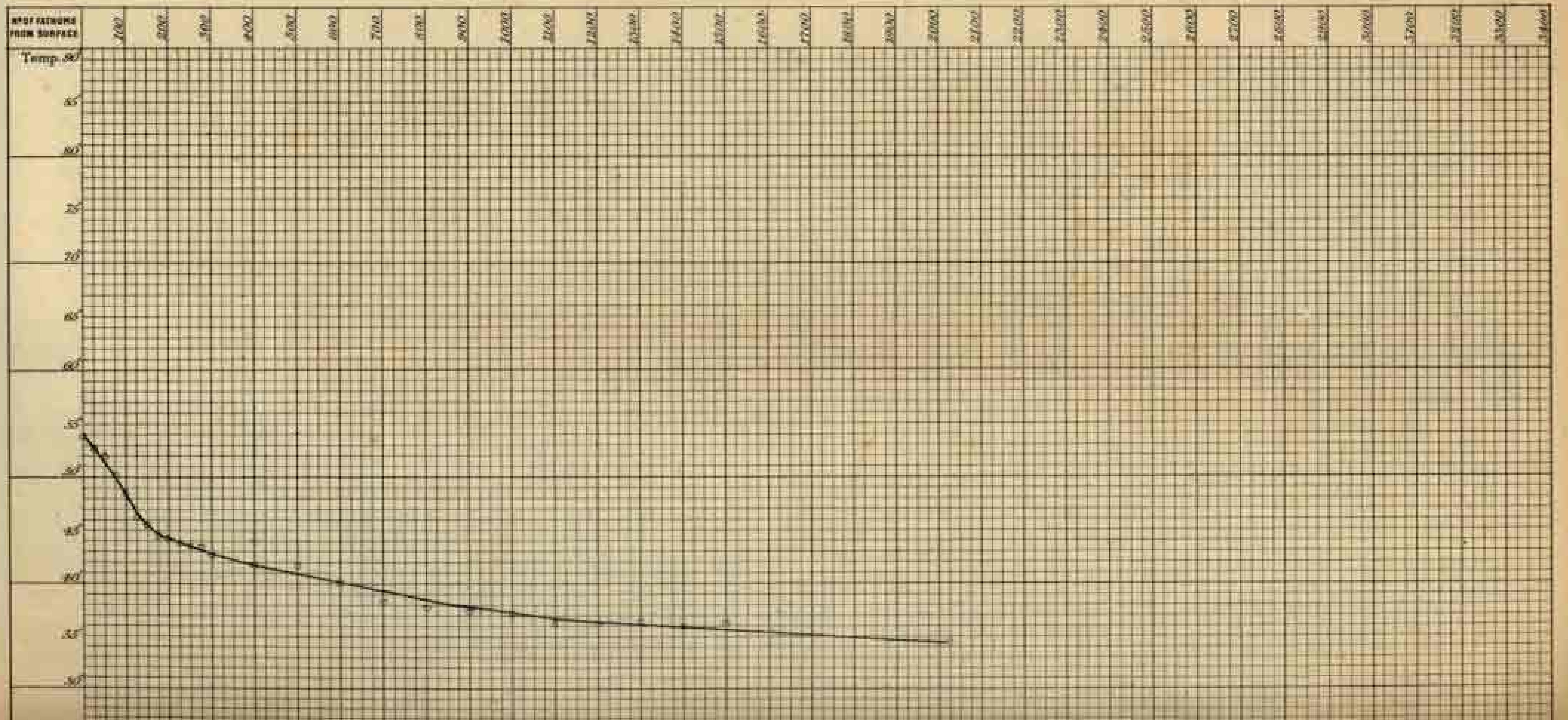
1 November 1875.

Nº of Sounding 438.
Station 293.

Depth 2025 fathoms.

Latitude 39° 4' S.
Longitude 105° 6' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			93			96		87			89		77			72		a16			94	87	89	85	88	77	79	a16	94	87	89	85	94	a16	87	89	85								87 93
TEMPERATURE SHEWN BY THERMOMETER	53.7		53.0			52.0		50.0			48.1		46.0			45.2		44.5			44.0	43.8	43.3	42.8	42.4	41.5	41.5	40.2	38.0	37.8	37.2	36.6	36.2	36.5	36.5	35.8	35.6								34.4 34.5
ERROR OF THERMOMETER	0.0		−0.2			0.0		+0.1			+0.2		+0.2			+0.2		−0.2			+0.1	+0.1	+0.2	+0.5	+0.3	+0.2	+0.2	−0.2	+0.1	+0.1	+0.2	+0.5	+0.1	−0.2	+0.1	+0.2	+0.5								+0.1 −0.2
CORRECTED TEMPERATURE	53.7		52.8			52.0		50.1			48.3		46.2			45.4		44.3			44.1	43.9	43.5	43.3	42.7	41.7	41.7	40.0	38.1	37.9	37.4	37.1	36.3	36.3	36.6	36.0	36.1								34.5 34.3
TEMPERATURE FROM CURVE	53.7		52.9			51.7		50.1			48.3		46.4			45.4		44.6			44.1	43.8	43.3	43.0	42.9	41.8	40.9	40.0	39.0	38.4	37.7	37.1	36.8	36.5	36.3	36.0	35.8								34.4



SECTION FROM A POSITION IN { Lat 40° 3′ S. Long 132° 58′ W. } TOWARDS MOCHA ISLAND

3 November 1875.

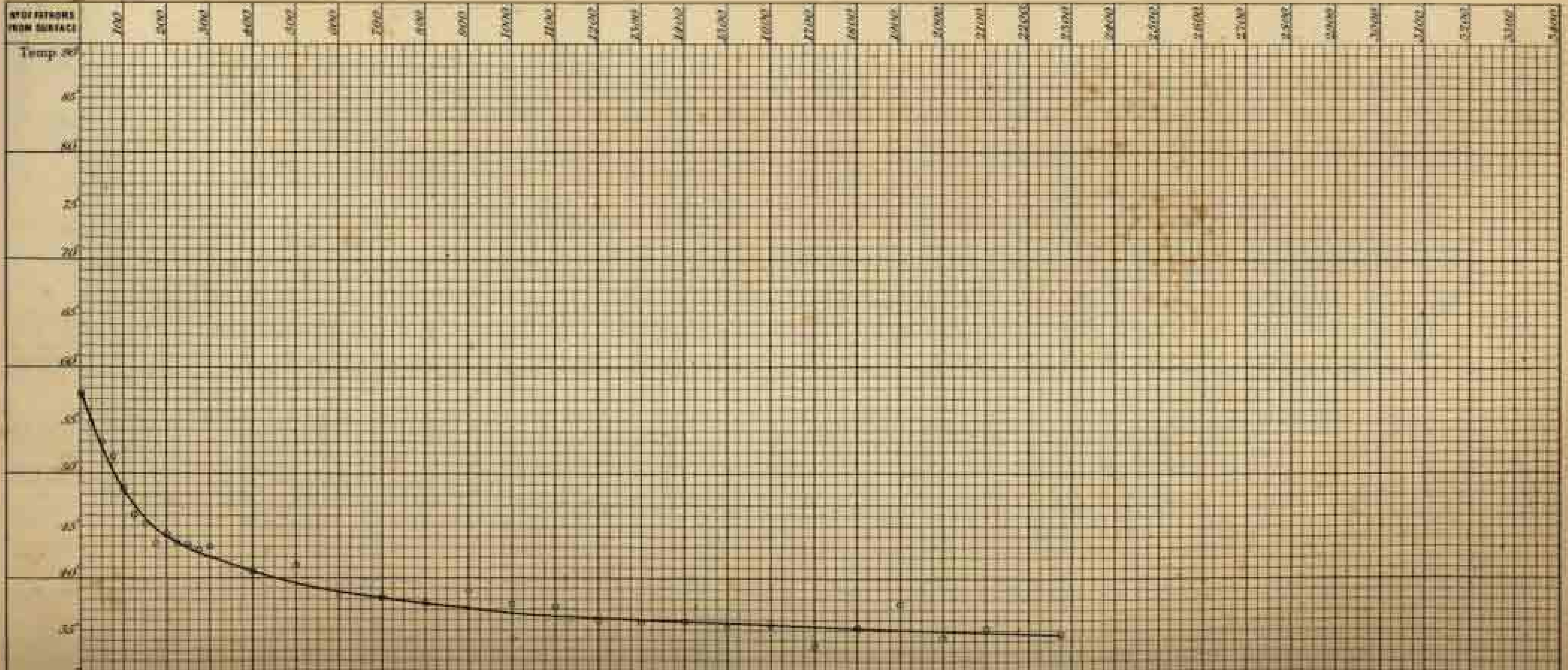
Nº of Sounding 439.
Station 294.

Depth 2270 fathoms.

Latitude 39° 22′ S.
Longitude 98° 46′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300
Nº OF THERMOMETER			80			87		85			94		a16			88		91			89	87	85	94	a16
TEMPERATURE SHEWN BY THERMOMETER	57·5		54·5			52·9		51·0			48·5		46·2			44·8		43·5			44·0	43·2	42·8	40·8	43·8
ERROR OF THERMOMETER	0·0		+0·2			+0·1		+0·5			−0·1		−0·2			+0·5		−0·2			+0·2	+0·1	+0·5	−0·1	−0·8
CORRECTED TEMPERATURE	57·5		54·7			53·0		51·5			48·4		46·0			45·3		43·3			44·2	43·3	43·3	40·7	43·0
TEMPERATURE FROM CURVE	57·5		55·1			52·5		50·1			48·2		46·3			45·3		44·7			44·2	43·3	43·1	42·7	42·4

Nº OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100		BOTTOM
Nº OF THERMOMETER	93	456	74	88	77	72	75	a16	94	85	89	87	77	93	75	78	74	456		96 87
TEMPERATURE SHEWN BY THERMOMETER	41·0	41·8	38·5	37·8	37·5	38·2	37·2	37·4	36·0	35·2	35·3	35·2	35·4	35·8	35·0	37·5	34·8	35·2		34·5 34·8
ERROR OF THERMOMETER	−0·7	0·0	0·0	+0·5	+0·2	+0·5	+0·2	−0·2	−0·1	+0·5	+0·4	+0·1	+0·2	−0·4	+0·4	+0·2	0·0	0·0		−0·2 +0·1
CORRECTED TEMPERATURE	40·3	41·8	38·5	38·3	37·7	38·7	37·4	37·2	35·9	35·7	35·7	35·3	35·6	35·4	35·4	37·7	34·8	35·2		34·3 34·9
TEMPERATURE FROM CURVE	40·8	39·5	38·8	38·3	37·7	37·1	36·7	36·3	36·0	35·9	35·8	35·6	35·5	35·3	35·2	35·0	34·9	34·8		34·8



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

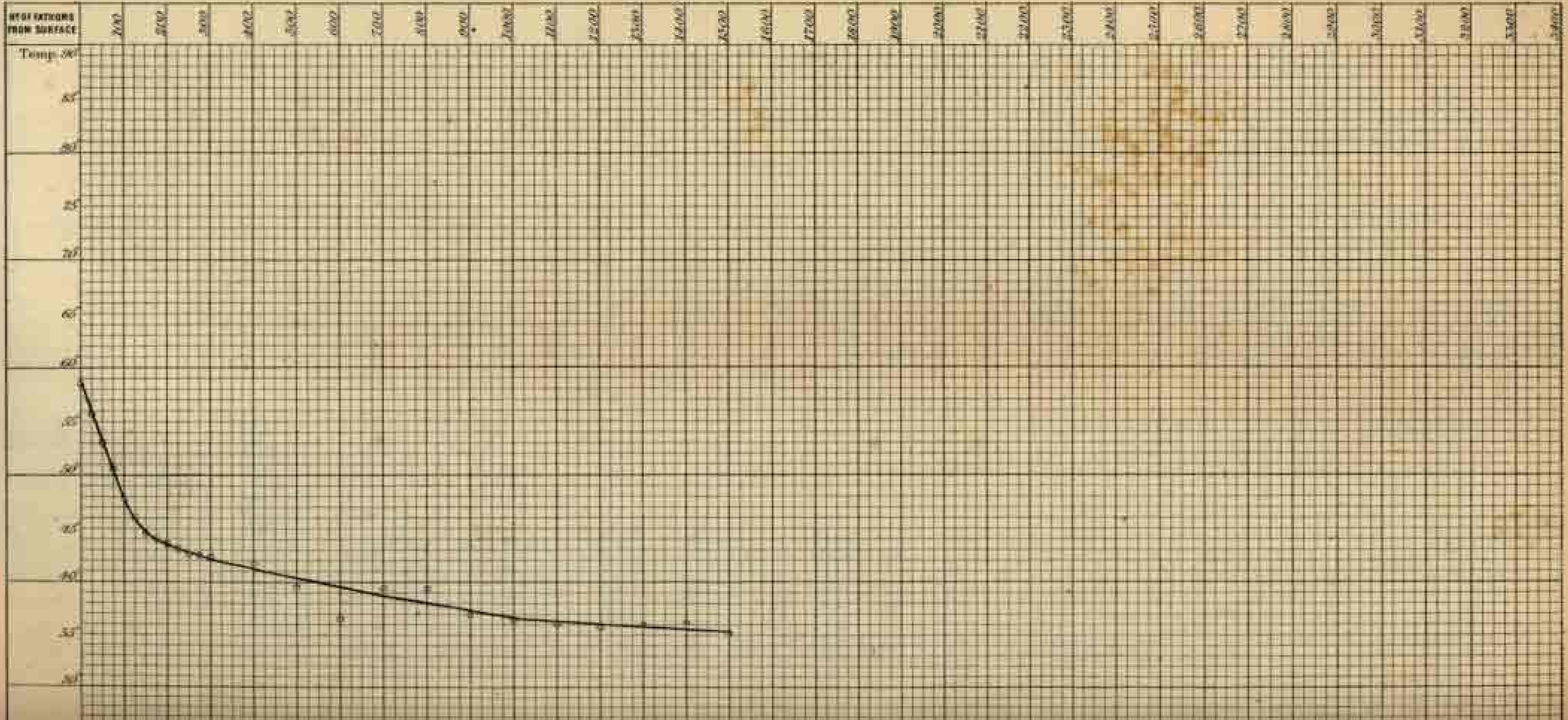
5 November 1875.

Nº of Sounding 440.
Station 295.

Depth 1500 fathoms.

Latitude 38° 7′ S.
Longitude 94° 4′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			88			72		96			74		75			77		88			78	96	71	75	77	89	91	85	83	116	93	77	116	94	80	85									93 87
TEMPERATURE SHEWN BY THERMOMETER	58.5		55.2			52.8		50.5			47.8		45.8			44.5		43.5			43.4	43.0	42.5	42.2	42.0	41.6	39.8	36.1	39.2	39.5	37.0	36.5	36.2	36.0	35.8	35.6									35.5 35.2
ERROR OF THERMOMETER	0.0		+0.5			+0.2		0.0			0.0		+0.2			+0.2		+0.5			+0.2	0.0	0.0	+0.2	+0.2	+0.2	−0.1	+0.5	+0.1	−0.2	−0.1	+0.2	−0.2	−0.1	+0.2	+0.5									−0.1 +0.1
CORRECTED TEMPERATURE	58.5		55.7			53.0		50.5			47.8		46.0			44.7		44.0			43.6	43.0	42.5	42.4	42.2	41.8	39.7	36.6	39.3	39.3	36.9	36.7	36.0	35.9	36.0	36.1									35.4 35.3
TEMPERATURE FROM CURVE	58.5		55.7			53.0		50.5			47.8		46.0			44.8		44.0			43.4	43.0	42.6	42.3	42.0	41.3	40.3	39.5	38.7	38.0	37.4	36.8	36.3	36.1	35.9	35.6									35.2



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

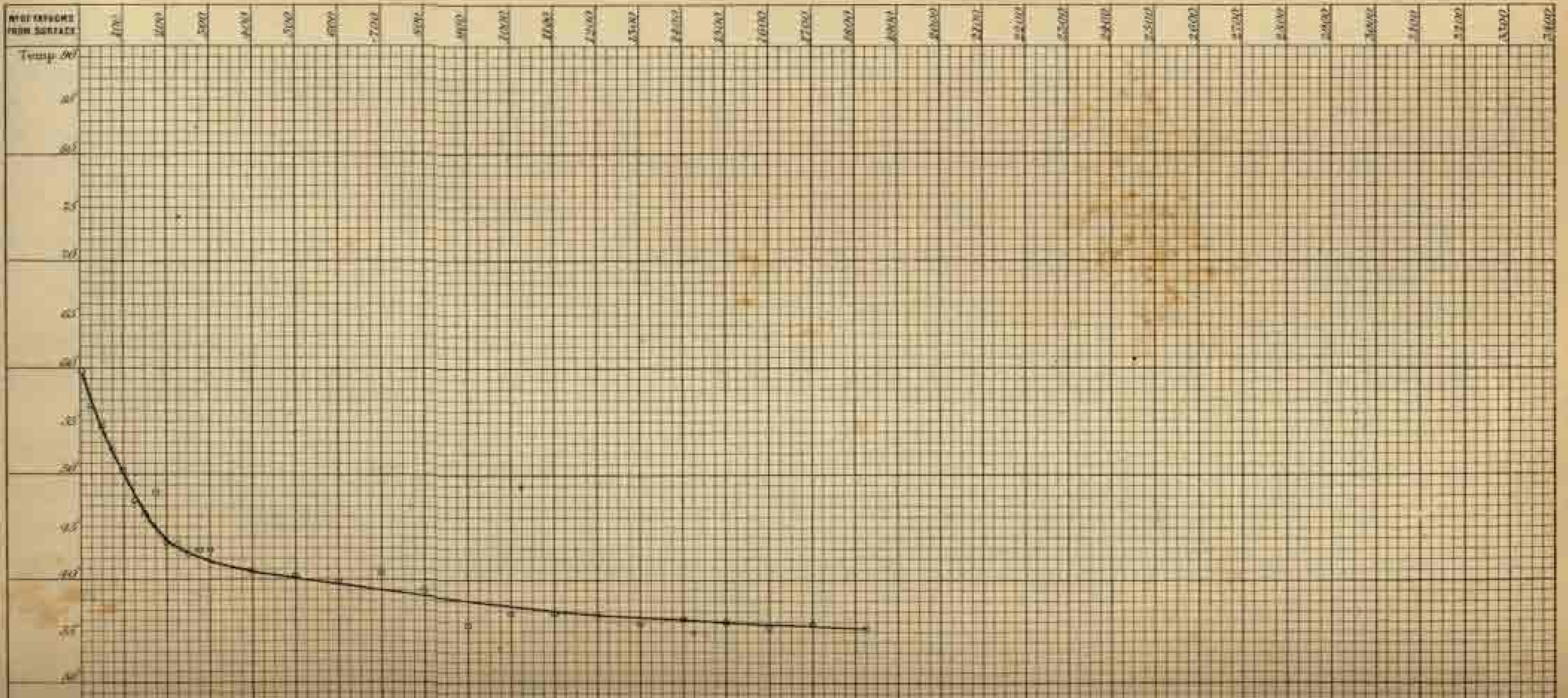
6 November 1875.

No. of Sounding 441.
Station 296.

Depth 1825 fathoms.

Latitude 38° 6′ S.
Longitude 88° 2′ W.

No. of Fathoms from Surface	No. of Thermometer	Temperature shewn by Thermometer	Error of Thermometer	Corrected Temperature	Temperature from Curve
Surface		59.8	0.0	59.8	59.8
10					
25	77	56.2	+0.2	56.4	56.8
30					
40					
50	79	54.4	+0.2	54.6	54.6
60					
75	116	52.4	−0.1	52.3	52.2
80					
90					
100	57	50.0	+0.1	50.1	50.1
110					
125	94	47.8	−0.1	47.7	48.1
130					
140					
150	73	46.0	+0.2	46.2	46.3
160					
175	96	45.1	0.0	45.1	45.0
180					
190					
200	74	43.5	0.0	43.5	43.8
225	88	42.8	+0.3	43.1	43.2
250	94	42.6	−0.1	42.5	42.7
275	89	41.4	+0.3	41.7	42.1
300	75	41.8	+0.0	41.8	41.7
400	93	41.0	−0.2	40.8	40.8
500	89	40.1	+0.2	40.3	40.2
600	116	40.0	−0.2	39.8	39.6
700	89	40.6	+0.1	40.7	39.0
800	79	38.8	+0.2	39.0	38.5
900	92	35.8	−0.2	35.6	38.0
1000	77	36.6	+0.2	36.8	37.5
1100	63	36.5	+0.4	36.9	37.0
1200	85	36.1	+0.3	36.4	36.5
1300	94	36.0	−0.1	35.9	36.4
1400	89	36.0	+0.0	36.0	36.0
1500	77	35.8	+0.2	36.0	36.0
1600	116	35.7	−0.2	35.5	35.8
1700	87	35.6	+0.1	35.7	35.6
1800					
1900					
2000					
Bottom	87 93	35.3 35.2	+0.3 −0.2	35.6 35.0	35.3



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

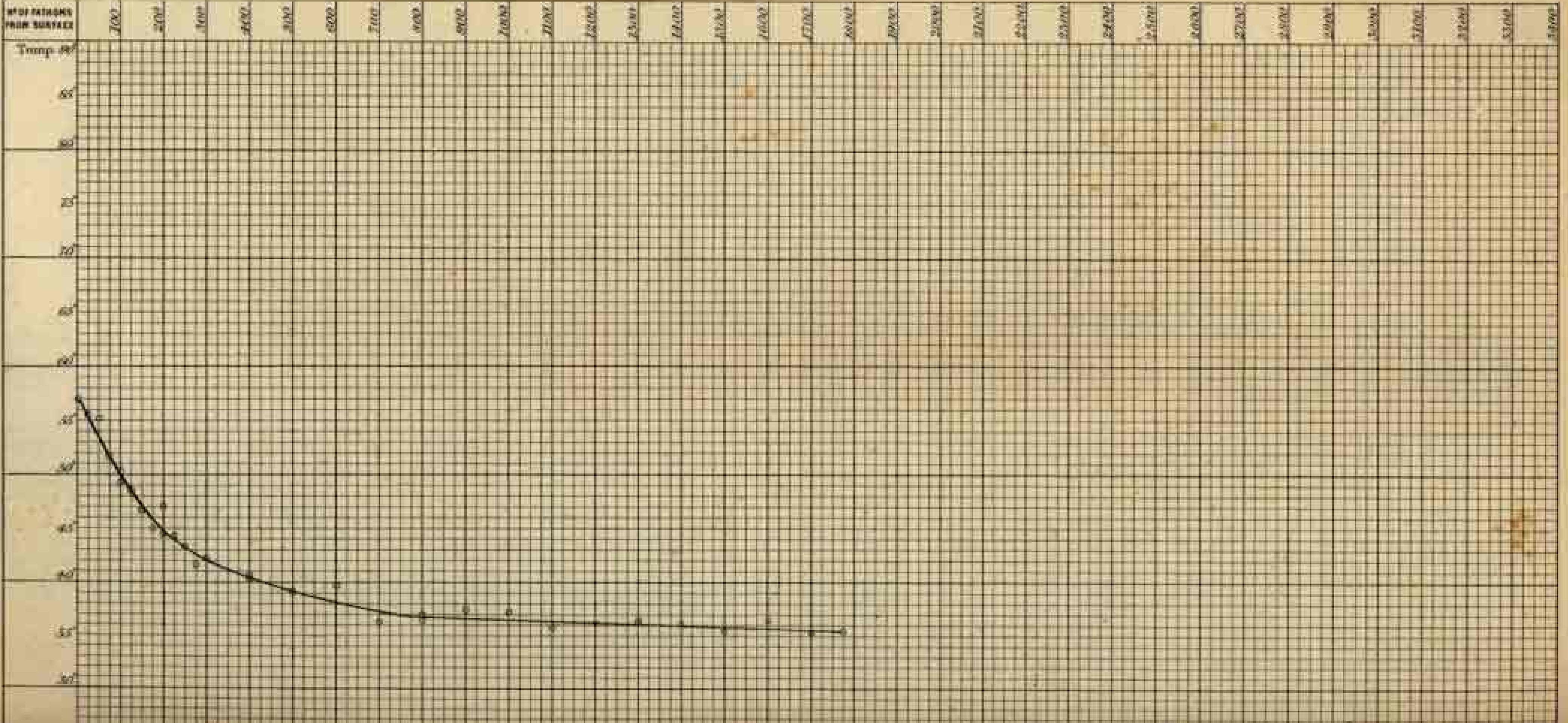
11 November 1875.

N° of Sounding 442.
Station 297.

Depth 1775 fathoms.

Latitude 37° 29′ S.
Longitude 83° 7′ W.

N° OF FATHOMS FROM SURFACE	N° OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE		57.0	0.0	57.0	57.0
10					
25	696	55.5	0.0	55.5	55.5
30					
40					
50	74	55.0	0.0	55.2	53.7
60					
75	88	51.2	+0.5	51.7	51.9
80					
90					
100	72 419	50.0 49.3	+0.2 0.0	50.2 49.3	50.1
110					
125	75	48.2	+0.2	48.4	48.4
130					
140					
150	88	46.2	+0.5	46.7	47.0
160					
175	74	45.0	0.0	45.0	45.7
180					
190					
200	696 419	47.0 44.5	0.0 0.0	47.0 44.5	44.5
225	72	44.0	+0.2	44.2	43.8
250	75	43.0	+0.2	43.2	43.1
275	98	41.3	−0.1	41.2	42.5
300	89	41.0	+0.8	41.8	41.9
400	83 419	39.8 40.5	+0.5 0.0	40.3 40.5	40.4
500	87	39.0	+0.1	39.1	39.2
600	208	40.0	−0.2	39.8	38.6
700	77	38.0	+0.2	38.2	37.4
800	94 419	36.5 37.0	−0.1 0.0	36.4 37.0	36.7
900	89	37.2	+0.2	37.4	36.5
1000	85	36.0	+0.5	37.1	36.4
1100	93	36.1	−0.2	35.9	36.1
1200	87	36.0	+0.1	36.1	36.0
1300	85	35.9	+0.5	36.4	36.1
1400	89	35.9	+0.2	36.1	36.0
1500	94	35.6	−0.1	35.5	35.9
1600	67	36.2	+0.1	36.3	35.8
1700	93	35.5	−0.2	35.3	35.8
1800					
1900					
2000					
BOTTOM	93 87	35.5 35.6	−0.2 +0.1	35.3 35.7	35.5



SECTION. FROM A POSITION IN { Lat. 40° 3′ S. Long. 132° 58′ W. } TOWARDS MOCHA ISLAND.

17 November 1875.

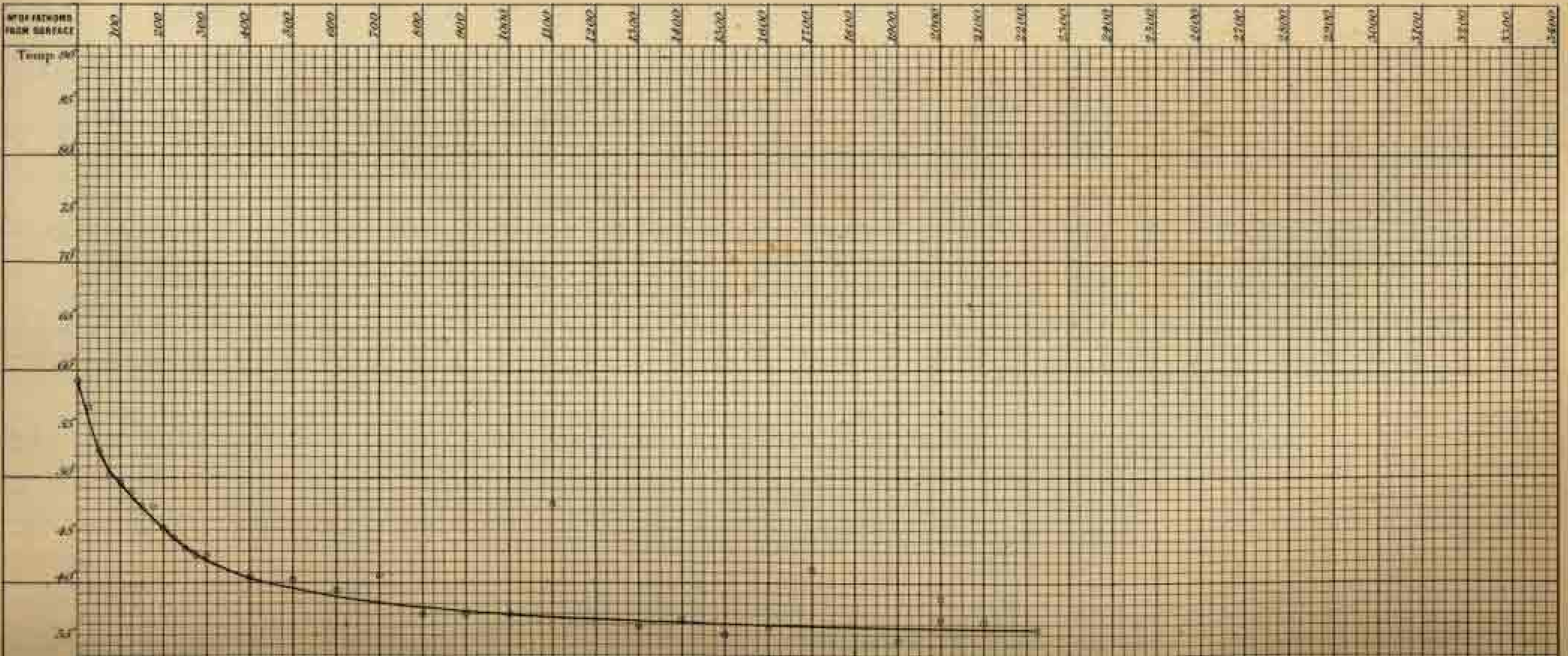
No. of Sounding 443.
. . Station 298.

Depth 2225 fathoms.

Latitude 34° 7′ S.
Longitude 73° 56′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225
No. of Thermometer			94			74		89			87		216			85		87			89	94
Temperature shewn by Thermometer	59.0		56.5			52.5		50.0			49.5		48.5			48.8		47.0			45.0	44.3
Error of Thermometer	0.0		−0.1			0.0		+0.2			+0.1		−0.2			+0.5		+0.1			+0.2	−0.1
Corrected Temperature	59.0		56.4			52.5		50.2			49.6		48.3			47.3		47.1			45.2	44.2
Temperature from Curve	59.0		55.8			52.5		50.5			49.6		48.7			47.9		46.1			45.1	44.1

No. of Fathoms from Surface	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100		Bottom
No. of Thermometer	74	216	85	211	89	85	72	74	75	87	98		75	78	93	77	67	94	85	210	89		93 67
Temperature shewn by Thermometer	43.2	42.5	42.0	40.5	40.0	38.6	40.6	37.0	36.8	36.8	47.4		35.6	36.2	35.2	35.6	41.0	33.0	33.8	36.6	36.2		35.8 35.8
Error of Thermometer	0.0	−0.2	+0.5	−0.2	+0.2	+0.5	+0.2	0.0	+0.2	+0.1	0.0		+0.2	+0.2	−0.2	+0.2	+0.1	−0.1	+0.5	−0.2	+0.1		−0.2 +0.1
Corrected Temperature	43.2	42.3	42.5	40.3	40.2	39.1	40.8	37.0	37.0	36.9	47.4		35.8	36.4	35.0	35.8	41.1	32.9	34.3	36.4	36.3		35.6 35.9
Temperature from Curve	43.0	42.4	41.9	40.3	39.5	38.7	38.1	37.7	37.2	36.9	36.7	36.5	36.3	36.2	36.1	36.0	35.9	35.9	35.8	35.7	35.7		35.6



SECTION. FROM TAHITI TO A POSITION IN { Lat. 40° 3' S. Long. 132° 58' W.

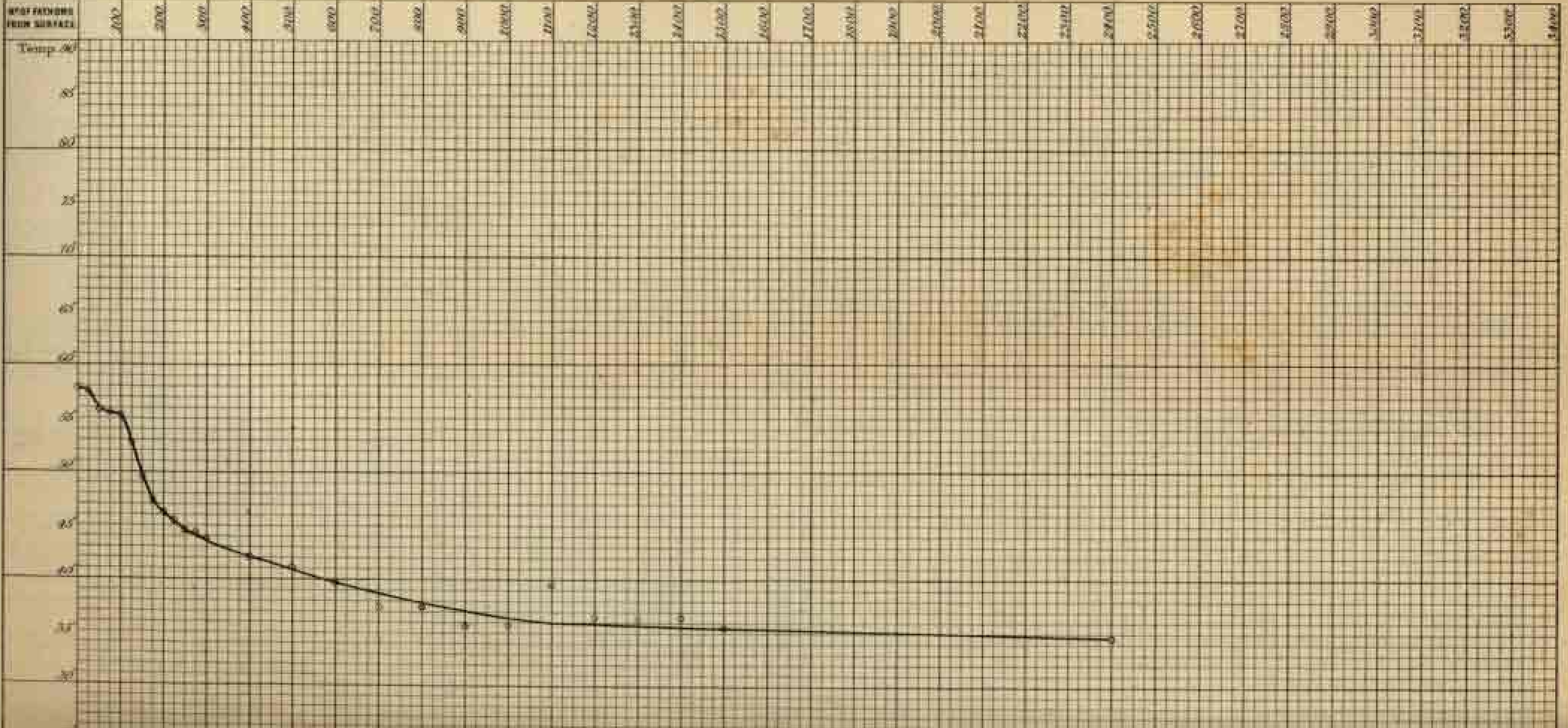
19 October 1875.

Nº of Sounding 432.
Station 287.

Depth 2400 fathoms

Latitude 36° 32' S.
Longitude 132° 52' W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			89			75		93			88		696			85		89			82	77	88	696	93	696	88	77	87	84	85	92	79	74	94	446	73								87 93
TEMPERATURE SHOWN BY THERMOMETER	57.8		57.2			55.2		55.8			54.8		52.8			49.0		47.1			46.0	45.2	44.2	44.2	44.0	42.0	40.5	39.5	37.5	37.2	35.2	36.0	35.4	36.5	36.2	36.4	35.5								33.3 34.6
ERROR OF THERMOMETER	0.0		+0.2			+0.5		-0.2			+0.5		0.0			+0.5		+0.2			+0.1	+0.2	+0.5	0.0	-0.2	0.0	+0.5	+0.2	+0.1	+0.2	+0.5	-0.2	+0.2	0.0	-0.1	-0.2	+0.2								+0.1 -0.2
CORRECTED TEMPERATURE	57.8		57.4			55.7		55.6			55.3		52.8			49.5		47.3			46.1	45.4	44.7	44.2	43.8	42.0	41.0	39.7	37.6	37.4	35.7	35.8	35.6	36.5	36.1	36.2	35.7								33.4 34.4
TEMPERATURE FROM CURVE	57.8		57.4			55.8		55.6			55.3		52.8			49.5		47.3			46.1	45.4	44.7	44.2	43.7	42.1	40.9	39.7	38.9	38.0	37.2	36.6	36.1	35.8	35.7	35.6	35.5								34.7



SECTION. OFF WEST COAST OF SOUTH AMERICA.

14 December 1875.

Nº of Sounding 444.
Station 209.

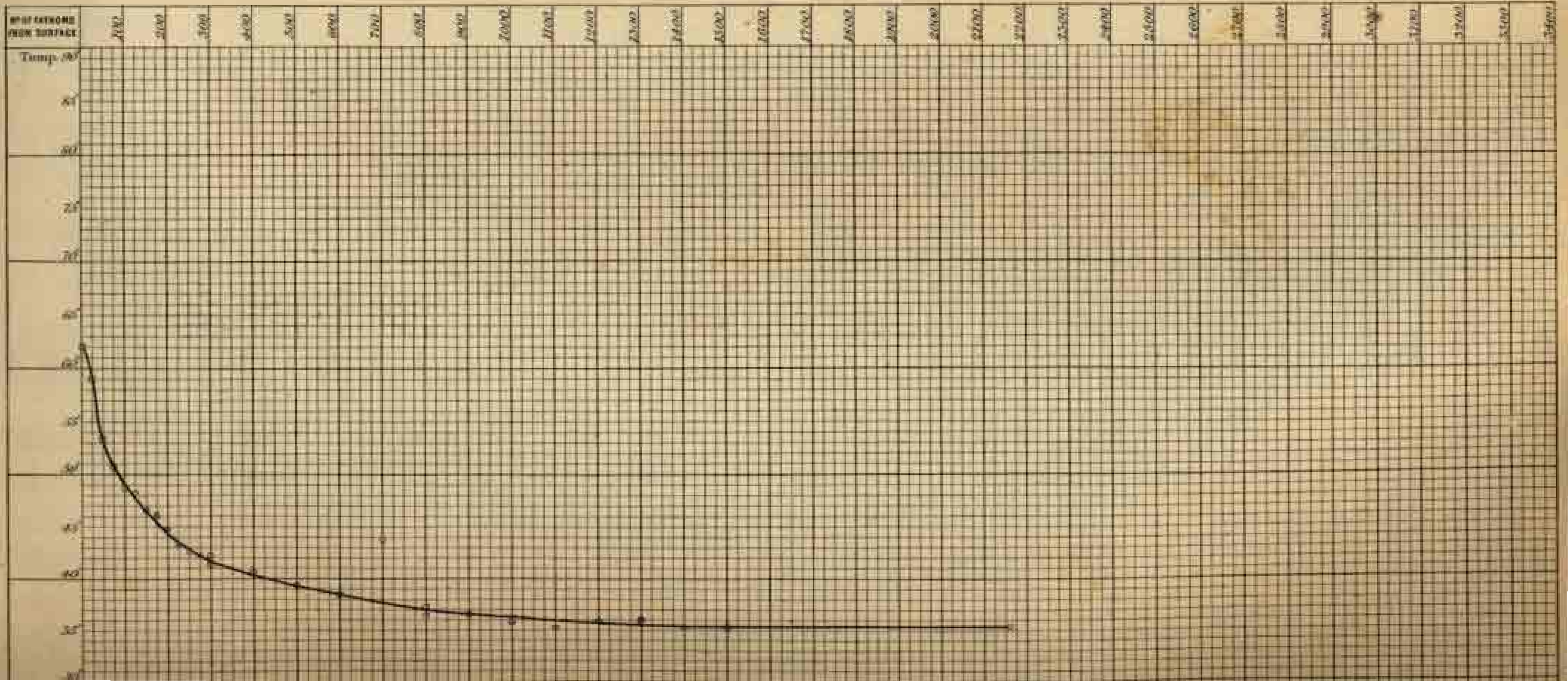
Depth 2160 fathoms.

Latitude 33° 31′ S.
Longitude 74° 43′ W.

Nº of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150
Nº of Thermometer			a5			a4		94			93		a5			a4
Temperature shewn by Thermometer	62.0		59.0			53.1		51.0			49.2		48.1			46.5
Error of Thermometer	0.0		0.0			0.0		-0.1			-0.2		0.0			0.0
Corrected Temperature	62.0		59.0			53.1		50.9			49.0		48.1			46.5
Temperature from Curve	62.0		59.0			53.4		50.9			49.1		47.8			46.5

Nº of Fathoms from Surface	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900
Nº of Thermometer		75			93	94	a16	85	87 a19	74 a19	86	89	a96	77 a19	85
Temperature shewn by Thermometer		45.8			45.0	43.5	42.9	41.7	41.3 42.1	40.6 40.6	38.8	38.2	37.8	36.4 37.3	36.1
Error of Thermometer		+0.2			-0.2	-0.1	-0.2	+0.3	+0.1 0.0	0.0 0.0	+0.5	+0.1	0.0	+0.2 0.0	+0.5
Corrected Temperature		46.0			44.8	43.4	42.7	42.0	41.4 42.1	40.6 40.6	39.3	38.3	37.8	36.6 37.3	36.6
Temperature from Curve		45.3			44.4	43.3	42.8	42.1	41.7	40.5	39.3	38.5	37.9	37.0	36.6

Nº of Fathoms from Surface	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
Nº of Thermometer	a16	91	a16	85	87	93 a5 a4								89 93
Temperature shewn by Thermometer	36.1	35.2	36.1	35.0	35.2	35.3 35.5 35.7								35.2 35.3
Error of Thermometer	-0.2	+0.1	-0.2	+0.5	+0.1	-0.2 0.0 0.0								+0.2 -0.2
Corrected Temperature	35.9	35.3	35.9	36.0	35.3	35.1 35.5 35.5								35.4 35.1
Temperature from Curve	36.2	36.0	35.8	35.6	35.4	35.2								35.7



SECTION. OFF WEST COAST OF SOUTH AMERICA.

17 December 1875.

Nº of Sounding 445.
Station 300.

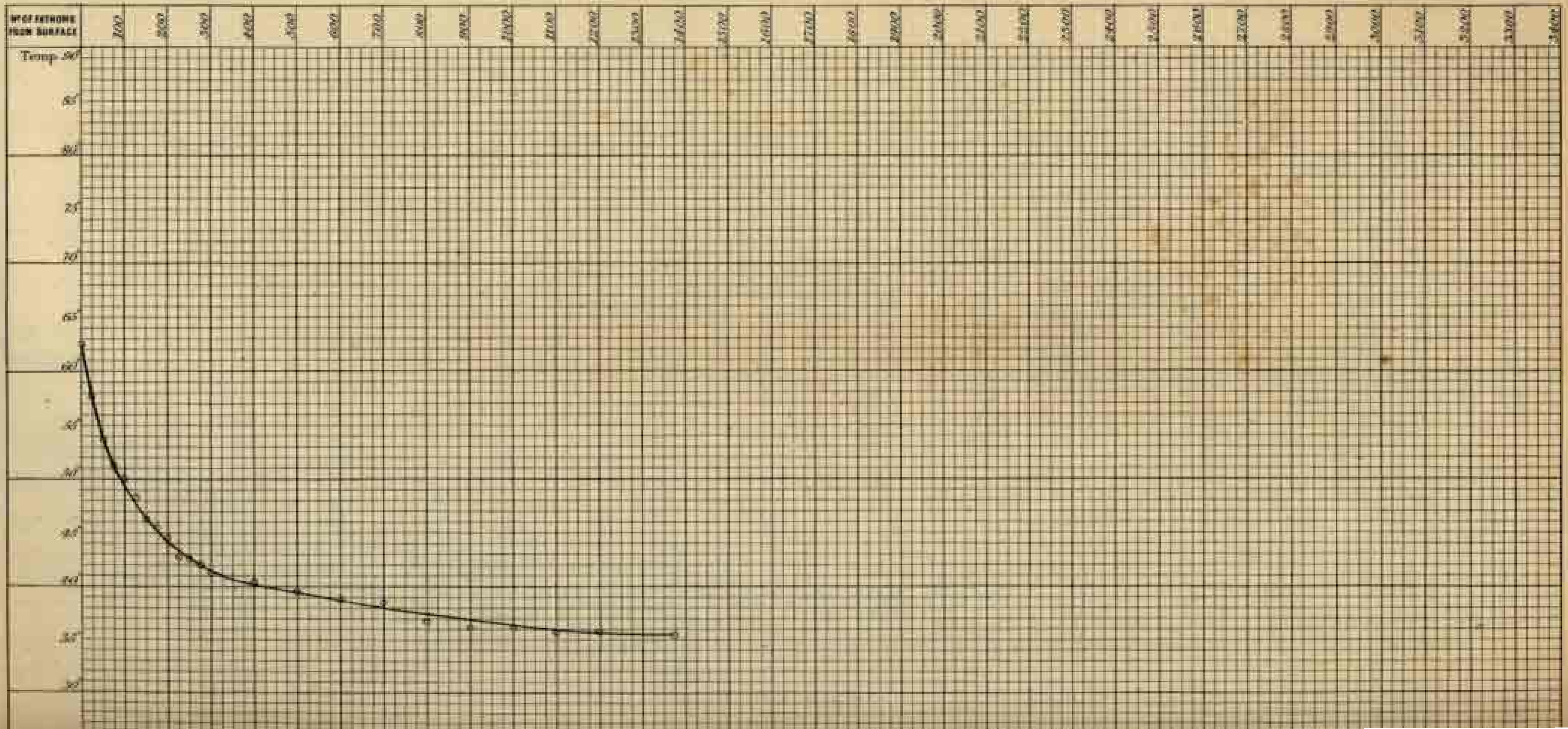
Depth 1375 fathoms.

Latitude 33° 42′ S.
Longitude 78° 18′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140
Nº OF THERMOMETER			93			87		9.4			9.5		89		
TEMPERATURE SHEWN BY THERMOMETER	62.5		58.0			53.6		51.2			50.0		48.0		
ERROR OF THERMOMETER	0.0		−0.2			+0.1		0.0			0.0		+0.0		
CORRECTED TEMPERATURE	62.5		57.8			53.7		51.2			50.0		48.0		
TEMPERATURE FROM CURVE	62.5		57.8			53.7		51.2			49.5		47.8		

Nº OF FATHOMS FROM SURFACE	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
Nº OF THERMOMETER	94		83			85	94	89	9.5	9.4	216	87	87	216	9.4
TEMPERATURE SHEWN BY THERMOMETER	46.3		45.0			43.8	43.0	41.5	42.0	41.8	40.5	39.5	38.8	38.6	36.8
ERROR OF THERMOMETER	−0.1		+0.3			+0.5	−0.1	+0.9	0.0	0.0	−0.2	+0.1	+0.1	−0.2	0.0
CORRECTED TEMPERATURE	46.2		45.3			44.3	42.9	42.4	42.0	41.8	40.3	39.6	38.9	38.4	36.8
TEMPERATURE FROM CURVE	46.3		45.3			44.1	43.4	42.6	42.0	41.3	40.1	39.4	38.7	38.0	37.4

Nº OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	9.5	85	94	85											93 87
TEMPERATURE SHEWN BY THERMOMETER	36.2	36.1	36.0	35.4											35.6 35.3
ERROR OF THERMOMETER	0.0	+0.2	−0.1	+0.5											−0.2 +0.1
CORRECTED TEMPERATURE	36.2	36.3	35.9	35.9											35.4 35.4
TEMPERATURE FROM CURVE	36.9	36.4	35.9	35.7											35.3



SECTION. OFF WEST COAST OF SOUTH AMERICA.

22 December 1875.

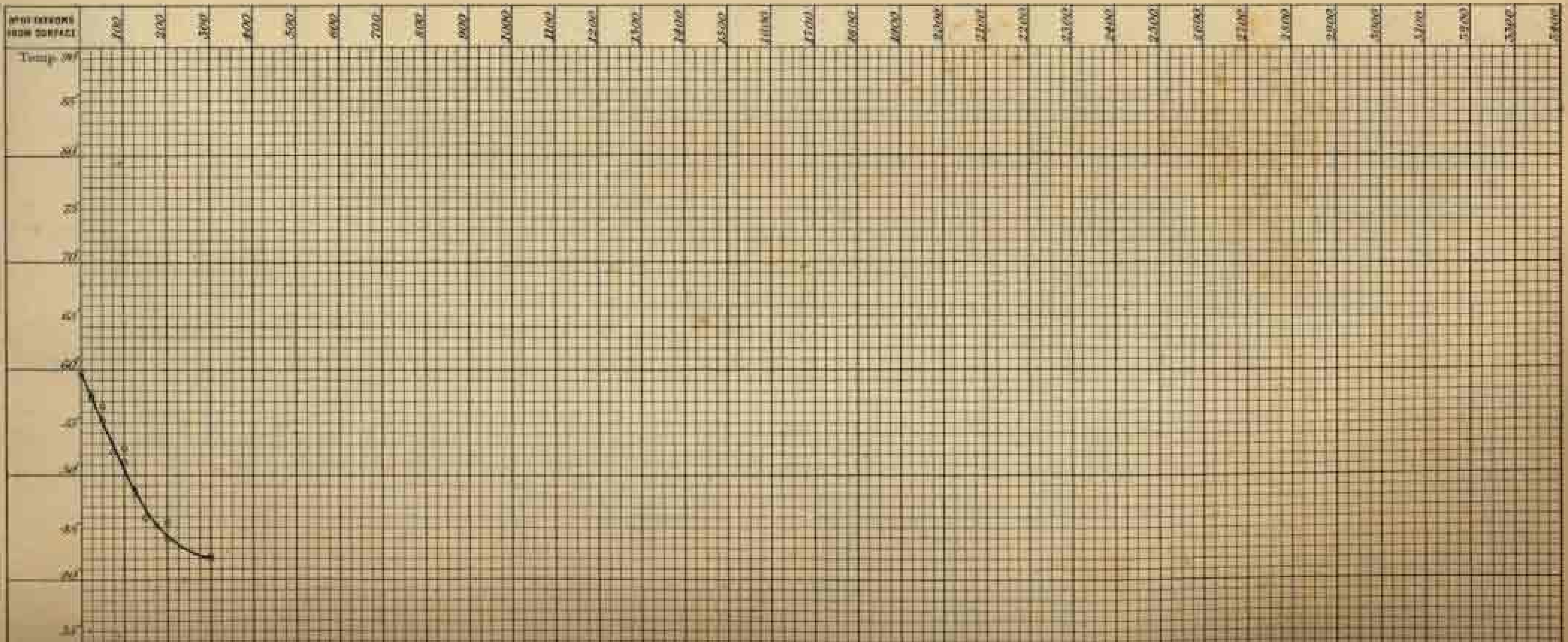
Nº of Sounding 446.
Station 301.

Depth None obtained.

Latitude 37° 29′ S.
Longitude 84° 2′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300
Nº OF THERMOMETER			74 85			77 85		0.4			87 85		71			93		87			9.3 85				85
TEMPERATURE SHEWN BY THERMOMETER	59.5		57.9 57.0			55.0 55.9		52.0			51.0 52.1		48.2			46.2		45.0			44.0 44.9				41.5
ERROR OF THERMOMETER	0.0		0.0 +0.5			+0.0 +0.5		0.0			+0.1 +0.5		+0.2			−0.2		+0.2			0.0 +0.5				+0.5
CORRECTED TEMPERATURE	59.5		57.9 57.5			55.0 56.4		52.0			51.1 52.6		48.4			46.0		45.2			44.0 45.4				42.0
TEMPERATURE FROM CURVE	59.5		57.4			55.2		52.8			51.3		48.4			46.5		45.7			44.2				42.0

Nº OF FATHOMS FROM SURFACE	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER																				
TEMPERATURE SHEWN BY THERMOMETER																				
ERROR OF THERMOMETER																				
CORRECTED TEMPERATURE																				
TEMPERATURE FROM CURVE																				



SECTION. OFF WEST COAST OF SOUTH AMERICA.

28 December 1875.

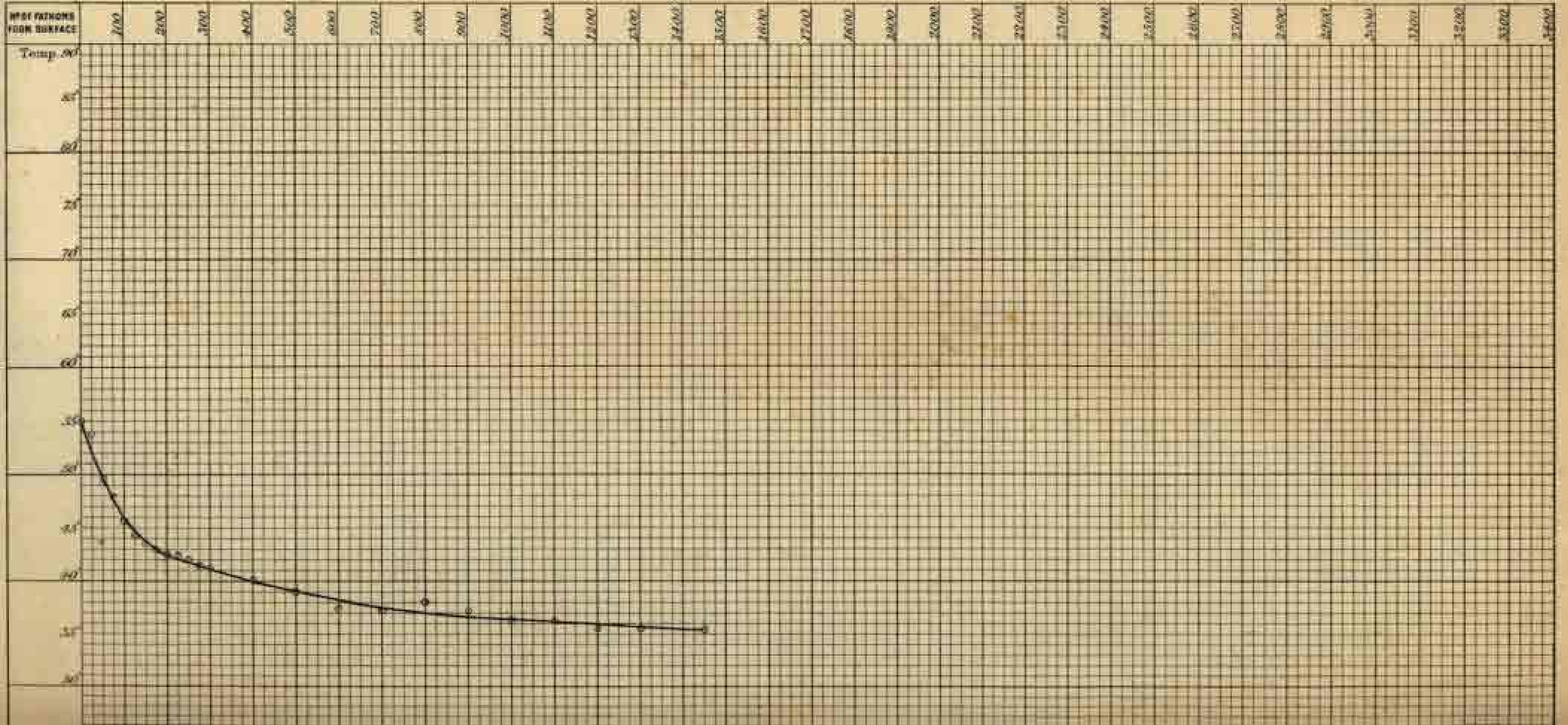
No. of Sounding 447.
Station 302

Depth 1450 fathoms.

Latitude 42° 43′ S
Longitude 82° 11′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
No. of Thermometer			84			95		94			116		83			85		87		
Temperature shewn by Thermometer	55.0		53.7			49.5		48.0			46.0		44.0			43.0		41.7		
Error of Thermometer	0.0		0.0			0.0		−0.1			−0.2		+0.2			+0.5		+0.1		
Corrected Temperature	55.0		53.7			49.5		47.9			45.8		44.2			43.5		41.8		
Temperature from Curve	55.0		53.5			49.5		47.5			45.8		44.3			43.5		43.0		

No. of Fathoms from Surface	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer	75	87	83	89	116	94	95	84	84	95	94	116	89	83	87										83 87
Temperature shewn by Thermometer	42.3	42.3	41.5	41.3	41.4	40.2	39.0	37.5	37.1	38.0	37.2	36.5	35.9	35.2	35.6										35.8 35.5
Error of Thermometer	+0.2	+0.1	+0.5	+0.2	−0.2	−0.1	0.0	0.0	0.0	0.0	−0.1	−0.2	+0.2	+0.5	+0.1										−0.2 +0.1
Corrected Temperature	42.5	42.4	42.0	41.5	41.2	40.1	39.0	37.5	37.1	38.0	37.1	36.3	36.1	35.7	35.7										35.6 35.6
Temperature from Curve	42.5	42.1	41.8	41.5	41.1	40.1	39.1	38.2	37.5	36.9	36.8	36.2	36.0	35.9	35.8										35.6



SECTION. OFF WEST COAST OF SOUTH AMERICA.

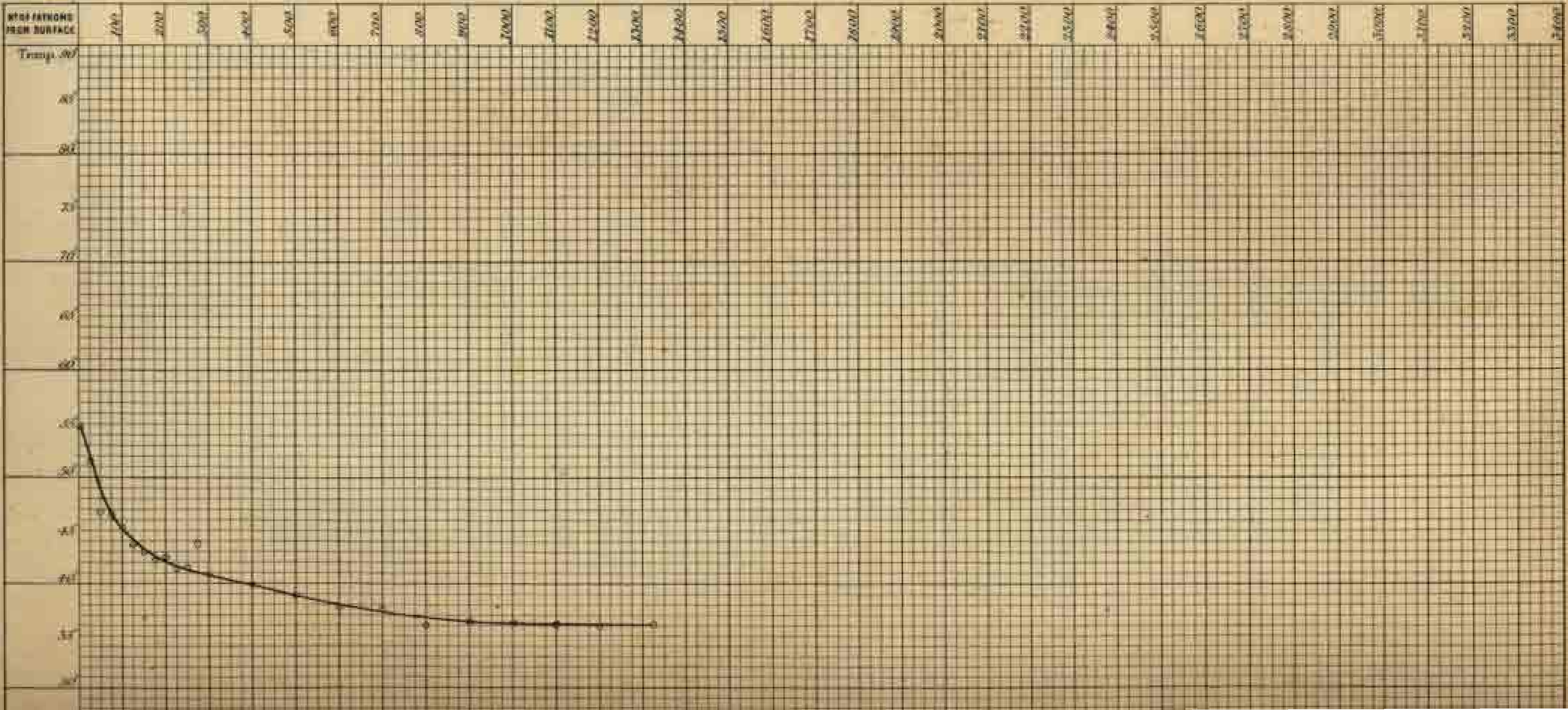
30 December 1875.

Nº of Sounding 448.
" Station 303.

Depth 1325 fathoms

Latitude 45° 31′ S.
Longitude 78° 9′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			79			89		75			87		93			74		77			88	89	75	116	81	91	74	77	88	88	89	75	115	114											93 85
TEMPERATURE SHEWN BY THERMOMETER	54.8		51.2			46.5		46.2			45.0		44.1			43.0		41.9			41.2	41.2	41.2	44.0	40.8	40.0	39.0	37.5	37.1	35.5	36.2	36.0	36.0	35.3											36.0 35.7
ERROR OF THERMOMETER	0.0		+0.2			+0.2		+0.2			+0.1		−0.2			0.0		+0.2			+0.1	+0.2	+0.2	−0.2	+0.1	−0.2	0.0	+0.2	+0.5	+0.5	+0.2	+0.4	0.0	+0.5											−0.2 +0.5
CORRECTED TEMPERATURE	54.8		51.4			46.7		46.4			45.1		43.9			43.0		42.1			41.3	41.4	41.4	43.8	40.9	39.8	39.0	37.7	37.6	36.0	36.4	36.4	36.0	35.8											35.8 36.2
TEMPERATURE FROM CURVE	54.8		51.4			48.5		46.4			44.9		43.9			43.1		42.5			42.0	41.6	41.3	41.0	40.8	39.8	39.0	38.1	37.4	36.8	36.4	36.0	36.0	36.0											36.0



SECTION. OFF MIDDLE ISLANDS TO MESSIER CHANNEL.

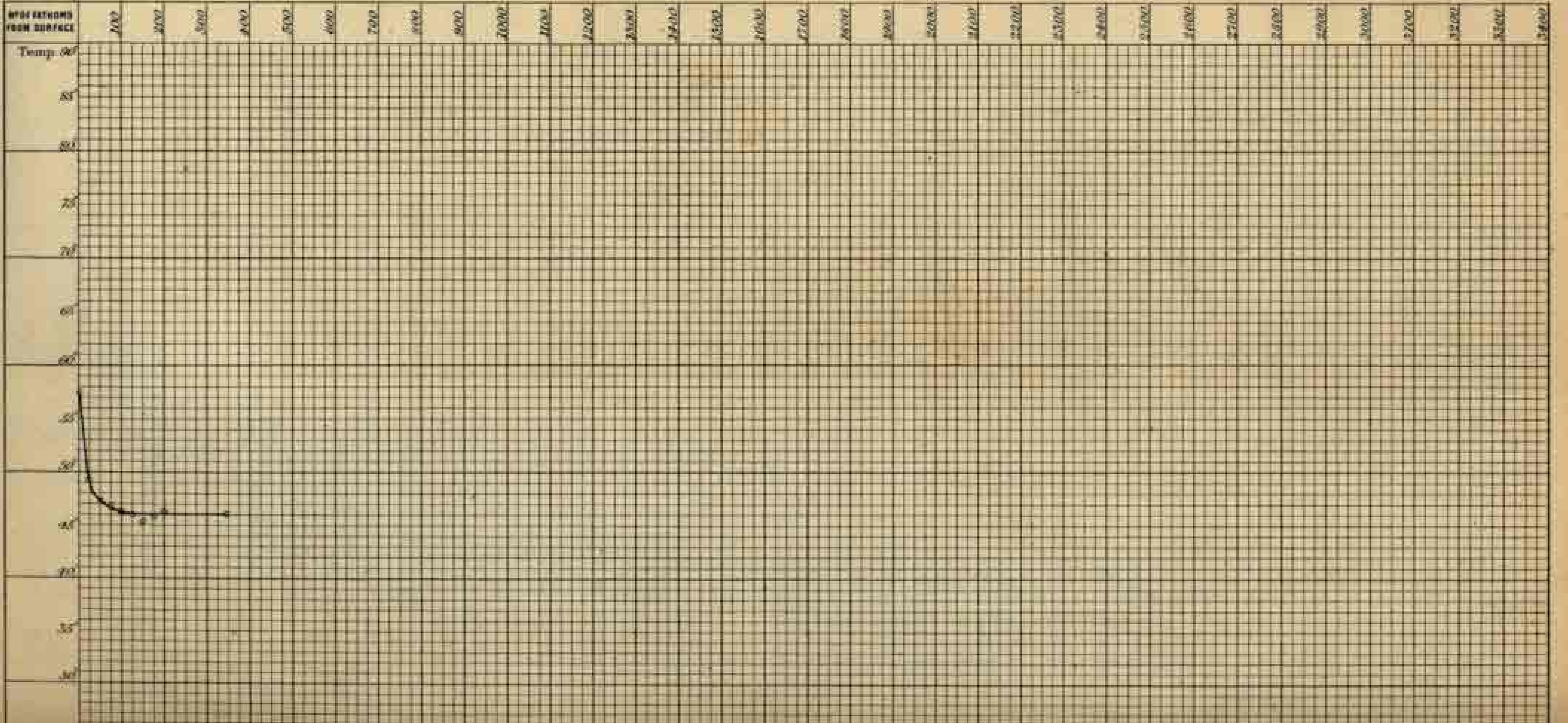
2 January 1876.

No. of Sounding 454
Station 306 a.

Depth 345 *fathoms.*

Latitude 48° 27′ S.
Longitude 74° 30′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer			89			93		95			94		94*			216		89			85																								93 87
Temperature shewn by Thermometer	57.5		49.2			47.4		46.8			45.8		46.1			45.6		45.6			45.8																								46.0 46.0
Error of Thermometer	0.0		+0.1			−0.2		0.0			+0.5		−0.1			−0.2		+0.2			+0.3																								−0.2 +0.1
Corrected Temperature	57.5		49.3			47.2		46.8			46.3		46.0			45.4		45.8			46.1																								45.8 46.1
Temperature from Curve	57.5		49.3			47.2		46.8			46.2		46.0			46.0		46.0			46.0																								46.0°



SECTION. MAGELHAENS STRAIT TO FALKLAND ISLANDS.

22 January 1876.

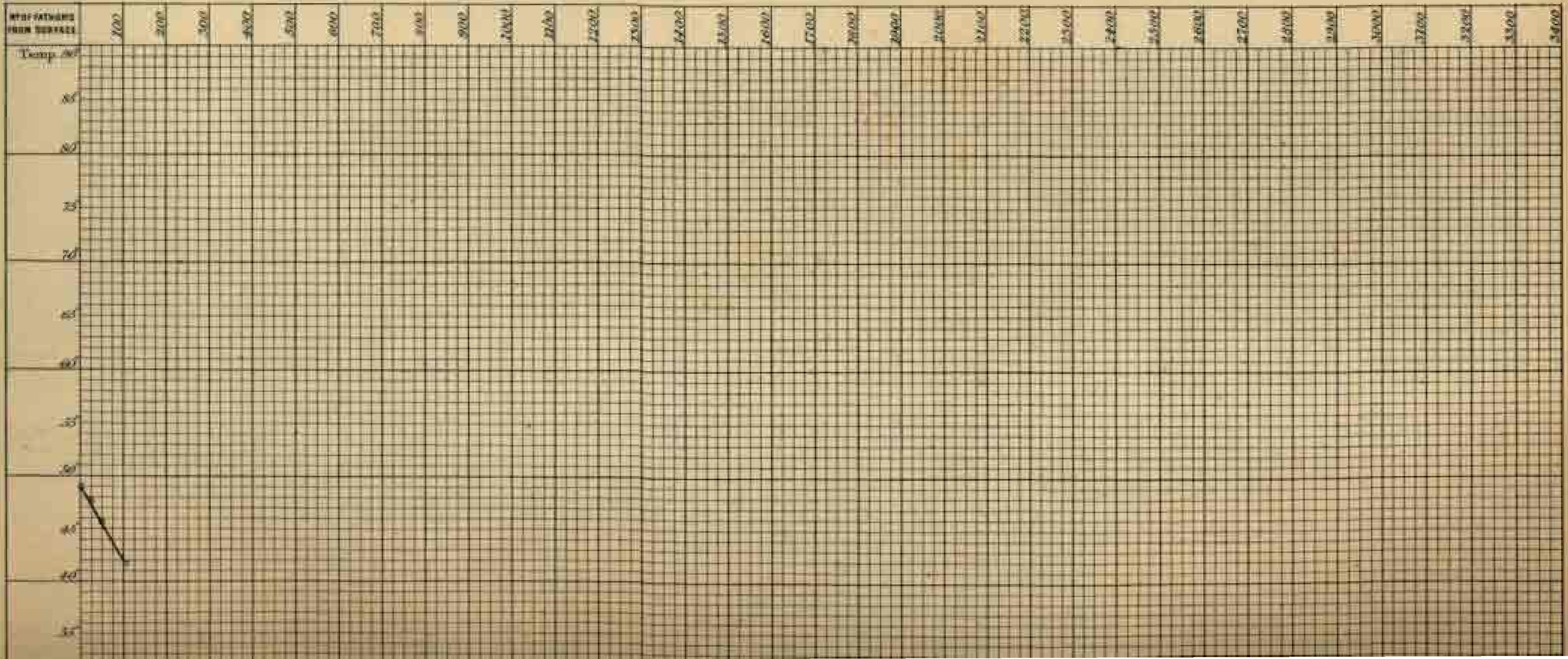
N° of Sounding 464.
Station 314 a.

Depth 110 *fathoms.*

Latitude 51° 24′ S.
Longitude 61° 48′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160
N° OF THERMOMETER			93			93											
TEMPERATURE SHEWN BY THERMOMETER	49.0		48.0			46.0											
ERROR OF THERMOMETER	0.0		−0.2			−0.2											
CORRECTED TEMPERATURE	49.0		47.8			45.8											
TEMPERATURE FROM CURVE	49.0		47.4			45.8											

N° OF FATHOMS FROM SURFACE	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER																												93
TEMPERATURE SHEWN BY THERMOMETER																												42.0
ERROR OF THERMOMETER																												−0.2
CORRECTED TEMPERATURE																												41.8
TEMPERATURE FROM CURVE																												41.8



SECTION. FALKLAND ISLANDS TO MONTE VIDEO.

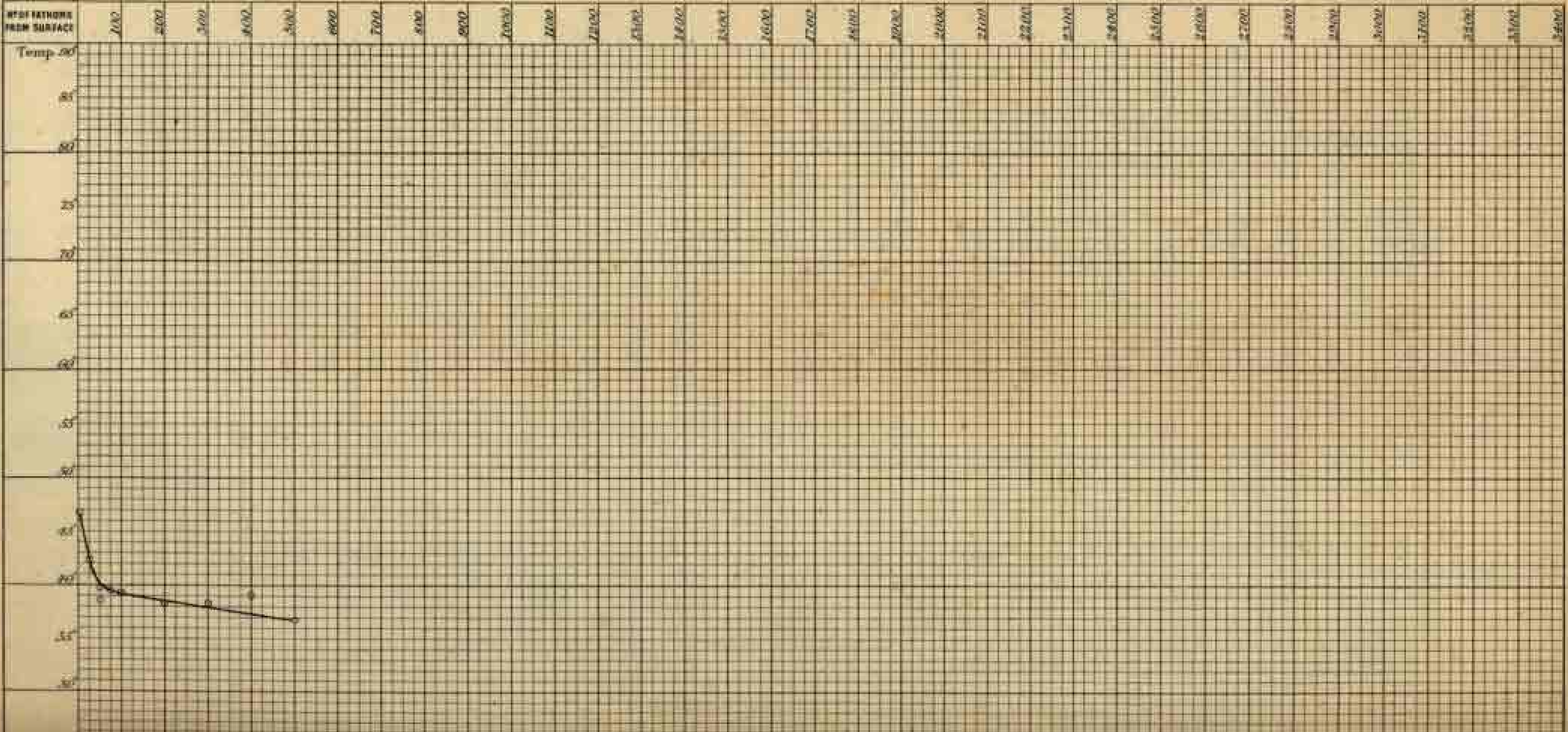
8 February 1876.

No. of Sounding 467.
Station 317.

Depth 1035 fathoms.

Latitude 48° 37′ S.
Longitude 55° 17′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer			93			89 97		87			87										89				0.4	0.5	91																		93 85
Temperature shewn by Thermometer	46.7		42.5			38.5 39.8		39.5			39.2										38.0				37.8	39.0	37.0																		35.6 35.5
Error of Thermometer	0.0		−0.2			+0.2 +0.1		+0.1			+0.1										+0.2				+0.5	0.0	−0.2																		−0.2 +0.5
Corrected Temperature	46.7		42.3			38.7 39.9		39.6			39.3										38.2				38.3	39.0	36.8																		35.4 36.0
Temperature from Curve	46.7		42.3			40.0		39.6			39.3										38.6				38.0	37.4	36.8																		35.7



SECTION. FALKLAND ISLANDS TO MONTE VIDEO.

11 February 1876.

No. of Sounding 468.
Station 318

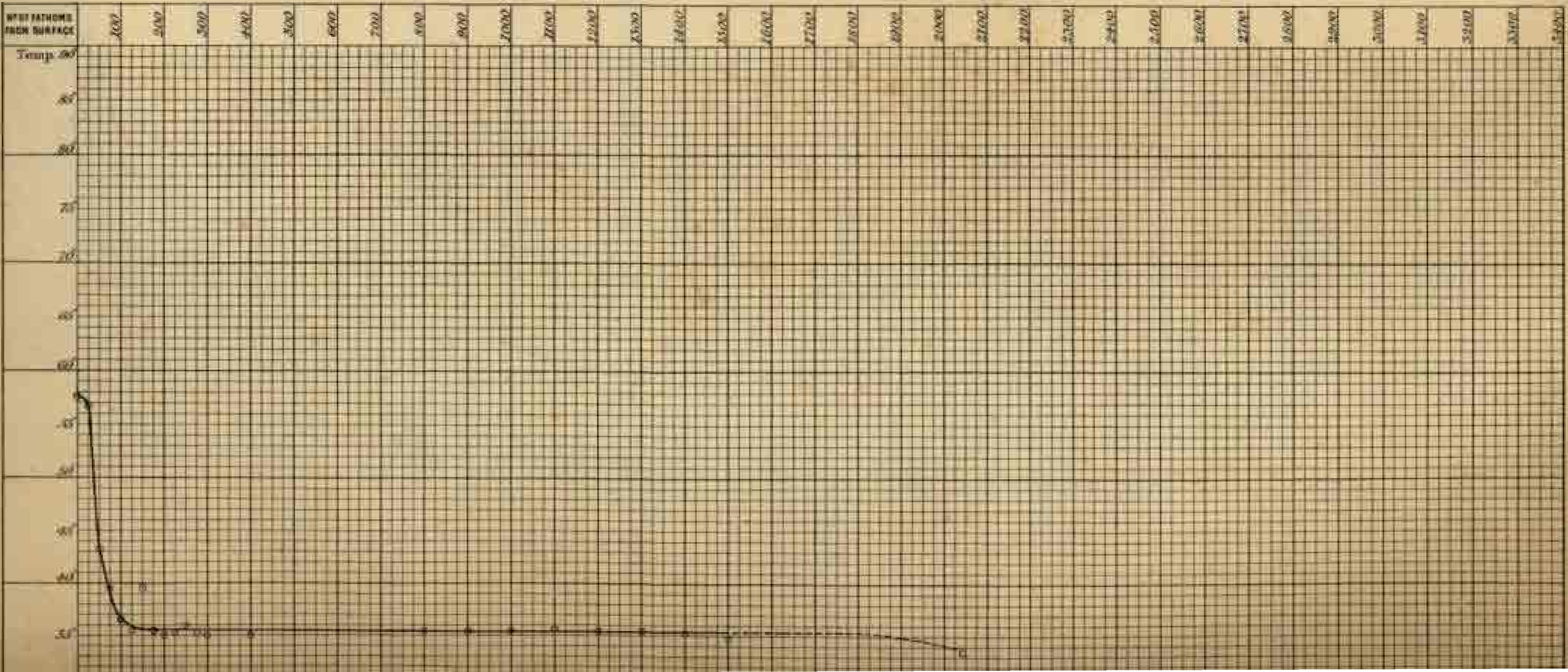
Depth 2040 fathoms.

Latitude 42° 32′ S.
Longitude 56° 29′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140
No. OF THERMOMETER			94			43		87			116		87		
TEMPERATURE SHEWN BY THERMOMETER	57·1		56·8			43·9		39·5			36·8		35·4		
ERROR OF THERMOMETER	0·0		−0·1			0·0		+0·1			−0·2		+0·1		
CORRECTED TEMPERATURE	57·1		56·7			43·9		39·6			36·6		35·5		
TEMPERATURE FROM CURVE	57·5		56·7			43·8		39·6			36·5		35·9		

No. OF FATHOMS FROM SURFACE	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800
No. OF THERMOMETER	69		88			74	75	64	72	77	93				94
TEMPERATURE SHEWN BY THERMOMETER	35·5		35·0			35·0	35·0	35·5	35·0	34·8	35·2				35·5
ERROR OF THERMOMETER	0·0		+0·5			0·0	+0·2	+0·5	+0·8	+0·2	−0·2				−0·1
CORRECTED TEMPERATURE	35·5		35·5			35·0	35·2	36·0	35·8	35·0	35·0				35·4
TEMPERATURE FROM CURVE	35·6		35·4			35·4	35·4	35·4	35·4	35·4	35·4				35·4

No. OF FATHOMS FROM SURFACE	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER	89	85	84	94	85	89	91								93 85
TEMPERATURE SHEWN BY THERMOMETER	35·2	35·0	35·0	35·5	34·8	35·0	35·0								33·8 33·8
ERROR OF THERMOMETER	+0·2	+0·5	+0·5	−0·1	+0·5	+0·2	−0·2								−0·2 +0·1
CORRECTED TEMPERATURE	35·4	35·5	35·5	35·4	35·3	35·2	34·8								33·6 33·9
TEMPERATURE FROM CURVE	35·4	35·4	35·4	35·4	35·4	35·4	35·4								33·7



SECTION. FALKLAND ISLANDS TO MONTE VIDEO.

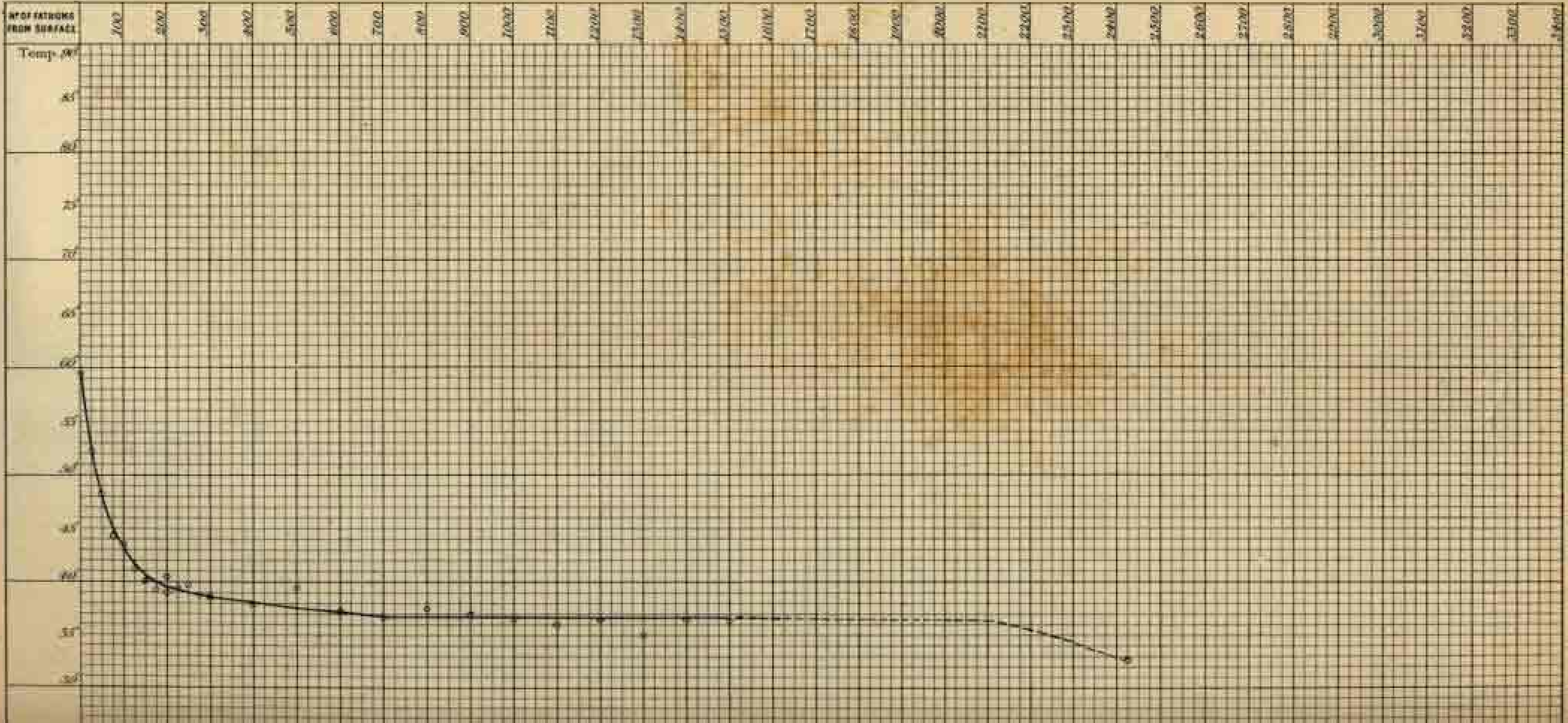
12 February 1876.

No of Sounding 469.
Station 319.

Depth 2425 fathoms.

Latitude 41° 54′ S.
Longitude 54° 48′ W.

No OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No OF THERMOMETER			88			87		93			87 72		74			88		74 85			93 416	77	77	88	85	75	95	87	94	[illegible]	89	93	94	89	85	[illegible]	75								93 87
TEMPERATURE SHEWN BY THERMOMETER	59·5		53·7			48·1		44·3			43·2 43·3		41·8			39·6		39·0 38·9			39·2 40·6	39·1	39·5	38·2	38·0	37·8	39·3	37·0	36·9	37·0	36·8	36·8	36·5	36·5	34·5	36·1	36·1								33·0 32·5
ERROR OF THERMOMETER	0·0		+0·5			+0·1		−0·2			+0·1 +0·2		0·0			+0·5		0·0 +0·5			−0·2 −0·2	+0·2	+0·2	+0·5	+0·5	+0·2	0·0	+0·1	−0·1	+0·5	+0·2	−0·2	−0·1	+0·2	+0·5	+0·5	+0·2								−0·2 +0·1
CORRECTED TEMPERATURE	59·5		53·9			48·2		44·1			43·3 43·5		41·8			40·1		39·0 39·4			39·0 40·4	39·3	39·7	38·7	38·5	38·0	39·3	37·1	36·8	37·5	37·0	36·6	36·4	36·7	35·0	36·6	36·3								32·8 32·6
TEMPERATURE FROM CURVE	59·5		52·0			48·0		44·8			43·6		41·6			40·6		40·0			39·5	39·2	39·0	38·8	38·6	38·1	37·6	37·1	36·8	36·8	36·8	36·8	36·8	36·8	36·8	36·8	36·8								32·7



14 February 1876.

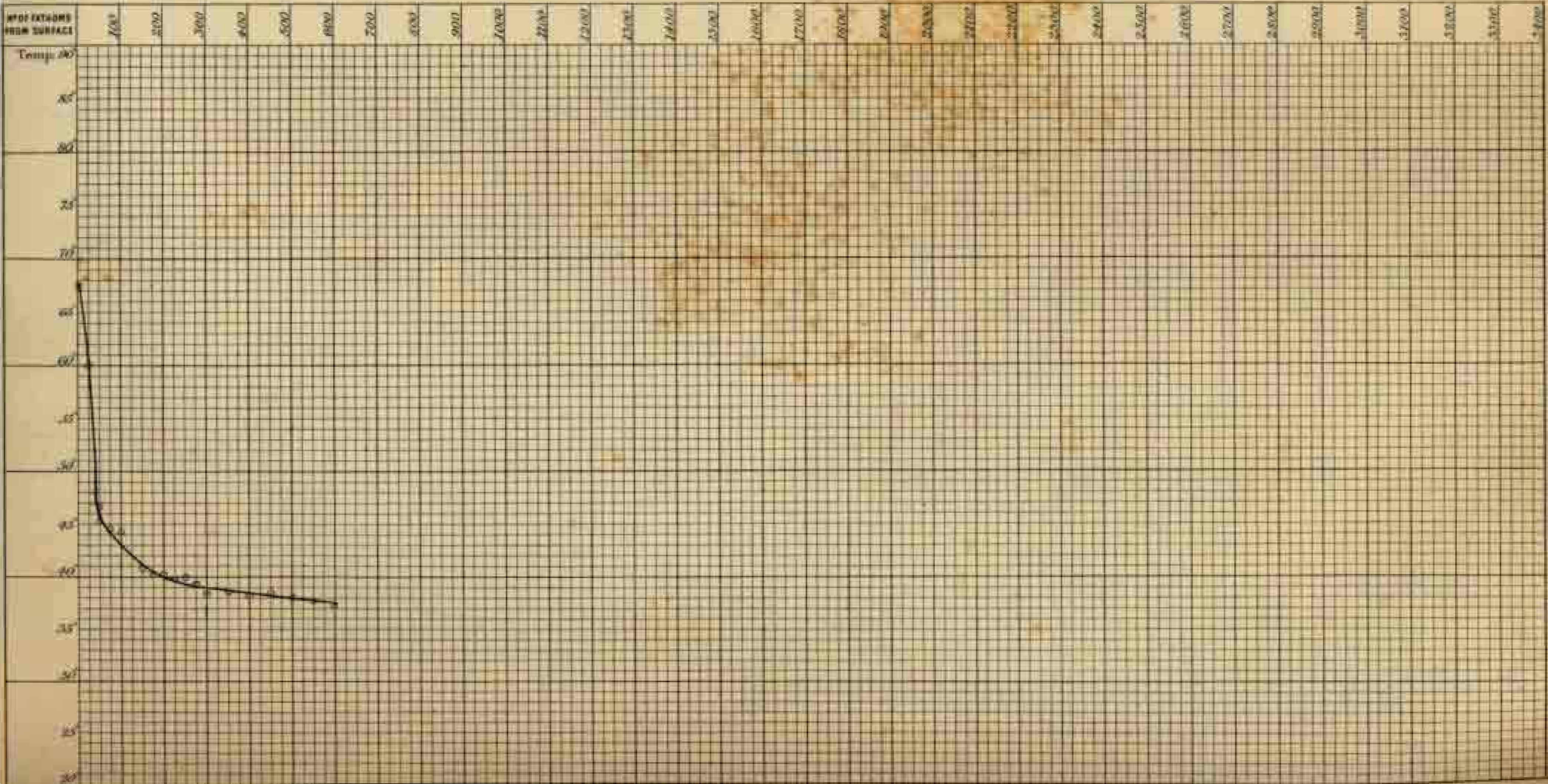
Nº of Sounding 470.
Station 320

Depth 600 fathoms.

Latitude 37° 17′ S.
Longitude 53° 52′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
Nº OF THERMOMETER			93			75 0.4		88			91		87			77		89		
TEMPERATURE SHEWN BY THERMOMETER	67.5		60.2			45.2 46.0		43.9			44.3					40.5		40.0		
ERROR OF THERMOMETER	0.0		−0.2			+0.2 +0.5		+0.5			−0.1					+0.2		+0.2		
CORRECTED TEMPERATURE	67.5		60.0			45.4 46.5		44.4			44.2					40.7		40.2		
TEMPERATURE FROM CURVE	67.5		60.0			46.0		44.0			43.0		42.0			41.0		40.3		

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	350	400	450	500	550	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	83	0.4	85	89	77	87	94	88	75	0.4															93 85
TEMPERATURE SHEWN BY THERMOMETER	39.8	39.5	39.5	39.2	38.2	38.7	38.4	38.0	37.6	37.1															37.2 36.9
ERROR OF THERMOMETER	+0.5	+0.5	+0.5	+0.2	+0.2	+0.1	−0.1	+0.5	+0.2	+0.5															−0.2 +0.5
CORRECTED TEMPERATURE	40.3	40.0	40.0	39.4	38.4	38.8	38.3	38.5	37.8	37.6															37.0 37.4
TEMPERATURE FROM CURVE	40.0	39.8	40.1	39.3	39.1	38.8	38.4	38.2	37.9	37.8															37.2



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

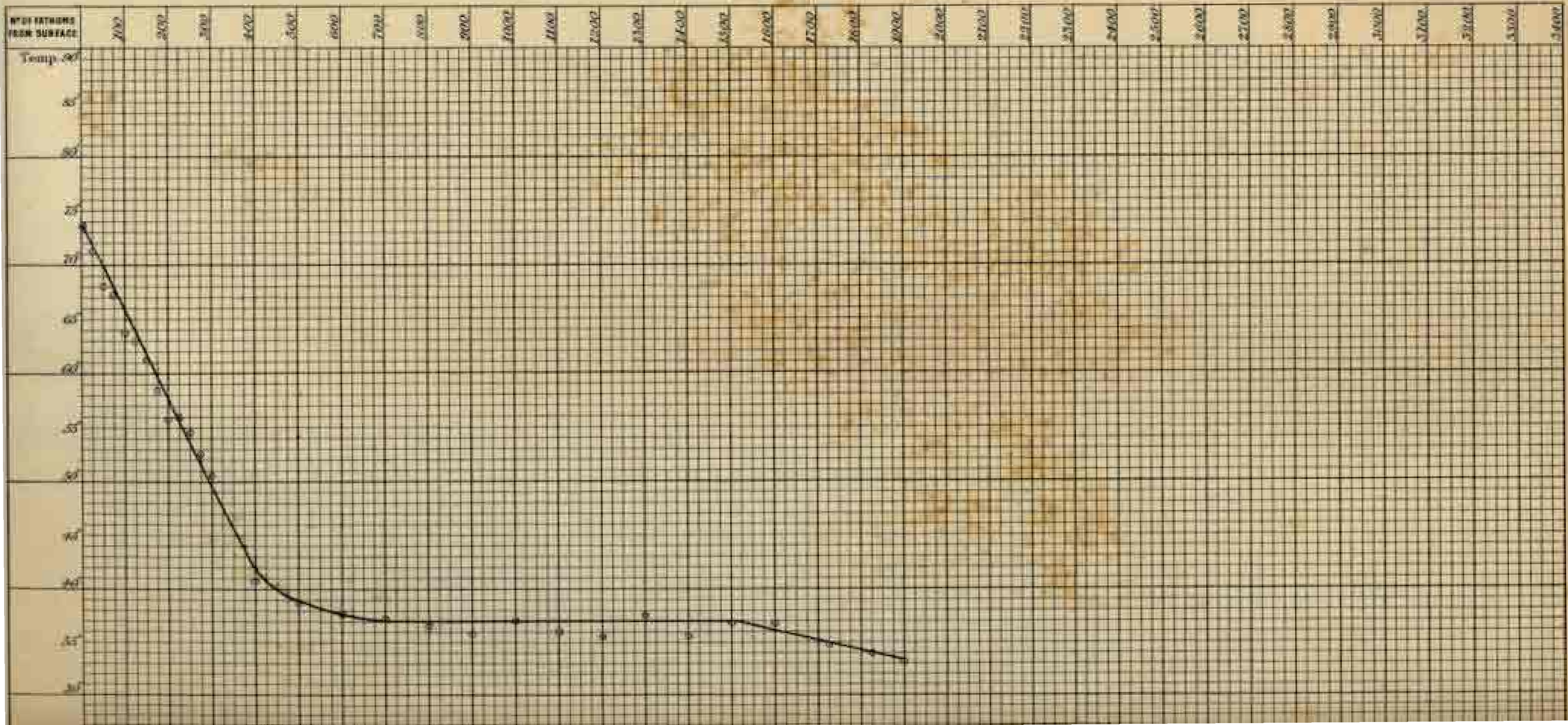
28 February 1876.

No. of Sounding 473.
Station 323.

Depth 1900 fathoms.

Latitude 35° 39′ S.
Longitude 50° 47′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1725	1775	1823	2000			BOTTOM
No. OF THERMOMETER			63			94		116			693		696			78		65			696	56	116	86	693	692	77	86	116	696	65	74	41	93	72	89	89	94	72	65	49				85 93
TEMPERATURE SHEWN BY THERMOMETER	73.5		71.3			68.0		67.3			63.8		62.8			61.2		58.1			55.3	56.0	54.7	52.4	50.5	40.9	39.1	37.8	37.2	36.5	36.0	37.0	36.0	35.8	35.2	35.2	36.9	36.9	34.6		33.8				32.6 33.1
ERROR OF THERMOMETER	0.0		−0.2			0.0		0.0			0.0		+0.2			0.0		−0.2			+0.2	0.0	0.0	0.0	0.0	0.0	−0.2	0.0	0.0	+0.2	−0.2	0.0	0.0	0.0	+0.2	+0.5	0.0	0.0	+0.2		0.0				+0.5 0.0
CORRECTED TEMPERATURE	73.5		71.1			68.0		67.3			63.8		63.0			61.2		58.3			55.0	56.0	54.7	52.4	50.5	40.9	38.9	37.8	37.2	36.7	35.8	37.0	36.0	35.8	37.4	35.7	36.9	36.9	34.8		33.8				33.1 33.1
TEMPERATURE FROM CURVE	73.5		71.5			69.5		67.5			65.5		63.5			61.5		59.5			57.5	55.5	53.5	51.5	49.5	40.0	38.9	37.8	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	36.3	34.8		33.8				33.1



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

29 February 1876.

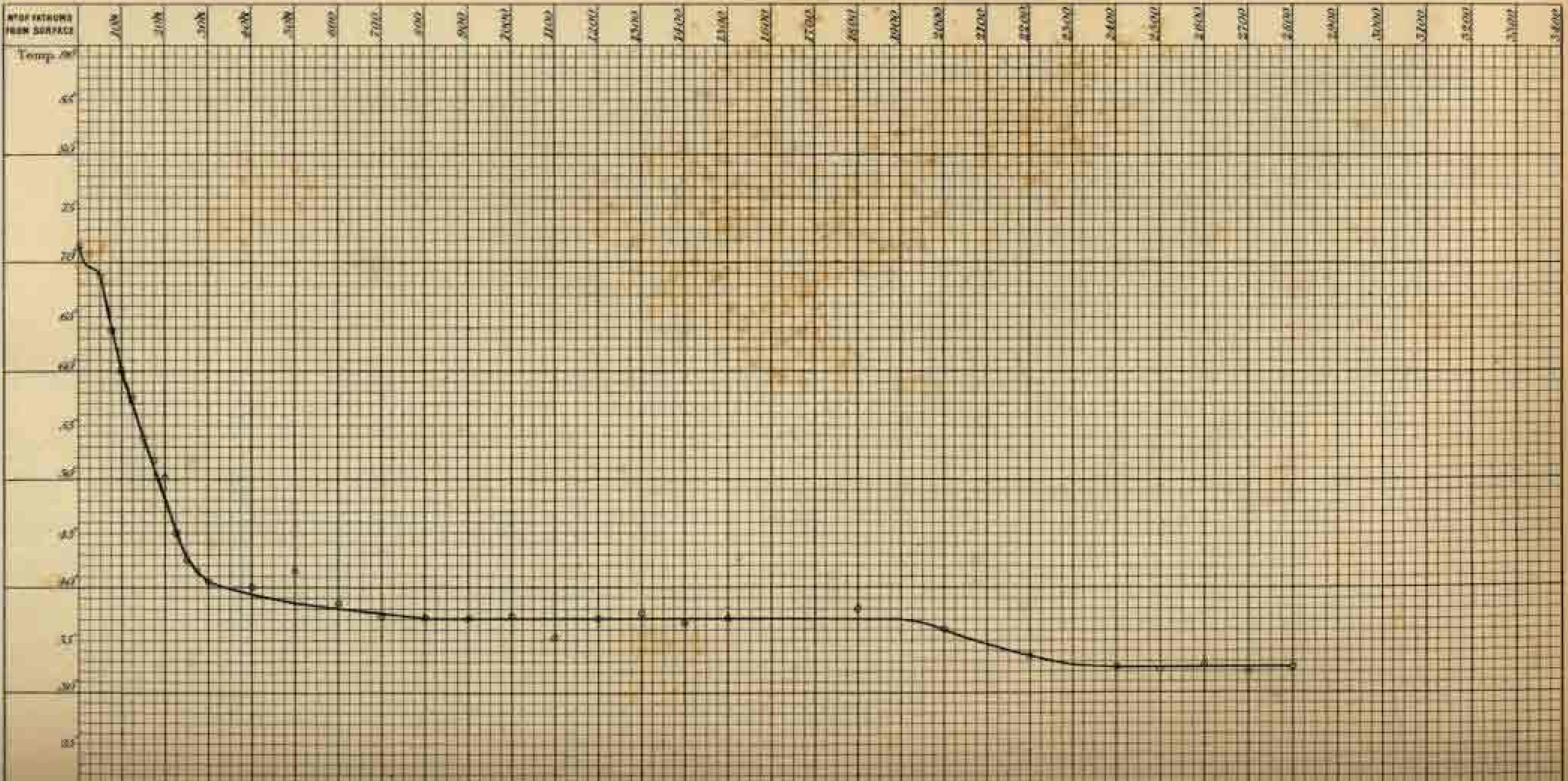
Depth 2800 fathoms.

Nº of Sounding 474.
" Station 324.

Latitude 36° 9′ S.
Longitude 48° 22′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225
Nº OF THERMOMETER		696	693	416	36	84		93			89		85			74		79			71	86
TEMPERATURE SHEWN BY THERMOMETER	71.5	69.5	69.0	69.5	69.3	68.8		64.0			60.0		57.0			53.8		51.6			50.3	45.0
ERROR OF THERMOMETER	0.0	+0.2	0.0	0.0	0.0	0.0		0.0			0.0		+0.5			0.0		+0.2			−0.2	0.0
CORRECTED TEMPERATURE	71.5	69.7	69.0	69.5	69.3	68.8		64.0			60.0		57.5			53.8		51.8			50.1	45.0
TEMPERATURE FROM CURVE	71.5	69.7	69.6	69.3	69.3	68.8		64.0			60.0		56.5			53.8	–	50.8			48.0	45.0

Nº OF FATHOMS FROM SURFACE	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1800	2000	2200	2400	2500	2600	2700	BOTTOM
Nº OF THERMOMETER	696	693	416	75	71	416	696	86	693	94	693	75	416	696	89	49	89	85	93	94	49	83	93 86
TEMPERATURE SHEWN BY THERMOMETER	42.0	41.5	40.5	39.8	41.8	38.5	37.0	37.1	37.0	37.9	35.2	36.8	37.5	36.5	37.0	38.0	36.0	32.8	32.5	32.4	32.6	31.5	32.4 32.8
ERROR OF THERMOMETER	+0.4	0.0	0.0	+0.2	−0.2	0.0	+0.2	0.0	0.0	0.0	0.0	+0.2	0.0	+0.2	0.0	0.0	0.0	+0.5	0.0	0.0	0.0	+0.5	0.0 0.0
CORRECTED TEMPERATURE	42.4	41.5	40.5	40.0	41.6	38.5	37.2	37.1	37.0	37.9	35.2	37.0	37.5	36.7	37.0	38.0	36.0	33.3	32.5	32.4	32.6	32.0	32.4 32.8
TEMPERATURE FROM CURVE	42.5	41.5	40.6	39.4	38.6	38.1	37.5	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	36.0	33.3	32.6	32.6	32.6	32.6	32.6



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

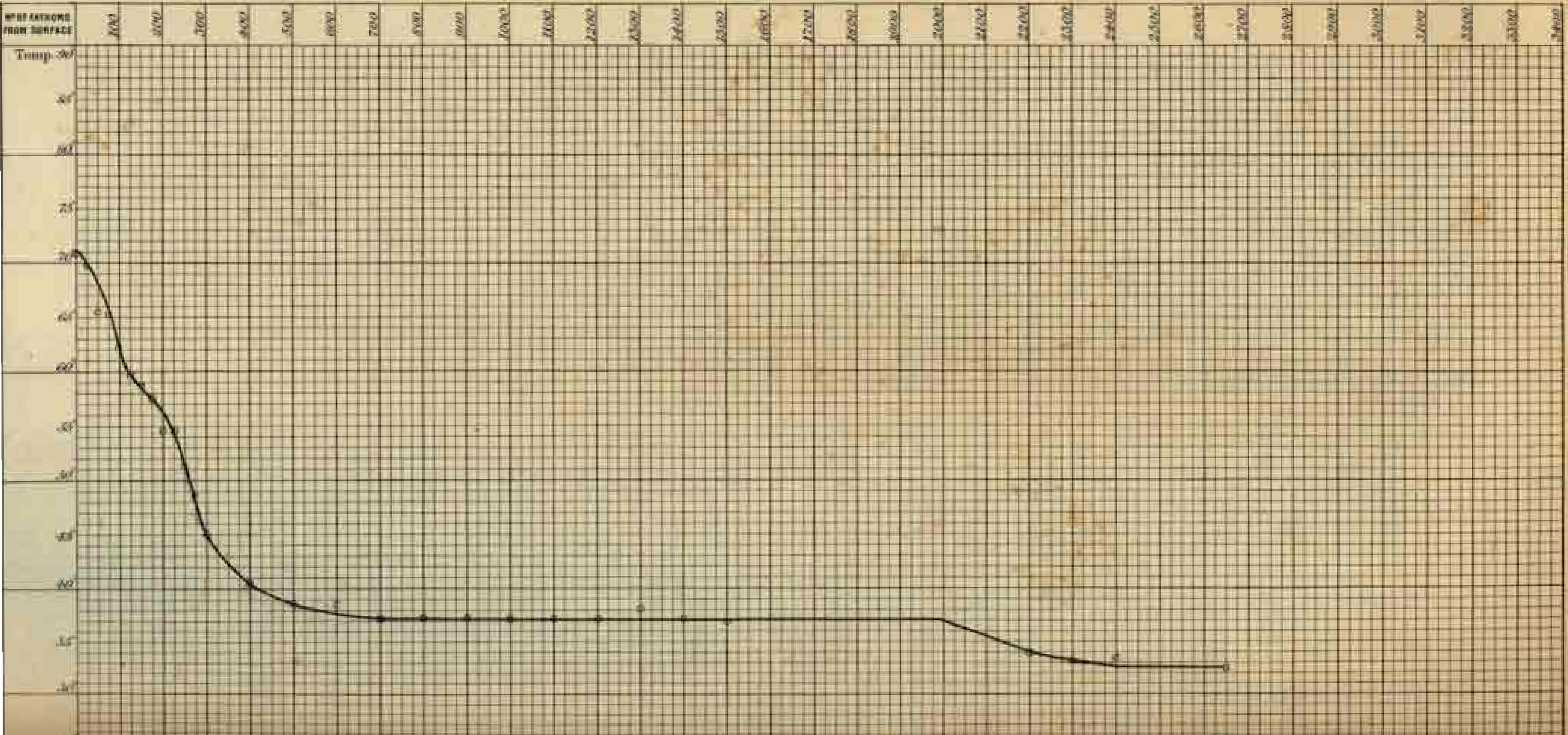
2 March 1876.

No. of Sounding 476.
. . Station 325.

Depth 2650 fathoms

Latitude 36° 44′ S.
Longitude 46° 16′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2200	2300	2400	Bottom
No. of Thermometer			53			62		71			74		696			66		89			94	49	216	699	85	216	692	19	94	89	85	86	94	26	85	49	89					89	75	49	77 66
Temperature shown by Thermometer	70.8		69.8			65.8		65.3			62.2		59.5			58.8		57.5			34.6	34.5	52.2	48.5	44.5	40.5	38.8	38.4	37.3	37.4	36.8	37.1	37.2	37.2	37.5	37.7	37.0					34.0	33.0	33.3	32.8 32.6
Error of Thermometer	0.0		0.0			+0.2		−0.2			0.0		+0.2			0.0		0.0			0.0	0.0	0.0	0.0	+0.5	0.0	0.0	0.0	0.0	0.0	+0.3	0.0	0.0	0.0	+0.3	0.0	0.0					0.0	+0.2	0.0	0.0 0.0
Corrected Temperature	70.8		69.8			65.6		65.3			62.2		59.7			58.8		57.5			34.6	34.5	52.2	48.5	45.0	40.5	38.8	38.5	37.3	37.2	37.2	37.1	37.2	37.2	38.0	37.8	37.0					34.0	33.0	33.5	32.8 32.6
Temperature from Curve	70.8		69.8			68.1		65.3			62.2		59.7			58.3		57.5			36.1	34.3	52.2	48.3	45.0	40.4	38.8	37.8	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2					34.0	33.2	32.8	32.7



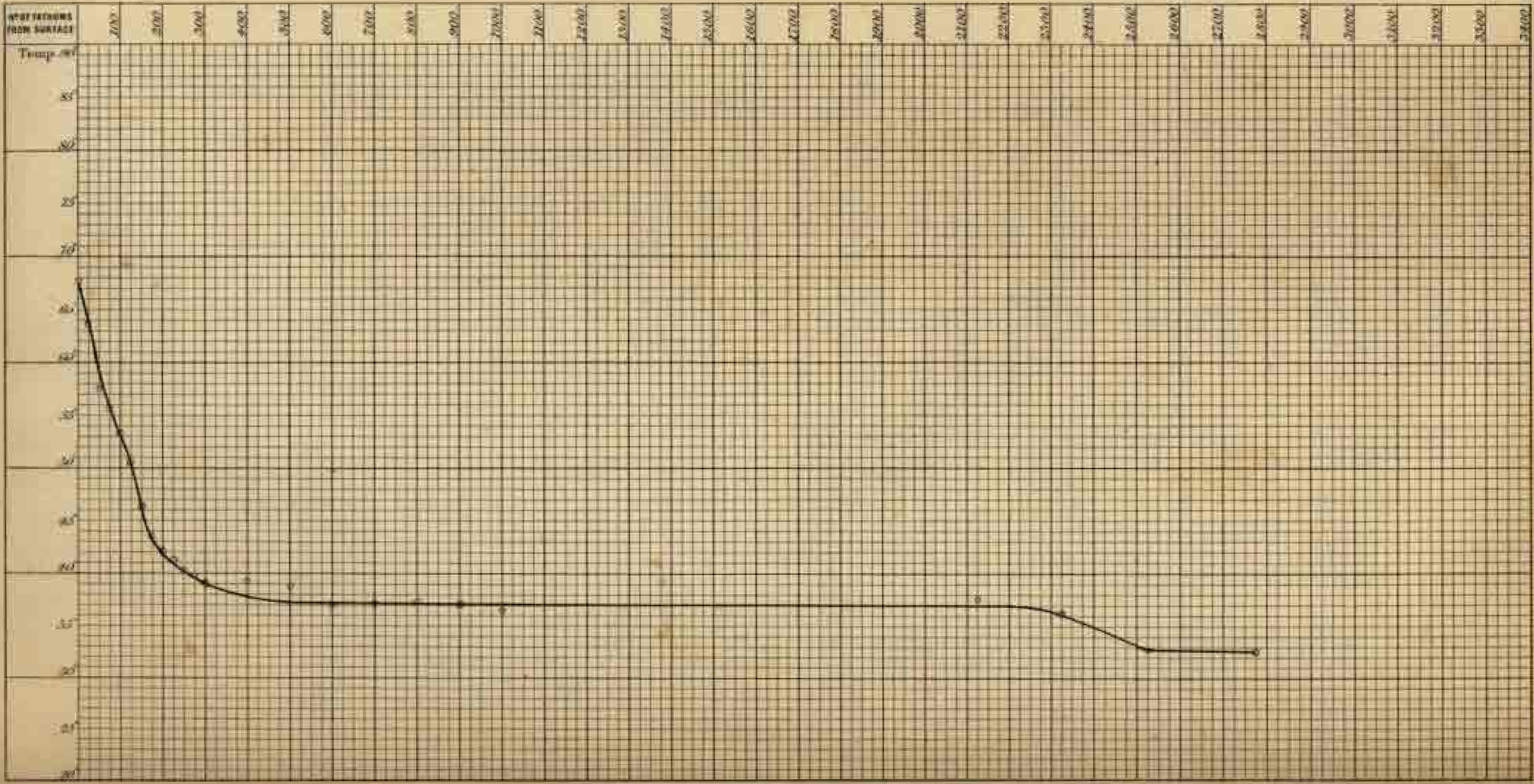
3 March 1876.

Nº of Sounding 476.
Station 326

Depth 2775 fathoms.

Latitude 37° 8′ S.
Longitude 44° 17′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	2123	2325	2525			BOTTOM
Nº OF THERMOMETER			896			71		72			893		215			65		94			71	896	74	72	893	216	65	94	71	75	74	896								85	49	89			93 86
TEMPERATURE SHEWN BY THERMOMETER	67.8		63.5			57.3		55.6			53.3		50.4			46.2		43.5			42.2	41.1	40.0	39.5	39.1	39.1	39.1	37.0	37.2	37.0	37.0	36.4								37.1	36.2	34.4			32.7 32.6
ERROR OF THERMOMETER	0.0		+0.2			0.0		+0.2			0.0		0.0			−0.1		0.0			−0.2	+0.2	0.0	+0.2	0.0	0.0	−0.2	0.0	−0.2	+0.2	0.0	+0.2								+0.5	0.0	−1.0			0.0 0.0
CORRECTED TEMPERATURE	67.8		63.7			57.3		55.8			53.3		50.4			46.1		43.5			42.0	41.3	40.0	39.7	39.1	39.1	38.9	37.0	37.0	37.2	37.0	36.6								37.6	36.2	33.4			32.7 32.6
TEMPERATURE FROM CURVE	67.8		63.7			59.0		55.8			53.3		50.4			46.1		43.5			42.0	41.3	40.0	39.7	39.1	37.8	37.2	37.0	37.0	37.0	37.0	37.0								37.0	36.2	33.0			32.6



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

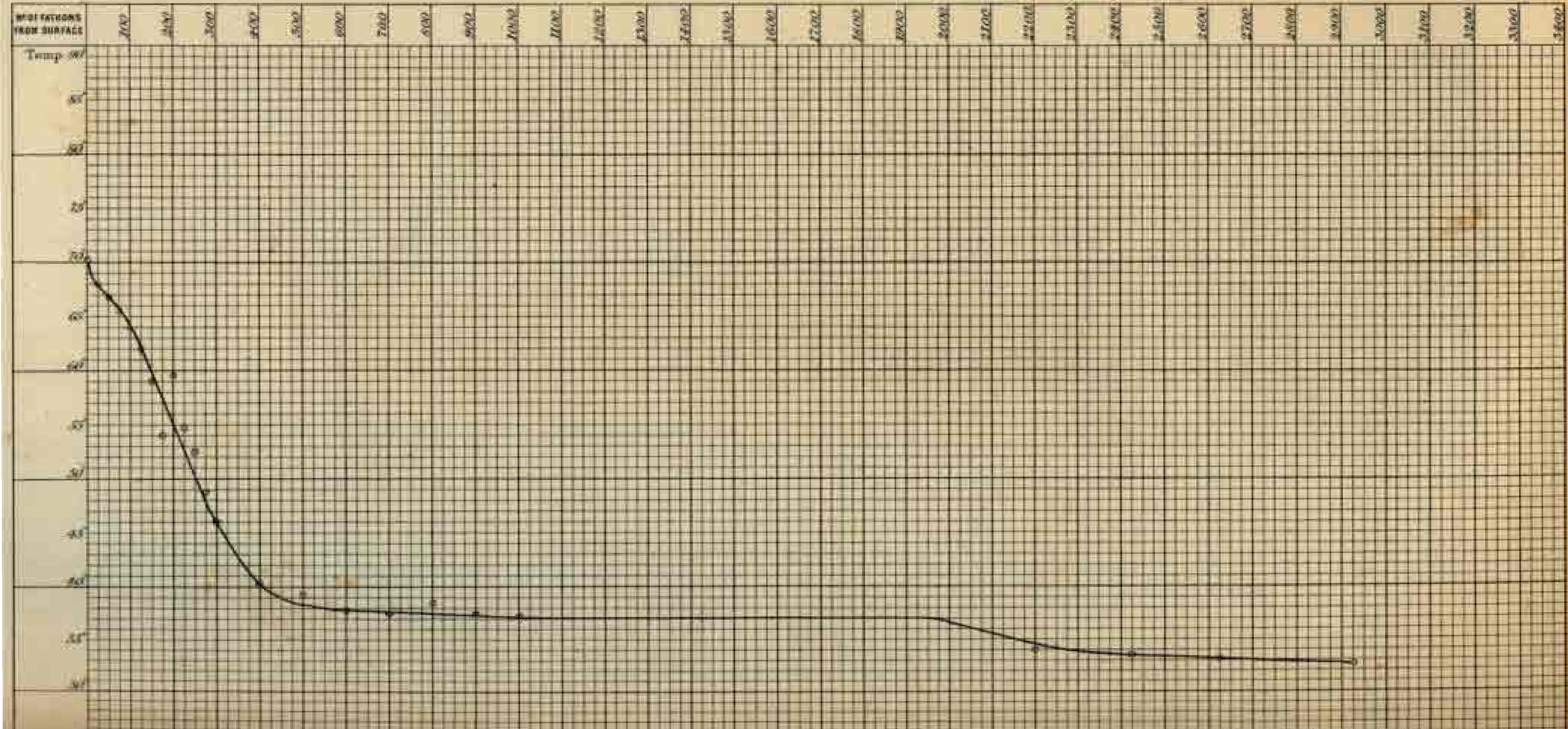
4 March 1876.

No. of Sounding 477.
Station 327.

Depth 2900 fathoms.

Latitude 36° 48′ S.
Longitude 42° 45′ W.

No. of fathoms from surface	No. of thermometer	Temperature shown by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		70.2	0.0	70.2	70.2
10					
25	631	68.0	0.0	68.0	68.0
30					
40					
50	416	66.8	0.0	66.3	66.3
60					
75	89	65.6	0.0	65.6	65.6
80					
90					
100	94	64.0	0.0	64.0	64.0
110					
125	49	60.0	0.0	60.0	60.0
130					
140					
150	85	59.2	−0.2	59.0	59.7
160					
175	74	54.0	0.0	54.0	57.3
180					
190					
200	71	60.0	−0.2	59.8	55.0
225	893	54.8	0.0	54.8	52.5
250	896	52.2	+0.2	52.4	50.3
275	75	49.0	+0.2	49.2	48.2
300	416	46.0	0.0	46.0	46.0
400	49	40.4	0.0	40.4	40.4
500	75	39.0	+0.2	39.2	38.4
600	896	37.6	+0.2	37.8	37.8
700	893	37.6	0.0	37.6	37.6
800	71	38.3	−0.2	38.3	37.4
900	49	37.6	0.0	37.6	37.0
1000	416	37.2	0.0	37.2	37.0
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2225	94	34.0	0.0	34.0	34.0
2425	85	33.0	+0.5	33.5	33.5
2625	89	33.2	0.0	33.2	33.1
Bottom	[illegible]	32.8 32.8	0.0 0.0	32.8 32.8	32.8



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

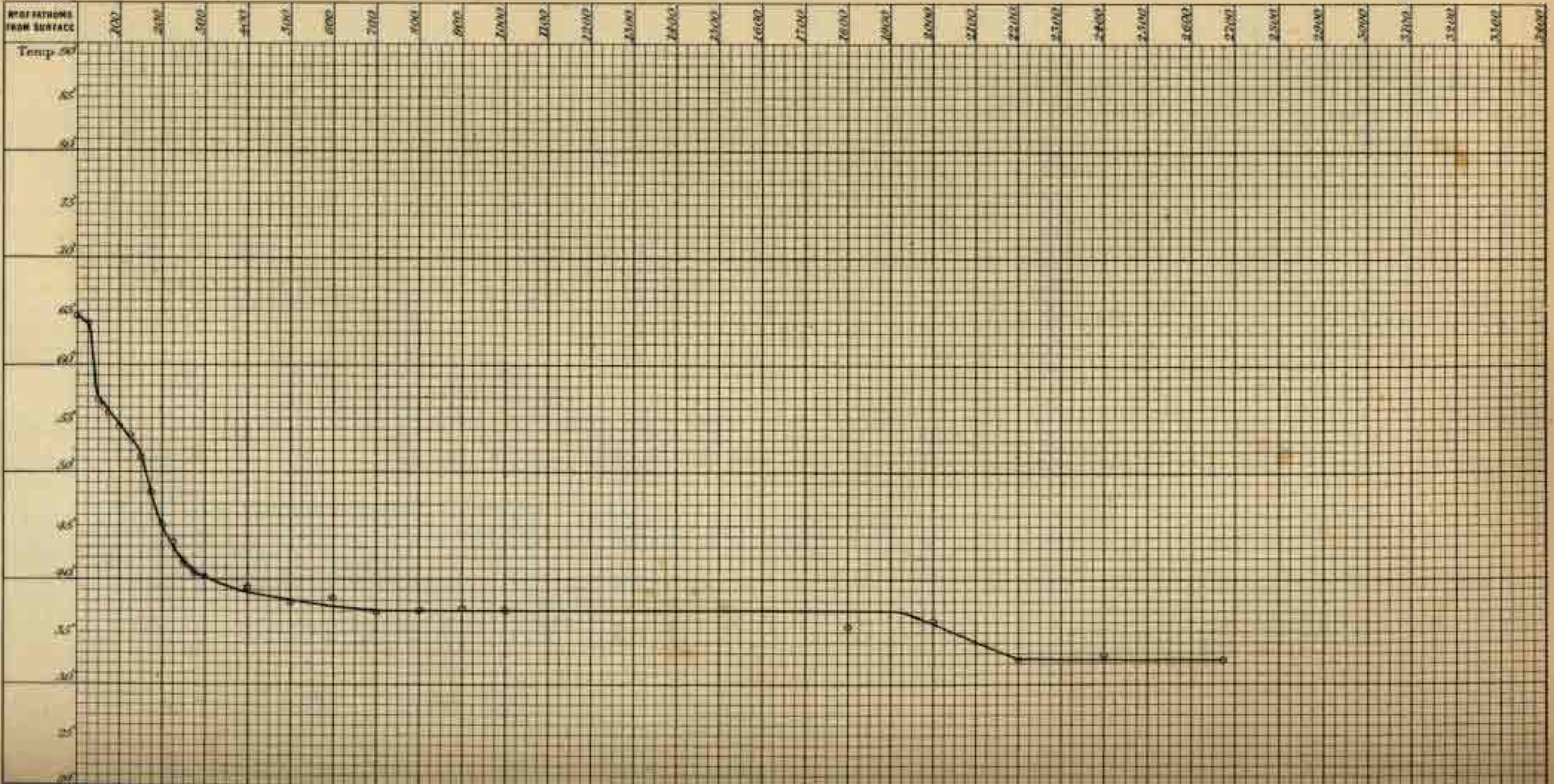
7 March 1876.

Nº of Sounding 479.
Station 329.

Depth 2675 fathoms

Latitude 37° 31′ S.
Longitude 36° 7′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2200	2400	BOTTOM
Nº OF THERMOMETER			93			396		65			89		693			416		693			89	65	396	75	71	71	75	396	65	89	693	416								94		85	74	92	26 93
TEMPERATURE SHEWN BY THERMOMETER	64.5		63.8			56.8		55.8			54.0		53.3			51.3		48.0			45.0	43.8	41.2	40.5	40.5	39.5	37.5	38.0	37.2	37.0	37.1	37.0								35.5		35.7	34.3	34.0	33.3 33.4
ERROR OF THERMOMETER	0.0		0.0			+0.2		-0.2			0.0		0.0			0.0		0.0			0.0	-0.2	+0.2	+0.2	-0.2	-0.2	+0.2	+0.2	-0.2	0.0	0.0	0.0								0.0		+0.5	0.0	0.0	0.0 0.0
CORRECTED TEMPERATURE	64.5		63.8			57.0		55.6			54.0		53.3			51.3		48.0			45.0	43.6	41.4	40.7	40.3	39.3	37.7	38.2	37.0	37.0	37.1	37.0								35.5		36.2	34.3	34.0	33.3 33.4
TEMPERATURE FROM CURVE	64.5		63.7			57.0		55.8			54.5		53.7			51.3		48.0			45.0	43.0	41.5	40.7	40.2	38.9	38.0	37.4	37.0	37.0	37.0	37.0								37.0		36.0	32.6	33.5	33.3



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

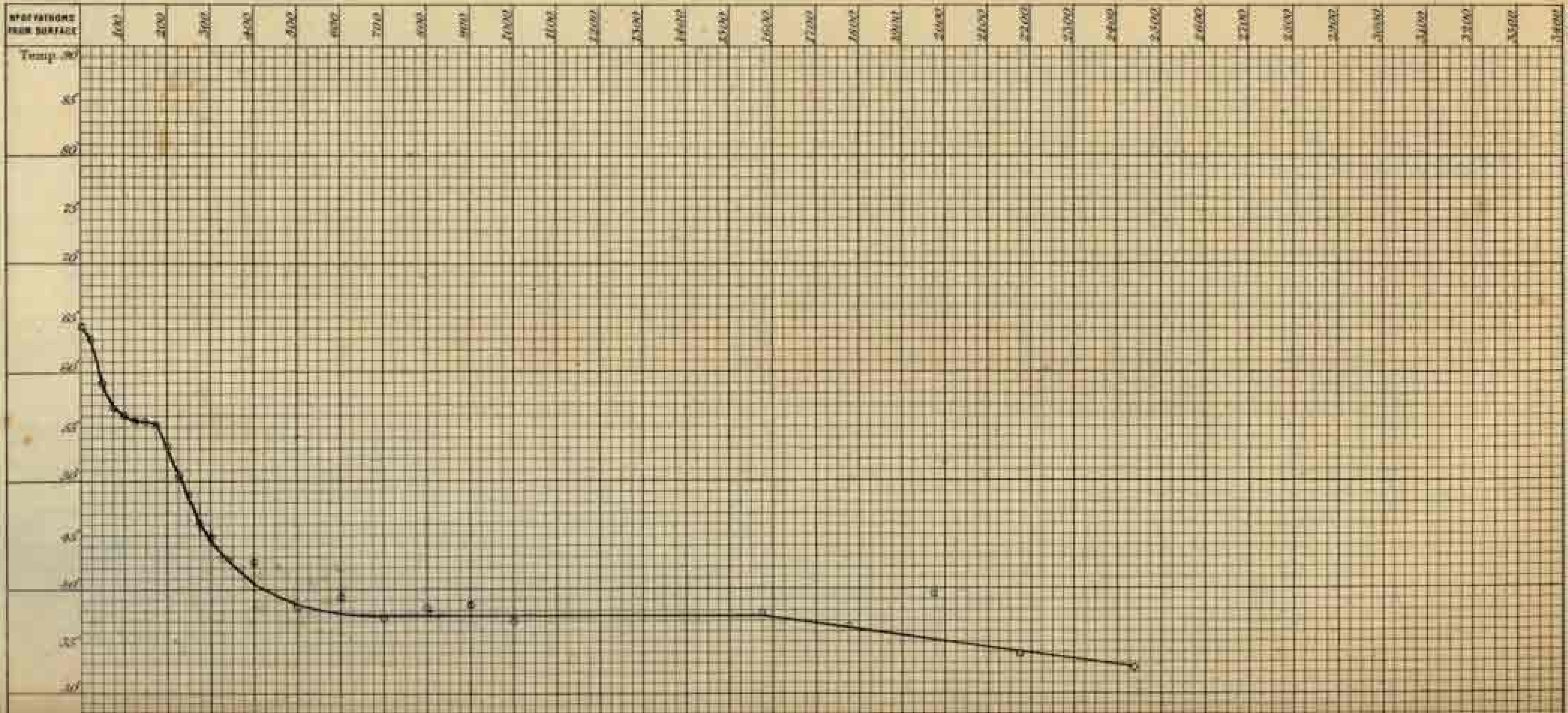
8 March 1876.

No. of Sounding 480.
Station 330.

Depth 2440 fathoms

Latitude 37° 45′ S.
Longitude 33° 0′ W.

No. of Fathoms from Surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1530	1600	1750	1800	1980	2180			Bottom
No. of Thermometer			86			49		89			693		94			75		74			696	93	71	65	40	65	73	72	74	46	296	693					85		89		216	94			92 86
Temperature shewn by Thermometer	64.2		63.0			59.0		57.0			56.2		55.6			55.2		55.2			53.0	50.5	48.1	46.2	44.8	42.8	38.2	39.5	37.2	38.1	38.2	37.0					37.2		36.5		35.5	33.9			32.5 33.0
Error of Thermometer	0.0		0.0			0.0		0.0			0.0		0.0			+0.2		0.0			+0.2	0.0	+0.2	−0.2	0.0	−0.2	+0.2	−0.2	0.0	0.0	+0.2	0.0					+0.5		0.0		0.0	0.0			0.0 0.0
Corrected Temperature	64.2		63.0			59.0		57.0			56.2		55.6			55.4		55.2			53.2	50.5	48.3	46.0	44.8	42.6	38.4	39.3	37.2	38.1	38.4	37.0					37.7		36.5		35.5	33.9			32.5 33.0
Temperature from Curve	64.2		63.0			59.0		57.0			56.2		55.6			55.4		55.2			53.0	50.5	48.0	46.0	44.7	40.7	38.7	37.8	37.5	37.5	37.5	37.5					37.3		36.5		35.3	34.2			32.7



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA

9 March 1876.

Nº of Sounding 481.
Station 331.

Depth 1715 fathoms.

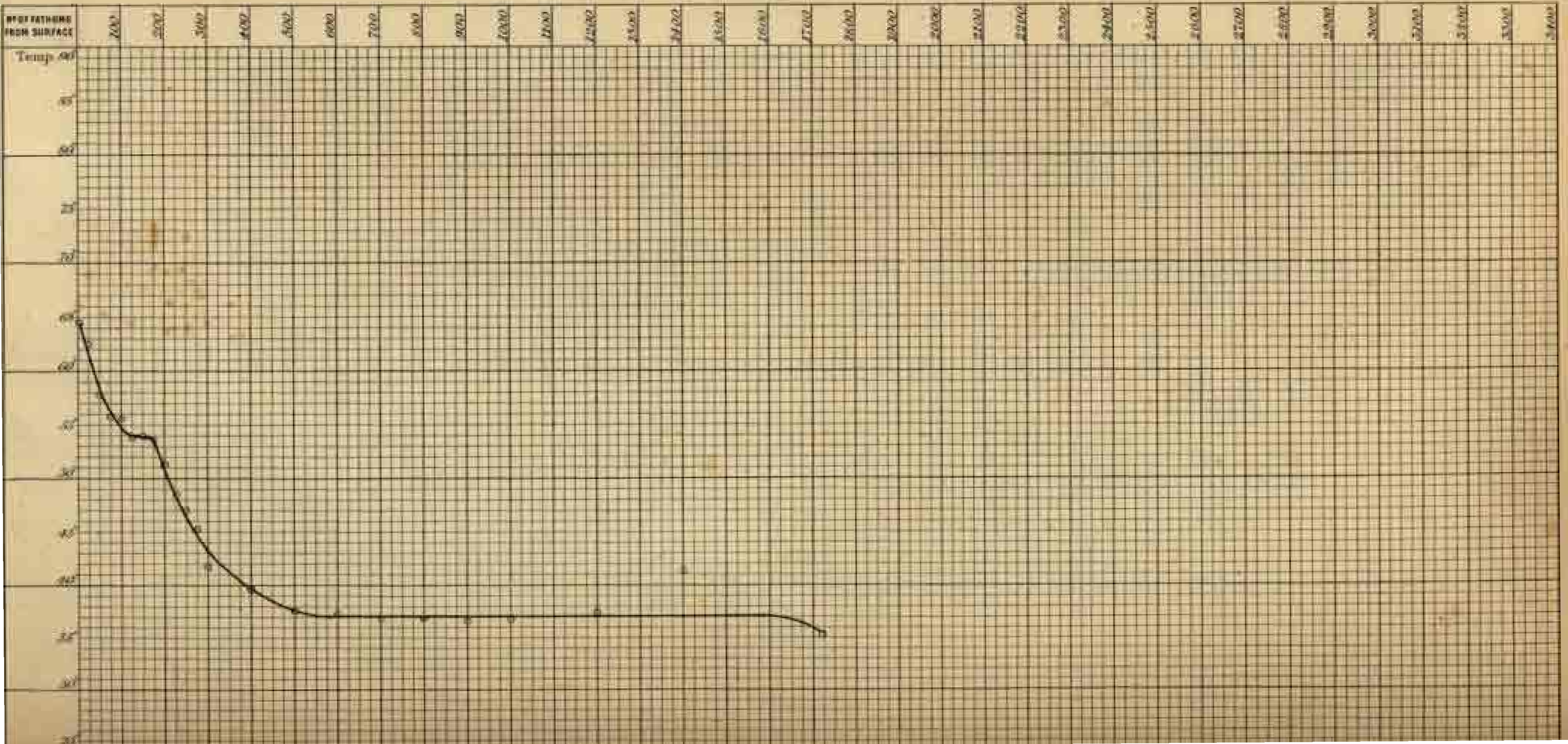
Latitude 37° 47′ S
Longitude 30° 20′ W

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100
Nº OF THERMOMETER			86			73		87			80
TEMPERATURE SHEWN BY THERMOMETER	64.5		60.3			57.2		56.2			55.3
ERROR OF THERMOMETER	0.0		0.0			+0.2		−0.3			0.0
CORRECTED TEMPERATURE	64.5		60.3			57.4		55.9			55.3
TEMPERATURE FROM CURVE	64.5		60.0			58.1		56.2			54.9

Nº OF FATHOMS FROM SURFACE	110	125	130	140	150	160	175	180	190	200	225	250
Nº OF THERMOMETER		93			94		72			126	73	45
TEMPERATURE SHEWN BY THERMOMETER		54.0			54.0		53.9			51.8	48.4	47.0
ERROR OF THERMOMETER		0.0			0.0		−0.2			0.0	+0.2	0.0
CORRECTED TEMPERATURE		54.0			54.0		53.7			51.8	48.6	47.0
TEMPERATURE FROM CURVE		54.7			54.5		53.7			52.0	48.5	46.3

Nº OF FATHOMS FROM SURFACE	275	300	400	500	600	700	800	900	1000	1100
Nº OF THERMOMETER	116	63	81	93	94	84	83	63	71	
TEMPERATURE SHEWN BY THERMOMETER	45.7	44.0	38.8	37.3	37.0	37.6	37.0	37.0	37.0	
ERROR OF THERMOMETER	0.0	−0.2	0.0	0.0	0.0	0.0	0.0	−0.2	−0.2	
CORRECTED TEMPERATURE	45.7	43.8	38.8	37.3	37.0	37.6	37.0	36.8	36.8	
TEMPERATURE FROM CURVE	45.4	43.3	38.6	37.3	37.0	37.0	37.0	37.0	37.0	

Nº OF FATHOMS FROM SURFACE	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER	69		45									26 93
TEMPERATURE SHEWN BY THERMOMETER	37.0		37.3									35.2 35.5
ERROR OF THERMOMETER	+0.4		0.0									0.0 0.0
CORRECTED TEMPERATURE	37.4		37.3									35.2 35.5
TEMPERATURE FROM CURVE	37.0		37.0									35.1



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

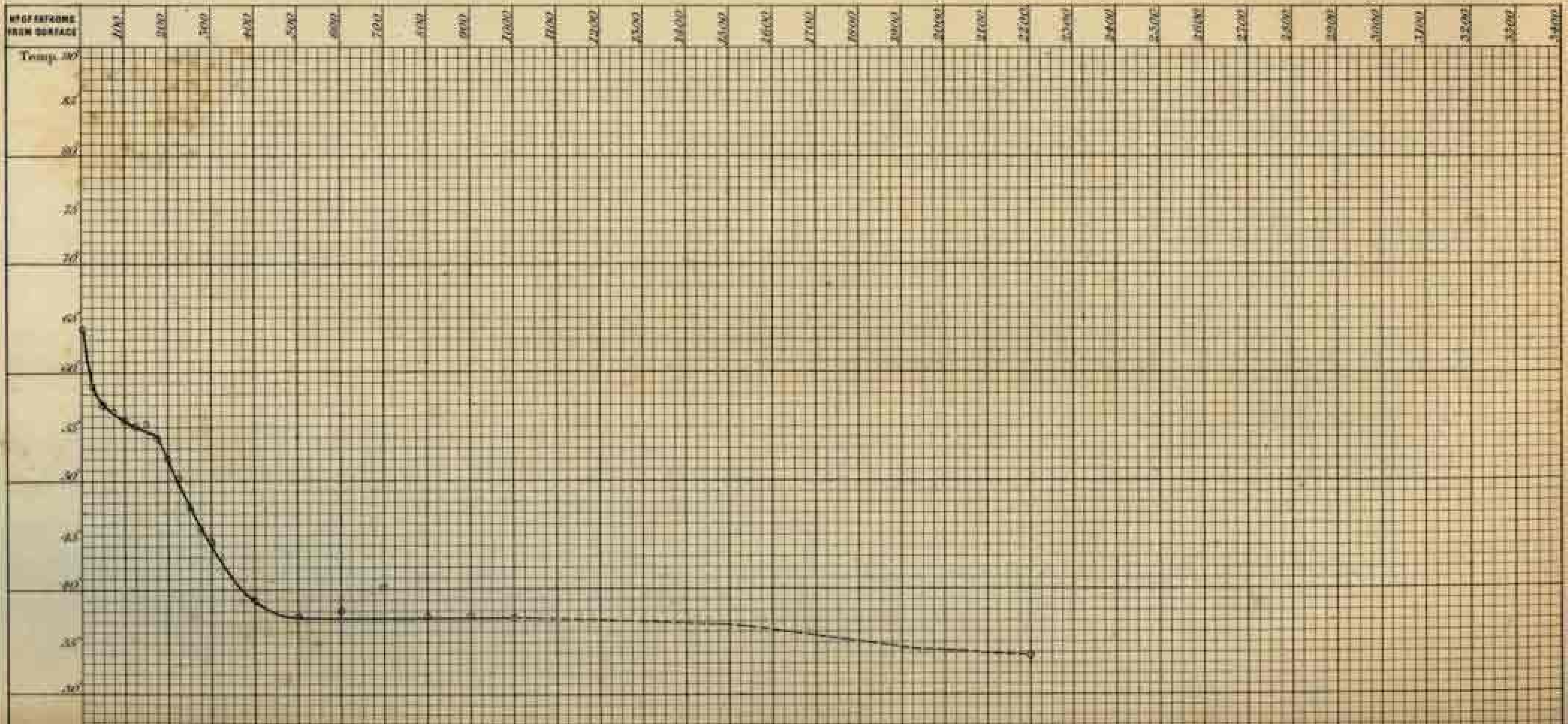
10 March 1876.

Nº of Sounding 482.
" Station 332.

Depth 2200 fathoms.

Latitude 37° 29′ S.
Longitude 27° 31′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			89			94		93			85		86			216		193			89	94	49	96	85	93	94	216	49	89	88	85													86 93
TEMPERATURE SHEWN BY THERMOMETER	64.0		58.8			57.0		56.5			55.0		55.0			55.1		54.0			52.0	50.2	47.5	45.2	43.6	39.0	37.6	38.0	40.2	37.4	37.3	36.8													34.0 34.0
ERROR OF THERMOMETER	0.0		0.0			0.0		0.0			+0.5		0.0			0.0		0.0			0.0	0.0	0.0	+0.2	+0.5	0.0	0.0	0.0	0.0	0.0	0.0	+0.5													0.0 0.0
CORRECTED TEMPERATURE	64.0		58.8			57.0		56.5			55.5		55.0			55.1		54.0			52.0	50.2	47.5	45.4	44.1	39.0	37.6	38.0	40.2	37.4	37.3	37.3													34.0 34.0
TEMPERATURE FROM CURVE	64.0		58.8			57.0		56.2			55.3		55.0			54.7		54.0			52.0	50.0	47.5	45.5	43.8	38.9	37.5	37.3	37.3	37.3	37.3	37.3													34.0



13 March 1876.

Nº of Sounding 483.
Station 333.

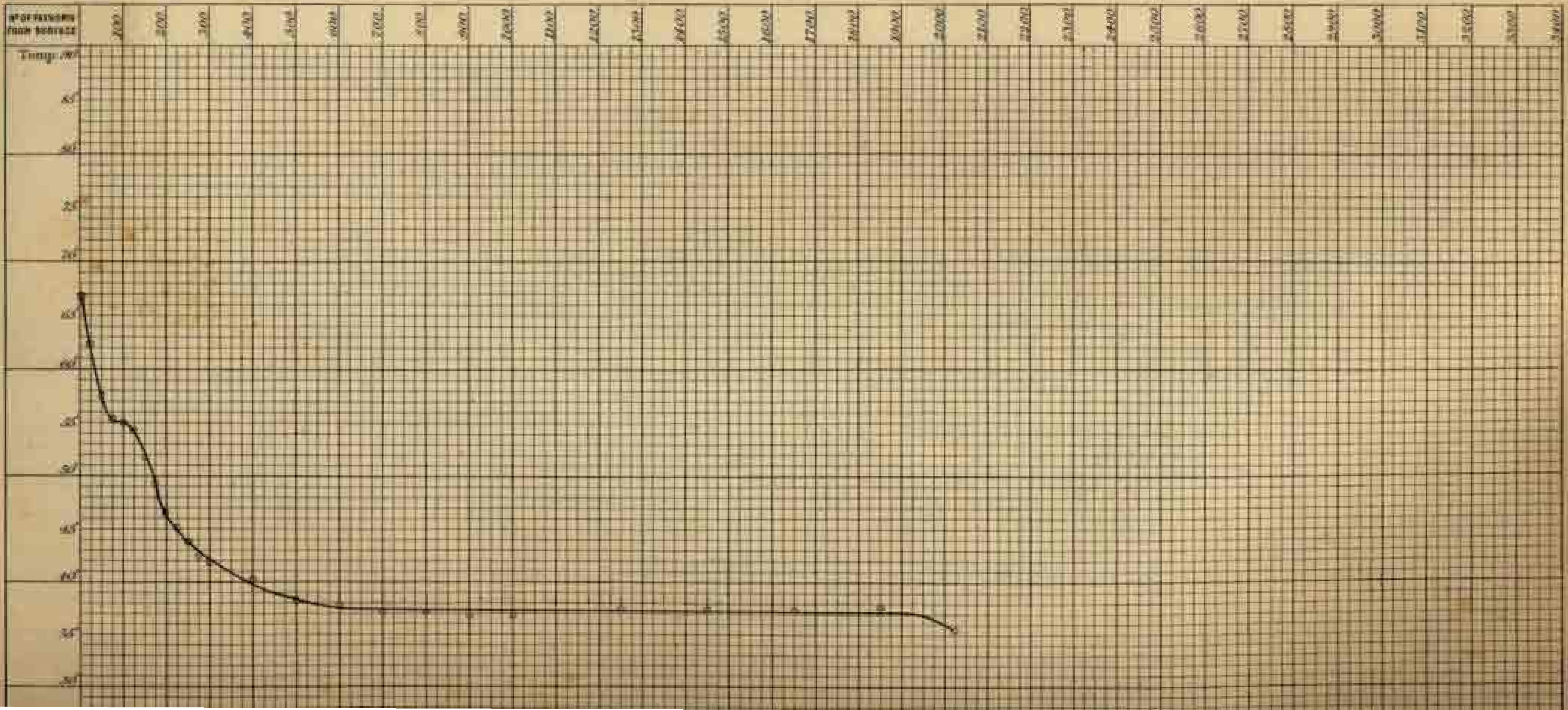
Depth 2025 fathoms.

Latitude 35° 36′ S.
Longitude 21° 12′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190
Nº OF THERMOMETER			396			75		89			86		396			86		71		
TEMPERATURE SHEWN BY THERMOMETER	69.0		62.0			57.1		55.2			55.0		54.0			51.8		49.5		
ERROR OF THERMOMETER	0.0		+0.2			+0.2		0.0			0.0		+0.2			0.0		−0.2		
CORRECTED TEMPERATURE	69.0		62.2			57.3		55.2			55.0		54.2			51.8		49.3		
TEMPERATURE FROM CURVE	69.0		62.2			57.0		55.2			55.0		54.0			52.0		49.3		

Nº OF FATHOMS FROM SURFACE	200	225	250	275	300	400	500	600	700	800	900	1000
Nº OF THERMOMETER	85	73	40	89	74	49	69	74	75	83	56	93
TEMPERATURE SHEWN BY THERMOMETER	46.0	44.8	43.9	42.3	41.8	40.2	38.0	37.8	37.0	36.6	36.8	36.2
ERROR OF THERMOMETER	+0.5	+0.2	0.0	0.0	0.0	0.0	0.0	0.0	+0.3	+0.5	0.0	0.0
CORRECTED TEMPERATURE	46.5	45.0	43.9	42.3	41.8	40.2	38.0	37.8	37.3	37.1	36.8	36.2
TEMPERATURE FROM CURVE	46.5	45.0	43.8	42.7	42.0	39.9	38.4	37.6	37.3	37.3	37.3	37.3

Nº OF FATHOMS FROM SURFACE	1100	1150	1200	1250	1300	1450	1700	1850	1900	2000			BOTTOM
Nº OF THERMOMETER		39		45		85		65					93 86
TEMPERATURE SHEWN BY THERMOMETER		37.5		37.4		36.8		37.3					35.1 35.2
ERROR OF THERMOMETER		0.0		0.0		+0.5		−0.2					0.0 0.0
CORRECTED TEMPERATURE		37.5		37.4		37.3		37.1					35.1 35.2
TEMPERATURE FROM CURVE		37.1		37.3		37.3		37.2					35.4



SECTION. MONTE VIDEO TO TRISTAN DA CUNHA.

14 March 1876.

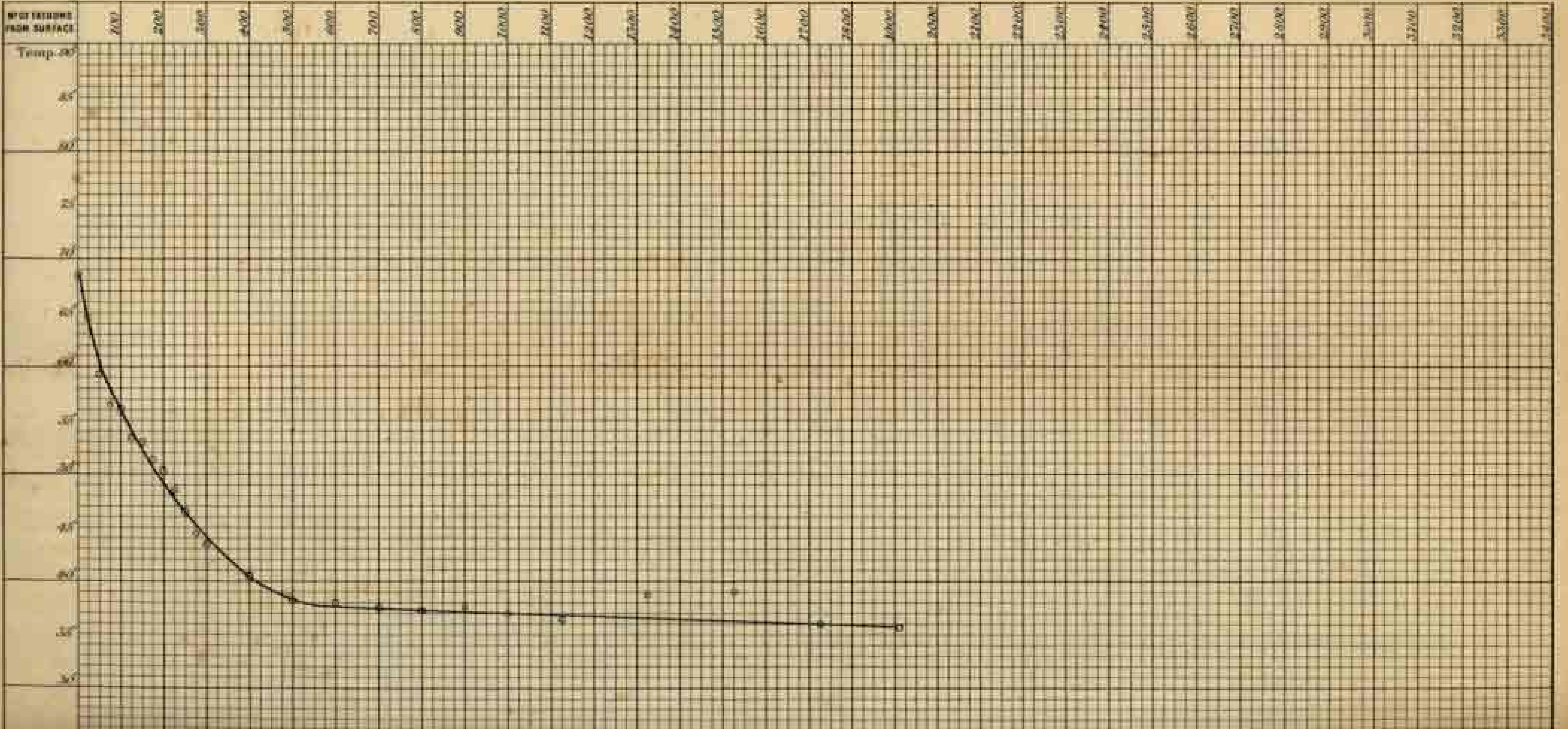
N.° of Sounding 484.
Station 334.

Depth 1915 fathoms.

Latitude 35° 45′ S.
Longitude 18° 31′ W.

Nº of fathoms from surface	Surface	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225
Nº of thermometer			88			49		80			88		896			94		74			71	85
Temperature shewn by thermometer	66.3		64.6			59.0		56.5			56.0		53.2			53.0		51.2			50.5	47.8
Error of thermometer	0.0		0.0			0.0		0.0			0.0		+0.2			0.0		0.0			−0.2	+0.5
Corrected temperature	66.3		64.6			59.0		56.5			56.0		53.4			53.0		51.2			50.3	48.3
Temperature from curve	66.3		64.5			60.3		55.7			56.0		54.0			52.3		50.6			49.3	48.0

Nº of fathoms from surface	250	275	300	400	500	600	700	800	900	1000	1130	1200	1330	1400	1530	1600	1730	1800	1900	2000			Bottom
Nº of thermometer	49	893	89	896	893	89	416	49	85	94	94		85		416		89						93 89
Temperature shewn by thermometer	46.0	44.6	43.5	40.2	38.2	38.0	37.6	37.2	37.0	37.0	36.5		38.2		39.0		36.2						35.8 35.8
Error of thermometer	0.0	0.0	0.0	+0.2	0.0	0.0	0.0	0.0	+0.5	0.0	0.0		+0.5		0.0		0.0						0.0 0.0
Corrected temperature	46.0	44.6	43.5	40.4	38.2	38.0	37.6	37.2	37.5	37.0	36.5		38.7		39.0		36.2						35.8 35.8
Temperature from curve	46.8	45.4	44.0	40.4	38.3	37.7	37.4	37.2	37.1	37.0	36.8		36.6		36.3		36.1						35.8



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND

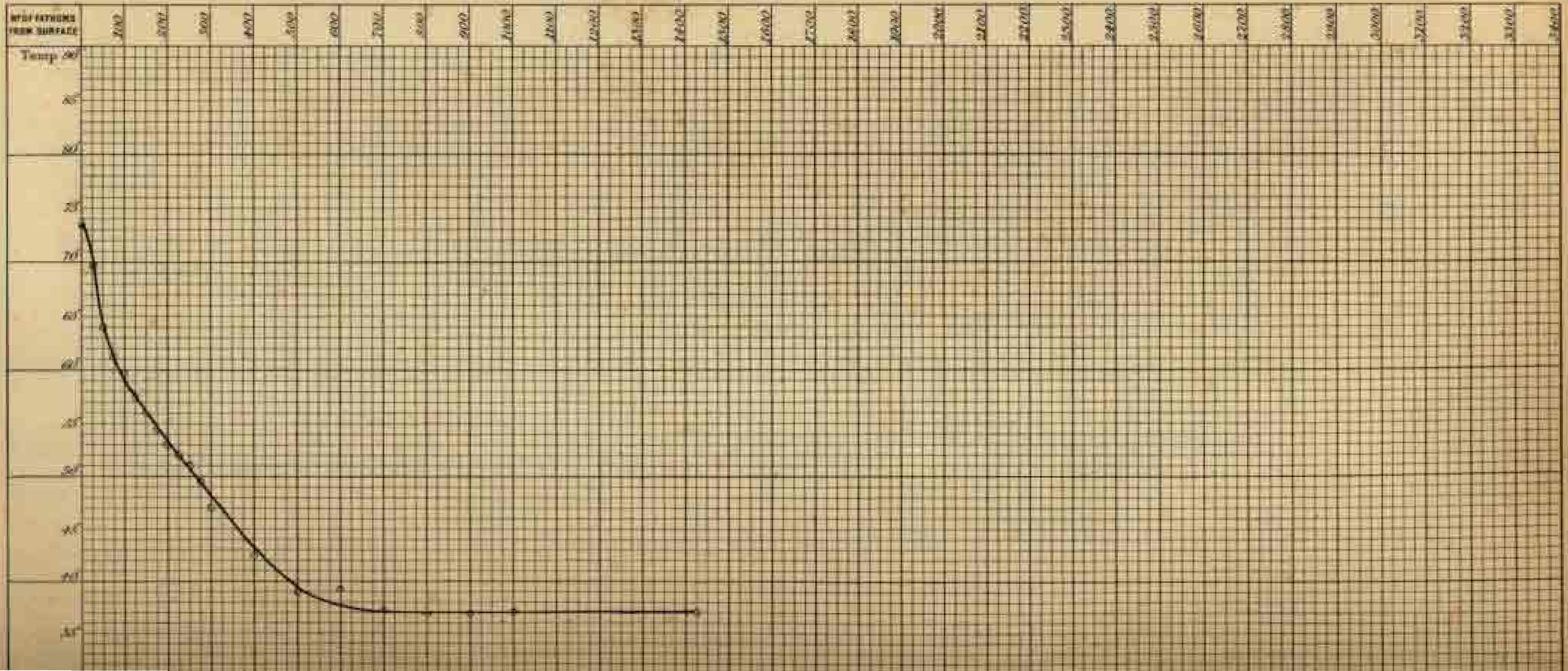
16 March 1876.

N° of Sounding 485.
Station 335.

Depth 1425 fathoms.

Latitude 32° 24′ S.
Longitude 13° 5′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			93			89		72			71		49			86		603			696	696	85	94	693	49	86	85	89	693	696	94													93 86
TEMPERATURE SHEWN BY THERMOMETER	73.5		69.3			64.0		61.2			60.0		57.5			56.0		54.5			52.8	51.8	50.5	49.5	47.0	42.5	39.0	38.7	37.1	37.0	36.8	37.1													37.0 37.0
ERROR OF THERMOMETER	0.0		0.0			0.0		+0.2			−0.2		0.0			0.0		0.0			+0.2	+0.2	+0.5	0.0	0.0	0.0	0.0	+0.5	0.0	0.0	+0.2	0.0													0.0 0.0
CORRECTED TEMPERATURE	73.5		69.3			64.0		61.4			59.8		57.5			56.0		54.5			53.0	52.0	51.0	49.5	47.0	42.5	39.0	39.2	37.1	37.0	37.0	37.1													37.0 37.0
TEMPERATURE FROM CURVE	73.5		69.3			64.0		61.3			59.3		57.7			55.8		54.8			53.4	52.0	50.8	49.5	48.0	43.0	39.3	37.8	37.2	37.0	37.0	37.0													37.0



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

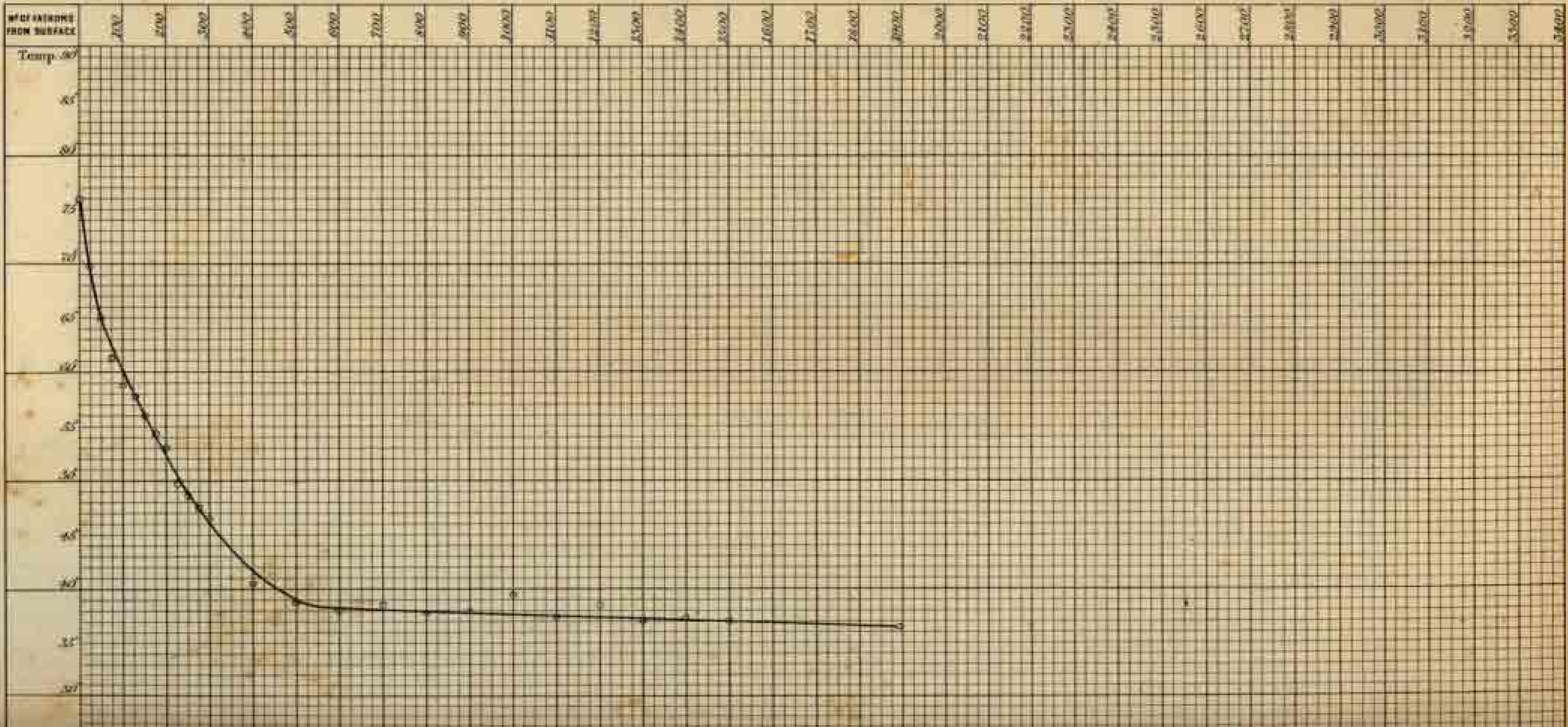
18 March 1876.

Nº of Sounding 486.
„ „ Station 336.

Depth 1890 fathoms.

Latitude 27° 54′ S.
Longitude 13° 13′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER			93			89		696			86		85			416		75			A93	A93	86	94	77	75	74	416	85	94	A93	71	75	85	74	416	94								[illegible]
TEMPERATURE SHEWN BY THERMOMETER	76.0		69.8			65.0		61.2			58.8		57.2			56.0		54.0			53.0	49.8	48.3	47.3	46.5	40.2	38.8	38.0	38.0	37.8	38.0	39.5	37.2	38.0	37.0	37.3	37.0								36.2 36.8
ERROR OF THERMOMETER	0.0		0.0			0.0		+0.2			0.0		+0.5			0.0		+0.2			0.0	0.0	0.0	0.0	−0.2	+0.2	0.0	0.0	+0.5	0.0	0.0	−0.2	+0.2	+0.5	0.0	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	76.0		69.8			65.0		61.4			58.8		57.7			56.0		54.2			53.0	49.8	48.3	47.3	46.3	40.4	38.8	38.0	38.5	37.8	38.0	39.3	37.4	38.5	37.0	37.3	37.0								36.2 36.8
TEMPERATURE FROM CURVE	76.0		69.8			65.0		62.0			59.7		57.7			55.5		54.8			51.9	50.3	48.7	47.3	46.1	41.7	39.1	38.2	38.1	37.9	37.8	37.7	37.5	37.4	37.2	37.1	37.0								36.5



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

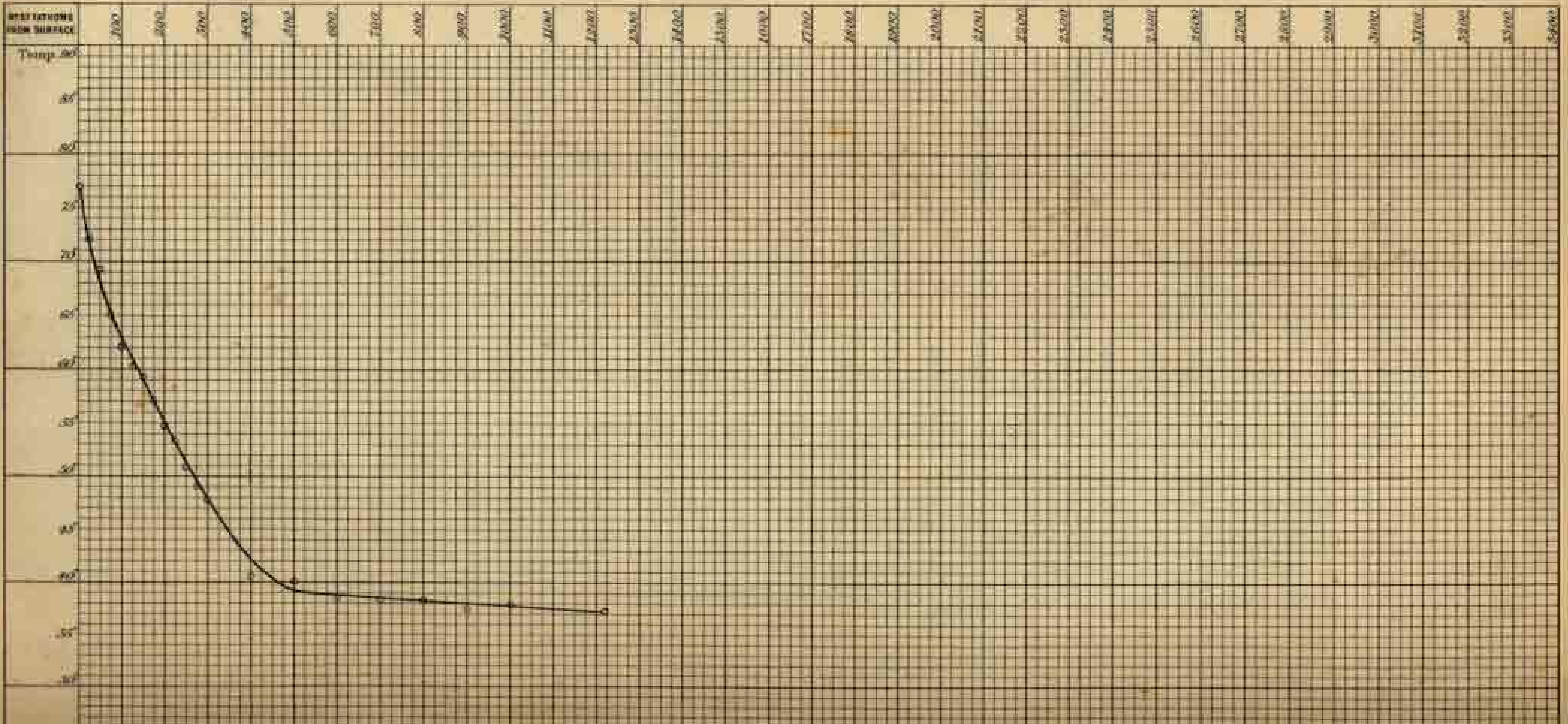
19 March 1876.

No. of Sounding 487.
Station 337.

Depth 1240 fathoms.

Latitude 24° 38′ S.
Longitude 13° 36′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER			93			66		71			72		74			216		94			49	593	93	596	85	66	49	596	216	71	74	85													86 93
TEMPERATURE SHEWN BY THERMOMETER	77.0		72.0			69.2		65.3			62.2		60.3			59.0		57.0			54.8	53.2	50.9	48.8	47.3	40.5	40.0	38.2	38.2	38.4	37.5	37.2													37.1 37.3
ERROR OF THERMOMETER	0.0		0.0			0.0		−0.2			−0.2		0.0			0.0		0.0			0.0	0.0	0.0	+0.2	+0.5	0.0	0.0	+0.2	0.0	−0.2	0.0	+0.5													0.0 0.0
CORRECTED TEMPERATURE	77.0		72.0			69.2		65.1			62.0		60.3			59.0		57.0			54.8	53.2	50.9	49.0	47.8	40.5	40.0	38.4	38.2	38.2	37.5	37.7													37.1 37.3
TEMPERATURE FROM CURVE	77.0		72.0			68.2		65.1			63.0		61.0			59.0		57.0			55.0	53.1	51.2	49.5	48.0	42.0	39.3	38.7	38.4	38.1	37.9	37.7													37.2



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

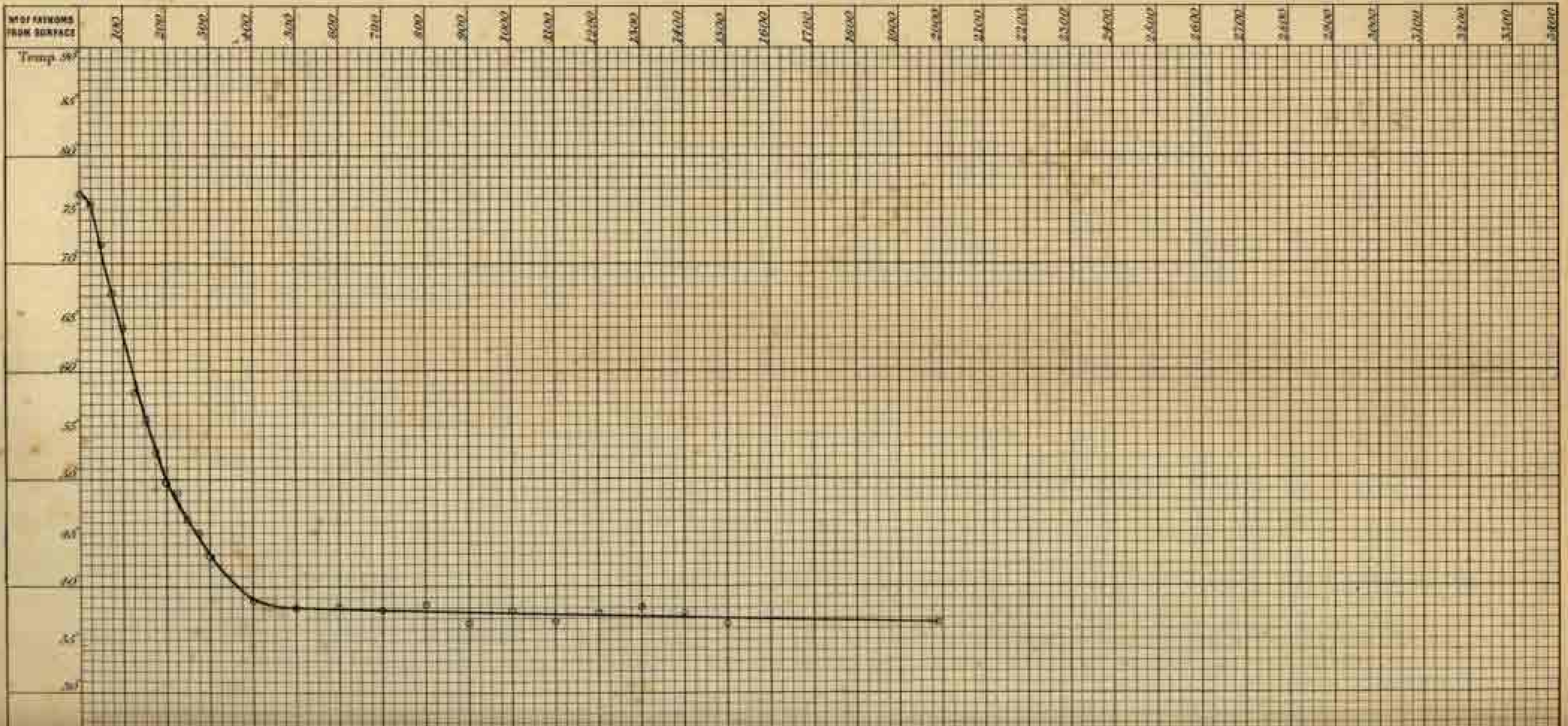
21 March 1876.

No. of Sounding 488.
Station 338.

Depth 1990 fathoms.

Latitude 21° 15′ S.
Longitude 14° 2′ W.

No. OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	125	130	140	150	160	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. OF THERMOMETER			216			71		91			691		74			216		693			696	85	91	89	71	85	693	74	89	85	69	74	696	89	85	86	93								86 93
TEMPERATURE SHEWN BY THERMOMETER	76.5		75.4			72.0		67.2			64.0		58.1			55.3		50.3			49.7	48.2	46.2	45.0	43.4	39.0	38.1	38.1	37.9	37.7	38.2	37.8	36.5	37.6	37.5	37.6	36.6								36.2 36.5
ERROR OF THERMOMETER	0.0		0.0			−0.2		0.0			0.0		0.0			0.0		0.0			+0.2	+0.5	0.0	0.0	−0.5	−0.5	0.0	0.0	0.0	+0.3	−0.2	0.0	+0.2	0.0	+0.5	0.0	0.0								0.0 0.0
CORRECTED TEMPERATURE	76.5		75.4			71.8		67.2			64.0		58.1			55.3		50.3			49.9	48.7	46.2	45.0	42.9	38.5	38.1	38.1	37.9	38.0	38.0	37.8	36.7	37.6	38.0	37.6	36.6								36.2 36.5
TEMPERATURE FROM CURVE	76.5		75.4			71.3		67.0			63.0		59.3			55.3		50.3			49.4	48.0	46.0	44.4	43.0	38.8	38.1	38.0	37.9	37.8	37.7	37.6	37.5	37.4	37.3	37.2	37.1								36.4



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

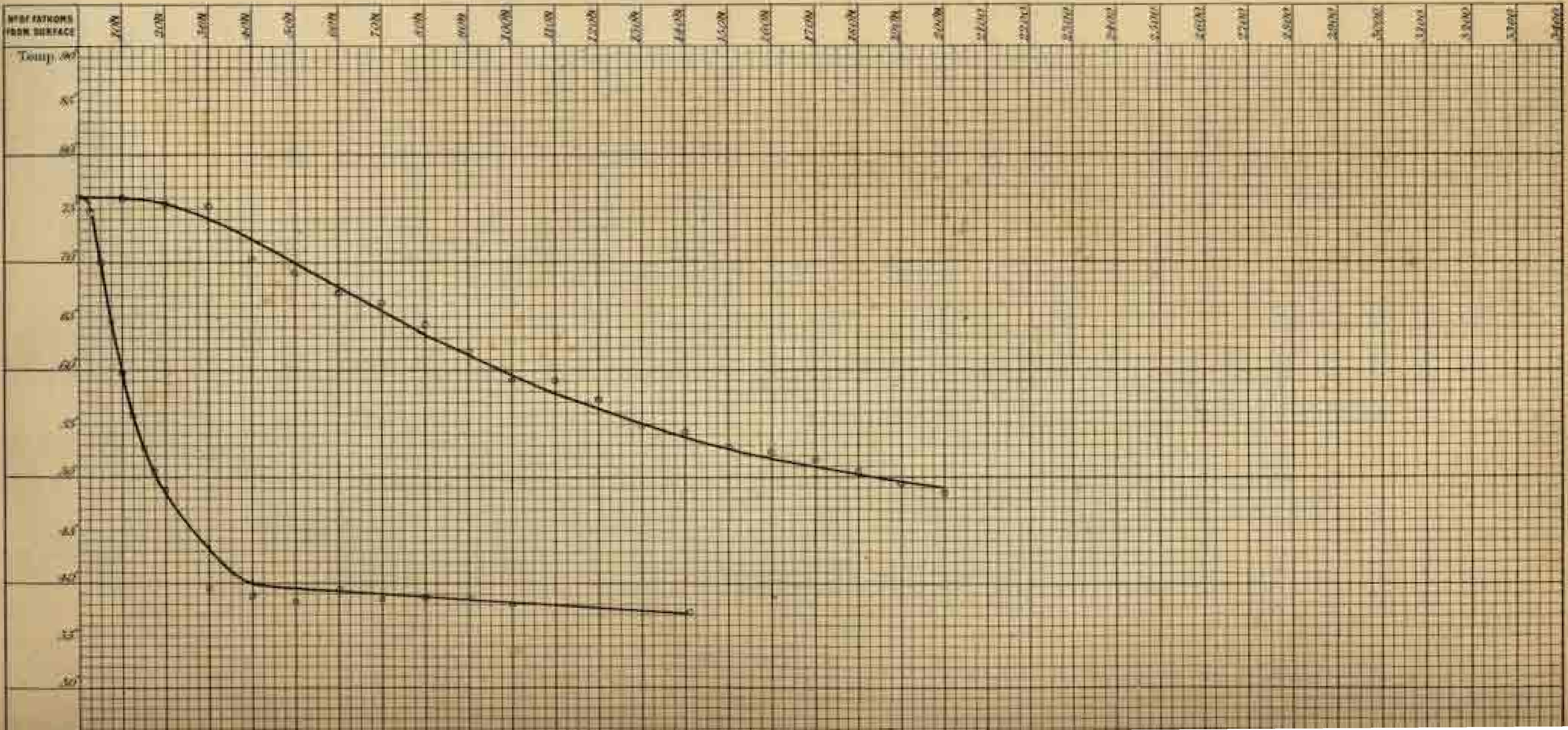
23 March 1876.

No. of Sounding 489.
Station 339.

Depth 1415 fathoms.

Latitude 17° 26′ S
Longitude 13° 52′ W

No. of fathoms from surface	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
No. of thermometer		83	94	118	896	893	84	92	71	80	89	49	74	83	893	896	116	98	89	85	77				65	893	896	118	94	89	83	71													88 93
Temperature shewn by thermometer	76.0	73.3	73.4	73.2	70.2	69.0	67.3	66.2	64.3	61.9	59.4	59.0	57.2	55.1	54.3	52.5	52.2	51.5	50.4	49.2	48.5				39.8	38.8	37.9	39.3	38.6	38.7	38.0	38.0													37.1 37.4
Error of thermometer	0.0	+0.5	0.0	0.0	+0.2	0.0	−0.2	0.0	−0.2	0.0	0.0	0.0	0.0	−0.2	0.0	+0.2	0.0	0.0	0.0	+0.3	−0.2				−0.2	0.0	+0.2	0.0	0.0	0.0	+0.3	−0.2													0.0 0.0
Corrected temperature	76.0	73.8	73.4	73.2	70.4	69.0	67.1	66.2	64.1	61.9	59.4	59.0	57.2	54.9	54.3	52.7	52.2	51.5	50.4	49.5	48.3				39.6	38.8	38.1	39.3	38.6	38.7	38.3	37.8													37.1 37.4
Temperature from curve	76.0	73.8	73.4	74.3	72.3	70.0	67.7	65.5	63.3	61.6	59.8	58.0	56.4	55.1	53.8	52.7	51.8	51.0	50.2	49.0	48.0				43.0	39.8	39.3	39.0	38.9	38.6	38.3	38.1													37.9



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

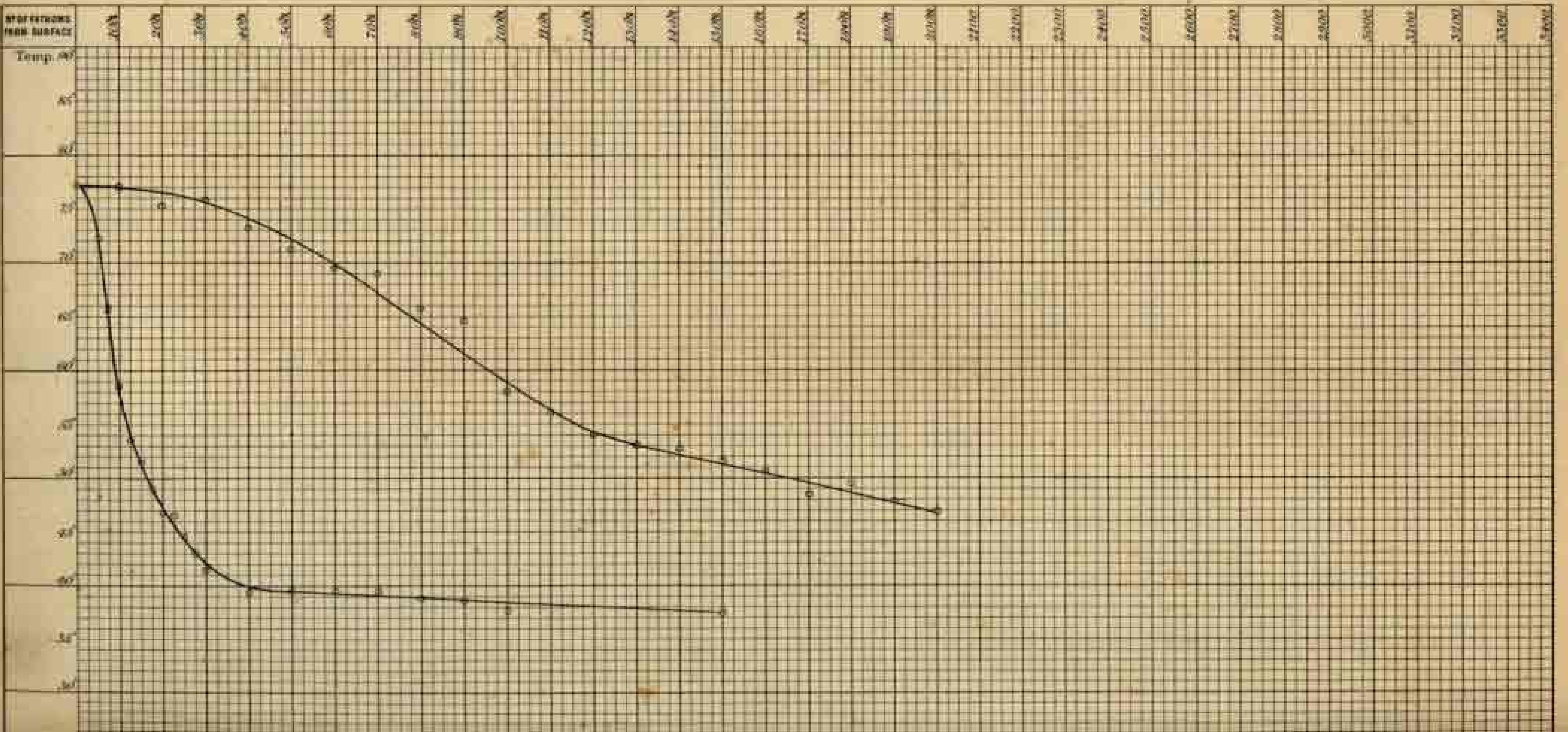
24 March 1876.

Nº of Sounding 490.
" " *Station* 340.

Depth 1500 fathoms.

Latitude 14° 33′ S.
Longitude 13° 42′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		88	94	71	108	73	89	88	496	85	74	94	85	89	75	493	85	496	71	86	496	85	493	73	89	65	94	89	65	94	85	496													73 86
TEMPERATURE SHEWN BY THERMOMETER	77.7	77.0	75.3	76.0	73.1	71.0	69.3	69.0	65.0	64.4	58.0	56.0	54.2	53.1	52.5	51.6	50.0	48.2	49.6	47.8	46.6	45.8	44.8	42.8	40.3	39.6	39.5	39.5	39.3	38.8	38.0	37.2													37.8 37.5
ERROR OF THERMOMETER	0.0	0.0	0.0	−0.2	0.0	+0.2	0.0	0.0	+0.8	+0.3	0.0	0.0	−0.2	0.0	+0.2	0.0	+0.3	+0.2	−0.2	0.0	+0.2	+0.5	0.0	+0.9	0.0	−0.2	0.0	0.0	−0.3	0.0	+0.1	+0.5													0.0 0.0
CORRECTED TEMPERATURE	77.7	77.0	75.3	75.8	73.1	71.2	69.3	69.0	65.8	64.7	58.0	56.0	54.0	53.1	52.7	51.6	50.3	48.4	49.4	47.8	46.8	46.3	44.8	43.7	40.3	39.4	39.5	39.5	39.0	38.8	38.1	37.7													37.8 37.5
TEMPERATURE FROM CURVE	77.7	77.0	76.4	75.5	74.1	72.3	69.8	67.3	64.3	61.9	58.8	56.3	54.2	53.0	52.2	51.1	50.4	49.3	48.6	47.7	46.9	45.7	44.3	43.0	42.0	39.9	39.4	39.2	39.0	38.8	38.6	38.4													37.6



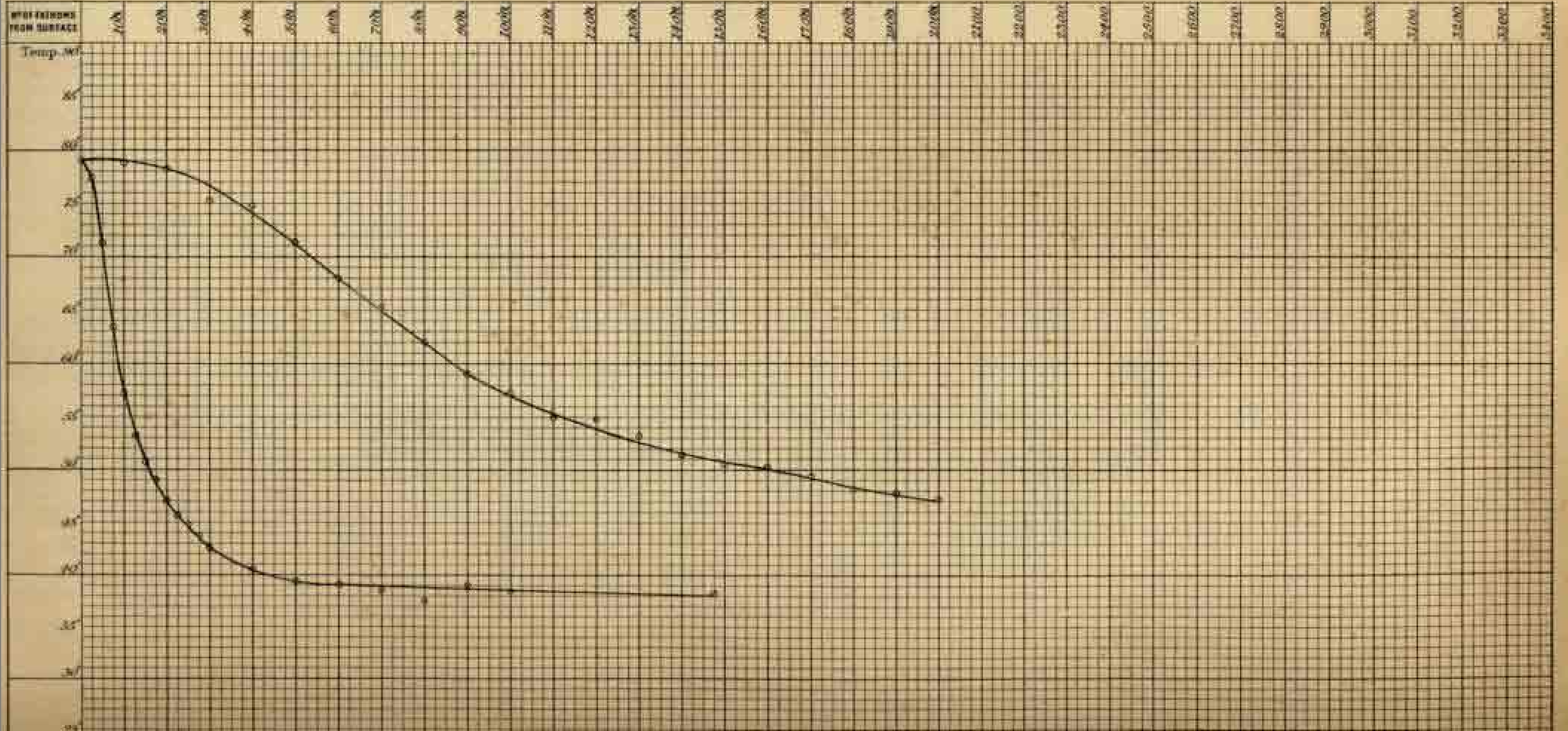
25 March 1876.

Nº of Sounding 491.
" Station 341.

Depth 1475 fathoms.

Latitude 12° 16′ S.
Longitude 13° 44′ W.

Nº OF FATHOMS FROM SURFACE	NO. OF THERMOMETER	TEMPERATURE SHEWN BY THERMOMETER	ERROR OF THERMOMETER	CORRECTED TEMPERATURE	TEMPERATURE FROM CURVE
SURFACE	–	79.0	0.0	79.0	79.0
10	83	78.4	+0.5	78.9	79.0
20	696	78.0	+0.2	78.2	78.2
30	89	75.7	0.0	75.7	76.7
40	216	74.8	0.0	74.8	74.6
50	71	71.6	-0.2	71.4	71.4
60	88	68.0	0.0	68.0	68.3
70	91	65.3	0.0	65.3	64.8
80	497	62.0	0.0	62.0	61.2
90	73	58.0	+0.1	58.1	59.6
100	74	57.3	0.0	57.3	57.2
110	65	55.7	-0.2	55.5	55.1
120	94	54.8	0.0	54.8	54.0
130	83	52.7	+0.5	53.2	52.7
140	696	51.3	+0.2	51.5	51.8
150	69	50.5	0.0	50.5	50.8
160	216	50.2	0.0	50.2	50.0
170	77	49.7	-0.2	49.5	49.7
180	56	48.1	0.0	48.1	48.5
190	33	47.8	0.0	47.8	47.8
200	94	47.1	0.0	47.1	47.0
225	85	45.2	+0.5	45.7	45.8
250	493	44.8	0.0	44.8	44.7
275	75	43.5	+0.2	43.7	43.5
300	74	42.6	0.0	42.6	42.6
400	74	40.3	0.0	40.3	40.3
500	696	39.1	+0.2	39.3	39.2
600	80	39.0	0.0	39.0	39.0
700	73	38.3	+0.2	38.5	38.9
800	85	37.8	-0.2	37.6	38.6
900	216	39.0	0.0	39.0	38.7
1000	71	38.2	−0.0	38.2	38.6
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
BOTTOM	92	38.2	0.0	38.2	38.2



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

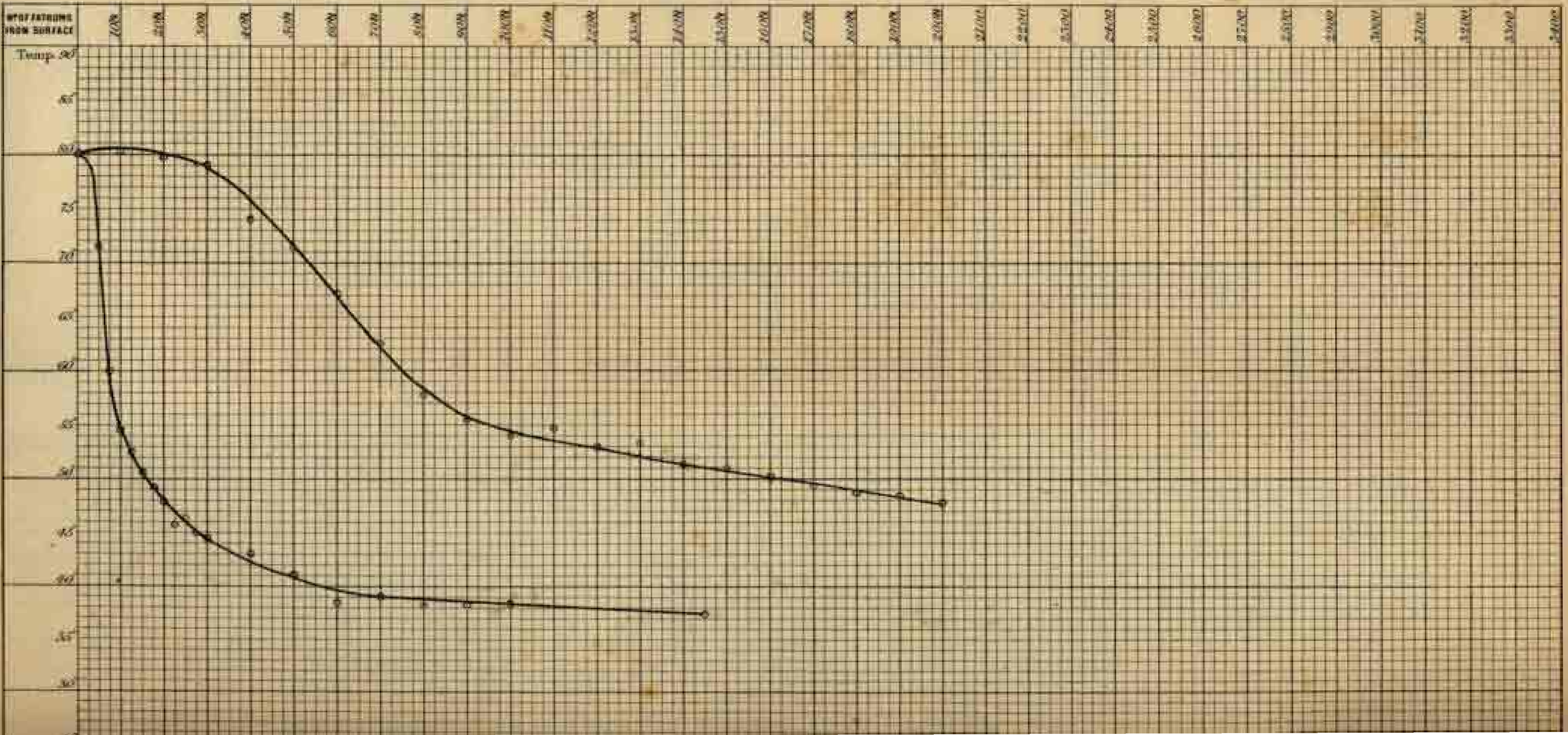
26 March 1876.

Depth 1445 fathoms.

No. of Sounding 492.
" " Station 342.

Latitude 9° 45' S.
Longitude 13° 51' W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer		94	65	416	693	696	94	89	73	66	95	74	65	416	89	86	93	73	94	693	71	696	85	91	65	416	69	93	94	693	696	85													93 86
Temperature shewn by Thermometer	80.0	80.0	80.0	79.0	74.0	71.2	67.2	60.6	57.6	55.5	54.0	54.8	53.1	53.1	51.3	51.1	50.0	49.2	48.8	48.6	48.0	45.7	45.7	45.0	44.8	43.0	41.0	38.2	39.1	38.2	38.1	37.8													37.6 37.4
Error of Thermometer	0.0	0.0	−0.7	0.0	0.0	+0.2	0.0	0.0	+0.2	0.0	0.0	0.0	−0.2	0.0	0.0	0.0	0.0	+0.2	0.0	0.0	−0.2	+0.2	+0.5	0.0	−0.2	0.0	0.0	+0.2	0.0	0.0	+0.2	+0.5													0.0 0.0
Corrected Temperature	80.0	80.0	79.3	79.0	74.0	71.4	67.2	60.6	57.8	55.5	54.0	54.8	52.9	53.1	51.3	51.1	50.0	49.4	48.8	48.6	47.8	45.9	46.2	45.0	44.6	43.0	41.0	38.4	39.1	38.2	38.3	38.3													37.6 37.4
Temperature from Curve	80.0	80.1	80.0	78.8	76.0	71.5	67.2	62.3	58.2	55.7	54.4	53.7	52.9	52.1	51.3	50.6	50.0	49.5	49.0	48.4	47.8	46.9	45.9	45.1	44.5	42.3	40.8	39.7	39.1	38.8	38.4	38.0													37.5



SECTION. TRISTAN DA CUNHA TO ASCENSION ISLAND.

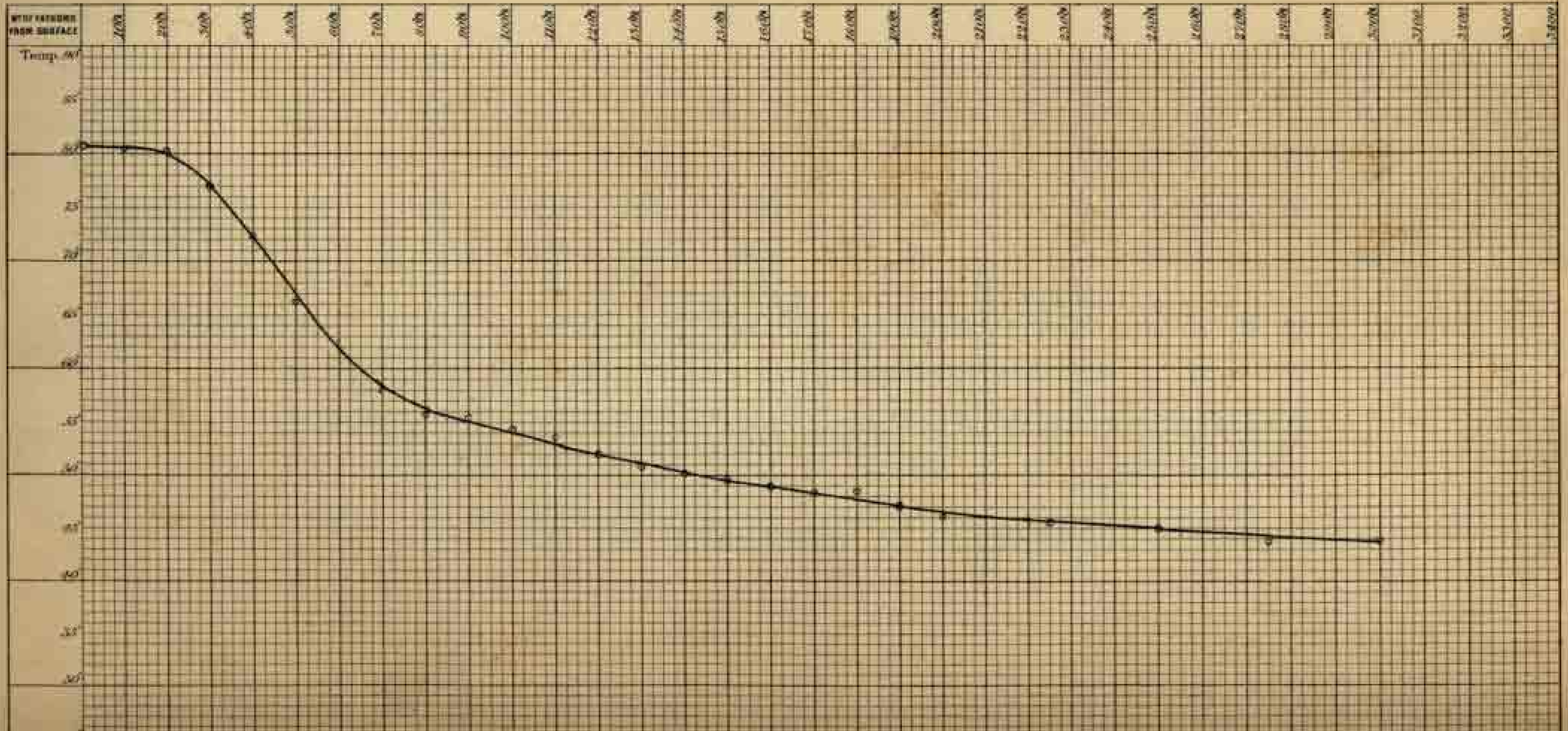
27 March 1876.

Nº of Sounding 493.
Station 343.

Depth 425 *fathoms*

Latitude 8° 3′ S.
Longitude 14° 27′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		496	491	93	86	94	216	74	89	71	83	73	65	496	491	93	86	94	216	74	89	71	85	65	73																				66 93
TEMPERATURE SHEWN BY THERMOMETER	80.8	80.3	80.1	77.0	72.4	66.2	62.2	58.1	55.8	55.5	54.0	53.2	52.2	50.5	50.2	49.6	49.2	48.5	48.5	47.7	46.1	45.8	44.5	44.0	43.6																				40.9 40.5
ERROR OF THERMOMETER	0.0	+0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.2	+0.5	+0.2	−0.2	+0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.2	+0.5	−0.2	+0.2																				0.0 0.0
CORRECTED TEMPERATURE	80.8	80.5	80.1	77.0	72.4	66.2	62.2	58.1	55.8	55.3	54.5	53.4	52.0	50.7	50.2	49.6	49.2	48.5	48.5	47.7	46.1	45.6	45.0	43.8	43.8																				40.9 40.5
TEMPERATURE FROM CURVE	80.8	80.5	80.0	77.0	72.5	67.0	62.0	58.5	56.5	55.0	53.8	52.8	52.0	51.1	50.2	49.7	49.1	48.4	47.8	47.1	46.6	45.8	45.0	44.3	43.8																				43.4



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

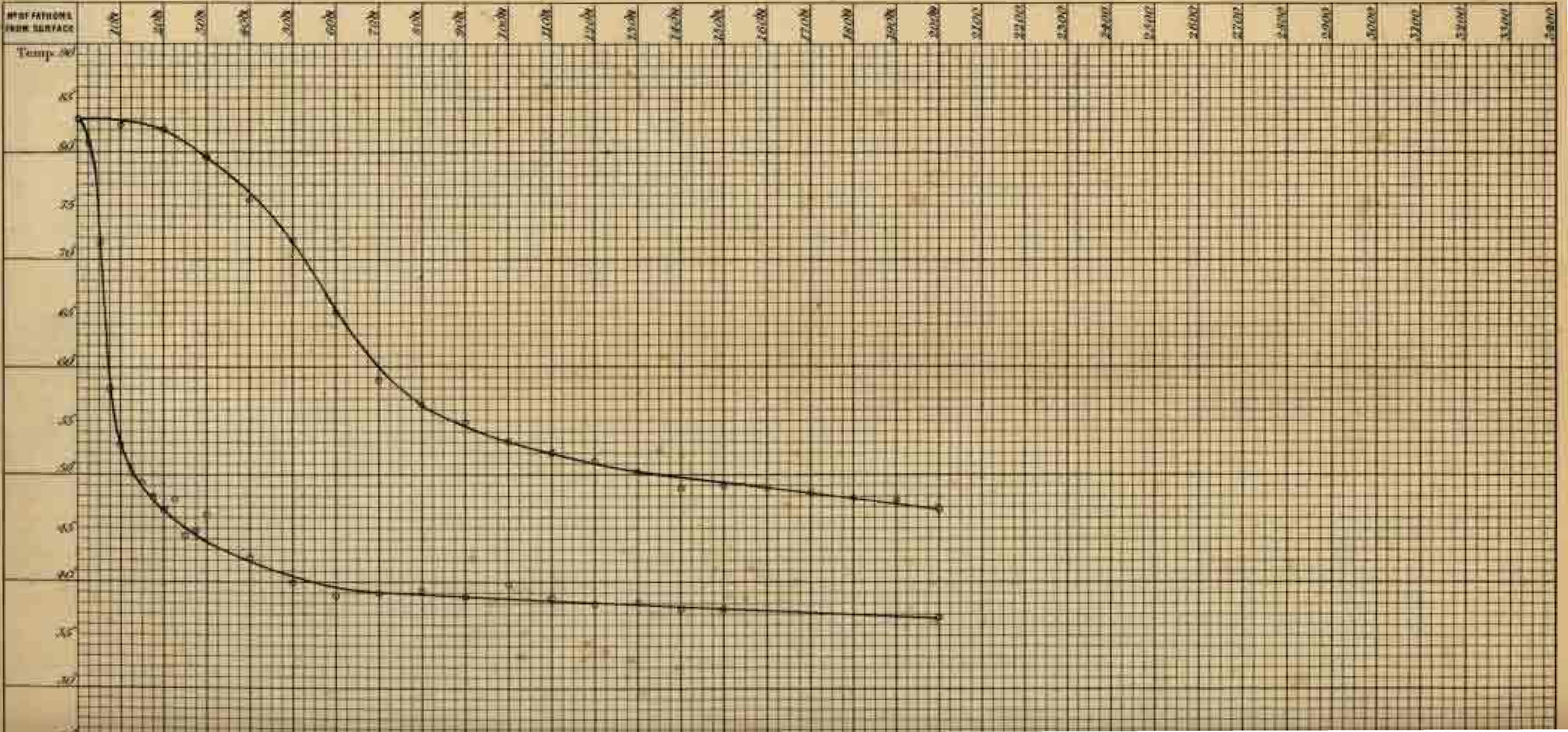
4 April 1876.

Nº of Sounding 405.
Station 345.

Depth 2010 fathoms.

Latitude 5° 45′ S.
Longitude 14° 25′ W.

Nº of fathoms from surface	Nº of thermometer	Temperature shewn by thermometer	Error of thermometer	Corrected temperature	Temperature from curve
Surface		82.8	0.0	82.8	82.8
10	74	82.5	0.0	82.5	82.8
20	33	82.0	0.0	82.0	82.0
30	86	79.6	0.0	79.6	79.6
40	85	75.1	+0.5	75.6	76.3
50	416	71.8	0.0	71.8	71.6
60	91	65.0	0.0	65.0	65.0
70	89	58.8	0.0	58.8	59.8
80	496	56.3	+0.2	56.5	56.5
90	493	54.8	0.0	54.8	54.4
100	72	52.6	+0.2	52.8	52.8
110	416	51.8	0.0	51.8	51.8
120	34	51.1	0.0	51.1	51.0
130	74	50.3	0.0	50.3	50.2
140	63	49.0	−0.2	48.8	49.7
150	89	49.0	0.0	49.0	49.0
160	85	48.4	+0.5	48.9	48.8
170	71	48.5	−0.2	48.3	48.3
180	496	47.6	+0.2	47.6	47.8
190	493	47.0	0.0	47.0	47.3
200	73	46.7	+0.2	46.9	46.9
225	416	47.8	0.0	47.8	45.9
250	94	44.4	0.0	44.4	45.0
275	89	44.8	0.0	44.8	44.3
300	496	42.0	+0.2	42.2	43.8
400	85	41.8	+0.5	42.3	42.0
500	36	40.0	0.0	40.0	40.6
600	91	38.8	0.0	38.8	39.7
700	74	39.0	0.0	39.0	39.1
800	71	39.4	−0.2	39.2	38.8
900	74	38.7	0.0	38.7	38.6
1000	85	39.4	+0.5	39.9	38.4
1100	496	38.0	+0.4	38.4	38.2
1200	71	38.2	−0.2	38.0	38.0
1300	89	38.0	0.0	38.0	37.8
1400	94	37.5	0.0	37.5	37.7
1500	416	37.6	0.0	37.6	37.6
1600					
1700					
1800					
1900					
2000					
Bottom	85 93	36.9 36.9	0.0 0.0	36.9 36.9	36.8



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

7 April 1876.

N.° of Sounding 407.
Station 347.

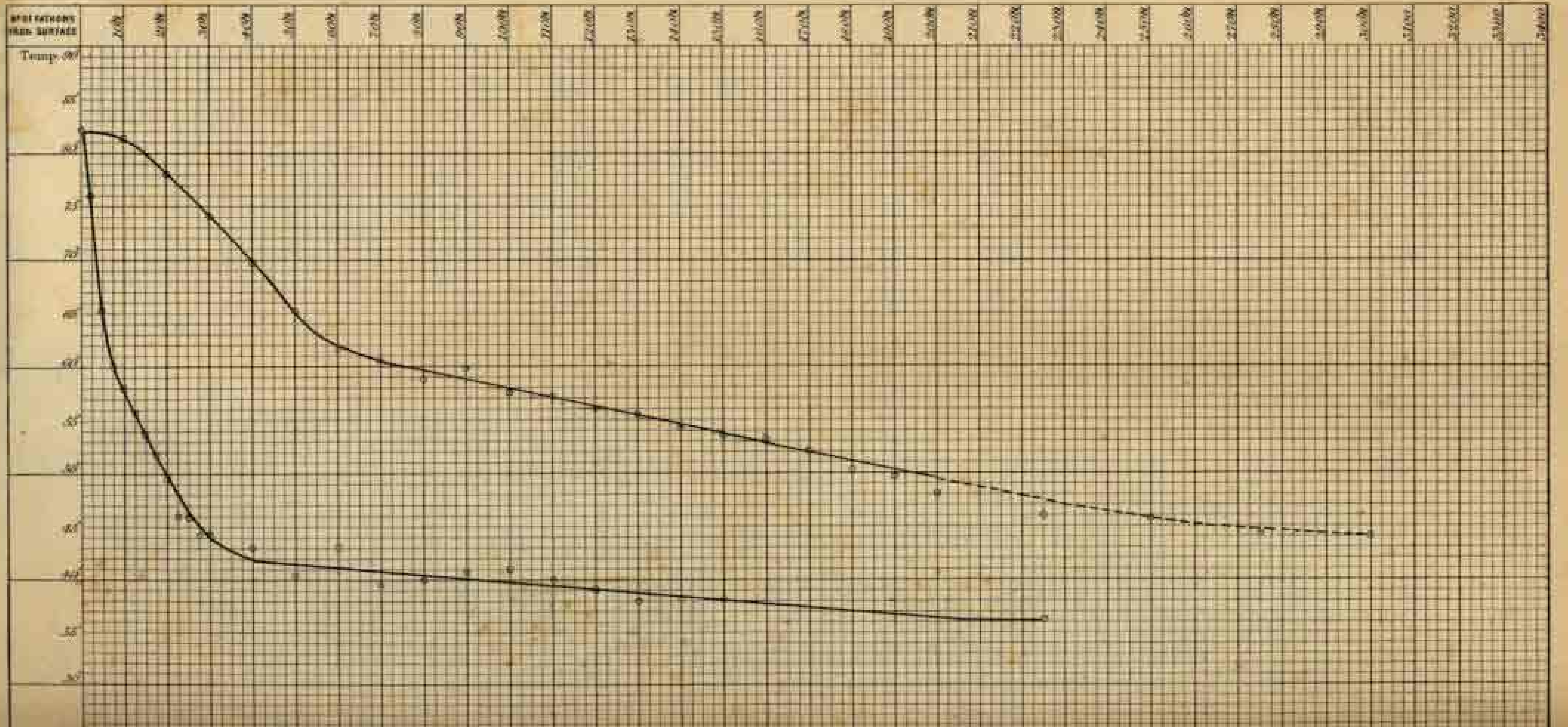
Depth 2250 fathoms.

Latitude 0° 15′ S.
Longitude 14° 25′ W.

N.° OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
N.° OF THERMOMETER		94	86	89	93	75	A13	85	A98	85	85	88	93	A93	89	74
TEMPERATURE SHEWN BY THERMOMETER	82.0	81.2	78.0	74.0	69.8	65.0	61.8	60.0	58.3	60.0	57.0	57.2	56.0	55.5	54.2	53.6
ERROR OF THERMOMETER	0.0	0.0	0.0	0.0	0.0	+0.2	0.0	+0.5	+0.4	−0.2	+0.5	0.0	0.0	0.0	0.0	0.0
CORRECTED TEMPERATURE	82.0	81.2	78.0	74.0	69.8	65.0	61.8	60.5	58.7	59.8	57.5	57.2	56.0	55.5	54.2	53.6
TEMPERATURE FROM CURVE	82.0	81.2	78.0	74.0	69.8	65.2	61.8	60.5	59.7	58.8	58.0	57.2	56.2	55.5	54.6	53.8

N.° OF FATHOMS FROM SURFACE	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900
N.° OF THERMOMETER	71	74	A98	94	75	89	A93	A96	94	89	A96	85	94	74	71
TEMPERATURE SHEWN BY THERMOMETER	53.5	52.0	50.0	49.8	47.8	48.0	45.8	44.7	44.0	43.0	40.2	43.2	39.5	40.0	41.0
ERROR OF THERMOMETER	−0.2	0.0	+0.2	0.0	+0.2	0.0	0.0	+0.2	0.0	0.0	+0.2	−0.2	0.0	0.0	−0.2
CORRECTED TEMPERATURE	53.3	52.0	50.2	49.8	48.0	48.0	45.8	44.9	44.0	43.0	40.4	43.0	39.5	40.0	40.8
TEMPERATURE FROM CURVE	53.0	52.2	50.3	49.6	48.7	47.8	46.0	45.0	44.0	42.0	41.4	41.0	40.8	40.5	40.0

N.° OF FATHOMS FROM SURFACE	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N.° OF THERMOMETER	A16	89	A93	94	A96	83								86 93
TEMPERATURE SHEWN BY THERMOMETER	41.0	40.0	39.0	38.0	38.0	37.5								36.0 36.5
ERROR OF THERMOMETER	0.0	0.0	0.0	0.0	+0.2	+0.5								0.0 0.0
CORRECTED TEMPERATURE	41.0	40.0	39.0	38.0	38.2	38.0								36.0 36.5
TEMPERATURE FROM CURVE	39.7	39.3	39.0	38.7	38.5	38.0								36.2



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

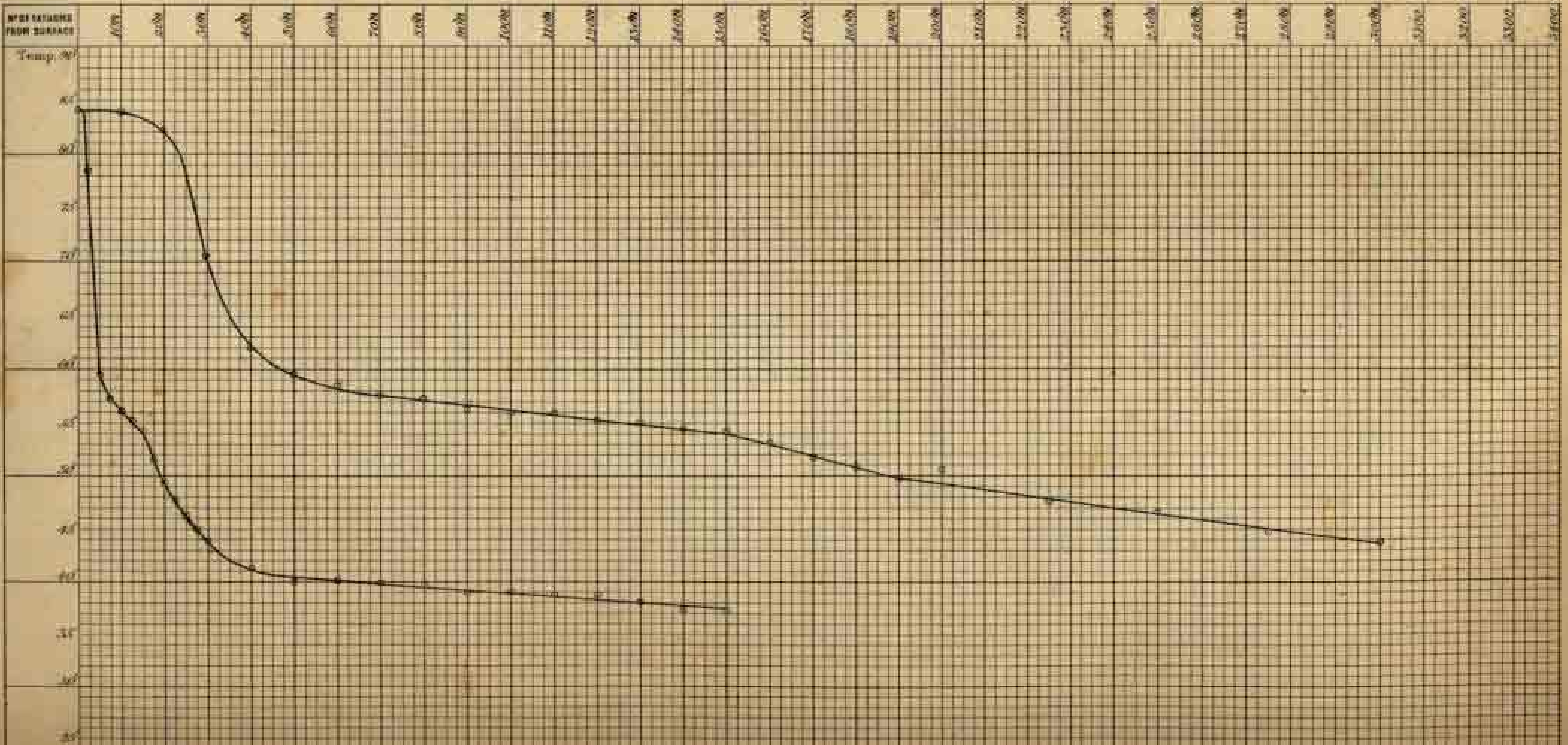
9 April 1876.

No. of Sounding 498.
Station 348.

Depth None obtained.

Latitude 3° 10′ N.
Longitude 14° 51′ W.

No. of Fathoms from Surface	No. of Thermometer	Temperature shewn by Thermometer	Error of Thermometer	Corrected Temperature	Temperature from Curve
SURFACE		84.0	0.0	84.0	84.0
10	98	84.0	0.0	84.0	84.0
20	93	82.0	0.0	82.0	82.0
30	71	71.0	−0.2	70.8	70.8
40	94	60.0	0.0	60.0	60.0
50	696	59.2	+0.2	59.4	59.5
60	85	58.0	+0.5	58.5	58.2
70	416	57.6	0.0	57.6	57.6
80	75	56.8	+0.2	57.0	57.0
90	693	56.8	0.0	56.8	56.5
100	89	56.0	0.0	56.0	56.1
110	74	56.0	0.0	56.0	55.7
120	71	55.5	−0.2	55.3	55.3
130	94	55.0	0.0	55.0	54.9
140	696	54.2	+0.2	54.4	54.5
150	85	53.7	+0.5	54.2	54.1
160	416	53.0	0.0	53.0	53.0
170	71	51.3	+0.4	51.7	52.0
180	693	50.8	0.0	50.8	50.9
190	89	49.8	0.0	49.8	49.7
200	696	50.5	+0.2	50.7	49.1
225	94	47.1	0.0	47.1	47.8
250	85	46.0	+0.5	46.5	46.4
275	416	45.0	0.0	45.0	45.1
300	71	43.6	+0.2	43.8	43.8
400	693	41.2	0.0	41.2	41.1
500	89	40.0	0.0	40.0	40.4
600	98	40.0	0.0	40.0	40.0
700	93	40.0	0.0	40.0	39.8
800	75	39.5	+0.2	39.7	39.6
900	94	39.0	0.0	39.0	39.2
1000	416	39.0	0.0	39.0	39.0
1100	693	38.8	0.0	38.8	38.7
1200	85	38.3	+0.5	38.8	38.4
1300	89	38.0	0.0	38.0	38.1
1400	86	37.3	0.0	37.3	37.8
1500	93	37.2	0.0	37.2	37.6
1600					
1700					
1800					
1900					
2000					
BOTTOM					



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

10 April 1876.

Nº of Sounding 409.
Station 349.

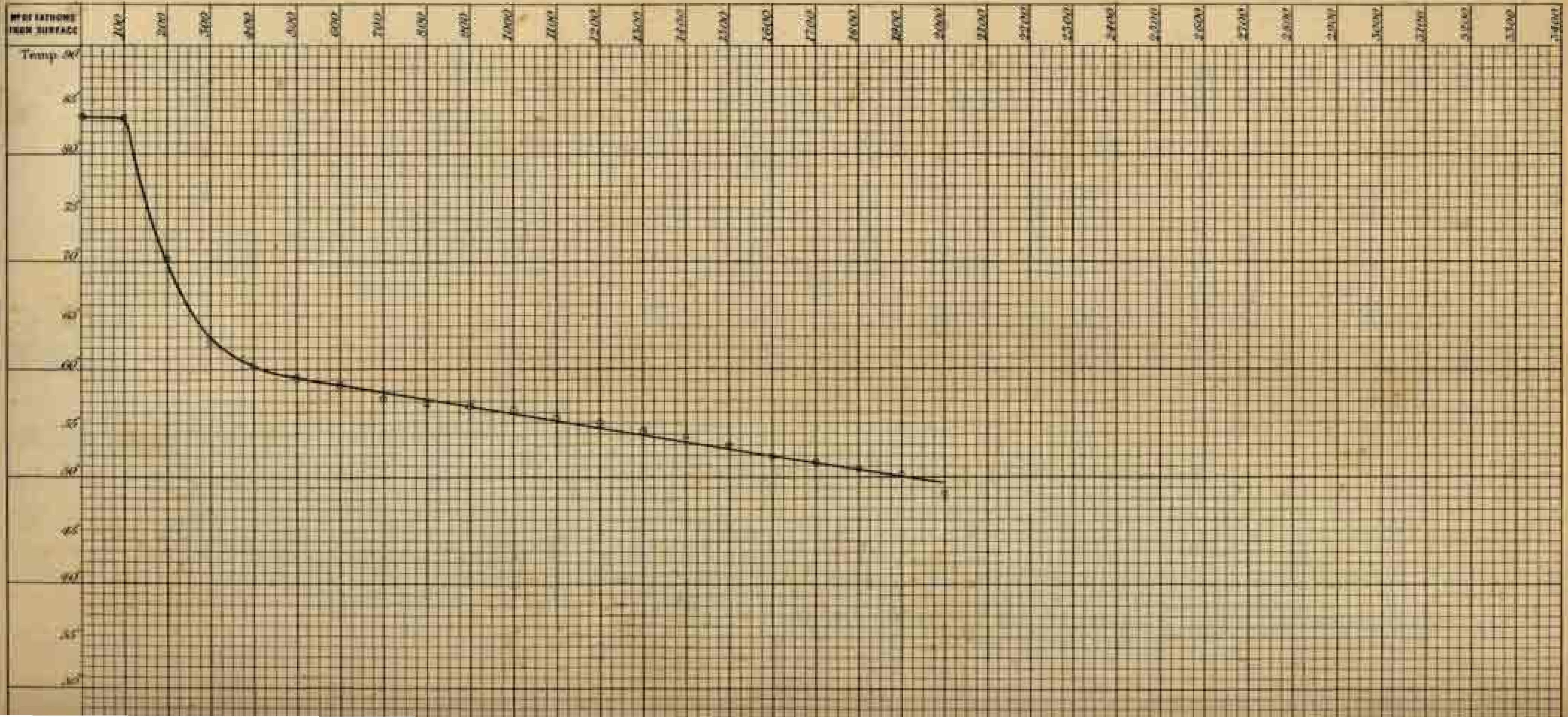
Depth None obtained

Latitude 5° 28′ N.
Longitude 14° 38′ W.

Nº of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100
Nº of thermometer		91	93	88	75	416	81	496	71	74	91
Temperature shewn by thermometer	83.5	83.2	70.2	62.5	60.0	59.2	58.0	57.1	57.1	56.6	56.2
Error of thermometer	0.0	0.0	0.0	0.0	+0.2	0.0	+0.5	+0.2	−0.2	0.0	0.0
Corrected temperature	83.5	83.2	70.2	62.5	60.2	59.2	58.5	57.3	56.9	56.6	56.2
Temperature from curve	83.5	83.2	70.0	62.6	60.2	59.2	58.5	57.8	57.1	56.5	55.9

Nº of fathoms from surface	110	120	130	140	150	160	170	180	190	200
Nº of thermometer	92	96	78	416	85	89	496	71	74	89
Temperature shewn by thermometer	55.3	55.0	54.1	53.8	52.5	52.0	51.2	51.0	50.1	48.5
Error of thermometer	0.0	0.0	+0.2	0.0	+0.5	0.0	+0.3	−0.2	0.0	0.0
Corrected temperature	55.3	55.0	54.3	53.8	53.0	52.0	51.5	50.8	50.1	48.5
Temperature from curve	55.2	54.8	54.0	53.3	52.7	52.1	51.4	50.8	50.1	48.5

Nº of fathoms from surface	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000		Bottom
Nº of thermometer																							
Temperature shewn by thermometer																							
Error of thermometer																							
Corrected temperature																							
Temperature from curve																							



SECTION. ASCENSION ISLAND TOWARDS ST. VINCENT.

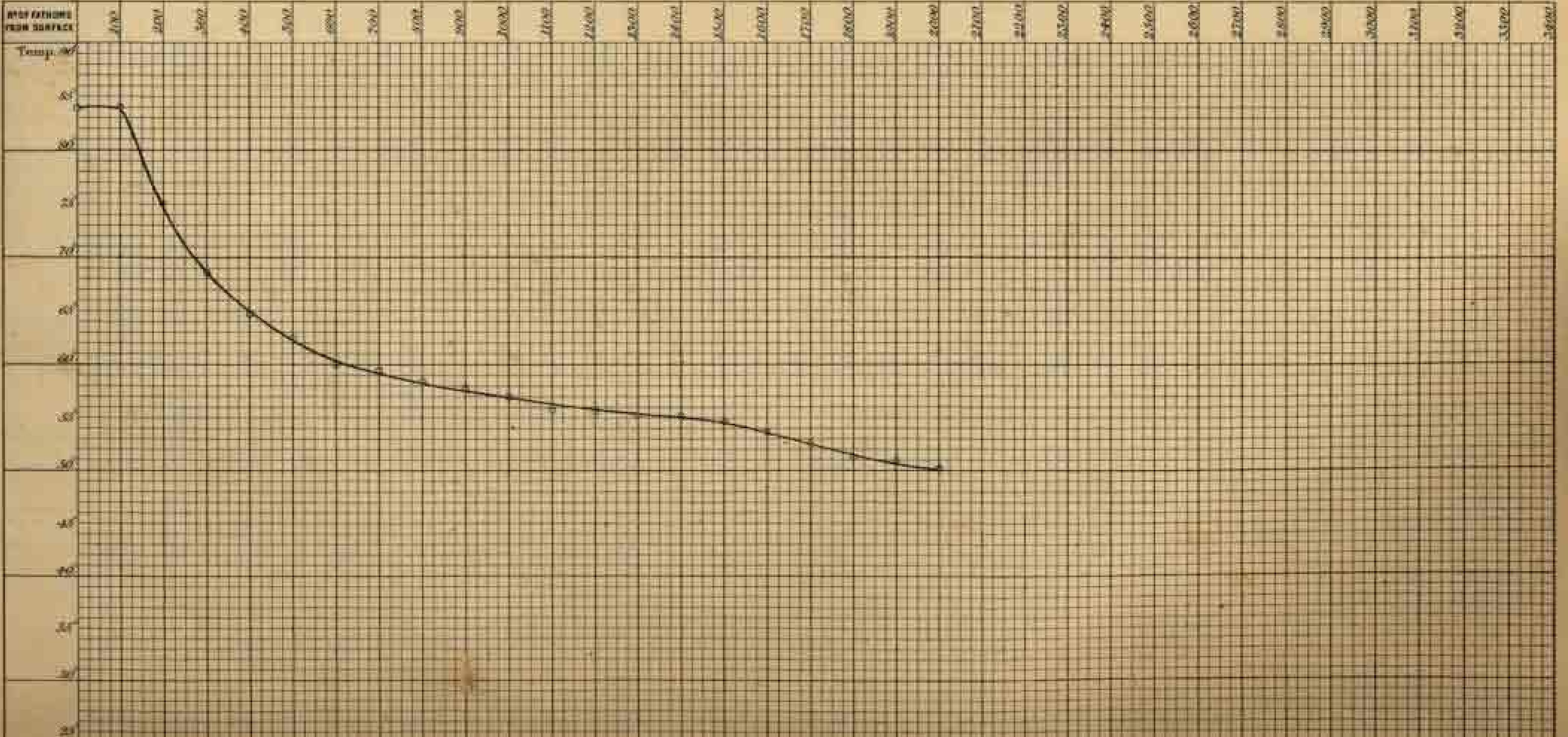
11 April 1876.

No. of Sounding 500.
Station 350.

Depth None obtained.

Latitude 7° 33′ N.
Longitude 15° 16′ W.

No. of Fathoms from Surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of Thermometer		93	93	86	a16	75	89	94	85	91	74	696	30	696	71	77	85	94	89	a16	73				a16																				
Temperature shewn by Thermometer	84.0	84.0	75.0	68.5	64.8	62.2	60.0	59.3	58.1	58.1	57.0	55.5	55.6	55.0	55.0	54.8	53.4	52.5	51.3	51.0	50.7				45.7																				
Error of Thermometer	0.0	0.0	0.0	0.0	0.0	+0.2	0.0	0.0	+0.5	−0.2	0.0	+0.2	0.0	+0.2	0.0	−0.2	+0.3	0.0	0.0	0.0	+0.2				0.0																				
Corrected Temperature	84.0	84.0	75.0	68.5	64.8	62.4	60.0	59.3	58.6	57.9	57.0	55.7	55.6	55.2	55.0	54.6	53.7	52.5	51.3	51.0	50.9				45.7																				
Temperature from Curve	84.0	84.0	75.0	68.5	64.8	62.4	60.3	59.2	58.3	57.5	56.2	56.3	55.7	55.4	55.0	54.5	53.6	52.5	51.6	50.7	50.0				45.0																				



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

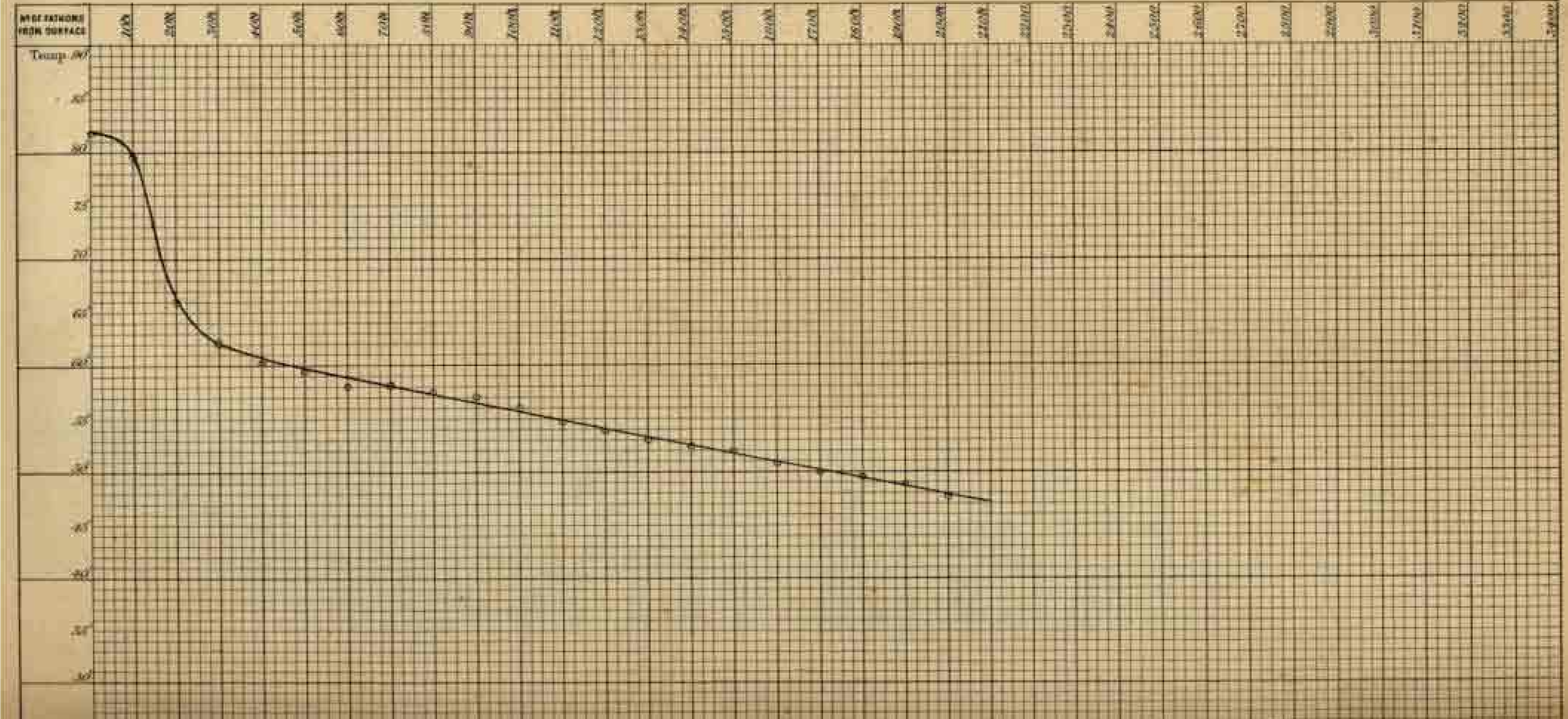
12 April 1876

Nº of Sounding 501.
. . *Station* 351.

Depth None obtained.

Latitude 9° 9′ N.
Longitude 16° 41′ W.

Nº OF FATHOMS FROM SURFACE	SURFACE	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
Nº OF THERMOMETER		93	416	86	94	85	89	74	71	496	75	893	416	88	94	85	89	74	77	75	496				419																				
TEMPERATURE SHEWN BY THERMOMETER	81.8	79.8	66.0	62.1	60.2	59.0	58.0	58.1	57.8	56.8	56.0	54.8	54.0	53.0	52.6	51.5	50.9	50.0	49.8	48.5	47.5				44.5																				
ERROR OF THERMOMETER	0.0	0.0	0.0	0.0	0.0	+0.5	0.0	0.0	−0.2	+0.2	+0.2	0.0	0.0	0.0	0.0	+0.5	0.0	0.0	−0.2	+0.2	+0.2				0.0																				
CORRECTED TEMPERATURE	81.8	79.8	66.0	62.1	60.2	59.5	58.0	58.1	57.6	57.0	56.2	54.8	54.0	53.0	52.6	52.0	50.9	50.0	49.6	48.7	47.7				44.5																				
TEMPERATURE FROM CURVE	81.8	79.8	66.0	62.1	60.7	59.8	59.1	58.2	57.4	56.5	55.8	55.0	54.2	53.4	52.6	51.8	51.0	50.2	49.4	48.7	48.0																								



SECTION. ASCENSION ISLAND TOWARDS CAPE VERDE ISLANDS.

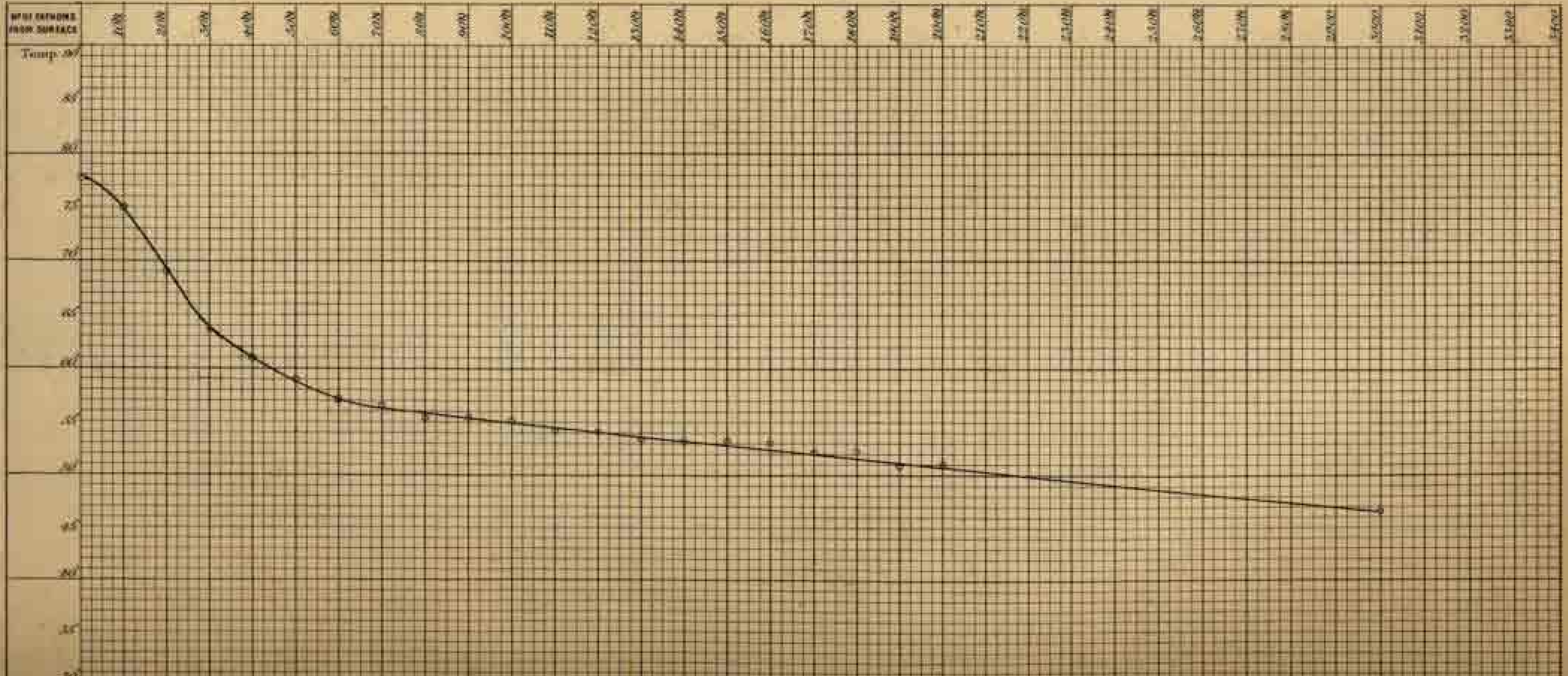
13 April 1876.

No. of Sounding 502.
" Station 352.

Depth None obtained.

Latitude 10° 55′ N.
Longitude 17° 46′ W.

No. of fathoms from surface	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			Bottom
No. of thermometer		87	88	89	94	116	75	77	74	85	96	72	71	75	116	96	85	89	94	88	93				119																				
Temperature shewn by thermometer	77.7	75.0	69.1	63.3	61.0	59.0	57.0	56.6	55.6	55.1	55.0	54.9	54.2	53.2	53.8	53.1	53.5	52.8	52.2	51.0	51.0				46.5																				
Error of thermometer	0.0	0.0	0.0	0.0	0.0	0.0	+0.2	−0.2	0.0	+0.5	+0.2	0.0	−0.2	+0.2	0.0	+0.2	+0.5	0.0	0.0	0.0	0.0				0.0																				
Corrected temperature	77.7	75.0	69.1	63.3	61.0	59.0	57.2	56.4	55.6	55.6	55.2	54.9	54.0	53.4	53.8	53.3	53.0	52.8	52.2	51.0	51.0				46.5																				
Temperature from curve	77.7	75.0	69.1	63.7	60.9	58.2	57.0	56.4	55.9	55.4	55.0	54.8	54.1	53.6	53.7	53.5	53.3	52.9	52.3	51.1	50.7				46.5																				



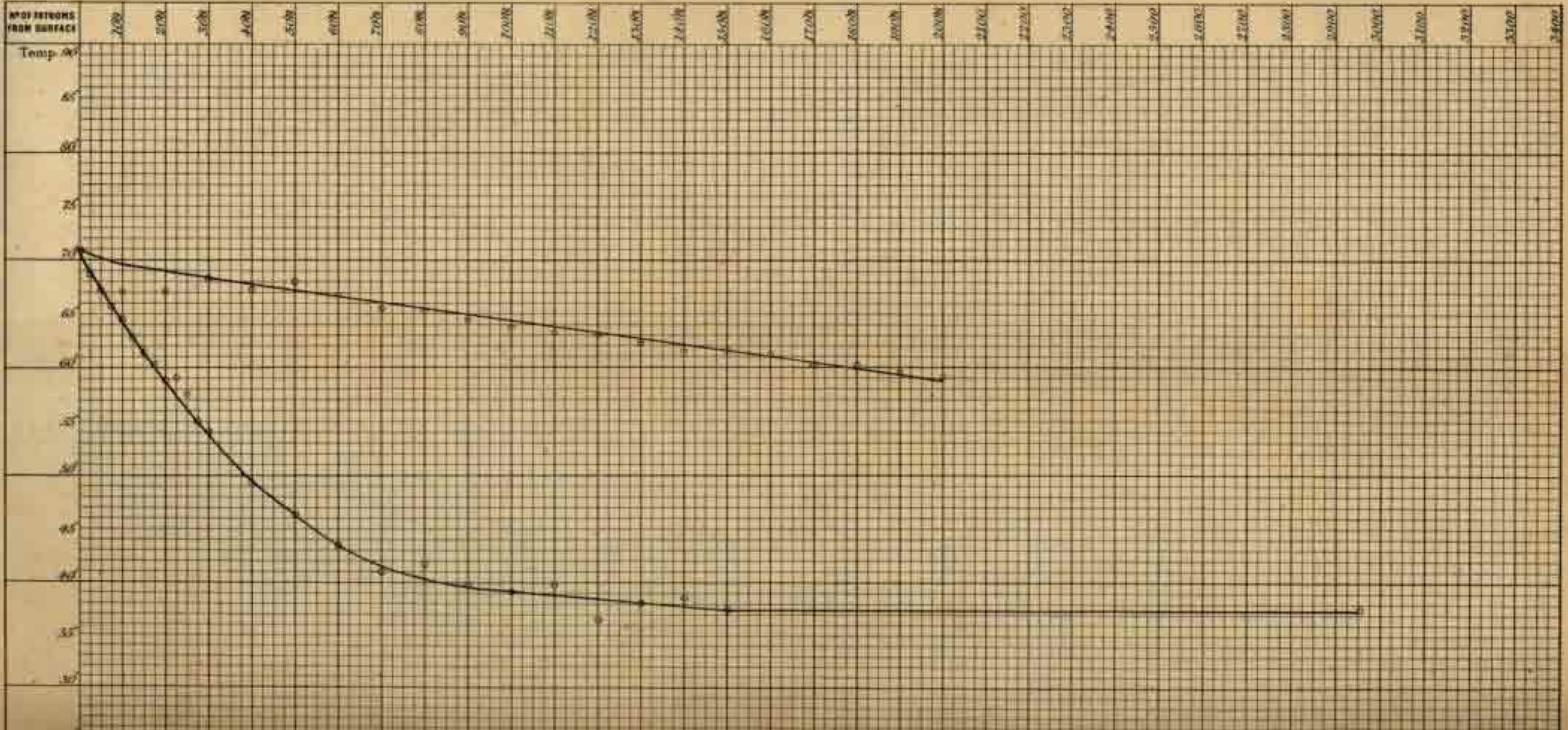
3 May 1876.

Nº of Sounding 503.
Station 353.

Depth 2965 *fathoms*

Latitude 26° 21′ N.
Longitude 33° 37′ W.

Nº of Fathoms from Surface	Nº of Thermometer	Temperature shewn by Thermometer	Error of Thermometer	Corrected Temperature	Temperature from Curve
Surface		70.7	0.0	70.7	70.7
10	219	67.0	0.0	67.0	69.7
20	93	67.0	0.0	67.0	69.0
30	696	68.0	+0.2	68.2	68.2
40	695	67.2	0.0	67.2	67.6
50	94	68.0	0.0	68.0	67.1
60	85	66.2	+0.5	66.7	66.5
70	89	65.3	0.0	65.3	66.0
80	72	65.0	+0.2	65.2	65.4
90	216	64.5	0.0	64.5	64.9
100	88	63.8	0.0	63.8	64.5
110	213	63.1	0.0	63.1	63.8
120	92	63.0	0.0	63.0	63.2
130	696	62.0	+0.2	62.2	62.7
140	695	61.5	0.0	61.5	62.2
150	94	61.5	0.0	61.5	61.6
160	85	60.6	+1.5	62.1	61.0
170	89	60.1	0.0	60.1	60.5
180	73	60.0	+0.2	60.2	59.9
190	216	59.6	0.0	59.6	59.4
200	88	59.0	0.0	59.0	58.8
225	74	59.0	0.0	59.0	57.4
250	71	57.6	−0.2	57.4	56.2
275	216	55.0	0.0	55.0	55.0
300	73	53.8	+0.2	54.0	53.9
400	89	49.3	0.0	49.3	49.3
500	85	45.8	+0.5	46.3	46.2
600	94	43.5	0.0	43.5	43.8
700	697	41.0	0.0	41.0	42.5
800	698	41.6	+0.2	41.8	40.3
900	219	39.8	0.0	39.8	39.7
1000	219	39.0	0.0	39.0	39.0
1100	698	39.5	+0.2	39.7	38.8
1200	693	36.5	0.0	36.5	38.5
1300	94	38.1	0.0	38.1	38.2
1400	85	38.0	+0.5	38.5	37.9
1500	89	37.5	0.0	37.5	37.6
1600					
1700					
1800					
1900					
2000					
Bottom	88 93	37.5 37.7	0.0 0.0	37.5 37.7	37.6



SECTION. MISCELLANEOUS.

6 May 1876.

N° of Sounding 504.
. . *Station* 354.

Depth 1675 fathoms.

Latitude 32° 41′ N.
Longitude 36° 6′ W.

N° OF FATHOMS FROM SURFACE	SURFACE	10	25	30	40	50	60	75	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000			BOTTOM
N° OF THERMOMETER			696			693		73			99										89				216	83	78	94	71	86	93	216	94	219	83	71	89								88 93
TEMPERATURE SHEWN BY THERMOMETER	70.0		66.0			64.4		63.1			63.0										60.0				53.6	50.0	45.6	44.8	43.0	41.2	40.2	40.0	38.4	37.6	38.6	39.5	37.2								37.8 37.8
ERROR OF THERMOMETER	0.0		+0.2			0.0		+0.2			0.0										0.0				0.0	+0.3	0.0	0.0	−0.2	0.0	0.0	0.0	0.0	0.0	+0.5	−0.2	0.0								0.0 0.0
CORRECTED TEMPERATURE	70.0		66.2			64.4		63.3			63.0										60.0				53.6	50.3	45.6	44.8	42.8	41.2	40.2	40.0	38.5	37.6	39.1	39.3	37.2								37.8 37.8
TEMPERATURE FROM CURVE	70.0		66.2			65.2		64.8			63.2										58.0				53.5	49.7	46.7	44.5	42.8	41.2	39.9	39.1	38.6	38.4	38.2	38.1	38.0								37.8

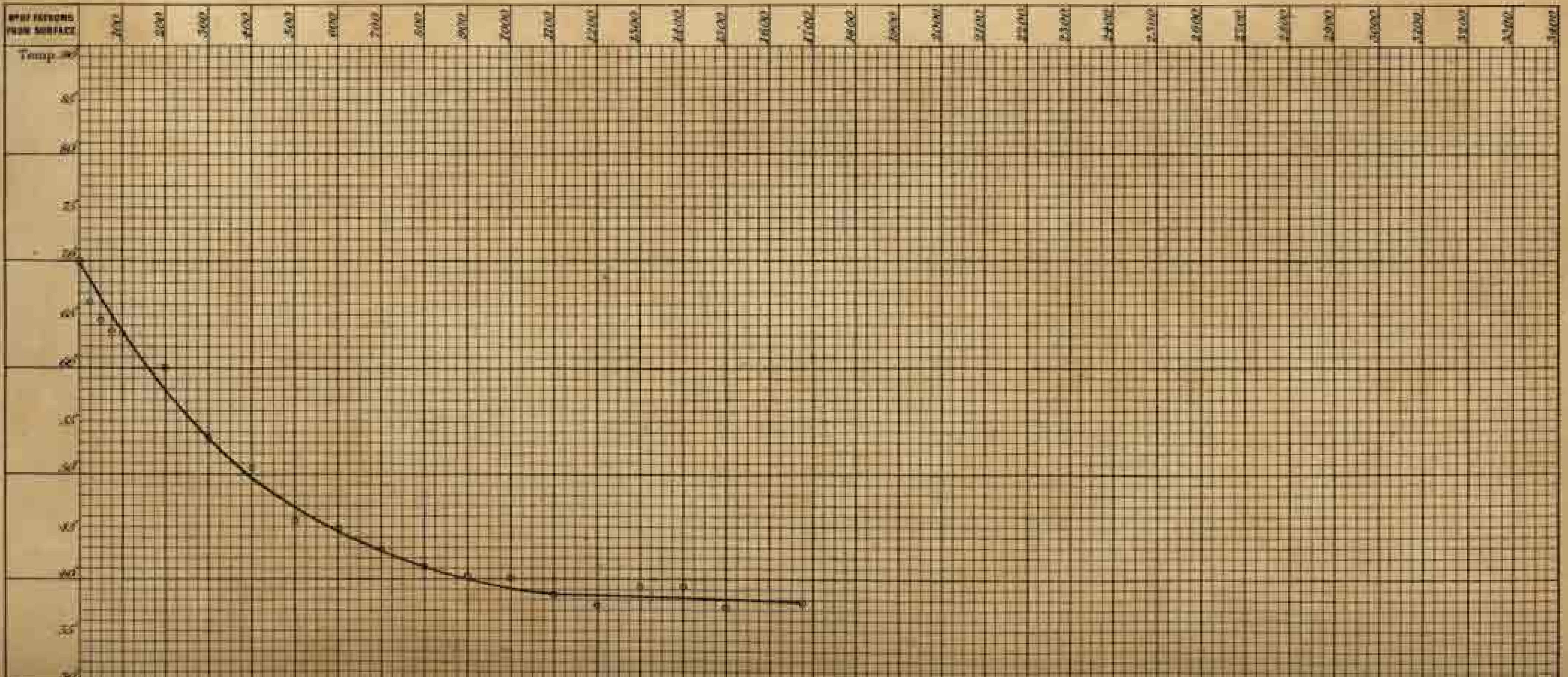


TABLE I.—(*continued*).

Showing the Temperatures obtained in the North Atlantic Ocean—*second part.*

Distinguishing Number of Station.	Latitude.	Longitude.	TEMPERATURE, IN DEGREES FAHRENHEIT, AT THE DEPTH, GIVEN IN FATHOMS.																																								
	° ′ ″	° ′ ″	Surf.	10	20	25	30	40	50	60	70	75	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	
11	22 45 00 N.	40 37 00 W.	72·2	...	72·1	...	...	72·0	...	72·0	...	...	71·2	...	67·9	...	64·5	...	...	61·3	...	59·8	...	...	59·2	...	58·6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Plate XI.
89	22 18 00 ,,	22 2 00 ,,	73·5	...	...	...	...	...	...	...	...	...	...	...	64·0	...	...	...	...	...	...	...	...	...	...	...	56·0	...	...	...	50·5	47·0	44·6	43·0	42·0	41·0	40·0	39·0	38·0	37·4	37·0	36·8	36·7	,, LIX.
13	21 38 00 ,,	44 39 00 ,,	72·0	...	...	...	...	...	...	...	...	...	...	...	66·0	...	...	...	...	...	...	...	...	...	...	...	60·3	...	...	...	54·5	49·5	45·0	42·0	40·5	39·7	39·1	38·7	38·3	38·0	37·7	37·4	37·2	,, XII.
90	20 58 00 ,,	22 57 00 ,,	74·0	...	...	...	...	...	...	...	...	...	...	...	62·2	...	...	...	...	...	...	...	...	...	...	...	56·0	...	...	...	50·7	46·7	44·0	42·2	40·8	39·8	39·1	38·6	38·2	37·8	37·4	37·0	...	,, LX.
15	20 49 00 ,,	48 45 00 ,,	72·5	...	...	...	...	...	...	...	...	...	...	...	66·5	...	...	...	...	...	...	...	...	...	...	...	60·3	...	...	...	53·3	47·5	43·2	41·6	40·7	40·2	39·8	39·3	38·8	38·8	37·9	37·5	37·1	,, XIII.
17	20 7 00 ,,	52 32 00 ,,	74·0	...	...	...	...	...	...	...	...	...	...	...	69·5	...	...	...	...	...	...	...	...	...	...	...	62·0	...	...	...	54·6	48·5	44·7	42·5	41·2	40·4	39·9	39·4	39·0	38·5	38·0	37·5	37·1	,, XIV.
18	19 41 00 ,,	55 18 00 ,,	74·0	...	...	...	...	...	73·5	...	...	...	...	...	60·8	...	...	...	...	...	64·5	...	...	...	...	...	60·0	...	56·7	...	53·5	47·8	43·2	41·2	40·4	40·0	...	...	...	...	...	...	...	,, XV.
25	19 41 00 ,,	65 7 0 ,,	76·0	...	...	...	...	...	...	...	...	...	...	...	68·8	...	...	...	...	...	...	...	...	...	...	...	61·5	...	...	...	54·0	47·4	43·8	41·5	40·0	39·0	38·7	38·5	38·3	38·1	37·9	37·7	37·5	,, XVIII.
91	19 4 00 ,,	24 6 00 ,,	74·0	...	...	...	...	...	...	...	...	...	...	...	60·0	...	...	...	...	...	...	...	...	...	...	...	54·0	...	...	...	49·6	46·2	43·5	41·9	40·7	39·8	39·1	38·6	...	...	...	...	...	,, LXI.
20	18 56 00 ,,	59 35 00 ,,	75·0	...	...	...	...	...	...	...	...	...	...	...	63·5	...	...	...	...	...	...	...	...	...	...	...	59·8	...	...	...	49·7	45·0	42·5	41·2	40·5	39·8	39·3	38·8	38·3	27·8	37·3	36·8	36·3	,, XVI.
22	18 40 00 ,,	62 56 00 ,,	76·0	...	...	...	...	...	...	...	...	...	...	...	69·0	...	...	...	...	...	...	...	...	...	...	...	61·5	...	...	...	54·8	45·9	45·2	43·0	41·2	40·0	39·5	39·2	39·0	38·7	38·4	...	...	,, XVII.
92	17 54 00 ,,	24 41 00 ,,	74·7	...	...	...	...	...	68·0	...	...	...	...	...	62·0	...	...	...	...	...	...	...	...	...	...	...	52·0	...	...	...	47·2	44·2	42·4	41·4	40·5	39·9	39·3	38·8	38·3	38·0	37·8	37·6	37·5	,, LXII.
95	13 36 00 ,,	22 49 00 ,,	79·0	76·0	65·2	...	...	...	...	...	...	...	...	...	52·5	...	...	...	...	...	...	...	...	...	...	...	49·5	...	...	...	46·4	43·3	41·1	40·5	40·0	39·7	39·2	38·9	38·5	38·1	37·8	37·6	37·4	,, LXIII.
96	12 15 00 ,,	22 28 00 ,,	78·7	70·5	62·8	60·2	...	...	54·2	...	...	53·0	...	...	52·2	...	...	51·4	...	...	50·0	...	...	49·8	...	...	49·1	...	47·5	...	45·9	42·9	39·9	...	...	...	...	...	...	...	...	...	...	,, LXIV.
352	10 55 00 ,,	17 46 00 ,,	77·7	75·0	69·1	...	63·7	60·9	58·8	57·2	56·4	...	55·9	55·4	55·0	54·6	54·1	...	53·6	53·1	52·7	52·8	[illegible]	...	51·5	51·1	50·7	...	...	...	46·5	...	...	...	...	...	...	...	...	...	...	...	...	,, CCLVI.
97	10 25 00 ,,	20 30 00 ,,	78·0	...	...	60·0	...	...	59·4	...	...	55·0	...	...	53·2	...	...	...	...	...	...	...	...	...	...	...	48·7	...	...	...	45·0	42·2	40·5	40·2	40·0	39·2	38·4	38·0	37·6	37·2	36·8	36·7	36·7	,, LXV.
98	9 21 00 ,,	18 28 00 ,,	78·2	...	...	66·5	...	...	59·3	...	...	55·5	...	...	54·2	...	...	53·1	...	...	52·0	...	...	...	...	...	49·7	...	...	...	45·2	42·0	41·2	...	...	...	...	...	...	...	...	...	...	,, LXVI.
351	9 9 00 ,,	16 41 00 ,,	81·8	79·8	66·0	...	62·1	60·7	59·8	59·1	58·2	...	57·4	56·5	55·8	55·0	54·2	...	53·4	52·6	51·8	51·0	[illegible]	...	49·4	48·7	48·0	...	...	...	44·5	...	...	...	...	...	...	...	...	...	...	...	...	,, CCLV.
99	7 58 00 ,,	17 26 00 ,,	78·0	...	...	...	...	...	63·2	...	...	...	...	...	56·2	...	...	...	...	...	...	...	...	...	...	...	40·8	...	...	...	45·8	42·2	41·4	...	...	...	...	...	...	...	...	...	...	,, LXVII.
350	7 33 00 ,,	15 16 00 ,,	84·0	84·0	75·0	...	68·5	64·8	62·2	60·8	59·2	...	58·3	57·6	56·7	56·3	55·7	...	55·2	55·0	54·5	53·6	52·5	...	51·6	50·7	50·0	...	...	...	45·0	...	...	...	...	...	...	...	...	...	...	...	...	,, CCLIV.
100	7 1 00 ,,	15 55 00 ,,	79·0	79·0	78·0	...	73·4	64·2	60·8	...	...	56·8	...	...	55·2	...	...	...	...	...	...	...	...	...	...	...	48·5	...	...	...	45·0	42·0	40·4	39·7	39·4	39·1	38·8	38·5	38·2	38·0	37·8	37·6	37·4	,, LXVIII.
101	5 48 00 ,,	14 20 00 ,,	79·2	...	...	72·6	...	...	62·5	...	...	58·8	...	...	56·2	...	...	54·1	...	...	52·2	...	...	...	...	...	48·2	...	...	...	43·8	40·8	39·7	39·5	39·4	39·3	...	...	...	...	...	...	...	,, LXIX.
349	5 28 00 ,,	14 38 00 ,,	83·5	83·2	70·0	...	62·0	60·2	59·2	58·5	57·8	...	57·1	56·5	55·9	55·2	54·6	...	54·0	53·3	52·7	52·1	51·4	...	50·8	50·1	49·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CCLIII.
348	3 10 00 ,,	14 51 00 ,,	84·0	84·0	82·2	...	70·8	62·2	60·5	58·2	57·6	...	57·0	56·5	56·1	55·7	55·3	...	54·9	54·5	54·1	53·0	[illegible]	...	50·9	49·7	49·1	47·8	46·4	45·1	43·6	41·2	40·4	40·0	39·8	39·6	39·3	39·0	38·7	38·4	38·1	37·8	37·0	,, CCLII.
102	3 8 00 ,,	14 49 00 ,,	78·0	78·5	76·2	...	73·5	70·5	67·8	65·0	...	61·0	...	...	57·0	...	...	...	...	...	51·3	...	...	...	...	...	46·8	...	...	...	41·8	40·6	39·9	39·4	39·0	38·7	38·4	38·1	37·8	37·6	37·4	37·2	37·0	,, LXX.
103	2 52 00 ,,	17 00 00 ,,	77·0	...	76·5	...	74·7	70·5	63·8	62·2	60·8	...	59·4	57·9	56·4	...	...	...	...	...	51·5	...	...	...	...	...	47·5	...	...	...	43·0	40·6	40·2	...	...	...	...	...	...	...	...	...	...	,, LXXI.
104	2 25 00 ,,	20 1 00 ,,	78·0	78·4	77·6	...	76·0	68·8	63·8	60·5	...	...	...	...	55·0	...	...	...	...	...	...	...	...	...	...	...	49·0	...	...	...	45·0	42·4	40·7	39·7	39·2	38·9	38·6	38·2	37·9	37·6	37·3	37·0	36·7	,, LXXII.
105	2 6 00 ,,	22 53 00 ,,	78·0	...	...	...	...	...	...	...	...	...	...	...	56·0	...	...	...	...	...	...	...	...	...	...	...	46·0	...	...	...	42·8	41·0	40·4	...	...	...	...	...	...	...	...	...	...	,, LXXIII.
106	1 47 00 ,,	24 26 00 ,,	78·8	78·6	78·4	...	78·2	76·2	62·4	59·0	58·0	...	...	...	55·0	...	...	...	...	...	...	...	...	...	...	...	45·0	...	...	...	40·7	40·5	40·3	40·2	40·1	40·0	39·6	39·2	38·3	38·3	37·9	37·5	37·0	,, LXXIV.
110	0 9 00 ,,	30 18 00 ,,	77·5	77·4	77·2	...	77·0	71·8	67·0	62·7	...	59·8	...	...	56·2	...	...	...	...	...	...	...	...	...	...	...	46·8	...	...	...	42·0	40·0	39·8	39·6	39·4	39·2	38·8	38·4	38·0	37·6	37·3	37·0	36·8	,, LXXV.

TABLE II.

Showing the Temperatures obtained in the South Atlantic Ocean.

Distinguishing Number of Station.	Latitude.	Longitude.	TEMPERATURE, IN DEGREES FAHRENHEIT, AT THE DEPTH, GIVEN IN FATHOMS.																																									
	° ′ ″	° ′ ″	Surf.	10	20	25	30	40	50	60	70	75	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	
347	0 15 00 S.	14 25 00 W.	82·0	81·2	78·0	...	74·0	69·8	65·2	61·8	60·5	...	59·7	58·6	58·0	57·2	56·3	...	55·5	54·6	53·8	53·0	52·7	...	50·3	49·5	48·7	47·8	46·0	45·0	44·0	42·0	41·4	41·0	40·6	40·3	40·0	39·7	39·3	39·0	38·7	38·3	38·0	Plate CCLI.
346	2 42 00 „	14 41 00 „	82·7	82·0	78·1	71·5	62·2	57·5	56·5	56·3	56·1	...	55·9	55·7	55·3	54·7	54·0	...	53·4	52·6	52·0	51·8	50·6	...	49·9	49·3	48·7	47·4	45·9	44·5	43·3	40·8	40·0	39·7	39·5	39·2	38·9	38·7	38·5	38·2	37·9	37·7	37·5	„ CCL.
112	3 38 00 „	32 16 00 „	78·0	78·0	72·0	...	77·5	73·3	63·2	59·0	...	56·5	...	...	54·4	...	...	...	...	...	...	...	—	...	...	...	46·6	...	...	...	42·0	40·0	39·7	39·7	39·7	39·7	38·6	38·1	37·9	37·8	37·7	37·6	37·5	„ LXXVI.
116	5 1 00 „	33 50 00 „	78·0	...	...	...	...	...	...	...	...	...	...	...	54·5	...	...	...	...	...	...	...	—	...	...	...	45·4	...	...	...	41·9	40·0	39·3	39·0	38·7	38·5	38·8	38·1	37·9	37·7	37·5	37·2	37·0	„ LXXVII.
345	5 46 00 „	14 25 00 „	82·8	82·8	82·0	...	79·6	76·3	71·6	65·0	59·3	...	56·5	54·4	52·8	51·8	51·0	...	50·2	49·7	49·2	48·8	48·3	...	47·3	47·3	46·9	45·9	45·0	44·3	43·8	42·0	40·6	39·7	39·1	38·8	38·6	38·4	38·2	38·0	37·8	37·7	37·6	„ CCXLIX.
119	7 30 00 „	34 12 00 „	77·5	...	...	...	...	...	...	...	...	...	...	...	62·2	...	...	...	...	...	...	...	—	...	...	...	47·5	...	...	...	41·0	39·5	39·0	...	...	...	...	...	...	...	...	...	...	„ LXXVIII.
343	8 3 00 „	14 27 00 „	80·3	80·5	80·0	...	77·0	72·5	67·0	62·0	58·5	...	56·3	55·0	53·8	52·8	52·0	...	51·1	50·2	49·7	49·1	48·4	...	47·8	47·1	46·6	45·6	45·0	44·3	43·8	...	...	...	...	...	...	...	...	...	...	...	...	„ CCXLVIII.
342	9 43 00 „	13 51 00 „	80·0	80·2	80·0	...	78·3	76·0	71·5	67·2	62·3	...	58·3	55·7	54·4	53·7	52·9	...	52·1	51·3	50·6	50·0	49·5	...	49·0	48·4	47·8	46·9	45·9	45·1	44·5	42·5	40·8	39·7	39·1	38·8	38·4	38·2	...	...	...	...	...	„ CCXLVII.
341	12 16 00 „	13 44 00 „	79·0	79·0	78·2	...	76·7	74·2	71·4	68·2	64·3	...	61·8	59·2	57·3	55·4	54·0	...	52·7	51·6	50·8	50·0	49·3	...	48·5	47·8	47·0	45·8	44·7	43·5	42·6	40·3	39·3	39·0	38·9	38·8	38·7	38·6	...	...	...	...	...	„ CCXLVI.
340	14 33 00 „	13 42 00 „	77·2	77·0	76·4	...	75·7	74·1	72·3	69·8	67·3	...	64·3	61·5	58·8	56·2	54·3	...	53·0	52·2	51·3	50·4	49·5	...	48·6	47·7	46·9	45·7	44·3	43·0	42·0	39·9	39·4	39·2	39·0	38·3	38·6	38·4	...	...	...	...	37·6	„ CCXLV.
339	17 26 00 „	13 52 00 „	76·0	75·8	75·4	...	74·3	72·3	70·0	67·7	65·5	...	63·5	61·6	59·8	58·0	56·4	...	55·1	53·8	52·7	51·8	51·0	...	50·2	49·6	49·0	...	...	...	43·0	39·8	39·5	39·2	38·9	38·0	38·3	38·1	...	...	...	...	...	„ CCXLIV.
120	20 13 00 „	35 19 00 „	74·0	...	...	...	...	...	...	...	...	65·9	...	...	63·2	...	...	...	...	...	...	...	...	...	...	...	51·5	...	...	...	43·5	40·1	38·6	38·1	37·7	37·3	37·1	36·9	36·7	36·5	36·3	36·1	36·0	„ LXXIX.
338	21 15 00 „	14 2 00 „	76·5	...	...	75·4	...	...	71·5	...	...	67·2	...	...	63·0	...	...	59·3	...	...	55·3	...	—	52·3	...	...	49·9	48·0	46·0	44·4	43·0	38·8	38·1	38·0	37·9	37·8	37·7	37·6	37·5	37·4	37·3	37·2	37·1	„ CCXLIII.
337	24 38 00 „	13 36 00 „	77·0	...	...	72·0	...	...	68·2	...	...	65·1	...	...	63·0	...	...	61·0	...	...	59·0	...	...	57·0	...	...	55·0	53·1	51·2	49·5	48·0	42·0	39·3	38·7	38·4	38·1	37·9	37·7	...	...	...	...	...	„ CCXLII.
130	26 15 00 „	32 56 00 „	69·0	...	...	...	...	...	...	...	...	...	...	...	60·5	...	...	...	...	...	...	...	...	...	...	...	54·3	...	...	...	48·3	42·3	39·0	38·0	37·5	37·3	37·1	37·0	36·9	36·8	36·7	36·6	36·5	„ LXXX.
336	27 54 00 „	13 13 00 „	76·0	...	...	69·8	...	...	65·0	...	...	62·0	...	...	59·7	...	...	57·5	...	...	55·5	...	—	54·8	...	...	51·9	50·3	48·7	47·3	46·1	41·7	39·1	38·2	38·1	37·9	37·8	37·7	37·5	37·4	37·2	37·1	37·0	„ CCXLI.
131	29 35 00 „	28 9 00 „	65·0	...	...	...	...	...	...	...	...	...	...	...	61·0	...	...	...	...	...	...	...	...	...	...	...	54·7	...	...	...	48·5	42·2	39·2	37·0	37·5	37·3	37·1	37·0	...	...	...	...	...	„ LXXXI.
335	32 24 00 „	13 5 00 „	73·5	...	...	69·3	...	...	64·0	...	...	61·3	...	...	59·3	...	...	57·7	...	...	56·2	...	...	54·8	...	...	53·4	52·0	50·3	49·5	48·0	48·0	39·3	37·8	37·1	37·0	37·0	37·0	...	...	...	...	...	„ CCXL.
140	35 00 00 „	17 57 00 E.	59·0	58·7	58·4	...	58·1	56·9	54·6	53·3	53·0	...	53·0	53·0	53·0	...	...	...	...	...	...	...	—	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	„ XC.
132	35 25 00 „	23 40 00 W.	58·0	...	...	...	...	...	...	...	...	...	...	...	55·2	...	...	...	...	...	...	...	...	...	...	...	50·0	...	...	...	43·8	40·0	38·8	...	...	...	...	...	...	...	...	...	...	„ LXXXII.
139	35 35 00 „	16 9 00 E.	56·2	56·1	56·0	...	55·0	52·9	52·3	52·1	52·0	...	51·3	51·6	51·5	...	...	...	...	...	47·3	...	...	...	...	...	45·3	...	44·0	...	41·0	38·0	37·5	...	37·2	...	37·0	...	36·8	...	36·6	...	36·4	„ LXXXIX.
333	35 36 00 „	21 12 00 W.	67·0	...	...	62·2	...	...	57·2	...	...	55·2	...	...	55·0	...	...	54·2	...	...	52·0	...	...	49·3	...	...	46·5	45·0	43·3	42·7	42·0	39·9	38·4	37·6	37·3	37·3	37·3	37·3	...	...	...	...	...	„ CCXXXVIII.
323	35 39 00 „	50 47 00 „	73·5	...	...	71·5	...	...	69·5	...	...	67·5	...	...	65·5	...	...	63·5	...	...	61·5	...	...	59·5	...	...	57·5	55·5	53·5	51·5	49·5	42·0	38·9	37·8	37·0	37·0	37·0	37·0	37·0	37·0	37·0	37·0	37·0	„ CCXXIX.
133	35 41 00 „	20 55 00 „	58·0	...	...	57·5	...	...	56·9	...	...	56·2	...	...	55·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	„ LXXXIII.
334	35 45 00 „	18 31 00 „	68·5	...	...	64·5	...	...	60·3	...	...	57·8	...	...	56·0	...	...	54·0	...	...	52·3	...	...	50·0	...	...	49·3	48·0	46·6	45·4	44·2	40·4	38·3	37·7	37·4	37·2	37·1	37·0	36·8	...	36·6	...	36·4	„ CCXXXIX.
137	35 59 00 „	1 34 00 E.	56·1	...	...	...	...	...	56·0	...	...	...	...	...	55·6	...	...	...	...	...	54·3	...	...	...	...	...	51·8	...	47·9	...	44·6	40·4	38·7	...	37·0	...	36·8	...	36·6	...	36·5	...	36·4	„ LXXXVII.
324	36 0 00 „	48 22 00 W.	71·5	69·7	69·6	...	69·5	69·3	68·8	...	...	61·0	...	...	60·0	...	...	56·5	...	...	53·3	...	...	50·3	...	...	48·0	45·0	42·5	41·5	40·6	39·4	38·6	38·1	37·5	37·0	37·0	37·0	37·0	37·0	37·0	37·0	37·0	„ CCXX.
134	36 12 00 „	12 16 00 „	58·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46·0	...	...	...	...	...	...	...	37·2	...	37·0	...	36·8	...	36·6	...	...	„ LXXXIV.
138	36 22 00 „	8 12 00 E.	56·2	...	...	...	...	...	56·1	...	...	...	...	...	56·0	...	...	...	...	...	53·5	...	...	...	...	...	50·5	...	47·0	...	44·0	39·9	38·3	...	...	...	...	...	...	...	...	...	...	„ LXXXVIII.
136	36 43 00 „	7 13 00 W.	54·0	...	...	...	...	...	...	...	...	...	...	...	52·2	...	...	...	...	...	...	...	...	...	...	...	49·2	...	...	...	43·2	39·5	38·0	37·2	...	...	...	...	...	...	...	...	...	„ LXXXVI.
325	36 44 00 „	46 16 00 „	70·8	...	...	69·8	...	...	68·3	...	...	65·3	...	...	62·2	...	...	59·7	...	...	58·8	...	...	57·5	...	...	56·1	54·3	51·2	48·3	45·0	40·4	38·8	37·8	37·2	37·2	37·2	37·2	37·2	37·2	37·2	37·2	37·2	„ CCXXXI.
327	36 48 00 „	42 45 00 „	70·2	...	...	68·0	...	...	66·8	...	...	65·6	...	...	64·0	...	...	62·0	...	...	59·7	...	...	57·5	...	...	55·0	52·5	50·3	48·2	46·0	40·4	38·4	37·8	37·6	37·4	37·2	37·0	...	...	...	...	...	„ CCXXXIII.
326	37 3 00 „	44 17 00 „	67·8	...	...	68·7	...	...	59·0	...	...	55·8	...	...	53·3	...	...	50·4	...	...	46·1	...	...	43·5	...	...	42·0	41·2	40·2	39·7	39·1	37·8	37·1	37·0	37·0	37·0	37·0	37·0	...	...	...	...	...	„ CCXXXII.
320	37 17 00 „	53 52 00 „	67·5	...	...	60·0	...	...	46·0	...	...	44·0	...	...	43·0	...	...	42·0	...	...	41·0	...	...	40·3	...	...	40·0	39·3	39·5	39·3	39·1	38·4	37·9	37·2	...	...	...	...	...	...	...	...	...	„ CCXXVIII.
135E	37 21 00 „	12 22 30 „	58·5	...	...	...	...	...	...	...	...	...	...	...	48·5	...	...	...	...	...	...	...	...	...	...	...	45·1	...	...	...	42·3	40·0	38·3	37·2	...	...	...	...	...	...	...	...	...	„ LXXXV.
332	37 29 00 „	27 31 00 „	64·0	...	...	58·8	...	...	57·0	...	...	56·2	...	...	55·5	...	...	55·0	...	...	54·7	...	...	54·0	...	...	52·0	50·0	47·5	45·5	43·8	38·9	37·5	37·3	37·3	37·3	37·3	37·3	...	...	...	...	...	„ CCXXXVII.
329	37 31 00 „	36 7 00 „	64·5	...	...	63·7	...	...	57·0	...	...	55·8	...	...	54·5	...	...	53·2	...	...	51·3	...	...	48·0	...	...	45·0	43·0	41·5	40·7	40·2	38·9	38·0	37·4	37·0	37·0	37·0	37·0	37·0	37·0	37·0	37·0	37·0	„ CCXXXIV.
330	37 45 00 „	33 0 00 „	64·2	...	...	63·0	...	...	59·0	...	...	57·0	...	...	56·2	...	...	55·6	...	...	55·4	...	...	55·2	...	...	53·0	50·6	48·0	46·0	44·7	40·7	38·7	37·8	37·5	37·5	37·5	37·5	37·5	37·5	37·5	37·5	37·5	„ CCXXXV.
331	37 47 00 „	30 20 00 „	64·5	...	...	62·0	...	...	58·0	...	...	56·0	...	...	54·9	...	...	54·1	...	...	54·0	...	...	53·7	...	...	51·0	48·5	46·5	45·0	43·3	39·6	37·5	37·0	37·0	37·0	37·0	37·0	...	37·0	...	37·0	...	„ CCXXXVI.
319	41 54 00 „	54 48 00 „	60·5	...	...	52·2	...	...	48·2	...	...	44·3	...	...	43·0	...	...	41·6	...	...	40·6	...	...	40·0	...	...	39·5	39·2	39·0	38·3	38·6	38·1	37·6	37·1	36·8	36·8	36·8	36·8	36·8	36·8	36·8	36·8	36·8	„ CCXXVII.
315	42 32 00 „	56 29 00 „	57·5	...	...	56·7	...	...	43·2	...	...	39·6	...	...	36·5	...	...	35·9	...	...	35·6	...	...	35·4	...	...	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	35·4	„ CCXXVI.
317	48 37 00 „	55 17 00 „	46·7	...	...	42·3	...	...	40·0	...	...	39·6	...	...	39·3	...	...	...	...	...	—	...	...	...	...	...	38·6	...	...	...	38·0	37·4	36·8	...	...	...	...	...	...	...	...	...	...	„ CCXXV.
314A	51 24 00 „	61 46 00 „	49·0	...	...	47·4	...	...	45·8	...	...	...	...	...	...	41·8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	„ CCXXIV.

TABLE III.

Showing the Temperatures obtained in the North Pacific Ocean.

Distinguishing Number of Station.	LATITUDE.	LONGITUDE.	TEMPERATURE, IN DEGREES FAHRENHEIT, AT THE DEPTH, GIVEN IN FATHOMS.																																									
			Surf.	10	20	25	30	40	50	60	70	75	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	
	° ′ ″	° ′ ″	°																																									
253	38 9 00 N.	156 25 00 W.	67·7	...	...	58·8	...	...	53·4	...	...	51·8	...	...	50·4	...	...	49·6	...	...	49·1	...	...	48·2	...	...	46·9	44·8	43·0	41·5	40·8	39·2	38·8	37·6	36·9	36·4	36·2	36·0	35·8	35·7	35·6	35·8	35·1	Plate CLXXII.
249	37 59 00 ,,	171 48 00 ,,	65·2	...	...	57·2	...	...	54·8	...	...	53·3	...	...	52·3	...	...	51·6	...	...	51·1	...	...	49·8	...	...	48·0	46·4	45·0	43·7	42·7	40·1	38·5	37·7	37·0	36·5	36·2	35·9	35·6	35·3	35·2	35·2	35·2	,, CLXVIII.
252	37 52 00 ,,	160 17 00 ,,	65·0	...	...	55·6	...	...	54·0	...	...	52·5	...	...	51·1	...	...	49·9	...	...	48·7	...	...	47·4	...	...	46·1	45·0	44·0	43·1	42·3	39·8	38·3	37·3	36·7	36·2	35·9	35·8	35·6	35·5	35·4	35·3	35·3	,, CLXXI.
250	37 49 00 ,,	166 47 00 ,,	65·0	...	...	58·5	...	...	55·0	...	...	54·0	...	...	53·0	...	...	52·0	...	...	51·0	...	...	50·1	...	...	49·1	48·1	47·1	46·2	45·8	42·6	40·0	38·5	37·6	36·9	36·4	36·2	36·0	35·8	35·6	35·4	35·2	,, CLXIX.
248	37 41 00 ,,	177 4 00 ,,	69·2	62·9	60·0	...	57·5	55·5	54·5	...	...	53·0	...	...	51·6	...	...	50·2	...	...	49·0	...	...	47·8	...	...	46·5	45·2	44·0	43·0	42·0	39·6	38·0	37·1	36·5	36·2	36·0	35·8	35·6	35·4	35·2	35·1	35·1	,, CLXVII.
251	37 37 00 ,,	168 26 00 ,,	65·0	...	...	58·2	...	...	55·2	...	...	53·5	...	...	52·5	...	...	51·5	...	...	50·5	...	...	49·4	...	...	48·2	46·9	45·4	43·7	42·8	40·0	38·5	37·6	37·0	36·8	36·6	36·3	36·1	35·9	35·6	35·3	35·1	,, CLXX.
245	36 23 00 ,,	174 31 00 E.	69·0	62·6	60·8	...	59·3	58·3	57·5	...	...	56·4	...	...	55·6	...	...	54·4	...	...	52·9	...	...	51·0	...	...	48·8	46·2	44·2	43·0	42·0	40·2	38·8	37·6	36·8	36·4	36·1	35·9	35·7	35·5	35·3	35·1	34·9	,, CLXIV.
246	36 10 00 ,,	178 00 00 ,,	73·0	67·0	63·0	...	60·4	59·0	58·4	...	...	57·8	...	...	57·0	...	...	56·2	...	...	55·3	...	...	54·2	...	...	53·0	52·0	50·4	48·9	46·9	41·8	39·7	38·3	37·4	37·0	36·7	36·4	36·1	35·9	35·6	35·3	35·1	,, CLXV.
247	35 49 00 ,,	179 57 00 W.	73·0	...	...	63·8	...	...	58·4	...	...	56·0	...	...	54·8	...	...	54·1	...	...	53·5	...	...	52·5	...	...	50·5	48·7	46·9	45·0	43·5	40·7	39·1	38·2	37·7	37·2	36·9	36·6	36·2	35·9	35·6	35·3	35·2	,, CLXVI.
241	35 41 00 ,,	157 42 00 E.	69·2	...	...	64·7	...	...	62·5	...	...	[illegible]	...	...	59·3	...	...	57·5	...	...	55·5	...	...	53·1	...	...	50·7	48·7	46·3	44·0	42·4	39·8	38·4	37·7	37·2	36·9	36·6	36·3	36·0	35·7	35·4	35·1	35·1	,, CLX.
242	35 29 00 ,,	161 52 00 ,,	68·5	...	...	62·9	...	...	60·7	...	...	58·3	...	...	56·0	...	...	54·1	...	...	52·2	...	...	50·3	...	...	48·3	46·4	44·4	42·8	41·6	39·6	38·2	37·4	36·9	36·5	36·3	36·1	35·9	35·8	35·7	35·5	35·3	,, CLXI.
243	35 24 00 ,,	166 35 00 ,,	71·0	70·3	65·6	...	63·9	...	60·4	...	...	59·3	...	...	58·3	...	...	57·2	...	...	56·2	...	...	55·1	...	...	53·5	52·0	49·6	47·2	45·0	40·5	39·1	38·1	37·2	36·6	36·1	35·9	35·8	35·7	35·5	35·4	35·3	,, CLXII.
244	35 22 00 ,,	169 53 00 ,,	70·5	...	...	61·0	...	...	59·2	...	...	57·6	...	...	56·2	...	...	54·9	...	...	53·3	...	...	51·7	...	...	49·8	48·0	46·0	44·3	43·1	40·4	38·9	38·0	37·4	36·9	36·4	36·0	35·7	35·5	35·3	35·3	35·3	,, CLXIII.
240	35 20 00 ,,	153 39 00 ,,	64·8	61·5	58·5	...	56·0	54·2	52·4	51·0	49·0	...	48·3	47·0	45·3	...	...	43·2	42·3	...	41·4	...	...	40·6	...	...	40·2	40·1	40·0	40·0	39·6	38·2	37·4	36·9	36·4	36·3	36·2	36·0	35·9	35·7	35·5	35·3	35·1	,, CLIX.
239	35 18 00 ,,	147 9 00 ,,	70·2	...	...	68·1	...	...	64·1	...	...	63·4	...	...	62·3	...	...	60·8	...	...	59·1	...	...	57·1	...	...	55·1	53·2	51·3	49·5	47·7	41·6	39·0	38·1	37·7	37·4	37·1	36·9	36·7	36·4	36·1	35·9	35·7	,, CLVIII.
238	35 18 00 ,,	144 8 00 ,,	70·5	69·6	68·7	...	67·8	66·9	66·0	65·1	64·2	...	63·3	62·4	61·5	...	...	59·3	...	...	57·0	...	...	54·9	...	...	52·7	50·7	48·8	47·1	45·9	42·2	39·7	38·8	37·6	37·0	36·6	36·4	36·2	36·0	35·7	35·5	35·3	,, CLVII.
254	35 13 00 ,,	154 43 00 W.	72·0	...	...	62·2	...	...	57·0	...	...	53·9	...	...	52·0	...	...	50·5	...	...	49·3	...	...	48·0	...	...	46·8	45·9	45·0	44·1	43·3	40·6	38·8	37·7	37·0	36·5	36·2	36·0	35·8	35·6	35·4	35·2	35·0	,, CLXXIII.
232	35 11 00 ,,	139 28 00 E.	64·2	...	...	62·8	...	...	58·8	...	...	55·4	...	...	53·0	...	...	51·4	...	...	50·0	...	...	48·7	...	...	47·4	46·1	45·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CLI.
236A	34 59 00 ,,	139 31 00 ,,	66·5	...	...	...	...	...	...	...	...	...	...	...	57·2	...	...	...	...	...	...	...	...	...	...	...	50·0	...	...	...	44·9	41·4	...	...	...	...	...	...	...	...	...	...	...	,, CLV.
237	34 37 00 ,,	140 32 00 ,,	73·0	73·4	72·0	...	70·5	69·0	67·5	66·1	65·0	...	64·0	63·2	62·4	...	...	59·8	...	...	57·0	...	...	54·5	...	...	52·0	50·0	48·0	46·0	44·1	40·8	38·8	37·7	37·0	36·6	36·4	36·2	36·0	35·8	35·6	35·4	35·3	,, CLVI.
235	34 7 00 ,,	138 00 00 ,,	73·0	...	...	71·2	...	...	66·4	...	...	63·5	...	...	60·5	...	...	57·7	...	...	54·7	...	...	51·5	...	...	48·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CLIV.
234	32 31 00 ,,	135 39 00 ,,	69·5	...	...	66·8	...	...	63·0	...	...	60·0	...	...	57·0	...	...	54·3	...	...	52·0	...	...	49·7	...	...	48·0	46·2	44·9	43·5	42·2	...	...	...	...	...	...	...	...	...	...	...	...	,, CLIII.
255	32 28 00 ,,	154 33 00 W.	74·0	...	...	62·5	...	...	60·3	...	...	57·6	...	...	55·4	...	...	53·3	...	...	51·4	...	...	49·8	...	...	47·9	46·6	45·0	43·5	42·4	39·2	38·1	37·4	36·8	36·4	36·1	35·8	35·6	35·4	35·2	35·0	35·0	,, CLXXIV.
231	31 8 00 ,,	137 8 00 E.	64·0	63·2	62·4	...	61·6	60·8	59·9	59·1	58·3	...	57·5	56·6	55·8	...	...	53·4	...	...	51·2	...	...	49·2	...	...	47·0	45·0	43·0	41·8	40·7	38·2	37·3	37·0	36·7	36·4	36·2	36·0	35·6	35·6	35·4	35·2	35·2	,, CL.
256	30 22 00 ,,	154 56 00 W.	74·0	...	...	70·0	...	...	65·0	...	...	60·0	...	...	55·6	...	...	53·2	...	...	51·2	...	...	49·5	...	...	48·0	46·5	45·2	43·3	42·3	39·7	38·2	37·3	36·7	36·3	36·1	35·9	35·8	35·7	35·5	35·4	35·3	,, CLXXV.
257	27 33 00 ,,	154 55 00 ,,	76·5	...	...	71·3	...	...	65·0	...	...	60·0	...	...	56·5	...	...	53·8	...	...	51·8	...	...	50·2	...	...	48·8	47·4	46·2	45·2	44·2	41·3	39·5	38·3	37·3	36·7	36·3	36·0	35·8	35·6	35·4	35·2	35·0	,, CLXXVI.
230	26 29 00 ,,	137 57 00 E.	68·5	...	...	67·0	...	...	66·0	...	...	65·0	...	...	63·9	...	...	62·8	...	...	61·7	...	...	60·7	...	...	59·7	58·2	56·0	53·3	50·5	43·0	39·7	38·0	37·2	36·7	36·3	35·9	35·5	35·5	35·5	35·5	35·5	,, CXLIX.
258	26 11 00 ,,	155 12 00 W.	77·0	...	...	72·6	...	...	66·6	...	...	62·5	...	...	58·8	...	...	55·3	...	...	52·5	...	...	49·8	...	...	47·6	45·9	44·5	43·4	42·6	40·4	39·0	38·3	37·6	37·0	36·5	36·1	35·8	35·6	35·4	35·2	35·2	,, CLXXVII.
259	23 3 00 ,,	156 6 00 ,,	77·0	...	...	75·6	...	...	72·7	...	...	69·5	...	...	64·5	...	...	59·2	...	...	55·0	...	...	51·5	...	...	48·8	46·5	45·0	43·8	42·9	40·5	39·3	38·6	37·9	37·4	36·9	36·5	36·2	35·9	35·6	35·3	35·0	,, CLXXVIII.
229	22 1 00 ,,	140 27 00 E.	78·5	...	...	75·7	...	...	73·3	...	...	71·0	...	...	69·0	...	...	66·9	...	...	64·8	...	...	62·5	...	...	60·4	58·8	56·2	54·1	52·0	44·2	40·3	38·5	37·7	37·2	36·7	36·3	35·8	35·3	35·2	35·2	35·2	,, CXLVIII.
260	21 11 00 ,,	157 27 00 W.	76·8	76·8	76·4	...	76·0	75·3	73·9	71·5	68·2	...	63·7	60·4	57·8	55·8	54·2	...	53·0	51·8	50·5	49·4	48·3	...	47·6	46·9	46·3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CLXXIX.
261	20 18 00 ,,	157 14 00 ,,	78·5	75·6	75·3	...	74·9	73·1	70·9	68·3	66·0	...	63·7	61·4	59·0	56·9	55·0	...	53·0	51·3	50·0	49·1	48·2	...	47·4	47·0	46·6	...	...	...	42·6	40·8	39·7	38·8	38·0	37·3	36·9	36·4	36·1	35·9	35·7	35·4	35·2	,, CLXXX.
228	19 24 00 ,,	141 13 00 E.	80·2	...	...	79·0	...	...	77·4	...	...	75·0	...	...	71·5	...	...	68·3	...	...	64·8	...	...	61·3	...	...	58·0	55·2	52·4	49·8	47·7	42·6	40·1	38·9	38·0	37·4	36·9	36·4	35·9	35·4	35·3	35·2	35·2	,, CXLVII.
262	19 12 00 ,,	154 14 00 W.	77·5	77·4	77·2	...	77·0	76·3	75·0	73·0	70·5	...	67·5	64·3	61·5	59·0	56·5	...	54·2	52·2	50·3	49·0	48·0	...	47·2	46·7	46·2	...	...	...	44·1	42·9	41·3	39·9	38·5	37·5	36·5	35·9	35·4	35·2	35·2	35·2	35·2	,, CLXXXI.
263	17 33 00 ,,	153 36 00 ,,	77·5	77·5	77·2	...	76·9	76·0	73·5	69·3	65·5	...	62·2	59·5	57·2	55·5	53·8	...	52·5	51·1	49·9	48·0	48·0	...	47·3	47·0	46·7	...	...	...	43·7	41·3	39·5	38·7	38·2	37·8	37·4	37·0	36·6	36·3	36·0	35·7	35·4	,, CLXXXII.
227	17 29 00 ,,	141 21 00 E.	79·2	79·0	78·8	...	78·6	78·4	78·2	78·0	77·6	...	76·5	75·0	73·3	71·5	70·0	...	68·3	66·7	65·2	63·5	62·0	...	60·4	58·8	57·0	...	...	...	46·2	42·0	40·3	39·0	38·3	37·8	37·3	36·8	36·3	35·9	35·5	35·2	35·2	,, CXLVI.
226	14 44 00 ,,	142 13 00 ,,	79·0	78·9	78·8	...	78·7	78·6	78·5	77·9	77·0	...	75·7	73·8	71·3	68·0	64·6	...	62·1	60·2	58·3	56·8	55·6	...	54·5	53·5	52·8	...	...	...	45·1	41·8	39·9	38·7	37·7	36·9	36·3	36·0	35·7	35·5	35·5	35·5	35·5	,, CXLV.
264	14 19 00 ,,	152 37 00 W.	77·5	77·5	77·4	...	77·2	76·8	73·9	67·7	63·0	...	59·1	56·0	54·1	53·0	52·0	...	51·3	50·5	49·8	49·3	48·9	...	48·5	48·0	47·6	...	...	...	44·5	42·4	40·6	39·5	38·7	38·0	37·4	36·9	36·6	36·3	35·9	35·5	35·2	,, CLXXXIII.
265	12 42 00 ,,	152 1 00 ,,	79·2	78·6	77·8	...	75·8	72·6	69·2	65·6	62·0	...	58·3	55·2	53·3	52·3	51·7	...	51·1	50·6	50·1	49·8	49·5	...	49·1	48·9	48·5	...	...	...	45·4	43·3	41·5	40·1	39·0	38·1	37·4	37·0	36·6	36·3	36·0	35·7	35·4	,, CLXXXIV.
225	11 24 00 ,,	143 16 00 E.	80·2	80·2	80·0	...	80·0	80·0	80·0	80·0	78·0	...	74·8	70·6	67·0	63·0	59·4	...	56·1	53·7	52·0	51·3	50·7	...	50·1	49·7	49·2	...	...	...	43·2	41·2	39·9	38·6	37·9	37·3	36·9	36·5	36·1	35·7	35·5	35·5	35·5	,, CXLIV.
266	11 7 00 ,,	152 3 00 W.	80·0	79·5	78·0	...	75·3	70·3	64·7	58·6	56·2	...	54·3	53·0	52·2	51·6	51·3	...	51·0	50·6	50·2	49·8	49·4	...	49·0	48·6	48·2	...	...	...	44·6	42·0	40·2	38·9	37·9	37·3	36·9	36·5	36·2	35·9	35·6	35·3	35·1	,, CLXXXV.
267	9 28 00 ,,	150 49 00 ,,	80·0	77·0	73·5	...	63·4	61·3	56·0	53·6	52·3	...	51·7	51·4	51·0	50·7	50·3	...	50·0	49·7	49·4	49·1	48·8	...	48·4	48·1	47·8	...	...	...	45·0	42·5	40·8	39·5	38·5	37·8	37·1	36·6	36·1	35·7	35·4	35·2	35·0	,, CLXXXVI.
224	7 45 00 ,,	144 20 00 E.	81·2	81·5	81·1	...	80·6	80·0	79·5	79·0	78·1	...	75·0	68·5	63·2	59·6	56·7	...	54·3	52·5	51·0	49·9	49·3	...	48·9	48·6	48·3	...	...	...	45·7	43·4	41·3	39·5	38·2	37·2	36·7	36·3	36·0	35·8	35·6	35·4	35·4	,, CXLIII.
268	7 35 00 ,,	149 49 00 W.	81·0	79·3	79·3	...	79·3	78·2	74·0	63·4	58·2	...	52·6	51·0	50·3	50·0	49·8	...	49·6	49·4	49·2	49·0	48·8	...	48·6	48·4	48·2	...	...	...	45·8	43·2	41·1	40·0	39·2	38·7	38·2	37·7	37·2	36·7	36·3	35·8	35·3	,, CLXXXVII.
269	5 54 00 ,,	147 2 00 ,,	81·2	80·4	78·0	...	77·8	77·8	77·8	77·6	77·0	...	73·1	66·0	59·5	55·4	52·5	...	51·1	50·3	49·7	49·4	49·2	...	49·0	48·6	48·5	...	...	...	46·0	43·7	41·4	39·9	38·6	37·5	36·7	36·0	35·5	35·3	35·2	35·2	35·2	,, CLXXXVIII.
223	5 31 00 ,,	145 13 00 E.	82·0	81·7	81·7	...	81·7	81·7	81·7	81·7	81·7	...	81·7	79·0	70·9	63·5	59·5	...	56·3	53·8	51·6	50·0	49·8	...	48·8	48·2	47·7	...	...	...	45·8	44·3	42·8	41·3	40·0	38·8	37·7	36·8	36·1	35·7	35·5	35·5	35·5	,, CXLII.
214	4 33 00 ,,	127 6 00 ,,	80·5	...	...	79·1	...	...	73·0	...	...	66·0	...	...	60·0	...	...	54·5	...	...	51·6	...	...	50·0	...	...	48·7	47·3	46·8	45·9	45·2	43·0	41·8	...	...	...	...	...	...	...	...	...	...	,, CXXXIII.
215	4 19 00 ,,	130 15 00 ,,	81·8	77·7	76·1	...	75·4	75·1	74·5	73·4	72·0	...	70·6	69·3	68·0	...	...	...	...	...	...	...	...	...	...	...	54·0	...	...	...	...	43·2	41·0	39·8	38·5	37·6	37·0	...	36·0	...	35·4	35·4	35·4	,, CXXXIV.
216A	2 56 00 ,,	134 11 00 ,,	82·8	...	...	83·2	...	...	81·5	...	...	78·8	...	...	71·8	...	...	65·0	...	...	57·8	...	...	51·5	...	...	48·7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CXXXVI.
216	2 46 00 ,,	133 58 00 ,,	82·8	...	...	...	...	...	...	...	...	...	...	...	71·9	...	...	...	...	...	...	...	...	...	...	...	49·2	...	...	...	44·3	42·3	41·0	39·9	35·9	38·0	37·4	37·0	...	...	...	...	...	,, CXXXV.
270	2 34 00 ,,	149 9 00 W.	79·5	78·7	77·7	...	77·0	76·2	75·5	75·3	75·3	...	72·8	67·3	62·8	59·1	56·5	...	55·0	54·2	53·5	53·2	52·9	...	52·6	52·3	52·0	...	...	...	48·3	45·0	42·7	40·6	39·5	38·7	38·0	37·7	37·3	37·0	36·7	36·3	36·0	,, CLXXXIX.
222	2 15 00 ,,	146 16 00 E.	82·8	82·8	82·6	...	82·4	82·2	82·0	81·8	81·7	...	81·2	80·3	78·9	76·0	63·2	...	55·6	52·7	51·0	50·2	49·7	...	49·3	48·9	48·5	...	...	...	45·5	43·2	41·1	39·3	38·0	37·1	36·5	36·1	35·9	35·7	35·5	35·2	35·2	,, CXLI.
221	0 40 00 ,,	148 41 00 ,,	83·3	83·0	82·8	...	82·4	82·0	81·5	81·0	80·4	...	78·5	75·0	71·2	67·2	63·2	...	59·4	55·6	53·1	51·8	51·2	...	50·6	50·2	49·9	...	...	...	48·3	44·2	41·3	39·8	38·6	37·8	37·1	36·7	36·3	36·0	35·7	35·4	35·4	,, CXL.

TABLE IV.

Showing the Temperatures obtained in the South Pacific Ocean.

Distinguishing Number of Station.	Latitude.	Longitude.	TEMPERATURE, IN DEGREES FAHRENHEIT, AT THE DEPTH, GIVEN IN FATHOMS.																																							
	° ′ ″	° ′ ″	Surf.	10	20	25	30	40	50	60	70	75	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	
271	0 33 00 s.	151 34 00 w.	78·7	77·0	76·2	...	76·2	76·2	76·2	76·2	74·5	...	68·3	63·2	59·4	57·0	56·0	...	55·3	54·7	54·1	53·4	[illegible]	...	52·2	51·6	51·0	...	...	...	46·5	42·0	40·7	39·5	38·7	38·2	37·7	37·2	36·7	36·3	36·1	35·9	35·7	Plate CXC.
217	0 39 00 ,,	138 55 00 E.	83·0	83·0	83·0	...	83·0	82·9	82·5	81·4	80·0	...	78·3	76·4	74·0	70·5	66·5	...	62·3	58·6	56·0	54·2	[illegible]	...	51·9	50·8	49·7	...	...	...	45·1	42·5	40·7	39·2	38·1	37·3	36·7	36·2	35·7	35·3	35·2	35·2	35·2	,, CXXXVII.
220	0 42 00 ,,	147 00 00 ,,	83·8	...	...	...	...	...	81·6	...	...	...	...	...	77·1	...	...	...	...	...	64·0	...	...	...	...	...	52·0	...	48·5	...	46·2	43·1	41·0	39·7	39·0	38·2	37·5	36·8	36·2	...	...	...	...	,, CXXXIX.
218	2 33 00 ,,	144 4 00 ,,	84·0	83·2	83·0	...	82·5	82·1	81·5	80·9	80·0	...	78·4	75·8	72·3	69·8	66·3	...	63·8	60·8	57·8	55·5	[illegible]	...	52·1	51·0	50·0	...	...	...	45·2	42·4	40·5	39·2	38·4	37·9	37·4	...	...	...	...	...	...	,, CXXXVIII.
272	3 48 00 ,,	152 56 00 w.	79·0	78·6	78·5	...	78·2	78·2	78·1	77·5	75·4	...	71·9	67·3	63·6	60·4	57·5	...	55·4	54·0	52·9	52·0	[illegible]	...	50·5	49·8	49·2	...	...	...	44·7	42·2	40·4	39·2	38·2	37·3	36·8	36·4	36·0	35·7	35·5	35·3	35·1	,, CXCI.
273	5 11 00 ,,	152 56 00 ,,	80·7	80·4	80·0	...	79·5	79·4	79·3	79·2	78·5	...	75·8	71·9	68·2	64·0	59·3	...	56·5	54·3	52·6	51·7	[illegible]	...	49·8	49·3	49·0	...	...	...	44·5	41·8	40·1	38·9	38·1	37·5	37·0	36·5	...	...	...	...	...	,, CXCII.
274	7 25 00 ,,	152 15 00 ,,	80·2	80·0	80·0	...	80·0	80·0	79·8	79·5	78·6	...	77·0	73·7	69·8	64·7	60·9	...	57·8	55·1	52·9	51·8	[illegible]	...	49·2	48·5	48·0	...	...	...	44·6	42·5	41·0	39·5	38·5	37·6	37·1	36·7	36·4	36·1	35·9	35·6	35·3	,, CXCIII.
275	11 20 00 ,,	150 30 00 ,,	80·0	79·9	79·8	...	79·8	79·4	79·0	78·0	76·7	...	75·3	73·7	72·0	70·1	68·3	...	66·2	64·0	61·4	58·9	[illegible]	...	54·2	52·4	50·8	...	...	...	45·0	42·6	40·9	39·5	38·4	37·5	37·0	36·7	36·5	36·2	36·0	35·8	35·6	,, CXCIV.
184	12 8 00 ,,	145 10 00 E.	77·5	...	...	...	...	...	76·6	...	...	74·3	...	...	70·8	...	...	66·8	...	...	62·5	...	...	58·2	...	...	54·2	51·0	48·0	...	44·3	41·0	39·7	...	...	...	...	...	...	...	...	36·0	...	,, CXX.
183	12 42 00 ,,	146 46 00 ,,	78·0	...	...	...	...	...	76·2	...	...	...	...	...	69·5	...	...	...	...	...	61·5	...	...	...	...	...	54·5	...	48·9	...	45·0	41·2	39·2	38·4	37·9	37·5	37·1	...	36·3	...	36·0	...	36·0	,, CXIX.
182	13 6 00 ,,	148 37 00 ,,	78·5	...	...	77·0	...	...	74·0	...	...	71·0	...	...	67·5	...	...	64·0	...	...	60·4	...	...	56·0	...	...	52·0	...	47·0	...	44·0	41·0	39·3	38·3	37·9	37·4	37·0	...	36·3	...	35·8	...	35·8	,, CXVIII.
276	13 28 00 ,,	149 30 00 w.	80·0	78·9	78·6	...	78·7	78·6	78·4	78·2	77·7	...	76·4	75·1	73·7	72·2	70·6	...	68·8	67·0	65·1	63·1	[illegible]	...	58·8	56·6	54·3	...	...	...	44·8	41·9	40·3	39·1	38·3	37·8	37·3	36·9	36·6	36·8	36·0	35·7	35·4	,, CXCV.
180	14 7 00 ,,	158 43 00 E.	80·0	...	...	...	...	...	75·4	...	...	...	...	...	72·8	...	...	...	...	...	61·8	...	...	...	...	...	58·5	...	48·5	...	45·5	41·5	39·6	38·8	38·3	37·8	37·3	36·8	36·4	36·0	36·0	36·0	36·0	,, CXVII.
277	15 61 00 ,,	149 41 00 w.	79·0	...	...	...	...	77·0	76·4	75·8	74·9	...	74·0	73·1	72·2	71·2	70·2	...	69·0	68·8	66·4	64·8	[illegible]	...	61·2	59·3	57·4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CXCVI.
179	15 58 00 ,,	160 48 00 E.	79·0	...	...	...	...	...	...	...	...	...	...	...	71·1	...	...	...	...	...	...	...	...	...	...	...	55·5	...	...	...	45·2	41·6	40·0	38·9	38·3	37·7	37·2	36·8	36·4	36·0	36·0	36·0	36·0	,, CXVI.
178	16 47 00 ,,	165 20 00 ,,	79·0	...	...	...	...	...	76·0	...	...	...	...	...	71·5	...	...	...	...	...	65·0	...	...	...	...	...	57·0	...	51·5	...	47·5	42·3	40·0	38·5	38·0	37·4	36·8	36·3	35·8	...	35·8	...	35·8	,, CXV.
278	17 12 00 ,,	149 43 00 w.	79·5	78·0	77·3	...	77·0	77·0	77·0	76·7	75·2	...	73·5	72·2	71·2	70·5	70·0	...	69·5	68·5	67·7	66·7	[illegible]	...	63·8	61·6	59·2	...	...	...	46·2	42·6	40·0	38·7	37·7	37·1	36·8	36·5	...	...	...	...	...	,, CXCVII.
279c	17 29 11 ,,	149 34 32 ,,	79·0	...	...	76·2	...	...	76·2	...	...	74·4	...	...	72·4	...	...	69·8	...	...	66·3	...	...	61·0	...	...	55·3	51·6	48·8	46·0	44·3	...	...	...	...	...	...	...	...	...	...	...	...	,, CXCVIII.
176	18 30 00 ,,	173 52 00 E.	77·5	...	...	76·0	...	...	75·2	...	...	72·9	...	...	69·7	...	...	67·0	...	...	64·0	...	...	61·0	...	...	56·8	...	...	...	45·2	41·8	40·3	...	...	...	...	...	...	...	...	...	...	,, CXIV.
280	18 40 00 ,,	149 52 00 w.	77·2	...	...	76·9	...	...	76·2	...	...	75·0	...	...	73·0	...	...	70·0	...	...	68·4	...	...	62·5	...	...	58·0	52·8	48·1	46·1	44·9	41·7	40·2	38·8	37·9	37·2	36·8	36·4	36·2	36·1	36·0	35·9	35·8	,, CXCIX.
175	19 2 00 ,,	177 10 00 E.	77·5	...	...	...	...	...	71·5	...	...	...	...	...	70·8	...	...	...	...	...	66·0	...	...	...	...	...	60·8	...	54·2	...	47·0	42·0	40·0	38·9	37·9	37·2	36·8	36·4	36·2	36·0	...	...	...	,, CXIII.
174c	19 7 50 ,,	178 19 35 ,,	78·0	...	...	...	...	...	76·8	...	...	...	...	...	71·0	...	...	...	...	...	65·2	...	...	...	...	...	59·5	...	53·7	...	47·8	42·3	39·8	39·0	...	...	...	...	...	...	...	...	...	,, CXII.
281	22 21 00 ,,	150 17 00 w.	74·5	...	...	74·3	...	...	73·5	...	...	72·1	...	...	68·9	...	...	65·7	...	...	62·5	...	...	59·3	...	...	56·2	53·1	50·0	47·4	45·6	42·3	40·5	39·3	38·4	37·5	37·0	36·5	36·2	36·0	35·8	35·6	35·5	,, CC.
282	23 46 00 ,,	149 59 00 ,,	73·2	...	...	72·0	...	...	71·0	...	...	69·8	...	...	66·1	...	...	66·5	...	...	64·3	...	...	61·5	...	...	58·3	54·7	50·8	48·3	46·2	43·2	41·2	39·6	38·8	37·8	36·7	36·3	36·0	35·8	35·6	35·4	35·2	,, CCI.
171A	25 5 00 ,,	172 56 00 ,,	72·0	...	...	...	...	...	...	...	...	...	...	...	67·6	...	...	...	...	...	...	...	...	...	...	...	59·2	...	...	...	50·4	44·0	41·3	39·2	37·9	37·2	36·9	36·7	36·4	36·2	36·0	...	...	,, CXI.
283	26 9 00 ,,	145 17 00 ,,	68·5	...	...	69·2	...	...	68·0	...	...	66·5	...	...	64·6	...	...	62·8	...	...	60·3	...	...	57·5	...	...	54·8	52·0	49·2	46·8	45·4	42·2	40·3	39·0	38·0	37·3	36·7	36·3	36·0	35·8	35·6	35·4	35·4	,, CCII.
284	28 22 00 ,,	141 22 00 ,,	68·0	...	...	67·4	...	...	66·6	...	...	65·0	...	...	63·2	...	...	61·0	...	...	59·0	...	...	56·8	...	...	54·6	52·5	50·2	48·1	45·2	41·6	40·0	39·0	38·2	37·4	36·9	36·4	36·0	35·3	35·7	35·0	35·4	,, CCIII.
170	29 55 00 ,,	178 14 00 ,,	65·0	...	...	...	...	...	62·0	...	...	...	...	...	60·5	...	...	...	...	...	56·2	...	...	...	...	...	53·0	...	50·8	...	49·0	45·7	43·0	...	...	...	...	...	...	...	...	...	...	,, CX.
285	32 36 00 ,,	137 43 00 ,,	65·0	...	...	63·8	...	...	63·4	...	...	63·0	...	...	61·8	...	...	60·0	...	...	57·5	...	...	55·0	...	...	52·3	49·8	46·8	46·2	45·2	42·5	41·0	39·5	38·4	37·7	37·0	36·6	36·3	36·1	35·9	35·8	35·7	,, CCIV.
286	33 29 00 ,,	133 22 00 ,,	63·0	...	...	62·6	...	...	59·4	...	...	59·4	...	...	59·4	...	...	57·3	...	...	54·3	...	...	51·3	...	...	49·0	47·5	46·2	45·3	44·5	42·4	41·0	40·0	39·0	38·2	37·7	37·1	36·5	36·2	36·0	35·9	35·8	,, CCV.
299	33 31 00 ,,	74 43 00 ,,	62·0	...	...	59·0	...	...	58·1	...	...	50·9	...	...	49·1	...	...	47·8	...	...	46·5	...	...	45·3	...	...	44·4	43·5	42·8	42·1	41·7	40·6	39·8	38·5	37·7	37·0	36·6	36·3	36·0	35·8	35·6	35·4	35·2	,, CCXVIII.
300	33 42 00 ,,	78 18 00 ,,	62·5	...	...	57·8	...	...	53·7	...	...	51·2	...	...	49·5	...	...	47·8	...	...	46·3	...	...	45·3	...	...	44·1	43·4	42·6	42·0	41·3	40·1	39·4	38·7	38·0	37·4	36·9	36·4	35·9	35·7	...	...	...	,, CCXIX.
298	34 7 00 ,,	73 56 00 ,,	59·0	...	...	55·8	...	...	52·5	...	...	50·5	...	...	49·6	...	...	48·3	...	...	47·2	...	...	40·1	...	...	45·1	44·1	43·2	42·4	41·9	40·3	39·5	38·7	38·1	37·7	37·2	36·9	36·7	36·5	36·3	36·2	36·1	,, CCXVI.
164c	34 19 00 ,,	151 31 00 E.	67·0	68·0	67·8	...	67·6	67·2	66·3	65·3	64·2	...	63·0	61·8	60·7	...	...	...	...	...	...	...	...	...	...	...	55·0	...	...	...	48·5	40·0	...	...	...	...	...	...	...	...	...	...	...	,, CII.
164B	34 27 00 ,,	154 57 00 ,,	64·0	...	63·2	...	...	63·0	...	59·5	...	...	56·0	...	52·6	...	...	...	...	...	...	...	...	...	...	...	48·2	...	...	...	45·1	42·8	40·4	38·9	37·8	37·2	36·9	36·6	36·3	36·0	35·7	35·4	35·1	,, CIII.
287	36 32 00 ,,	132 52 00 w.	57·8	...	...	57·4	...	...	55·8	...	...	55·6	...	...	55·3	...	...	52·8	...	...	49·5	...	...	47·3	...	...	46·1	45·4	44·7	44·1	43·7	42·1	40·9	39·7	38·9	38·0	37·2	36·6	36·1	35·8	35·7	35·6	35·5	,, CCXVII.
165A	36 41 00 ,,	158 20 00 E.	62·5	62·8	62·5	...	62·5	62·0	60·5	59·2	58·0	...	57·0	56·4	55·8	...	...	...	...	...	...	...	...	...	...	...	50·8	...	...	...	47·0	43·8	41·6	39·8	38·6	37·5	36·9	36·5	36·2	36·0	35·7	36·4	35·1	,, CIV.
168	36 57 00 ,,	150 34 00 ,,	72·0	...	...	...	...	...	65·2	...	...	...	...	...	59·3	...	...	...	...	...	54·0	...	...	...	...	...	51·4	...	49·2	...	47·6	...	...	...	...	...	...	...	...	...	...	...	...	,, CI.
297	37 29 00 ,,	83 7 00 w.	57·0	...	...	55·5	...	...	53·7	...	...	51·9	...	...	50·1	...	...	48·4	...	...	47·0	...	...	45·7	...	...	44·5	43·8	43·1	42·5	41·9	40·4	39·2	38·2	37·4	36·7	36·5	36·4	36·3	36·2	36·1	36·0	35·9	,, CCXV.
301	37 29 00 ,,	84 2 00 ,,	59·5	...	...	57·4	...	...	55·2	...	...	52·8	...	...	50·5	...	...	48·4	...	...	46·5	...	...	45·2	...	...	44·2	...	...	...	42·0	...	...	...	...	...	...	...	...	...	...	...	...	,, CCXX.
169	37 34 00 ,,	179 22 00 E.	58·2	...	...	...	...	...	...	...	...	...	...	...	55·2	...	...	...	...	...	...	...	...	...	...	...	50·0	...	...	...	46·7	44·8	43·0	41·5	40·0	...	...	...	...	...	...	...	...	,, CIX.
165B	37 58 00 ,,	163 18 00 ,,	59·5	...	59·8	...	...	59·0	...	58·0	...	...	57·2	...	55·9	...	...	...	...	...	...	...	...	...	...	...	51·2	...	...	...	47·8	44·9	42·5	40·4	38·7	37·5	36·8	36·4	...	...	...	...	34·8	,, CV.
296	38 6 00 ,,	88 2 00 w.	59·6	...	...	56·3	...	...	54·6	...	...	52·2	...	...	50·1	...	...	48·1	...	...	46·3	...	...	45·0	...	...	43·8	43·2	42·7	42·1	41·7	40·8	40·2	39·6	39·0	38·5	38·0	37·5	37·0	36·6	36·4	36·2	36·0	,, CCXIV.
295	38 7 00 ,,	94 4 00 ,,	58·5	...	...	55·7	...	...	53·0	...	...	50·5	...	...	47·8	...	...	46·0	...	...	44·5	...	...	44·0	...	...	43·4	43·0	42·6	42·3	42·0	41·3	40·3	39·5	38·7	38·0	37·4	36·9	36·2	36·1	35·9	35·6	35·3	,, CCXIII.
165c	38 36 00 ,,	166 39 00 E.	58·2	...	58·1	...	...	57·8	...	57·4	...	...	56·6	...	55·9	...	...	...	...	...	...	...	...	...	...	...	52·2	...	...	...	48·5	45·3	42·0	39·8	38·2	37·4	36·9	36·5	36·4	...	...	...	...	,, CVI.
292	38 43 00 ,,	112 31 00 w.	53·2	...	...	52·8	...	...	51·7	...	...	50·0	...	...	48·5	...	...	47·4	...	...	46·2	...	...	45·2	...	...	44·3	43·9	43·5	43·0	42·5	41·1	40·0	39·0	38·3	37·6	37·1	36·6	36·2	36·0	35·8	35·5	35·3	,, CCX.
166	38 50 00 ,,	169 20 00 E.	56·5	...	...	...	...	...	58·5	...	...	...	...	...	56·5	...	...	...	...	...	54·7	...	...	...	...	...	52·7	...	50·8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	,, CVII.
293	39 4 00 ,,	105 5 00 w.	53·7	...	...	52·9	...	...	51·7	...	...	50·1	...	...	48·3	...	...	46·4	...	...	45·4	...	...	44·6	...	...	44·1	43·8	43·5	43·2	42·9	41·8	40·9	40·0	39·2	38·4	37·7	37·1	36·8	36·5	36·3	36·0	35·8	,, CCXI.
291	39 13 00 ,,	118 49 00 ,,	53·0	...	...	52·1	...	...	50·3	...	...	49·5	...	...	47·7	...	...	46·1	...	...	45·4	...	...	44·9	...	...	44·4	44·0	43·6	43·3	42·9	41·4	40·1	39·2	38·3	37·5	36·8	36·2	35·9	35·8	35·7	35·5	35·4	,, CCIX.
290	39 16 00 ,,	124 7 00 ,,	52·5	...	...	52·0	...	...	49·6	...	...	48·6	...	...	47·6	...	...	46·7	...	...	46·0	...	...	45·8	...	...	44·9	44·5	44·1	43·7	43·4	42·0	40·7	39·4	37·8	36·9	36·4	36·2	36·0	35·8	35·6	35·3	35·1	,, CCVIII.
294	39 22 00 ,,	98 46 00 ,,	57·5	...	...	55·1	...	...	52·5	...	...	50·1	...	...	48·2	...	...	46·5	...	...	45·5	...	...	44·7	...	...	44·1	43·5	43·1	42·7	42·2	40·8	39·5	38·8	38·2	37·7	37·1	36·7	36·3	36·0	35·9	35·8	35·6	,, CCXII.
289	39 41 00 ,,	131 23 00 ,,	54·5	...	...	54·0	...	...	49·2	...	...	48·9	...	...	48·3	...	...	47·5	...	...	46·0	...	...	46·2	...	...	45·6	45·0	44·4	43·8	43·2	41·2	39·5	38·2	37·6	37·0	36·7	36·4	36·2	36·0	35·8	35·6	35·5	,, CCVII.
288	40 3 00 ,,	132 58 00 ,,	54·5	...	...	54·2	...	...	51·1	...	...	50·6	...	...	49·8	...	...	48·3	...	...	47·1	...	...	46·1	...	...	45·2	44·7	44·2	43·8	43·3	41·9	41·0	40·0	39·0	38·2	37·5	36·9	36·5	36·1	35·9	35·7	35·5	,, CCVI.
168	40 28 00 ,,	177 43 00 E.	57·2	...	...	56·5	...	...	56·5	...	...	56·5	...	...	55·7	...	...	54·8	...	...	53·0	...	...	...	...	...	51·7	...	...	...	48·2	45·4	43·7	42·1	...	...	...	...	37·2	...	...	...	...	,, CVIII.
302	42 43 00 ,,	82 11 00 w.	55·0	...	...	52·5	...	...	49·5	...	...	47·5	...	...	45·8	...	...	44·3	...	...	[illegible]	...	...	43·0	...	...	42·5	42·1	41·8	41·5	41·1	40·1	39·7	38·2	37·5	36·9	36·5	36·2	36·0	35·9	35·8	...	...	,, CCXXI.
303	45 31 00 ,,	78 9 00 ,,	54·8	...	...	51·4	...	...	48·5	...	...	46·4	...	...	44·9	...	...	43·9	...	...	43·1	...	...	42·5	...	...	42·0	41·6	41·3	41·0	40·8	39·8	39·0	38·1	37·4	36·8	36·4	36·2	36·0	36·0	36·0	...	...	,, CCXXII.

TABLE V.

Showing the Miscellaneous Temperatures obtained.

Distinguishing Number of Station.	Latitude. ° ′ ″	Longitude. ° ′ ″	TEMPERATURE, IN DEGREES FAHRENHEIT, AT THE DEPTH, GIVEN IN FATHOMS.																																								Plate.	Where obtained.
			Surf.	10	20	25	30	40	50	60	70	75	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200	225	250	275	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500		
141	34 41 00 S.	18 26 00 E.	66·5	66·2	65·3	...	63·9	59·8	54·9	52·3	51·4	...	50·3	49·6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	XCI.	Off Cape of Good Hope.
143	36 48 00 "	19 24 00 "	73·0	73·0	73·0	...	68·5	64·0	59·5	57·7	56·5	...	55·0	53·6	52·5	...	...	...	...	...	...	...	...	...	...	...	46·2	...	...	...	43·0	40·8	...	...	...	...	...	...	...	...	...	...	...	XCII.	In Agulhas current.
144	45 57 00 "	34 39 00 "	43·0	...	...	...	...	...	...	...	...	...	...	...	41·6	...	...	...	...	...	...	...	...	...	...	...	38·5	...	...	...	38·0	37·8	37·6	37·4	37·2	37·0	36·9	36·8	36·6	36·4	36·2	36·1	...	XCIII.	In the southern part of the Indian Ocean between the Cape of Good Hope and Australia.
146	46 46 00 "	45 31 00 "	43·0	...	...	...	...	...	41·1	...	...	...	...	...	39·2	...	...	...	...	...	39·0	...	...	...	...	...	38·8	...	...	...	...	38·3	...	37·8	...	37·2	...	36·6	...	...	...	...	...	XCIV.	
147	46 16 00 "	48 27 00 "	41·0	...	...	...	...	...	40·0	...	...	...	...	...	37·4	...	...	...	...	...	...	...	...	...	...	...	37·1	...	...	...	...	36·4	...	36·2	...	36·0	...	35·8	...	...	...	...	...	XCV.	
150	52 4 00 "	71 22 00 "	37·5	...	...	...	...	...	36·3	...	...	...	...	...	35·2	...	...	...	...	...	35·2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	XCVI.	
152	60 52 00 "	80 20 00 "	34·5	34·0	33·5	...	...	...	32·2	32·2	32·2	32·2	32·2	32·2	32·0	...	...	...	...	...	35·0	...	...	...	...	...	35·3	...	...	...	35·3	...	...	...	...	...	...	...	...	...	...	...	...	XCVI.A	
153	65 42 00 "	79 49 00 "	29·5	...	...	...	...	...	29·0	...	...	...	...	...	29·0	...	...	...	...	...	...	...	...	...	...	...	30·5	...	...	...	32·0	...	32·8	...	...	...	...	...	...	...	...	...	...	XCVI.B	
154	64 37 00 "	85 49 00 "	32·0	...	...	...	...	...	29·2	...	...	...	...	...	29·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33·8	...	...	...	...	...	...	...	...	...	...	...	...	XCVI.C	
156	62 26 00 "	95 44 00 "	33·0	...	...	...	...	...	...	...	...	...	...	...	31·9	...	...	...	...	...	34·0	...	...	...	...	...	34·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	XCVI.D	
157	53 55 00 "	108 35 00 "	37·2	36·8	36·8	...	36·6	36·6	36·6	36·6	33·0	...	32·5	32·5	32·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33·0	32·6	32·8	...	...	...	...	...	...	...	...	...	...	XCVII.	
158	50 1 00 "	123 4 00 "	45·0	...	...	...	...	...	44·5	...	...	...	...	...	43·4	...	...	...	...	...	42·3	...	...	...	...	...	41·8	...	...	...	39·5	38·2	37·0	36·3	36·0	36·0	36·0	36·0	36·0	35·7	35·8	35·0	34·7	XCVIII.	
159	47 25 00 "	130 22 00 "	51·5	...	...	...	...	...	50·0	...	...	...	...	...	49·0	...	...	...	...	...	45·1	...	...	...	...	...	47·4	...	...	...	47·2	46·9	44·8	41·8	39·4	38·8	37·9	37·7	37·5	37·3	37·1	36·9	36·7	XCIX.	
160	42 42 00 "	134 10 00 "	55·0	...	...	...	...	...	51·8	...	...	...	...	...	48·5	...	...	...	...	...	47·9	...	...	...	...	...	47·7	...	47·5	...	47·2	44·9	41·6	38·5	37·0	36·8	36·6	36·4	...	...	...	...	...	C.	
191	5 41 00 "	134 4 30 "	82·2	...	...	...	...	...	...	...	...	...	...	...	67·5	...	...	...	...	...	...	...	...	...	...	...	51·5	...	...	...	46·0	43·2	41·5	40·5	39·8	39·5	...	...	...	...	...	...	...	CXXI.	In Banda Sea.
191A	5 26 00 "	133 19 00 "	81·5	...	...	80·0	...	...	75·5	...	...	71·5	...	...	67·5	...	...	63·0	...	...	59·0	...	...	47	...	...	51·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	CXXIA.	
193	5 24 00 "	130 37 15 "	83·5	...	...	81·0	...	...	78·0	...	...	72·0	...	...	66·0	...	...	60·0	...	...	55·3	...	...	...	...	...	50·2	...	...	...	40·0	43·6	41·5	40·1	39·2	38·3	38·0	38·0	38·0	38·0	38·0	38·0	38·0	CXXII.	
197	0 41 00 N.	126 37 00 "	82·5	...	...	78·8	...	...	74·0	...	...	68·5	...	...	63·5	...	...	58·5	...	...	54·0	...	...	...	...	...	60·0	...	...	...	45·8	43·0	40·7	39·2	38·2	37·7	37·1	36·6	36·0	35·9	...	...	...	CXXIII.	In Molucca Passage.
198	2 55 00 "	124 53 00 "	85·0	...	...	81·2	...	...	77·2	...	...	71·8	...	...	65·0	...	...	58·0	...	...	53·6	...	...	...	...	...	49·2	...	...	...	45·0	42·0	40·3	39·5	39·0	39·0	39·0	39·0	39·0	39·0	39·0	39·0	39·0	CXXIV.	In Celebes Sea.
213	5 47 00 "	124 1 00 "	83·0	...	...	...	...	...	77·3	...	...	...	...	...	65·0	...	...	...	...	...	52·5	...	...	...	...	...	49·3	...	47·3	...	45·7	43·2	41·2	40·0	39·2	38·6	38·6	38·6	38·6	38·6	38·6	38·6	38·6	CXXXII.	
190	5 44 00 "	123 34 00 "	83·0	...	...	81·5	...	...	79·2	77·7	74·5	72·9	71·2	67·5	63·8	...	...	57·6	...	...	54·5	...	...	...	...	...	48·3	...	46·2	...	44·8	...	...	...	...	...	...	...	...	...	...	...	...	CXXV.	
202	8 32 00 "	121 55 00 "	83·0	...	...	...	...	...	74·1	...	...	...	...	...	62·0	...	...	...	...	...	57·5	...	...	...	...	...	54·3	...	52·8	...	52·0	50·5	50·5	50·5	50·5	50·5	60·5	50·5	50·5	50·5	50·6	50·5	50·5	CXXVI.	In Sulu Sea.
211	8 00 00 "	121 42 00 "	81·0	...	...	79·0	...	...	73·0	...	...	66·0	...	...	61·0	...	...	...	...	...	56·0	...	...	...	...	...	53·8	...	52·6	...	51·8	50·5	...	...	...	...	...	...	...	...	...	...	50·5	CXXXI.	
205	16 42 00 "	119 22 00 "	82·0	81·5	79·5	...	76·5	73·2	69·8	66·3	64·2	...	62·0	60·0	58·6	...	...	...	...	...	55·0	...	...	...	...	...	51·2	...	48·0	...	45·8	42·0	40·0	38·8	37·8	37·0	37·0	37·0	...	...	...	...	...	CXXVII.	In China Sea.
206	17 54 00 "	117 14 00 "	75·2	75·1	75·0	...	74·2	72·3	68·5	66·0	64·2	...	62·2	60·6	59·2	...	...	...	...	...	51·6	...	...	...	...	...	48·6	...	46·5	...	45·0	42·4	40·2	38·7	37·5	36·7	36·5	36·5	...	...	...	...	...	CXXVIII.	
207	12 21 00 "	122 15 00 "	80·0	...	...	77·2	...	...	72·5	...	...	62·0	...	...	58·5	...	...	66·0	...	...	54·1	...	...	...	...	...	52·4	51·9	51·7	51·6	51·6	51·0	51·6	51·6	51·6	...	...	...	...	...	...	...	...	CXXIX.	In sea enclosed by the Philippine Islands.
210	9 26 00 "	123 45 00 "	80·2	...	...	...	...	...	78·6	...	...	...	...	...	61·5	...	...	...	...	...	56·6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	CXXX.	
235C	34 18 00 "	133 21 00 "	66·8	60·3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	CLII.	Inland Sea, Japan.
306A	48 27 00 S.	74 30 00 W.	57·5	...	...	49·3	...	...	47·2	...	...	46·5	...	...	46·2	...	...	46·0	...	...	46·0	...	...	...	...	...	46·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	CCXXIII.	Messier Channel, Magellan Strait.

TABLE VI.—*continued.*

Showing Mean Ocean Temperatures (deduced from Observations obtained in H.M.S. Challenger) arranged in 5° Belts of Latitude.

NORTH PACIFIC.

Depth in Fathoms	0° to 5°.			5° to 10°.			10° to 15°.			15° to 20°.			20° to 25°.			25° to 30°.			30° to 35°.			35° to 40°.		
	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.
	°		°	°		°	°		°	°		°	°		°	°		°	°		°	°		°
Surf.	82·00	7	4·3	81·98	5	2·0	79·18	5	2·7	78·60	4	2·7	77·70	4	1·7	74·00	3	8·5	70·57	7	10·0	65·50	13	8·6
100	69·22	7	16·0	58·98	5	20·6	60·58	5	10·1	65·67	4	14·3	62·57	4	11·2	59·73	3	7·4	57·70	7	7·0	54·59	18	16·5
200	50·14	7	5·5	48·10	5	0·8	49·28	5	5·2	51·97	4	11·8	50·22	4	14·1	52·03	3	12·1	48·70	7	5·0	45·98	18	11·9
300	46·32	5	4·9	45·66	5	1·0	44·50	5	2·2	45·42	4	4·0	45·85	3	9·4	45·77	3	7·9	42·85	6	4·2	44·35	17	7·2
400	43·48	6	2·7	43·42	5	1·8	42·14	5	2·1	42·20	4	1·6	41·83	3	3·4	41·67	3	2·6	39·56	6	3·2	40·41	17	4·4
500	41·48	6	1·7	41·48	5	2·0	40·42	5	1·8	40·20	4	1·8	39·77	3	1·0	39·40	3	0·7	38·10	4	1·5	38·75	17	2·0
600	39·88	5	1·3	40·04	5	1·8	39·16	5	1·5	39·12	4	1·2	38·63	3	0·2	38·20	3	0·3	37·35	4	0·7	37·77	17	1·6
700	38·70	5	1·5	38·90	5	1·2	38·24	5	1·2	38·25	4	0·5	37·87	3	0·3	37·27	3	0·4	36·80	4	0·3	37·11	17	1·3
800	37·82	5	1·6	38·00	5	1·0	37·52	5	1·2	37·62	4	0·4	37·20	3	0·2	36·80	3	0·2	36·42	4	0·2	36·49	17	1·2
900	37·20	5	1·5	37·28	5	1·0	36·86	5	1·1	37·02	4	0·9	36·83	3	0·2	36·37	3	0·2	36·20	4	0·3	36·88	17	1·2
1000	36·87	4	1·6	36·88	5	1·7	36·56	5	1·0	36·52	4	1·1	36·40	3	0·2	36·00	3	0·2	35·98	4	0·4	36·15	17	1·1
1100	36·37	4	1·4	36·18	5	1·7	36·24	5	0·9	36·05	4	1·2	36·03	3	0·4	35·70	3	0·3	35·80	4	0·4	35·92	17	1·1
1200	36·23	3	1·3	35·84	5	1·4	35·94	5	0·8	35·70	4	1·1	35·70	3	0·6	35·67	3	0·1	35·62	4	0·4	35·72	17	1·1
1300	35·82	4	1·2	35·60	5	1·1	35·70	5	0·5	35·60	4	0·8	35·50	3	0·5	35·43	3	0·1	35·42	4	0·4	35·51	17	0·9
1400	35·57	4	1·1	35·42	5	0·6	35·50	5	0·4	35·32	4	0·5	35·38	3	0·2	35·30	3	0·8	35·25	4	0·4	35·22	17	0·8
1500	35·50	4	0·8	35·28	5	0·5	35·24	5	0·4	35·25	4	0·2	35·13	3	0·2	35·22	3	0·5	35·20	4	0·2	35·19	17	0·8

SOUTH PACIFIC.

Depth in Fathoms	0° to 5°.			5° to 10°.			10° to 15°.			15° to 20°.			20° to 25°.			25° to 30°.			30° to 35°.			35° to 40°.		
	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.	Mean Temp.	No. of Obs.	Extreme Range.
	°		°	°		°	°		°	°		°	°		°	°		°	°		°	°		°
Surf.	81·70	5	5·3	80·45	2	0·5	79·00	6	2·5	75·41	9	2·5	73·35	2	1·3	68·37	4	7·6	63·21	7	8·0	57·20	11	10·5
100	69·38	5	17·7	68·75	2	1·1	71·05	6	6·2	71·43	9	2·3	68·50	2	0·8	63·07	4	7·1	54·67	7	12·2	51·95	11	11·7
200	50·38	5	2·8	49·50	2	1·0	58·22	6	3·7	57·72	9	3·5	57·25	2	2·1	55·40	4	6·2	48·20	7	10·9	46·92	11	9·3
300	45·54	5	1·8	44·55	2	0·1	44·77	6	1·5	46·01	8	3·5	45·90	2	0·6	47·46	4	5·0	44·03	7	7·2	44·13	10	5·0
400	42·62	5	0·9	42·15	2	0·7	41·52	6	1·6	42·84	7	0·7	42·73	2	0·9	43·37	4	4·1	41·29	7	2·8	42·29	14	4·9
500	40·60	5	0·6	40·23	2	0·6	39·85	6	1·6	40·04	7	0·5	40·82	2	0·7	41·15	4	3·0	40·16	6	1·7	40·74	14	3·0
600	39·36	5	0·5	39·20	2	0·6	39·32	5	1·2	39·00	6	0·2	39·45	2	0·3	39·07	3	0·2	39·65	6	1·5	39·21	14	2·2
700	38·48	5	0·9	38·30	2	0·4	38·10	5	0·5	37·90	6	0·6	38·35	2	0·1	38·43	3	0·3	38·17	6	1·3	38·40	14	2·6
800	37·78	5	0·2	37·25	2	0·1	37·60	5	0·4	37·22	5	0·6	37·40	2	0·2	37·30	3	0·2	37·23	6	1·2	37·50	13	1·8
900	37·22	5	1·0	37·05	2	0·1	37·14	5	0·3	36·88	5	0·4	36·85	2	0·2	36·65	3	0·2	37·05	6	1·1	37·04	13	1·6
1000	36·65	4	1·0	36·60	2	0·2	36·80	3	0·2	36·48	5	0·5	36·40	2	0·2	36·47	3	0·4	36·65	6	0·8	36·61	13	1·3
1100	36·15	4	1·6	36·40	1	...	36·42	5	0·2	36·15	4	0·6	36·10	2	0·2	36·12	3	0·4	36·22	6	0·8	36·01	13	1·1
1200	35·77	3	1·3	36·10	1	—	36·17	3	0·3	36·00	3	0·1	35·80	2	0·3	35·95	3	0·4	36·05	6	0·8	36·07	11	0·6
1300	35·03	3	0·9	35·90	1	—	35·67	6	0·2	36·00	1		35·70	2	0·2	35·77	3	0·4	35·90	5	0·7	35·90	11	0·8
1400	35·47	3	0·7	35·60	1	—	35·75	2	0·1	35·90	1		35·56	2	0·2	35·50	2	0·2	35·71	5	0·9	35·40	11	0·9
1500	35·33	3	0·6	35·30	1	—	35·50	2	0·2	35·60	1		35·35	2	0·9	35·40	2	0·0	35·55	5	1·0	35·44	12	1·2

TABLE VI.

Showing Mean Ocean Temperatures (deduced from Observations obtained in H.M.S. Challenger) arranged in 5° Belts of Latitude.

NORTH ATLANTIC.

Depth in Fathoms.	0° to 5° Mean Temp.	0° to 5° No. of Obs.	0° to 5° Extreme Range.	5° to 10° Mean Temp.	5° to 10° No. of Obs.	5° to 10° Extreme Range.	10° to 15° Mean Temp.	10° to 15° No. of Obs.	10° to 15° Extreme Range.	15° to 20° Mean Temp.	15° to 20° No. of Obs.	15° to 20° Extreme Range.	20° to 25° Mean Temp.	20° to 25° No. of Obs.	20° to 25° Extreme Range.	25° to 30° Mean Temp.	25° to 30° No. of Obs.	25° to 30° Extreme Range.	30° to 35° Mean Temp.	30° to 35° No. of Obs.	30° to 35° Extreme Range.	35° to 40° Mean Temp.	35° to 40° No. of Obs.	35° to 40° Extreme Range.
	°		°	°		°	°		°	°		°	°		°	°		°	°		°	°		°
Surf.	79·78	7	7·0	80·03	7	6·0	79·35	4	1·3	74·05	6	2·0	72·22	12	4·5	67·98	8	7·5	70·43	12	9·0	68·18	23	[illegible]
100	55·98	7	2·9	55·74	7	2·5	53·22	4	2·8	66·33	6	9·8	65·01	12	11·5	62·05	8	6·9	63·72	12	9·2	60·14	22	10·6
200	47·17	7	4·1	49·26	7	2·0	49·50	4	2·0	56·13	6	9·5	59·25	12	9·2	57·22	8	8·0	61·62	12	10·6	56·79	21	22·1
300	43·72	7	4·3	44·60	6	2·5	45·95	4	1·5	51·37	6	7·1	53·46	11	7·8	53·12	8	6·5	59·47	12	11·2	54·16	19	[illegible]
400	40·90	7	2·4	41·75	4	1·4	42·80	3	1·1	46·58	6	4·7	48·50	11	5·4	49·23	7	2·4	53·02	12	8·8	50·22	18	[illegible]
500	40·24	7	0·9	40·67	4	1·7	40·50	2	1·2	43·43	6	2·8	44·21	11	3·1	46·09	7	2·1	47·70	11	5·0	46·65	19	[illegible]
600	39·78	5	0·6	39·60	2	0·2	40·25	2	0·3	41·70	6	1·8	42·72	11	3·1	43·98	6	3·2	43·51	10	6·2	42·77	17	[illegible]
700	39·50	5	1·1	39·40	2	0·0	40·00	2	0·0	40·55	6	1·2	41·42	11	2·8	42·38	6	2·7	41·62	9	0·9	41·66	12	[illegible]
800	39·29	5	1·0	39·20	2	0·2	39·45	2	0·5	39·75	6	1·9	40·23	11	2·4	41·22	6	2·2	40·42	9	4·3	40·15	12	[illegible]
900	38·94	5	1·2	38·90	1	...	38·85	2	0·9	39·18	5	0·8	39·85	11	1·9	40·45	6	1·9	39·65	8	2·7	39·44	12	[illegible]
1000	38·58	5	1·1	38·50	1	...	38·45	2	0·9	38·78	5	0·7	39·24	11	1·4	39·70	5	1·6	39·00	8	1·8	38·77	11	[illegible]
1100	38·24	5	1·0	38·20	1	...	38·05	2	0·9	38·47	4	0·7	38·64	9	1·2	39·10	3	1·1	38·92	5	0·9	38·22	9	1·4
1200	37·90	5	0·8	38·00	1	...	37·65	2	0·9	38·15	4	0·9	38·23	9	1·3	38·70	3	1·0	38·34	5	0·7	38·06	7	1·3
1300	37·60	5	0·8	37·80	1	...	37·30	2	1·0	37·85	4	1·1	37·84	9	1·2	38·30	3	0·7	38·04	5	0·5	37·79	7	1·2
1400	37·30	5	0·8	37·60	1	...	37·15	2	0·6	37·57	3	0·9	37·51	9	1·1	37·90	3	0·4	37·78	5	0·6	37·55	8	1·1
1500	37·02	5	0·8	37·40	1	...	37·05	2	0·7	37·10	3	1·2	37·27	8	0·9	37·50	3	0·2	37·54	5	0·7	37·29	5	1·0

SOUTH ATLANTIC.

Depth in Fathoms.	0° to 5° Mean Temp.	0° to 5° No. of Obs.	0° to 5° Extreme Range.	5° to 10° Mean Temp.	5° to 10° No. of Obs.	5° to 10° Extreme Range.	10° to 15° Mean Temp.	10° to 15° No. of Obs.	10° to 15° Extreme Range.	15° to 20° Mean Temp.	15° to 20° No. of Obs.	15° to 20° Extreme Range.	20° to 25° Mean Temp.	20° to 25° No. of Obs.	20° to 25° Extreme Range.	25° to 30° Mean Temp.	25° to 30° No. of Obs.	25° to 30° Extreme Range.	30° to 35° Mean Temp.	30° to 35° No. of Obs.	30° to 35° Extreme Range.	35° to 40° Mean Temp.	35° to 40° No. of Obs.	35° to 40° Extreme Range.
	°		°	°		°	°		°	°		°	°		°	°		°	°		°	°		°
Surf.	80·00	3	4·7	79·82	5	6·2	78·10	2	1·8	70·00	1	...	75·88	3	3·0	70·00	3	11·6	73·50	1	...	62·79	21	20·0
100	55·90	3	3·6	55·64	5	9·4	58·65	2	1·5	59·50	1	...	63·07	3	6·2	60·10	3	1·3	59·20	1	...	55·94	22	[illegible]
200	48·07	3	1·0	46·84	5	2·4	46·95	2	0·1	49·00	1	...	52·13	3	5·1	53·03	3	2·9	53·40	1	...	49·16	19	[illegible]
300	43·10	3	2·0	42·00	5	3·5	42·30	2	0·6	43·00	1	...	44·92	3	5·0	47·03	3	2·4	48·00	1	...	43·13	19	[illegible]
400	40·93	3	2·0	41·00	4	3·0	40·10	2	0·4	39·80	1	...	40·30	3	3·2	42·23	3	1·1	43·00	1	...	39·76	18	[illegible]
500	40·37	3	1·7	39·92	4	1·8	39·35	2	0·1	39·50	1	...	38·71	3	1·2	39·10	3	0·5	39·30	1	...	38·23	18	[illegible]
600	40·13	3	1·3	39·47	3	0·7	39·10	2	0·2	39·20	1	...	38·27	3	0·7	38·03	3	0·3	37·80	1	...	[illegible]	13	[illegible]
700	39·60	3	1·1	38·97	3	0·4	38·95	2	0·1	38·90	1	...	38·00	3	0·7	37·70	3	0·6	37·10	1	...	37·23	11	[illegible]
800	39·23	3	1·1	38·70	3	0·3	38·80	2	0·9	38·00	1	...	37·73	3	0·8	37·50	3	0·6	37·00	1	...	37·17	11	[illegible]
900	39·17	3	1·4	38·43	3	0·2	38·65	2	0·1	38·30	1	...	37·67	3	0·8	37·33	3	0·7	37·00	1	...	37·10	11	[illegible]
1000	38·83	3	1·6	38·23	3	0·3	38·50	2	0·2	38·10	1	...	37·40	3	0·8	37·23	3	0·7	37·00	1	...	37·12	11	[illegible]
1100	38·57	3	1·4	38·05	2	0·3	...	...	...	...	...	...	37·10	2	0·8	37·20	2	0·6	...	...	...	36·67	9	[illegible]
1200	[illegible]	3	1·2	37·85	2	0·3	...	...	...	...	...	...	36·95	2	0·9	37·10	2	0·6	...	...	...	37·14	8	[illegible]
1300	38·10	3	1·0	37·65	2	0·3	...	...	...	...	...	...	36·80	2	1·0	36·65	2	0·5	...	...	...	[illegible]	8	[illegible]
1400	37·87	3	0·7	37·45	2	0·5	...	...	...	...	...	...	36·65	2	1·1	36·55	2	0·5	...	...	...	37·12	6	[illegible]
1500	37·67	3	0·5	37·30	2	0·6	...	...	...	...	...	...	36·55	2	1·1	36·75	2	0·0	...	...	...	[illegible]	8	[illegible]

TABLE VII.

Showing the TEMPERATURES obtained between the depth of 1500 fathoms and the Bottom.

I. *South Pacific Ocean.*

Station 294.		Station 296.		Station 297.		Station 298.	
Position { Lat. 39° 22′ S. Long. 98° 46′ W.		Position { Lat. 38° 6′ S. Long. 88° 2′ W.		Position { Lat. 37° 29′ S. Long. 83° 7′ W.		Position { Lat. 34° 7′ S. Long. 73° 56′ W.	
Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.
1500	35°·6	1500	36°·0	1500	35°·9	1500	36°·1
1600	35·5	1600	35·8	1600	35·8	1600	36·0
1700	35·3	1700	35·6	1700	35·6	1700	35·9
1800	35·2	Bottom 1825	35·2	Bottom 1775	35·5	1800	35·9
1900	35·0					1900	35·8
2000	34·9					2000	35·7
2100	34·8					2100	35·7
Bottom 2270	34·6					Bottom 2225	35·6

II. *South Atlantic Ocean.*

Station 323.		Station 324.		Station 325.		Station 326.	
Position { Lat. 35° 39′ S. Long. 50° 47′ W.		Position { Lat. 36° 9′ S. Long. 48° 22′ W.		Position { Lat. 36° 44′ S. Long. 46° 16′ W.		Position { Lat. 37° 3′ S. Long. 44° 17′ W.	
Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.	Depth in Fathoms.	Temperature.
1500	37°·0	1500	37°·0	1500	37°·2	1900	37°·0
1600	36·3	1800	37·0	2200	34·0	2125	37·0
1725	34·8	2000	36·0	2300	33·2	2325	36·2
1825	33·9	2200	33·3	2400	32·5	2525	33·0
Bottom 1900	33·1	2400	32·6	Bottom 2650	32·7	Bottom 2775	32·6
		2500	32·6				
		2600	32·6				
		2700	32·6				
		Bottom 2800	32·6				

Station 327.		Station 329.		Station 330.		Station 333.		Station 334.	
Position { Lat. 36° 48′ S. Long. 42° 45′ W.		Position { Lat. 37° 31′ S. Long. 36° 7′ W.		Position { Lat. 37° 45′ S. Long. 33° 0′ W.		Position { Lat. 35° 36′ S. Long. 21° 12′ W.		Position { Lat. 35° 45′ S. Long. 18° 31′ W.	
Depth in Fathoms.	Temp.	Depth in Fathoms.	Temp.	Depth in Fathoms.	Temp.	Depth in Fathoms.	Temp.	Depth in Fathoms.	Temp.
1000	37°·0	1000	37°·0	1500	37°·5	1000	37°·3	1330	36°·6
2225	34·0	1500	37·0	1580	37·5	1450	37·3	1500	36·4
2425	33·5	2000	36·0	1780	36·5	1650	37·3	1530	36·3
2625	33·1	2200	32·6	1980	35·3	1850	37·3	1730	36·1
Bottom 2900	32·8	2400	32·5	2180	34·2	Bottom 2025	35·4	Bottom 1915	35·8
		Bottom 2675	32·3	Bottom 2440	32·7				