CONTRIBUTIONS
OF THE
UNIVERSITY OF CALIFORNIA
ARCHAEOLOGICAL RESEARCH FACILITY

Number 20 **May 1974**

FOUR GREAT BASIN PETROGLYPH STUDIES

Costs for publication of this number of the Contributions were supplied by the Dean of the Graduate Division, Professor Sanford S. Elberg (1-443822-21543; 1-443822-21569). Part of the fieldwork reported here was supported by the Jon and Francesca Wiig Fund for Archaeological Research in the Great Basin (1-443822-56410). To all of these we express our appreciation.

UNIVERSITY OF CALIFORNIA
DEPARTMENT OF ANTHROPOLOGY
BERKELEY, CALIFORNIA

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UNIVERSITY OF CALIFORNIA
Department of Anthropology
Berkeley

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TWO PETROGLYPH SITES IN LINCOLN COUNTY, NEVADA

Robert F. Heizer and Thomas R. Hester

Preface

Since this paper was completed one of the present authors (RFH) has been the target of some rather hard criticism for having been so thoughtless and inconsiderate of the welfare of prehistoric rock art sites as to include in a recently published work by R. F. Heizer and C. W. Clewlow (Prehistoric Rock Art of California. 2 volumes. Ballena Press, Ramona, California, 92065) a brief description and location of about 500 sites in California. Although the number of such sites in this list could have been trebled, this kind of information was reported only for the sites for which Professor Clewlow and I were offering specific information which had, for the most part, not before appeared in print, or if so, was less accurate than the information we had in hand in 1971 when we finished our writing. We were hopeful for a time that our friend, Dr. E. Anati, Director of the Centro Camuno di Studi Preistorici, Capo di Ponte, Italy would be able to publish the monograph, but his financial capability to do so was limited and we saw no prospect of securing the rather large subvention which he required in order to put it in print. Further, the only copy of the manuscript was lost in the Italian postal service for eight months due to one of the nearly continuous postal workers' strikes to which that country is prone. Finally, after recovering our somewhat battered, but well rested, manuscript we submitted it for consideration by the University of California Press. After some months of waiting, which made it appear that this organization was trying to beat the record of the Italian postal service for delaying action, we were finally advised that the University of California Press would publish the work provided we substantially rewrote the text discussion and paid attention to a series of what seemed to us to be nonsensical suggestions made by one or the other of the two outside readers who provided opinions of the work. Neither of the outside readers objected to the section on site descriptions and locations. Neither Professor Clewlow nor I can remember whether we were by this time tired of writing on the subject, or just tired of the subject, but in either case we concluded to withdraw the manuscript and try to find another publisher. One of us (RFH) had been intermittently involved for about 20 years in the compilation and digestion of the data in the monograph, and being within a dozen years of retirement, was hoping to provide, before going on the inactive list, something in print on the subject as an earnest of his good intentions to supporting organizations within the University of California, the Wenner Gren Foundation for Anthropological Research, and the National Science Foundation which had in the past provided funds to conduct the research. What Professor Clewlow felt about wanting to see the work in print seems now beyond recall and the chief memory of his connection with the ill-starred project is similar to having eaten some tainted food and being invited back to the same place where he had just been poisoned for a second helping. One of the authors of the present paper (RFH) who in 1972-73 held appointment jointly as Fellow of the John Simon Guggenheim Foundation and Fellow of the Center for Advanced Study in the Behavioral Sciences was in a position to have enough free time to try to find some unwary publisher for the California rock art manuscript. He did succeed, as Mr. O'Neal who runs the press which published the two volumes only too well knows, since he has also been the target of criticism directed at him by a number of California residents.

Now, the two authors of the present article have committed the same act of including the site locations. But an aroused public, or at least that fraction of it which feels it has a duty to criticize serious scholars who study prehistoric petroglyphs and report their findings in a traditional manner, has made its voice heard, and we are here providing them in the Addendum to Preface a sample of a report which omits direct and immediate clues to the location of the two sites we discuss. We are hopeful that critics of the practice of archaeologists to inform the reader where the sites are located that are being discussed did not intend to force us to write our reports to please their literary sensibilities. The present authors would find it hard to change their spots on such short notice because we are in some sort of a rut, as is indicated by the fact that our combined bibliographies comprise a list of published articles, reviews, books and monographs which runs to nearly 600 items. We are too set in our ways to change our view of what archaeology is and how it should be reported, but as a one-time experiment we have excised from a few pages of the finished text as many specific clues or leads which we can find and which might be used by unscrupulous readers to visit and mutilate the sites we report. In this emasculated extract certain published references have been omitted in order to conceal site locations, and the name of one individual who aided us has been deleted to avoid the possibility that some determined site-destroyer might search him out and extract from him information on how to reach the sites. The result of our experimentation was so interesting that we wanted to share it not only with our non-professional California critics who we assume will approve, but also with our professional colleagues who we trust will <u>not</u> approve of this method of archaeological reporting. We are sharing the product of our experiment in order to call attention to the possible results if archaeologists allow themselves to be influenced in their reporting by uninformed laymen who decide to take up the cudgel and become vigilantes whose mission is to guard, by suppression of essential information, sites which are on public lands and which are already protected by federal and state laws. There has been in last decade much ink spilled by persons espousing the "new archaeology," and the edited pages are offered as an example of new archaeology if we view it as a spinoff of what is called "public archaeology." There has also been a lot written about the "crisis in American archaeology," and in our opinion too few of these writers have anticipated that this threatens to become also a crisis for archaeologists.

Much concern is being expressed nowadays over the defacement of petroglyphs by unappreciative persons, and this practice of disfiguring and marking up surfaces such as walls of public buildings and historical sites seems to be a part of American culture. The wide publicity in California newspapers in recent months, while aimed at creating public awareness of the danger in which unprotected petroglyph sites stand, may not have been altogether wise since it may have the additional result of advertising to persons otherwise ignorant of the fact that portable rocks bearing petroglyph designs have become collectors' items, and that many of the sites are unprotected. What can be done to instill in the American public a respect for other people's property, including archaeological sites and historical monuments, we do not know. We do not condone such despoliation; we are students of the human past and University teachers, not policemen. Apparently a vogue of collecting petroglyph-bearing boulders and installing them in rock gardens, in patio walls or over fireplaces is becoming common. Anyone who does this is not only a thief and a lawbreaker, but also is a person who thereby proves he has no respect for the history of man. This practice will no doubt continue until federal and state authorities are goaded into enforcing the federal and state civil codes which prohibit such activities.

Many petroglyph sites in the West occur in unoccupied and little-visited desert areas. Such sites are difficult to protect from vandalism. Cutting off access roads is impracticable (and perhaps illegal); fencing sites is expensive and usually ineffective, and there is no apparently economical and easy solution to the problem of protection of petroglyph sites on public lands with free access to four wheel drive motorists. There must be enough of both ability and funds left in Washington to spare, even after the recent series of crises, for the protection and preservation of the rock art aliquot of the heritage of the American Indians. That heritage which many Americans tend to assume is theirs, is in fact one minor physical element involved in the preemption of the land and the near-extinction of its original and legal occupants. Now, having assumed custodianship for the Indians' land, and having passed laws for its protection, why then does not the federal government enforce the laws it has promulgated for that purpose? When that question is answered to our satisfaction we will give consideration to withholding information on site locations on public lands, but until that time we do not believe that we are justified in imposing censorship of the spatial dimension of archaeological data.

While we must all be concerned over the uninterrupted process of site destruction everywhere in the world it is unlikely that this can be brought wholly to an end. The best we can hope for is that whatever part of any citizenry which commits these depredations can be educated to believe that such acts cannot be morally, and will not be legally, condoned. The worst we can look forward to is the continuation of such acts of destruction while the perpetrators ignore the pleas of conservationists and persist in flouting the law.

Petroglyphs on cliff faces are relatively safe from being carried off, though they can be defaced by graffiti such as those inscribed by Carl Williams in 1926 on Panel XI at Locality 2, site NV-Li-9, or by W. E. Hutching in 1911, Locality 5. Site NV-Li-7 has not been significantly damaged, and it seems to be adequately watched by the federal people stationed at the nearby Game Refuge headquarters. Petroglyphs on boulders weighing up to two or three hundred pounds are portable, and if there actually is a collector's craze for carting these off, as alleged in recent newspaper articles, then such sites will either have to be protected to save these rocks, or those persons in authority over the public land on which the sites are located, should see to it that an accurate map is made, and the catalogued rocks are removed to some storage or study area where they will be safe. It is much too late to try to protect remote and unguarded petroglyph sites by hounding the occasional archaeologist who publishes drawings or photographs of a site and provides the reader with information on its location. The Nevada State Highway Department publishes and sells a book of road maps[1/] and on these any number of petroglyph sites are located and so labelled. This kind of "advertising" will no doubt be decried by site conservationists, but in fact probably little harm is done by it. There are few, if any, unknown petroglyph sites--someone has seen each of them, remembers where they are, and is usually perfectly willing to tell any stranger how to get there. Our 1958 survey of petroglyph sites in the northern half of Nevada was made easy simply by making local inquiries about sites as we moved about. Trying to conceal site locations is quite impossible, and those who think that their efforts to protect sites by suppressing free speech, censoring archaeological publication, or limiting sale, distribution or availability of publications will be effective has got to be living in a dream world. Archaeological investigation in this country has been for a very long time essentially a race between site looters and public and private land disturbers. Petroglyph and pictograph sites have for a long time been the targets of vacant-minded people who like to ruin and wreck or destroy whatever they find that is unwatched. I have seen this scores of times in Nevada where some unguarded cabin or barn has had the windows knocked out, the sheathing torn off, and every conceivable kind of damage inflicted which could insult and denigrate that hapless and unwatched structure. Why do American citizens commit such acts? If we knew the answer to this we would probably qualify as experts in some field such as social psychology, criminal behavior, child-training, or sociology, rather than merely being students of the Native American past. At the risk of repeating ourselves, we observe that the only way to save for posterity the record of

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1/ Nevada Map Atlas. Produced by Nevada State Highway Department, Planning Survey Division, Cartographic Section in cooperation with U.S. Department of Transportation. N.d. (ca. 1973).

the rocks in the Far West is: 1), to study them as promptly and completely as possible before they become so disfigured that they can no longer be recorded; or, 2), guard those sites on public lands and apply to persons who ignore the laws protecting them the full force of the punitive sanctions; or, 3), remove the stones on which the petroglyphs occur to some place of safekeeping. Those, we think, are the three alternatives open. All of the breast-beating and declaiming against petroglyph site wreckers will have no real effect--we suspect that this kind of public concern is always motivated for some aim (usually pecuniary) by the boss breast-beaters, and that their call to arms appeals to a group of faceless followers who are pleased to find a cause to join--provided that it is safe, high-minded, and inexpensive. Our challenge to the rock art conservationists is simply this: really do something effective about site protection, by making enough noise directed at federal and state law enforcement officers so that they are forced to do something about it.

Probably the best practical solution to the problem of vandalism (defacement and removal) of petroglyphs in defiance of laws which were passed by an indifferent government and its agencies is a crash program of complete and full recording of all known sites on public lands and the preservation of these records in some archival collection where they may outlive the sites themselves. Perhaps we must recognize, before it is really too late, that unprotected sites have a life span analogous to that of living organisms. The real problem in American archaeology at the moment is the future of the past.

Addendum to Preface

TWO PETROGLYPH SITES IN ______ COUNTY, _____[state]

Robert F. Heizer and Thomas R. Hester

Introduction

We report here our observations at two petroglyph localities in _______ [portion] _____[state] based on fieldwork carried out on March 31, April 1, and August 4, 1973. We were aided by Michael Heizer and Robert Deiro of CIVA Corporation who provided shelter, good companionship and a Dodge Power Wagon for transport. Our petroglyph recording was not planned in advance and spur-of-the-moment exigencies account, in part at least, for some of the admitted deficiencies in the present report.

The general area of the sites is the _____ _____ _____ ______ (which extends from ___________[portion] ___ County southward between the ______ Range on the west and the _____ ______ Range on the east) and one small area of the _________ Valley which connects with the _____ _____ Valley north of ____ and runs north-south between the ____ Range on the east and ____ _______-___ Range on the west (Fig. 1). This area is roughly equivalent to ______ and _______'s[authors] (19__:97-99) Survey Area No. 1, the data they report apparently being based on a 1967 reconaissance by __ __ _________[person]. Although they refer to "intensive site survey" carried out in _________ Valley, our _____ _________ Lake site, (__-__-_ in the _____________ ________ ________ site survey records for _____[state]) is not mentioned. The _____ _____ _____ Valley canyon or "_______" (______ ____________ ______[repository] site __-__-___[trinomial site designation] ; _________ __ __________ _______-_______ ________ ________[repository] site __-__-_[trinomial site designation]) is mentioned, but only a very partial (and inaccurate) record of what we identify as Locality 2, Panel 1 is presented (______ and ________[authors] 19__: ___, Fig. __, A; compare with our Fig. 4). A small part of our Panel 6 is shown by _____ and ______[authors] (19__:Fig. 28) erroneously labelled as "pictographs." _____ and ______[author] (19__:Fig. 25) have a photo of the steep-walled "_______" canyon at about our Locality 4. _. _______'s [author] site __ ___ (_______[author] 19__:___) is possibly the first notice of the _____ _____ Valley petroglyph sites, but we cannot be certain that this is not a reference to _________ Canyon which is also mentioned by _____ and ______ [authors] (19__:Figs. 27,29). _______'s[author] site __ ___ (_______ 19__: ___) at ____ _______,[place] _____ County, is not the same locality as ____, _______ County. In March, 1968, Dr. ____ _. ______ sent the __________ __ ___________[institution] at ________[place] an excellent four-page report on petroglyph sites in the __________ Valley and neighboring areas which we have found in the files, and we mention this to acknowledge Dr. ______ as the first serious student to visit these locations.

Although the environment is _______[descriptive term] (________, _____ _____[plant types] at lower elevations and ____-______ in the upper mountains), there is an occasional spring and there exists a good stream which is fed by _______ Springs which waters the _________ Valley. Deer are present, and mountain sheep survive in numbers in the _____ Range south of _____ under the watchful protection of the personnel of the _________ ________ ______[Federal agency]. The valley floor elevation inclines from about 4500 feet a.s.l. at the north end of the _____ River canyon to about 3000 feet a.s.l. in the lower _________ Valley. _____ River is a ___ ____ which long ago, in ___________ [geological term] times, carried water (_____ and ______ 19__:__-__).

In the canyon of the _____ _____(dry except for cloudburst freshets which in the spring or summer may course through the narrow raceway) we attempted during our brief survey to plot petroglyphs by general area ("locality"), and within localities by "panels"--restricted spatial congregations of inscriptions which can be geographically separated from each other to the extent that a casual observer would say that these were separate (Fig.2).[1/] We believe that such distinctions may be important since different groups over time (or the same group at different times) may have resorted to the _____ _____ Canyon and recorded their presence in the form of petroglyphs.

_____ _____ _____ ______ (Site __-__-_)

Locality 1. About __ miles north of ____[place] along the road labelled ___ __[road system designation] one enters the steep-walled gorge or "_______" of the _______ _____ River. Just inside the narrow entrance on the south cliff wall of the canyon is Panel 1 (Fig. 3a) with a single pecked design consisting of a long horizontal line with vertical ticking along the top. It was suggested that this might represent a diversion fence for game drives, and wherever we found this element at the site the locality also seemed to be a logical one for diverting moving animals to a location immediately under the cliff where they could be shot with the bow and arrow. We are far from certain about this explanation, but such actual drive fences consisting of stone piles to support juniper (?) posts are known in ______ (_______ and ________[authors] 19__:__). Temporary diversion fences could have been made of piles of grass,

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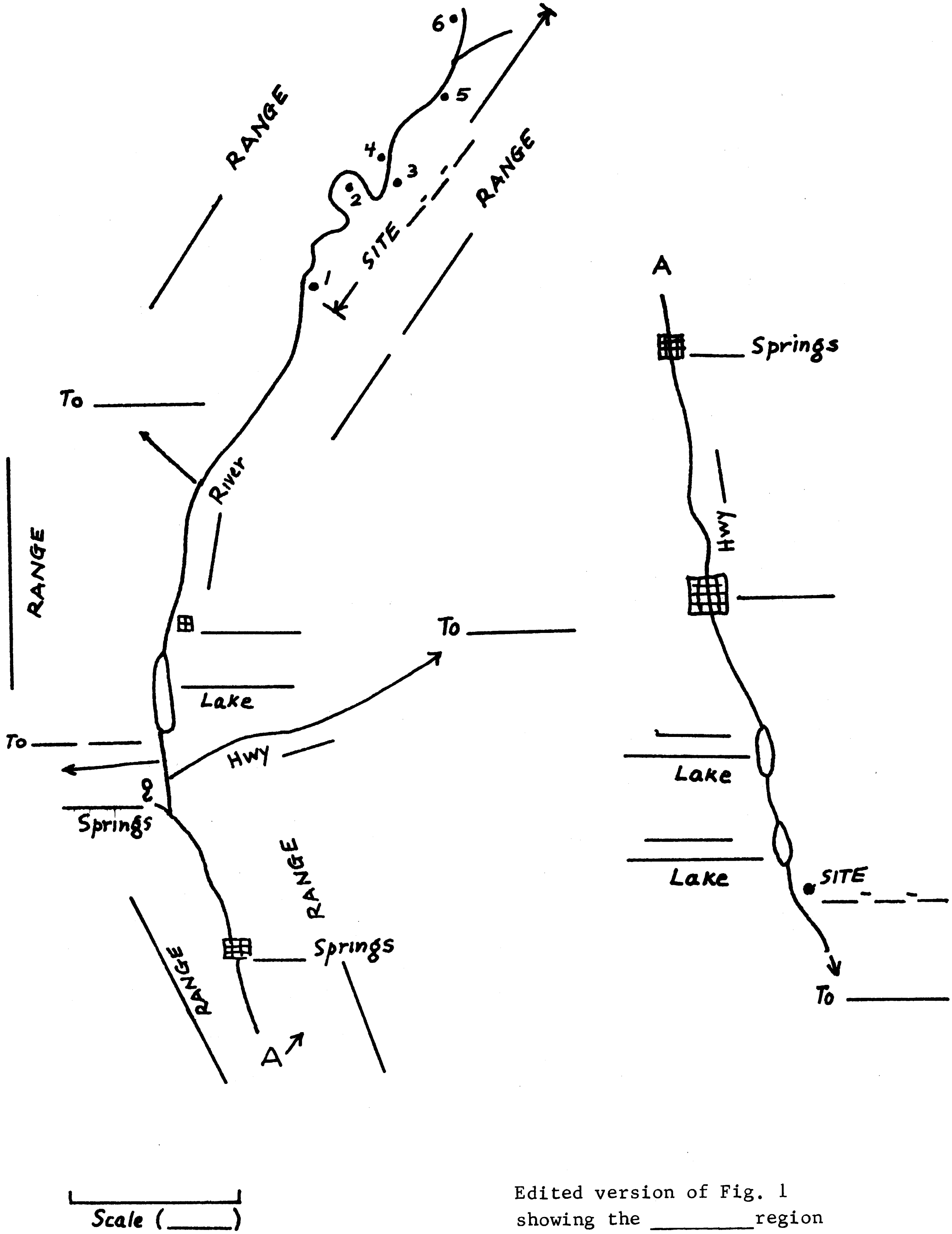
1/ During our recording of sites, sketches, measured drawings, and color photographs were made. These are on file in the ______________ ________ ________, [institution] __________ __ ____________, __________ __ _______. _____, ________[address].



Edited version of Fig. 1
showing the _________ region
of ___________ _________ [state]
with location of the two sites
discussed in this paper. Spots
numbered 1-6 at site __-__-__
are "localities" referred to
in the text.

Introduction

We report here our observations at two petroglyph localities in southeastern Nevada based on fieldwork carried out on March 31, April 1 and August 4, 1973. We were aided by Michael Heizer and Robert Deiro of CIVA Corporation who provided shelter, good companionship and a Dodge Power Wagon for transport. Our petroglyph recording was not planned in advance and spur-of-the-moment exigencies account, in part at least, for some of the admitted deficiencies in the present report.

The general area of the sites is the Lower White River Valley (which extends from southeastern Nye County southward between the Seaman Range on the west and the North Pahroc Range on the east) and one small area of the Pahranagat Valley which connects with the White River Valley north of Hiko and runs north-south between the Hiko Range on the east and the East Pahranagat Range on the west (Fig. 1). This area is roughly equivalent to Fowler and Sharrock's (1973:97-99) Survey Area No. 1, the data they report apparently being based on a 1967 reconaissance by R. L. Stephenson. Although they refer to "intensive site survey" carried out in Pahranagat Valley, our Lower Pahranagat Lake site, (NV-Li-7 in the Archaeological Research Facility site survey records for Nevada) is not mentioned. The Lower White River Valley canyon or "Narrows" Nevada Archaeological Survey site 26-LN-210; University of California Archaeological Research Facility site NV-Li-9) is mentioned, but only a very partial (and inaccurate) record of what we identify as Locality 2, Panel 1 is presented (Fowler and Sharrock 1973:101, Fig. A9, A; compare with our Fig. 4). A small part of our Panel 6 is shown by Hubbs and Miller (1948:Fig. 28), erroneously labelled as "pictographs." Hubbs and Miller (1948:Fig. 25) have a photo of the steep-walled "Narrows" canyon at about our Locality 4. J. Steward's site PT 225 (Steward 1929:147) is possibly the first notice of the White River Valley petroglyph sites, but we cannot be certain that this is not a reference to Arrowhead Canyon which is also mentioned by Hubbs and Miller (1948:Figs. 27, 29). Steward's site PT 228 (Steward 1929:150) at Hiko Springs, Clark County, is not the same locality as Hiko, Lincoln County. In March, 1968, Dr. John J. Cawley sent the Department of Anthropology at Berkeley an excellent four-page report on petroglyph sites in the Pahranagat Valley and neighboring areas which we have found in the files, and we mention this to acknowledge Dr. Cawley as the first serious student to visit these locations.

Although the environment is desertic (shadscale, black brush at lower elevations and pinon-juniper in the upper mountains), there is an occasional spring and there exists a good stream which is fed by Crystal Springs which waters the Pahranagat Valley. Deer are present, and mountain sheep survive in numbers in the Desert Range south of Alamo under the watchful protection of the personnel of the Pahranagat Wildlife Refuge. The valley floor elevation inclines from about 4500 feet a.s.l. at the north end of the White River canyon to about 3000 feet a.s.l. in the lower Pahranagat Valley. White River is a dry wash which long ago, in Pleistocene times, carried water (Hubbs and Miller 1948:96-98).

In the canyon of the White River (dry except for cloudburst freshets which in the spring or summer may course through the narrow raceway) we attempted during our brief survey to plot petroglyphs by general area ("locality"), and within localities by "panels"--restricted spatial congregations of inscriptions which can be geographically separated from each other to the extent that a casual observer would say that these were separate (Fig. 2). [2] We believe that such distinctions may be important since different groups over time (or the same group at different times) may have resorted to the White River Canyon and recorded their presence in the form of petroglyphs.

LOWER WHITE RIVER VALLEY (Site NV-Li-9)

Locality 1. About 10 miles north of Hiko along the road labelled NEV 38 one enters the steep-walled gorge or "Narrows" of the ancient White River. Just inside the narrow entrance on the south cliff wall of the canyon is Panel 1 (Fig. 3a) with a single pecked design consisting of a long horizontal line with vertical ticking along the top. It was suggested that this might represent a diversion fence for game drives, and wherever we found this element at the site the locality also seemed to be a logical one for diverting moving animals to a location immediately under the cliff where they could be shot with the bow and arrow. We are far from certain about this explanation, but such actual drive fences consisting of stone piles to support juniper(?) posts are known in Nevada (Heizer and Baumhoff 1962:55). Temporary diversion fences could have been made of piles of grass, brush or tree limbs which would leave no archaeological traces. Such fences are widely reported from the Great Basin as used in antelope hunting.

About 40 feet above the floor of the wash a few hundred yards north of Locality 1 is a natural open arch about 3 feet high and 5 feet wide which has a dry-laid boulder wall across the front. Such a spot would have been an ideal shooting location for animals below. Whether this spot so served we do not know.

Locality 2. This is the major petroglyph concentration in the White River Narrows and it occurs in a great semicircular bay ringed by vertical cliffs of andesite which rise to 50 or 60 feet above the surface of the wash. Animals

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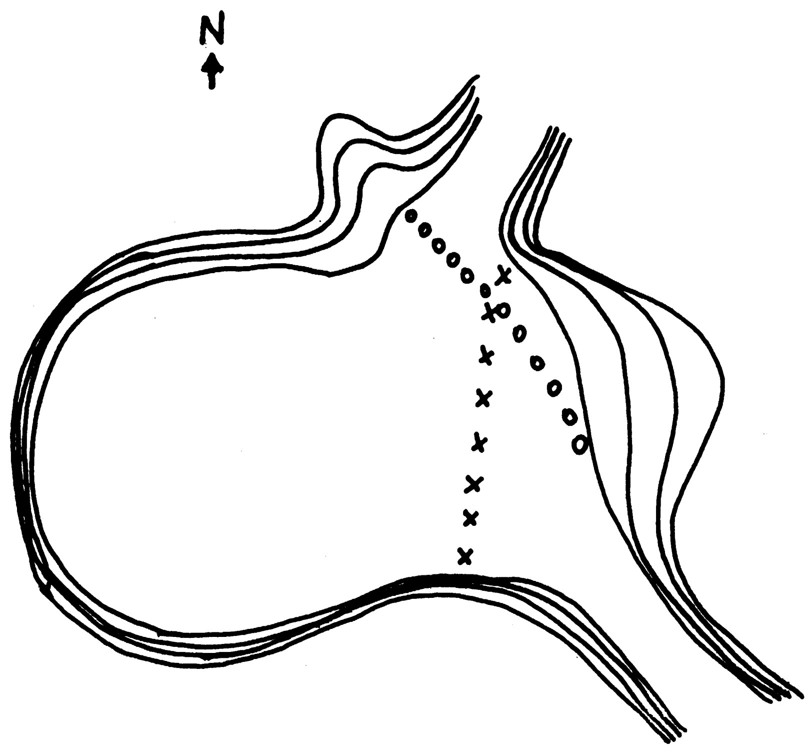
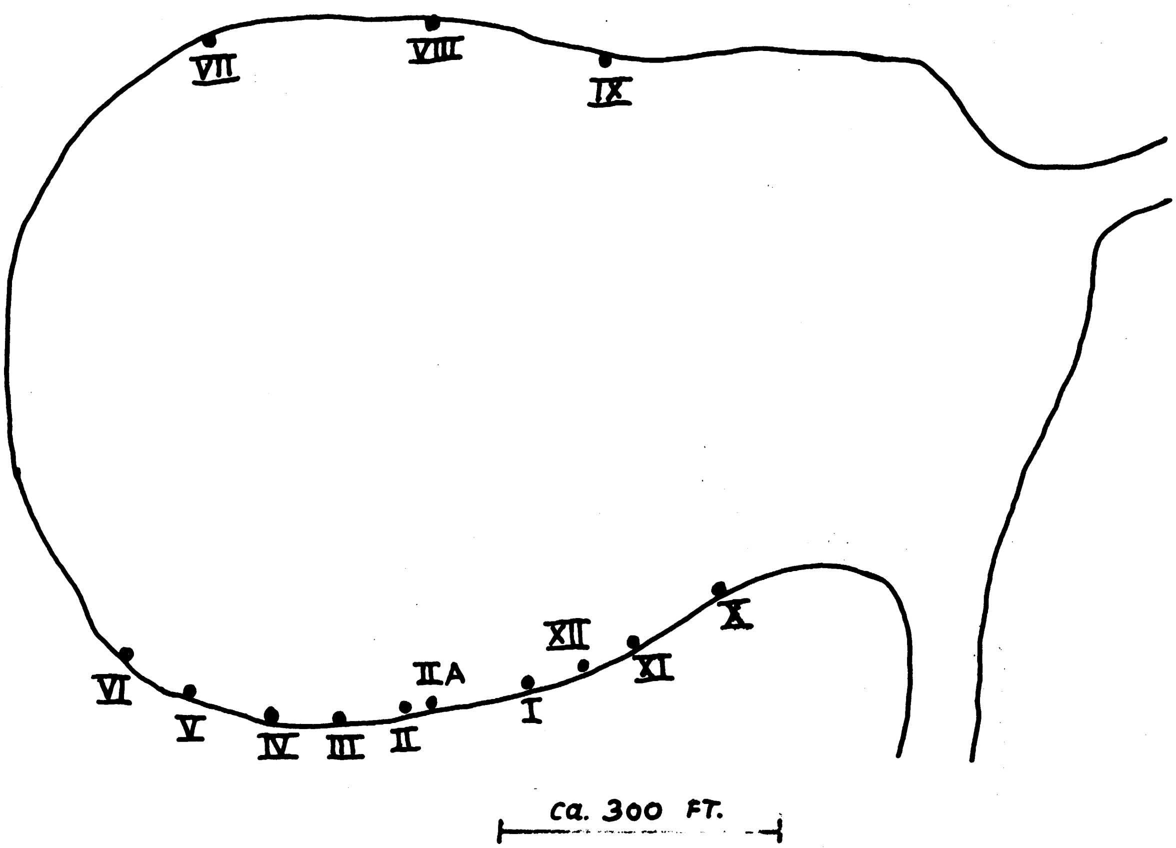
2/ During our recording of sites, sketches, measured drawings, and color photographs were made. These are on file in the Archaeological Research Facility, Department of Anthropology, University of California, Berkeley.

moving either north or south in the narrow canyon could have been forced into this amphitheater and prevented from escaping by a fence or stationed archers stretched across the opening and would have been at the mercy of the hunters. The design we tentatively identify as a diversion fence is a prominent feature of Panel 1 (Fig. 3a) which is the most notable of the several petroglyph panels occurring around the perimeter of this natural arena. The animals, moving either north or south, once having entered the opening could have been prevented from escaping by a brush fence as shown in the accompanying sketch.



Sketch of Locality 2, site NV-Li-9. Line of circles shows course of hypothetical diversion fence to hold animals coming north; line of exes shows course of hypothetical diversion fence to hold animals coming south.

The location of petroglyph panels at Locality 2 are shown here and the glyphs of each panel are shown in Figs. 3-8.



Sketch map of Locality 2, site NV-Li-9 in Lower White River Valley. Roman numbers (I-XII) refer to panels with petroglyphs.

Panel 1 (Locality 2) is complex (Fig. 4a, b). Another "drive fence", a clearly recognizable antlered deer, bighorn sheep, foot or paw prints, a spiral, dot and circle, human figure, diamond chains, snakes, rakes, ladder, and other familiar Great Basin petroglyph symbols allow us to class this as mainly in the Great Basin Representative style. Above, but not superimposed upon, the pecked petroglyphs below, are three Scratch Style designs (Fig. 7g) as well as a modern equinophobic graffito which reads, "NO HORSES". The basaltic stone is fairly soft and both grooving and pecking were used to make the designs at all of the NV-Li-9 localities. The stone is a yellowish tan and the surface patina is rather darker, ranging to dark brown.

Proceeding clockwise we come to Panels IIA and II which are not elaborate or very distinctive (Figs. 6d; 5c).

Panel III at Locality 2 shows three dancing figures holding hands, two square-shouldered figures of "Basketmaker" type, and several "vulva" symbols (Fig. 5a, e, g). The body areas (not the head) of the two square-shouldered figures are painted red.

Panel IV, Locality 2 (Fig. 8f) is small and geometric.

Panel V (Fig. 6a) consists of a series of circles connected with lines. These are rather like the common dumbbells of the Great Basin Curvilinear Abstract Style.

Panel VI (Fig. 6f) consists of circles connected by lines and a line of short vertical ticking.

Panel VII (Fig. 8g) is undistinctive, as is Panel VIII (Fig. 8b).

Panel IX (Fig. 8d) is on a boulder which has broken in two, and parts of the same "star" glyph are to be seen on the separated sections. Near Panel IX are the linear elements shown in Fig. 8a.

Panel X (Fig. 8c) has two elements which are components of the Great Basin Style.

Some minor occurrences of glyphs occur at intervals between what we have termed "panels"--among these is a geometric series near Panel VII (Fig. 7a), two "rakes" near Panel VIII (Fig. 7b), a miscellaneous geometric set 75 feet west of Panel IX (Fig. 7c), and a slightly separated curved "rake" near the last (Fig. 7d). On the cliff face, about 30 feet above the floor of the wash and accessible by a narrow ledge, are the two glyphs shown in Fig. 7e which occur above Panel IX, and the complicated "rake" shown in Fig. 7f which occurs between Panels VII and VIII. Near Panel V are the two glyphs shown in Fig. 6c. and near Panel XI the designs shown in Fig. 5d.

Locality 3 stretches along the lower cliff surface for about 30 feet, and the glyphs occur in three groups, the southernmost shown in Fig. 8e, the central one in Fig. 3d and the northernmost shown in Fig. 3f. The horned figures (Fig. 3d) are the most unusual of this set.

Locality 4, not far up the wash north of Locality 3, occurs on two faces of a right-angled fracture block at the base of the cliff. Fig. 3e is the southern part; Fig. 3h is the northern part.

Locality 5 is a flat vertical cliff surface which for petroglyph artists should have been an inviting "canvas", but it was not much exploited. Curvilinear and geometric elements are present (Fig. 3c), and an incised double-line horizontal zigzag has been covered with red paint (detail shown in Fig. 3g).

The element consisting of two circles and a bisecting line with small circles running parallel to the line between the larger circles is also embellished with red paint.

Locality 6 was encountered at the end of a long and rather uncomfortable day. With numbed hands, poor light, and snow squalls we spent about an hour here trying to make notes and photographs. Figs. 9-12 represent what we can now salvage from these efforts. The cliff face turns from a north-south line to run east-west, and Figs. 9 to 12 should be read as proceeding from south to north and then west along the cliff base. Hubbs and Miller (1948:Fig. 28) illustrate in a photograph what is recognizably the right half of our Fig. 9 and the left half of our Fig. 10. This extensive cliff surface is decorated from ground level to about 6 to 7 feet high for a distance of about 200 feet. The rhyolite is weathered and fairly soft, and many of the inscriptions are unclear due to weathering. It would require several days of work to try to identify and record the individual elements, but such a labor might be rewarding in indicating superimpositions. We leave this duty to future researchers who have more time and better weather conditions than were available to us.

We note at Locality 6, which is as far north in the valley as we proceeded, that this is the upper end of the narrow canyon. Whether petroglyphs occur further north we do not know, but from Locality 6 the prospects do not look promising for the next two or three miles.

What we have tentatively identified as drive fences are abundant at Locality 6, and such a fence built from near the cliff base running northeast could easily divert moving animals to a favorable position as targets if they were moving south.

We observed with interest that in several panels an unusual design is repeated twice or more times. Examples may be seen in Figs. 3c; 8c, d; 9; 12. Can we infer from this that one person engraved the two designs on the same occasion, or perhaps that the same person came back on different occasions to the same place to leave his "signature" glyph--one he had invented and which he felt would bring him luck?

We warn the reader to beware of placing significance in the number of dots or line ticks or bars in a ladder design since the precise numbers of these in the original are not only often difficult to determine, but also copying errors can occur. Our figures are as accurate as we could draw them, but their precision is not guaranteed as absolute.

LOWER PAHRANAGAT LAKE (Site NV-Li-7)

The lay of the land at this site is one favorable for hunting animals at close range. Today deer are not common in the vicinity of the site, but bighorn sheep are known to frequent the spot during the coldest winter weather when both food and water may be difficult to secure in the higher parts of the Desert Range to the south. Deer might not be attracted to this spot at the present time because the area is fenced, holds horses, and is near the highway leading to (or from) Las Vegas on which automobiles careen at top speed either on their way to (hopefully) or from (disappointedly) the gaming tables. Today it is not good country for deer.

Figure 13 shows the site area and the five concentrations of pecked petroglyphs which are termed "localities."

Locality 1 glyphs are shown in Figs. 14a, e; 17d. These occur on the basalt cliff face and on talus boulders below the rim and above the flood plain. The solidly pecked human figure in the lower part of Fig. 14a is associated with a bighorn sheep. Another solid sheep is shown above and to the right, but this animal may be associated with the two headless (?) rectangular figures whose dress is indicated by lines of dots or connected solid circles. Each figure holds an atlatl. We believe these rectangular figures are, despite their stylized form, atlatl-bearing hunters. Also in this locality is the panel of four solidly pecked south-pointed sheep associated with a disk (Fig. 14e). Fig. 17d shows a series of line-connected solidly pecked circles at *Locality 1.*

Locality 2 is on the exposed cliff face below the mesa rim. Some designs occur on fallen boulders on the steep talus slope. Fig. 14b shows a similar combination of a solidly pecked figure with a projection rising from the top of the head, a rectangular outlined figure holding an atlatl and bighorn sheep to that seen in Fig. 14a from Locality 1. The solid figure differs in having peephole eyes and a right-angled sex organ. The outlined figure is filled with grid lines, and it holds two (perhaps three) atlatls. On a talus boulder below the top of the hill is the figure shown in Fig. 14c which may be compared to the atlatl-holding humans in Figs. 14a, b, d; 15c, e, and 16d, and to similar ones which are not holding spearthrowers shown in Figs. 16a, 17a and 18a-c. Also recorded at Locality 2 is the solid-bodied, spike-top headed unarmed figure associated with two solid-pecked bighorn sheep shown in Fig. 14f, and which is similar to the solid-pecked figures of Fig. 15a and c, except that the latter, which has four arms, is the result of applying a second figure over an earlier one. Other Locality 2 atlatl-bearing figures, done partly in lines and partly in solid-pecking are shown in Figs. 15b, d, and 16d. The four north-pointed sheep (Fig. 16e), and the lines-of-dots designs shown in Fig. 17b, e-f, and the unusual branched lines associated with two south-pointing sheep (Fig. 17c) complete the designs we recorded at Locality 2. Our search may have been incomplete and there may still be unrecorded glyphs at this locality.

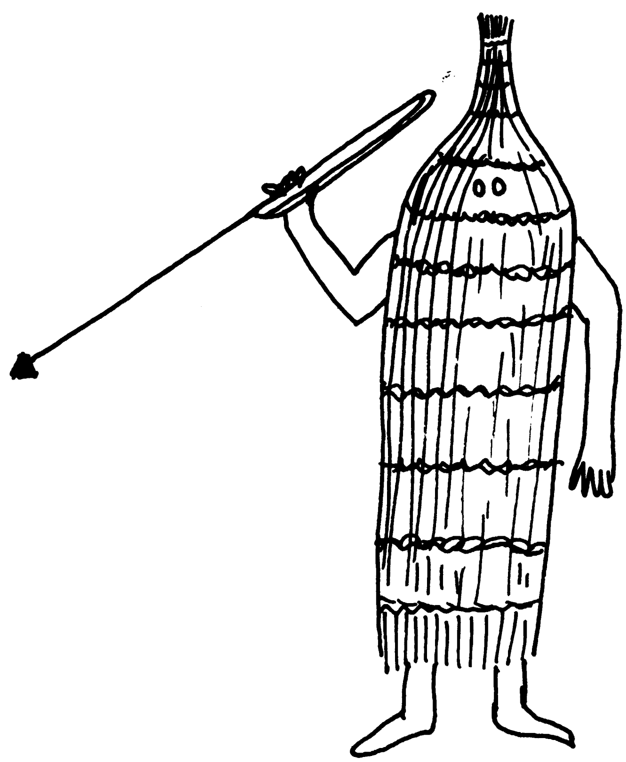
Locality 3 is a fair-sized exposure of vertical rock faces at the southern end of the hill. Here were inscribed the glyphs shown in Figs. 15a, 17a, and 16a-c.

Locality 4 designs are not illustrated here because we did not have time to find a way up to them. They are in the form of two 4 foot high costumed figures but details could not be observed from the ground surface. There may be additional petroglyphs on the boulders and rock exposures north of Locality 4.

Locality 5 is marked by a single pecked figure holding an atlatl in one hand and a stick or dart in the other. Once more the specific association of bighorn sheep occurs.

On the flat top of the little isolated hill at site NV-Li-7 is a series of about 20 "house rings" made of boulders piled to a height of from two to three feet, and 6 to 12 feet in diameter. Recent looters have dug around and in these and have partially thrown down some of the walls. They can scarcely have been hunting blinds as such since they are not within atlatl or bow range of the hill base, and they may represent a small settlement whose location, however inconvenient to water, provided protection from attack. The several centuries of Puebloan occupation in this area may not have been altogether ones of tranquility, and the earlier residents might have resorted at certain times to living in such defense spots. No potsherds and a very few flint flakes were observed. We saw no indication that the spot was one of intensive occupation or industry. Just above the flood plain at the northeastern edge of this hill is a slightly curved three-foot high wall of rough boulders which might have served as a hunting blind. On the other hand it may have been built for some reason by a recent rancher, though it is apparently not a section of a stone fence.

A fairly common design at the Lower Pahranagat Lake site (NV-Li-7) is the figure of a standing human whose body is covered with what is apparently some kind of garment with a fringed bottom with a spiked top, armholes and eyeholes and extending to the lower legs. That these are males seems probable, both because they at times hold atlatls in one hand, and also by reason of the projection between the legs of the persons shown in Figs. 14b and 15c which can be interpreted as the male sex organ--despite the obvious remark that this is not shown in the anatomically correct position and in one instance has a right-angled bend. The common feature of the projection or spike rising from the top of the head we interpret as tapering bound warp selvage elements of a woven tent-like garment of bark or rushes manufactured by the coarse twined matting technique or perhaps of sewed skin. We see these figures as atlatl-armed men dressed in a portable disguise waiting for the game to approach sufficiently close to cast the dart. Our reconstruction of such a disguised hunter is shown here. The disguise, we suppose, may have been sufficiently effective to fool the animals. This suggestion would also be convincing if we could interpret the projection rising above the top of the head as antlers or horns, but since it is a single uncurved and unbranched element it does not appear to be either sheep horns or deer antlers. Incidentally, in the Coso Range to the west there are clearly depicted armed hunters wearing bighorn sheep head disguises (Grant, Baird and Pringle 1968:40) but these figures are not wearing the cover disguise garment. The frequent association of bighorn sheep with the disguised hunters at NV-Li-7 may be evidence that this was the animal here being hunted. Such disguise outfits are not reported in the ethnographic literature for Great Basin groups although stationary blinds covered with grass or rushed were widely employed in waterfowl hunting. It is possible that when the atlatl was the hunting weapon it may have been important to be able to launch the projectile at close range, and that when the bow came into use the disguise was no longer needed because of the greater distance at which the arrow was effective.



Our reconstruction of an atlatl-armed hunter wearing a disguise garment.

OTHER PAHRANAGAT VALLEY SITES

There is a large petroglyph site on the east side of the artificial lake which lies just below the Hiko postoffice. We did not visit this, but noted one boulder at the postoffice which had been carried there and which bears what are probably GB Curvilinear Abstract designs (Fig. 18d).

Near the road about 15 miles south of Alamo is another locality of boulder petroglyphs. We recorded three examples (Fig. 18e-g) of a larger assortment.

On Mt. Irish, which lies ca. 15 miles west of Hiko is the unusual panel of four bighorn sheep shown in Fig. 18h. We have not seen this site, but have made our sketch from the photograph by Townley (1970) and a kodachrome kindly supplied by Dr. John J. Cawley of Bakersfield. It is quite different in style from the petroglyphs at NV-Li-7 and NV-Li-9. Townley suggests that the four sheep represent a "family" arranged so as to create "a feeling of depth." While this may be the case, it would be wholly unique that true perspective was evidenced in Great Basin rock art. An alternative explanation is that the superimpositions are of different dates and of different dates and if this were true, both the "family" and perspective elements would be incidental rather than planned and deliberate. Possibly careful study of the panel would answer this question.

STYLE CONSIDERATIONS

The several petroglyph localities stretching along the walled course of the Lower White River Valley (site NV-Li-9) are mostly done in the Great Basin Representational Style (Heizer and Baumhoff 1962:202). Puebloan influence is apparent in the horned figures (Fig. 3d) and the square-shouldered figures (Fig. 5a). Great Basin Curvilinear Abstract Style elements are also present (Figs. 6b, e, f; 8d) as are designs associated with Great Basin Curvilinear Abstract Style (Figs. 3b, bird track; 4a-b, dots; 9, rake).

Heizer and Baumhoff (1962:Figs. 30-31) mapped the area in which the White River Valley lies as within the distribution zone of the Great Basin Curvilinear Abstract, GB Rectilinear Abstract and GB Representational Styles. The Great Basin Scratched Style was not then reported for the area, but its presence at NV-Li-9 is now attested and allows this part of southern Nevada to be added to the distribution as plotted in 1962.

Turner (1963:Map II) includes the southern part of Nevada in which both NV-Li-9 and NV-Li-7 occur as lying within the distribution areas of his Styles 3, 4 and 5.

What is needed at this point is for some person to collect as much detailed information on petroglyphs of southern Nevada as possible, organize this by classifying elements, and make a detailed comparison of these data with the Glen Canyon styles as defined by Turner, the Utah-Arizona styles defined by Schaafsma and the Great Basin styles as defined by Heizer and Baumhoff. Through such a program we can learn whether the overlapping distributions of the several styles represent distinctive regional substyles of major styles with wide distributions or whether the latter are unitary styles which spread rapidly and widely without undergoing significant internal variability. Because the Great Basin styles are at best only roughly dated and the Glen Canyon styles have much stricter chronological floruits, the study proposed may be expected to contribute to a more precise dating of at least the later Great Basin styles.

If students of prehistoric western North American rock art are correct in believing that there has occurred, over the past several thousand years, a succession of spreads of petroglyph styles, we can draw a main conclusion from this that the basic function of this aspect of prehistoric behavior has probably remained the same. While we have argued for that main purpose to have been hunting magic, it is still possible that there were other (i.e. additional or alternative) purposes of rock pecking. But, regardless of the exact function(s), it is most probable that we are dealing with several styles, each in their own time and space frame, with a single behavioral aspect of Great Basin native culture.

The NV-Li-7 (Lower Pahranagat Lake) petroglyphs are clearly different in style from those in the White River Valley (NV-Li-9). The two petroglyph sites differ from each other presumably because they are of different ages, and if this is the case, then they are also presumably the work of different people. Our strong impression is that NV-Li-7 is older than NV-Li-9 because the glyphs at the latter site are much sharper and less eroded. The NV-Li-7 site does not fit comfortably into any of the several Great Basin or Glen Canyon styles as presently recognized.

The Scratch Style petroglyphs at NV-Li-9 (Fig. 4c-d, 7b, d-g) are, as noted at all sites where they occur in the Great Basin, the most recent. It may be suggested that they were applied to existing petroglyph-bearing surfaces by the immediate ancestors of the Shoshonean tribes occupying the area at the time of white contact, and that they may simply be the last manifestation of a half-remembered practice whose details and purpose were mostly forgotten. Why the making of pecked petroglyphs was given up in late prehistoric times we do not know (for discussion see Heizer and Baumhoff 1962:14, 226 ff.). Nor do we know whether the old game ambush sites continued to be used after petroglyphs were no longer made. Our guess would be that the hunt continued at these spots for as long as the game animals were present, and because the older petroglyphs occurred at ideal hunting spots the later hunters noted the frequent association, and perhaps were dimly aware of the point that it was a no longer used form of hunting magic. Perhaps to "play it safe," or in a spirit of imitation or re-invention, they took to superimposing their own scratch style designs on the older ones. The Scratch Style is so widespread, and utilizes pretty much the same designs that it too, despite its simplicity, can also be assumed to have diffused over a large part of Nevada. How widespread the Scratch Style is in the Great Basin remains to be determined since most earlier observers failed to recognize and record its presence.

Some designs at Lower Pahranagat Lake are reminiscent of ones occurring elsewhere. What we take to be disguised hunters with atlatls (Figs. 14a, c, d; 15a, d, e) are rather like the somewhat more elaborately drawn figures with rectangular bodies clothed in decorated garments from the Coso Range, California about 160 miles to the east (cf. Grant, Baird and Pringle 1968:p. 38, figs. b, c, d, f, j). In the Coso Range figures of men holding what are apparently weighted atlatls are shown (Grant, Baird and Pringle 1968:p. 54 top). We have suggested that the headless line-of-dots filled rectangles (e.g. Fig. 14a, d) are stylized representations of costumed hunters, and these latter are so similar in many respects to what Grant, Baird and Pringle (1968:36) have labelled "medicine bags" (see also Grant, Baird and Pringle 1968:pp. 74 bottom; 84 bottom) that the latter may also be a highly abstract representation of men. Further, the costumed human figures at site NV-Li-7 shows features reminiscent of designs in Glen Canyon (Turner 1963:Fig. 80) and of some as far distant as west central Wyoming (Gebhard 1962-63:Fig. 3; Gebhard 1969:Pls. 4, 52). From some unspecified location on nearby Mt. Irish there is a record (Fig. 18h) of large scale representations of bighorn sheep with cloven hoofs (Townley 1970) which can be affiliated both with the Coso Range area (Grant, Baird, and Pringle 1968:20) and the Puebloan area of Utah and Arizona (Schaafsma 1971: passim; Turner 1963). The so-calley "vulva" design is pretty clearly just that, as Figs. 5a, e, g shows. This symbol often occurs alone and is noted elsewhere in Nevada by Heizer and Baumhoff (1962:Figs. 41, 79h, 80b, 94d) from sites Ch-57 (Allen Spring), La-9 (Hickison Summit), and Ly-1 (East Walker River). The outlined cross design seen in Fig. 12 occurs also about 150 miles to the south in the Valley of Fire (Schaafsma 1971:Fig. 130), and in New Mexico (Schaafsma 1972:Figs. 20, 73). The cross with knobbed points but without the bordering line is noted in Nevada at Lost City, Clark County (Scaafsma 1971: Pl. 53) and site NV-Cl-143 (Heizer and Baumhoff 1962:Fig. 78a). Schaafsma (Op. cit.) says this is an element of the Western Virgin Kayenta style. The rows of hand-holding figures (dancers?) is not uncommon in southern Nevada (Heizer and Baumhoff 1962:Figs. 69c, 70a, 76a) and it is also present in the Santa Barbara painted cave art (Grant 1965:pl. 4). Interestingly enough, the use of dots to make lines or fill outlined figures which is common at NV-Li-7 is also a notable feature of the Santa Barbara painted cave art (Grant 1965:87). Turner (1963:Map II) shows Glen Canyon Styles 2 and 4 present in the Santa Barbara region. The element of horizontal line with pendant wavy lines seen in Figs. 3b, 4a, 5b, 8g(?), 9, 12 is also noted at Atlatl Rock, Valley of Fire, Clark County, Nevada (Schaafsma 1971:Pl. 55). It thus appears from the above that there are a number of elements which are characteristic specifically of southern Nevada petroglyphs, and if this list could be expanded it might become the core of elements of a regional substyle.

The excellent review by Rusco (1973) of types of anthropomorphic painted and pecked figures in the Great Basin does not include reference to any figures similar to the ones we interpret as disguised hunters at site NV-Li-7.

Site NV-Li-9 (White River Valley) shares many specific elements with Glen Canyon Style 4 as defined by Turner (1963)--these include ticked lines, parallel zigzags, watchspring scroll, simple rectilinear meander, fringed line, squiggled line, lizard men, sheep, footprints, snakes, and bird tracks). The similarities are great enough to class NV-Li-9 as a site largely done in Glen Canyon Style 4 which is dated at 1050-1250 A. D. It was during this period (P I-III) when Puebloan peoples "colonized" (to use C. Turner's term) southern and eastern Nevada north and west of the Colorado River (see Shutler 1961:Pl. 1 for the area in question). R. Shutler (1961) defines at Lost City (Pueblo Grande de Nevada) a Mesa House Phase dating from 1100-1150 A.D. and an earlier Lost City Phase, 700-1100 A.D. Peoples of both periods are known to have hunted deer, antelope, bighorn sheep, and elk, and it is possible that the White River Valley petroglyphs (NV-Li-9) were made by these people. It is further possible, though here we operate in a chronological void, that during the Basket Maker occupation of southern Nevada which Shutler (1961:67) dates at ca. 300 B.C. to 500 A.D. the Lower Pahranagat Lake (NV-Li-7) petroglyphs were made. Since the atlatl was the Basket Maker weapon (Shutler and Shutler 1962:15) and because atlatls are depicted in use at NV-Li-7 this suggestion of authorship may have some support.

Schaafsma (1971:113, 119, 125) states that Glen Canyon Style 4 is "essentially identical" to the Eastern Virgin Kayenta style of rock art, and that her Western Virgin Kayenta style is closely connected with Great Basin Rectilinear and Great Basin Curvilinear styles. Once more we observe that what is much needed is a broad survey of the data on which the various petroglyphs styles from the Great Basin, Glen Canyon, Utah, Arizona and New Mexico areas have been derived and to try to see a little more clearly than we are now able to how much duplication there is in the several styles. Until now workers have had to analyze data from localized regions, but we are now at the point where the wider relationships, areas of origin and directions of diffusion can be estimated.

We are still at a loss to fit NV-Li-7 into any so far recognized style, and while it shares elements with some styles it seems closest to the early period Coso Range style, though not sufficiently to encourage us to so label it. Since only the atlatl is represented as a weapon here, we think that this may be an additional reason to place it earlier in time and of a separate derivation than the nearby White River petroglyph localities.

Beyond this we do not feel justified in going at the present time. Only two of a much larger number of unstudied sites in the Lincoln and Clark counties area are reported here, and before too many unsupported theories are advanced we should be in possession of information from more sites in order to speak with any assurance about regional styles since what seem to us now as unusual may in fact, with better data, prove to be characteristic.

Most students of petroglyphs of the Far West have concluded that the various styles differ in age and from some region of origin have diffused, and each, in the process, have either replaced or incorporated the existing style. Many of the rock art styles are so widespread that they occur in what are, ethnographically, areas occupied by rather different linguistic groups. If we were able to plot the geographical limits of each of the several petroglyph styles and arrange them in their correct time order, these maps might reflect linguistic areas of earlier times. On the other hand if we judge from recent Great Basin Indians a tendency to be fairly mobile, absence of hard-and-fast territorial borders and the probability of bi-lingual villages or bands along linguistic boundaries would throw doubt on any simple correspondence of petroglyph style areas and linguistic areas. A good test case might be the Scratch Style which is clearly the most recent form of Great Basin rock art--perhaps late enough in time to be attributed to the ancestors of the ethnographic Great Basin peoples encountered by the Caucasians in the nineteenth century. A thorough analysis of Scratch Style petroglyphs which, offhand, look much alike, might nevertheless show that there are localized substyles which do correspond to recent linguistic divisions. Such an effort would be worth making, but it would entail careful fieldwork to make more complete and accurate observations than have to date been accomplished.

One of the things which interests us about the two main petroglyph concentrations discussed here is how different they are. They are quite near to each other (ca. 33 miles) geographically, but they are quite distinct stylistically. There are several logical explanations for this, among them being that the two sets of petroglyphs were made by two different social groups ("tribes") at the same period of time, or at different periods in time. Or, the same social group ("tribe"), but not the same individuals or division of that social group ("subtribe" or "band") made the petroglyphs at the same period in time, or at different periods in time. While we could proceed to list a longer series of hypothetical social-temporal-geographical situations to account for the two quite different manifestations of the same expression of pecked designs on vertical rock faces in these two nearby areas, this will probably bring us no closer to a solution because we lack any other evidence than the inscribed designs themselves. The two sites we studied are not connected, so far as we could tell, in any direct way with occupation spots. It is possible that practitioners of the "new archeology" might provide us with some interesting answers based on the positivist method of hypothetico-deductive procedure, but so far they have not shown us how to get at the real explanation of petroglyphs. Our "old archaeology" methods have been able to show that for many, perhaps the majority, of petroglyph sites in the Great Basin area their presence can be explained in terms of a magical (or shamanistic?) motivation connected with appropriate spots where migrating animals (mainly mountain sheep or deer) were shot in ambush (Heizer and Baumhoff 1959; Heizer and Baumhoff 1962; von Werlhof 1960, 1965; Grant, Baird and Pringle 1968).

In 1958 when Heizer and Baumhoff, with the help of A. B. Elsasser and E. Prince, developed the idea that Great Basin petroglyphs occurred on game migration trails at spots where suitable rock surfaces were present and where the moving animals could be shot at close range, they tested and proved the proposition by determining that petroglyphs often did occur on game migration trails, and that petroglyphs did not ordinarily occur, despite attractive rock surfaces and potentially ideal ambush spots, in places which are not along game trails.[3/] Our hypothesis led to the generalization that in the Great Basin area most petroglyph sites exist at definite places where seasonally migrating deer moving from summer to winter range could be shot. In the western part of Nevada the main movement of deer is out of the eastern slopes of the Sierra Nevadas into Nevada mountain ranges; in central and eastern Nevada these may be from higher to lower elevations, often for long distances through or across valleys. Ambush spots most often occur where a migration trail narrows down, usually in a wash or canyon, where the moving deer have no alternative but to pass through a narrow passage where they can be shot from above.[4/] Where suitable concealment or cover (e.g. large boulders) is lacking, a simple hunting blind of rocks piled up to a height of 2 or 3 feet afforded not only cover for the hunter, but perhaps also some protection from the wind, not a negligible factor to ill-clad bow-hunter patiently waiting without a fire and its telltale smoke in the late fall or early winter. So far, and without unduly bending this proposition to fit particular cases, we can explain the occurrence of the majority of Great Basin petroglyph sites.

Petroglyph sites in narrow canyons may stretch out for long distances, usually concentrating at the best close-range shooting locations. At times a hunt spot on a game trail would require some slight modification by the hunters in order to improve it to the point of effectiveness. The hunting blinds mentioned earlier are one such example of improvement, presumably one demanded because the natural features did not provide effective concealment of the waiting hunters. Another modification was the occasional need to prevent the moving deer, if they became spooked, from exploiting an available escape route, or forcing them to enter the opening of a wash, along which the hunters waited, by means of a diversion fence built of piled-up stones or posts,

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3/ A main exception is the occurrence of petroglyphs at desert springs where animals may come to find water.

4/ Deer hunters in Nevada tell us that these animals when on the move do not look up, and that if a hunter is stationed above the animals they will simply pass along below. No doubt a downwind location is also important since deer have good noses.

or (as we suppose) of piles of brush. These "fences" were made of natural materials and while they may have been recognized as man-made by the deer, they were immobile, inanimate and merely to be skirted. We cannot prove the former presence of such brush-pile fences[5] but, by assuming them to have been made, some petroglyph sites do fit the whole bill of requirements. We suppose, further, that petroglyphs as an expression of hunting magic, also represent an effort on the part of the waiting hunters to attract the deer to the spot, or to insure a successful kill when the animals did make their appearance. The alternative that petroglyphs represent some sort of memorial or record of a hunt that had already been concluded does not strike us as very probable. We say this because it does not seem consistent with Great Basin Indian world view insofar as we envisage what this may have been in earlier times and as seen through the ethnographic records. We would place hunting blinds, diversion fences and petroglyphs in a single general category of the human influencing of a hunting site for the purpose of success in killing game.

The instances of testable association of deer migration routes and petroglyph sites are not as numerous as we might desire for the reason that in the past century land use, open hunting, barbed-wire fences, roads and the like have caused great changes in deer migration habits. State and federal wildlife experts are more concerned with present day management and protection problems than they are with trying to learn from older local residents (both whites and surviving Indians) what the migration patterns of deer were in earlier times before these became disrupted. And for this reason the archaeologist, who is an improbable person to be interested in such matters, often finds it impossible to now learn whether a particular valley or wash or pass was formerly on a deer route. Occurrences of deer bones in nearby sites would prove only that deer were hunted and eaten locally--they could not answer the question of regular seasonal migrations of that animal along a particular trail where petroglyphs occur, nor would such deer bones, even in great quantity, be directly associable with specific petroglyphs.

Now, if the arguments given above are admitted as acceptable hypotheses (though we actually think they are stronger than that), we might be able to exploit this by supposing that some of the petroglyph "symbols" or designs can be interpreted since they were directly derived from the minds and hands of the living persons who conceived and executed them--the men who were there and killing the game.

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[5] That is, at petroglyph sites. They are abundantly attested for antelope hunting in the ethnographic literature.

Most immediately we would assume that the animal being hunted would be prominently displayed. Better still would be dead animals shown lying on the ground with weapon shafts protruding from their bodies. Still another possibility is that the hunters themselves would be represented as discharging arrows or darts at animal targets. More abstractly, depictions of humans or weapons might indicate the same but we would not argue for this interpretation. Beyond this one could speculate that some designs, albeit non-representative, were conventionalized signs for dead animals, live animals, good luck, hunger, plenty, hunting blinds, diversion fences, weapons, and so forth.

In Great Basin petroglyphs one can, in fact, find instances of some of these logical pictorial adumbrances of the hunt, but in terms of the totality of petroglyphs they are only a minor quantitative element. Animals which would have been worthy targets include sheep and antlered deer (Heizer and Baumhoff 1962:Figs. F-11, 30; Steward 1929:Fig. 87; Shutler and Shutler 1962:Pls. 15c, 16b; Schaafsma 1971:Figs. 49, 104; Schaafsma 1972:Figs. 14, 164, 165) and mountain sheep (Grant, Baird and Pringle 1968:132). Whether deer, sheep or rabbit(?) tracks, and bear paws can be taken as equivalent is impossible to say. There are also snakes and lizards in considerable numbers, and these were surely not food staples. For the reason that we cannot today determine, in many cases, which animals made seasonal movements and made appearances along what are presumed to be old migration trails, we cannot be certain that a petroglyph locality where mountain sheep are represented in numbers was in fact anciently a mountain sheep hunting site. Grant, Baird, and Pringle (1968) have argued persuasively that there existed in parts of the Great Basin a "mountain sheep hunting cult"--an organized ritual with members and a body of action and belief which is manifested in petroglyphs. It is a possiblity that once a successful technique for hunting bighorn sheep was devised it then spread through most of the desert West. Where sheep were not accessible the technique ("cult") was either not adopted, or the attempt was made to apply it to another large, seasonally-appearing, animal, the deer, as it moved from high mountains with the advent of heavy snow to wintering grounds in the desert ranges. It is thus possible that petroglyphs at one time were primarily associated with the hunting of sheep and that subsequently, for reasons which we do not understand,[6] the sheep-petroglyph-hunting complex shifted to deer hunting and that with this shift the representation of the sheep as a petroglyph symbol was simply carried along and not substituted for by a representational

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6/ von Werlhof (1965) has hypothesized that a change in deer migration patterns may account for the abandonment in late prehistoric times of petroglyph making in the Inyo-Mono County area. Grant, Baird and Pringle (1968) theorize that the sheep cult was abandoned due to heavy killing of bighorns after the introduction of the bow and arrow.

glyph of the deer. If in earlier times sheep were much more abundant than they are known (or suspected) to have been at the opening of the historic period this animal may have ranked in some areas as a considerably more important source of "big game" meat than deer which were also presumably hunted. But here again we really lack any hard facts on demographic changes in mountain sheep or deer populations in prehistoric times when Great Basin Indians were busy making petroglyphs. And while these may seem like pretty wild speculations--ones for which there is no evidence--we nevertheless believe that they also rank as hypotheses which might be tested rather than being mere flights of fanciful thinking. They are hypotheses because their construction is framed around an attempt to explain, or account for, certain observable facts regarding Great Basin petroglyph sites and the design elements (or "glyphs" or "symbols") which occur at a substantial number of these sites.

Animals shown with darts or arrows fixed in their bodies also occur, though rarely (Grant, Baird and Pringle 1968:73; Schaafsma 1971:Fig. 121). This kind of realism is rare for reasons which we cannot explain. Possibly such stark representation was considered unnecessary, or for some reason inappropriate. Possibly also, since the depiction of realistic compositions in any known kind of Great Basin parietal art is lacking, it may have simply been beyond the artistic conceptual abilities of most Great Basin hunters to make such portrayals. In other words, while we might search for such "photographic records" or "still life" depictions, we should not forecast that they would occur. That some do occur, but rarely, is of interest to us, but the few example we have may only be those authored by some individual and innovative petroglyph artist.

When we come to petroglyphs showing armed hunters engaged in their work we also have some examples. The magnificent Coso Range (Inyo County) "gallery" described by Grant, Baird and Pringle (1968) has a number of examples of humans shooting bows or holding (or casting?) atlatls at sheep, and these can scarcely be taken as anything else than hunters at work (op. cit. p. 54, passim; Ritter 1970:Fig. 201). At the Lower Pahranagat Lake site (NV-Li-7) some of the costumed human figures hold what appear to be atlatls, and the human either with or without a weapon is often associated with one or more bighorn sheep.[7]

Beyond these literal identifications we can scarcely go. Some of the NV-Li-7 designs which take the form of linear-dotted or line-ruled rectangles may very well be abstracted or conventionalized and abbreviated portrayals of the more completely drawn figures, some of which hold atlatls (compare Figs. 14 and 15 with Figs. 16-18). But the other glyphs do not suggest to us any clearly identifiable objects or life forms.

7/ We have a strong impression but do not try to document this here, that when archers are shown they are more often associated with antlered deer than bighorn sheep.

Mr. Leon Hill on the staff of the Nevada Desert Game Refuge tells us that he had never seen or heard of seasonal deer migrations in the Pahranagat and Lower White River valleys, but that in the coldest part of the winter bighorn sheep come down out of the higher elevations of the Desert Range to feed, and presumably, to water. Whether in pre-white times deer moved either north up or south down the Lower White River-Pahranagat valleys we do not know. Perhaps bighorn sheep made such seasonal movements in past centuries in search of winter pasture when the cold was unbearable in the higher mountains where they are particularly adapted for survival.

The main difficulty in trying to make a connection between the hunting of bighorn sheep and petroglyphs is the severe decrease in recent times of the sheep population. The pre-white distribution of this animal was obviously much wider than it is at present, but we know nothing of its population numbers in prehistoric times. Whether deer in earlier times were as abundant as sheep we also do not know. If we had some data on these matters we might be in a better position to understand and explain some aspects of petroglyph hunting magic insofar as it concentrated on the capture of one or the other animals. In this regard good faunal collections from dated stratified sites in the Great Basin might inform us either about temporal fluctuations in the relative abundance of the two forms or selective hunting practices.

On balance, since we cannot provide any evidence, we find it impossible to decide whether the Lower White River Valley and Lower Pahranagat Lake petroglyph localities were associated with the hunting of deer or mountain sheep, or possibly both. We simply do not know enough about the earlier habits of these animals in this area to make a guess. That the two sites are well suited to shooting game, either with the bow or atlatl, as they passed by, we think is clear, and we find that the two sites conform agreeably with a good many other such Great Basin sites. In the case of the Coso Range sites in Inyo County it is most reasonable to think that petroglyphs were connected with bighorn sheep hunting--the conclusion which was arrived at by Grant, Baird and Pringle (1968) and with which we agree. In the several instances of the association of petroglyphs sites with known deer migration trails in western Nevada which Heizer and Baumhoff reported in their 1962 publication, we think the indication is very strong for petroglyph sites to be linked with deer hunting. Von Werlhof (1965) provides what seems to be good evidence for Owens Valley petroglyphs as associated with deer hunting.

Not only were Great Basin Indians probably not sufficiently expert in delineating all of the details which we might expect a trained illustrator today to provide, but in addition there is no reason to assume that they were even interested in trying to create pictorial representations which were exact in the sense a photograph is exact. While the motivation or thought behind the design itself may have been very complex, we have no reason to assume that the Indian who executed the petroglyph was under any requirement to be so literal in making the design that it could be understood by anyone.

If he knew what he was doing, that was enough. In many cases the petroglyph maker cum hunter was probably operating under a considerable degree of emotional stress. Contributing to this may have been hungry wives and children and old people waiting at home for something to eat. Many of the seasonal hunts at petroglyph sites took place in the winter when it must have been uncomfortable in the extreme to sit through the day without the comfort of a fire, with its telltale smoke, and wait for the game. The waiting itself may have been boring, but the uncertainty over when, or whether, and how many of the migrating animals would make their appearance, and that when they did that they would be killed must have loomed large in the hunters' thoughts. We suggest that it is to some degree a reflex of such stresses that led Great Basin Indians to invoke the help of magic to alleviate these worries, and that petroglyphs are the surviving evidence of that practice. We would guess that out of a larger number of possible uncertainties which the hunters were attempting to mitigate, the most important ones were: 1), to reduce the period of waiting for the animals to appear--i.e. to hasten them on their way; and 2), to influence them to approach closely, constitute good targets, and therefore increase the probability of a kill. But for whatever reason or reasons Great Basin Indians anciently came to think that by engraving their hunting hopes on rocks they might thereby influence the outcome of the hunt, it seems clear that they did so, and the abundance of rock engravings indicates that they believed such acts were effective.

Beyond what we have here reported on and speculated about, we admit that we are still intrigued by the larger problem of what the glyphs meant to their makers. For a limited number of glyphs at certain sites we can make informed guesses, but for the majority of signs we cannot. Imaginative efforts at "translating" petroglyphs such as the proposal by Martineau (1973) we reject as wholly without support or credibility. But we do not discount the possibility, or even the probability, that through the application of methods which may in future be developed a certain proportion of western North American petroglyph designs will be "deciphered." We say this because we believe that the widespread occurrence of many specific design elements can be taken as presumptive evidence that the meaning of the design was accompanied, as it diffused, with its form. A form and its meaning need not diffuse together, of course, but we believe that a specific glyph or sign which is repeated over a wide territory and which must have been learned by one local group from a neighboring one would be more likely to be diffused in its particular form if the teacher said "This design represents the life-essence of the deer, and if you engrave it correctly it will increase your chances for a kill," than if the teacher said "This is a good design for hunting luck." It is difficult to believe that many of the petroglyph designs, whether geometric, curvilinear or representational, did not have quite specific meanings. Specific glyphs (e.g. most of those named in Heizer and Baumhoff 1962:73, Figs. 16-30) are often widely distributed in the Great Basin. It is most likely, it seems to us, that as different styles developed and spread the design elements which comprise each style had a name and meaning. What the "snake," or "dumbbell" or "grid" or "rake" design signified in their makers' minds we admit we do not know, but at the same time we do believe that they probably stood for some specific item, or idea, or concept. How to now determine what in prehistoric times particular designs meant we do not know, but if it is admitted that the glyphs are part of hunting magic the parameters of possible meanings are not infinite, and logic, ethnographic analogy, the use of controlled imagination, and application of some existing mathematical techniques for sorting data may lead us to some understanding of what now seems to be an unorganized jumble or arcane design elements. Some stimulating suggestions on how one might go about interpretation can be found in discussions by Levine (1957) and Vinnicombe (1972).

The question of why the making of petroglyphs went out of vogue in late prehistoric times generally throughout the Great Basin is one which we cannot answer. Whatever impelled Indians to abandon the practice must have been important to them. If we are correct in believing petroglyphs were employed as an aid in food-getting, then we can conclude that petroglyphs generally were no longer considered effective as an adjunct to making a living in this difficult environment. A drastic animal depopulation (through disease or drought or other climatic alteration) might have made the ambush spots no longer suitable for hunting, and if this game scarcity persisted for several human generations the practice may have been forgotten. Or, a change in hunting methods which involved other kinds of hunting areas would have made the making of petroglyphs unnecessary and the tradition could have been lost and forgotten. Conceivably some change in ritual procedures may have led to an iconoclastic rejection of petroglyph magic. But whatever the cause, and we have no direct leads as to what this might have been, the making of petroglyphs seems to have been given up generally throughout the Great Basin sometime in the late prehistoric period.

Where do we stand, in 1974, on the matter of understanding petroglyphs and pictographs of the Far West? We do know a few things. One is that in the Great Basin physiographic province petroglyphs are very commonly linked with the hunting of large game such as deer, or antelope or mountain sheep. In broad terms, therefore, it has been shown that the main function of petroglyphs was for success in hunting animals--i.e. they served in some way as a magical element in the procedure of getting something to eat.[8/] Thus, petroglyphs are part of the fabric of the ecological relationship syndrome, and so their study is one which is now respectable in professional terms. There still appear in print, however, all kinds of strange interpretations of petroglyph designs which are, in our opinion, quite far from the truth. Efforts being made at the moment to see astronomical and calendrical recordings in

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8/ For support of this statement see Heizer and Baumhoff (1959, 1962), Heizer and Clewlow (1973); von Werlhof (1965); Grant, Baird and Pringle (1968).

"scratch style" Great Basin petroglyphs, evidence of sophisticated time-reckoning schemes registered in pecked designs, and representations of supernovae, "star maps", and constellations seem to us to be little more than efforts of semi-informed amateurs to become the "code-breakers" of the great mystery of the designs pecked on the rocks by prehistoric Great Basin Indian hunters. "Solving the secret of rock writings" probably is part of a larger public interest in such things as astrology, exorcism, Cryogenics (deep-freezing human corpses for ultimate restoration to life); accepting the proposition that plants can respond to human speech, emotions and thought (for a corrective review see Galston 1974); ESP, black magic, the "Chariots of the Gods" and visits to earth by "ancient astronauts." Any and all unusual remains of antiquity are seized upon as evidence of some occult or extraterrestrial visitation, and petroglyphs and pictographs are one element of this "evidence". Since such crackpot theories are apparently more exciting to accept than ones advanced by careful scholars, it is probable that we will simply have to live with them, as we have with earlier crazes such as the "lost continents" of Mu and Atlantis, and with others no doubt still to come.

We doubt that prehistoric western North American rock scribblings will ever provide the basis for any major pseudo-scientific hypothesis, but in view of the vogue which the crackpot theories of Velikowsky have enjoyed, and have even been recognized, lamentably, by their having been given a hearing at the AAAS meeting in San Francisco in early 1974 (for a report see Science 183: 1059-1062, 1974) one cannot be certain of this. On reflection, and in view of the impressive sales of books by Velikowsky, von Daniken and other charlatans who write about the past, one is led to wonder what the real effect of general education, the promotion of literacy, and the growth of scientific knowledge since the awakening we call the Renaissance in the middle of the fifteenth century has really amounted to. Perhaps the best answer is that there are always two worlds--the real and the imaginary, and that this duality is for some reason necessary.

EXPLANATION OF FIGURES[9/]

1. Sketch map of the Lower White River Valley and Upper Pahranagat Valley showing location of sites referred to in this report.

2. The "Narrows" section of the Lower White River Valley (site NV-Li-9) showing the 6 petroglyph "localities". This is a rough field sketch and not accurate as to orientation or distances.

3. Site NV-Li-9. _a_, Locality 1, Panel I; _b_, Locality 2, Panel X; _c_, Locality 5; _d_, Locality 3 (part), no scale; _e_, Locality 4; _f_, Locality 3 (part), no scale; _g_, Locality 5 (detail), stippling indicates red paint; _h_, Locality 4.

4. Site NV-Li-9. _a_, Locality 2, Panel I; _b_, slight enlargement of part of _a_ based on a separate photograph; _c_, Scratch Style glyph above and to the right of Locality 2, Panel XI; _d_, Scratch Style glyphs above Locality 2, Panel XII pecked petroglyphs.

5. Site NV-Li-9. _a_, Locality 2, Panel III; _b_, Locality 2, Panel XI; _c_, Locality 2, Panel II; _d_, Locality 2, near Panel XI; _e_, Locality 2, Panel XII; _f_, Locality 2, near Panel XII; _g_, Locality 2, Panel XII (detail).

6. Site NV-Li-9. _a_, Locality 2, 20 feet east of Panel V; _b_,Locality 2, Panel V; _c_, Locality 2, near Panel V; _d_, Locality 2, Panel IIA; _e_, Locality 2, near Panel I; _f_, Locality 2, Panel VI.

7. Site NV-Li-9. _a_, Locality 2, near Panel VII; _b_, Locality 2, near Panel VIII; _c_, Locality 2, 75 feet west of Panel IX; _d_, Locality 2, 75 feet west of Panel IX; _e_, Locality 2, 50 feet above Panel IX; _f_, Locality 2, between Panels VII and VIII; _g_, Locality 2, Scratch Style markings above Panel I.

8. Site NV-Li-9. _a_, Locality 2, 75 feet west of Panel IX; _b_, Locality 2, Panel VIII; _c_, Locality 2, near Panel X; _d_, Locality 2, Panel IX; _e_, Locality 3, southern part; _f_, Locality 2, Panel IV; _g_, Locality 2, Panel VII.

9. Site NV-Li-9. Locality 6, part.

[9/] Scale in drawings is one foot unless otherwise specified.

10. Site NV-Li-9. Locality 6, part.

11. Site NV-Li-9. Locality 6, part.

12. Site NV-Li-9. Locality 6, part.

13. Lower Pahranagat Lake petroglyph site NV-Li-7. Scale is approximate; contour lines suggested to show general topography. Numbers 1 to 5 refer to "localities" at this site.

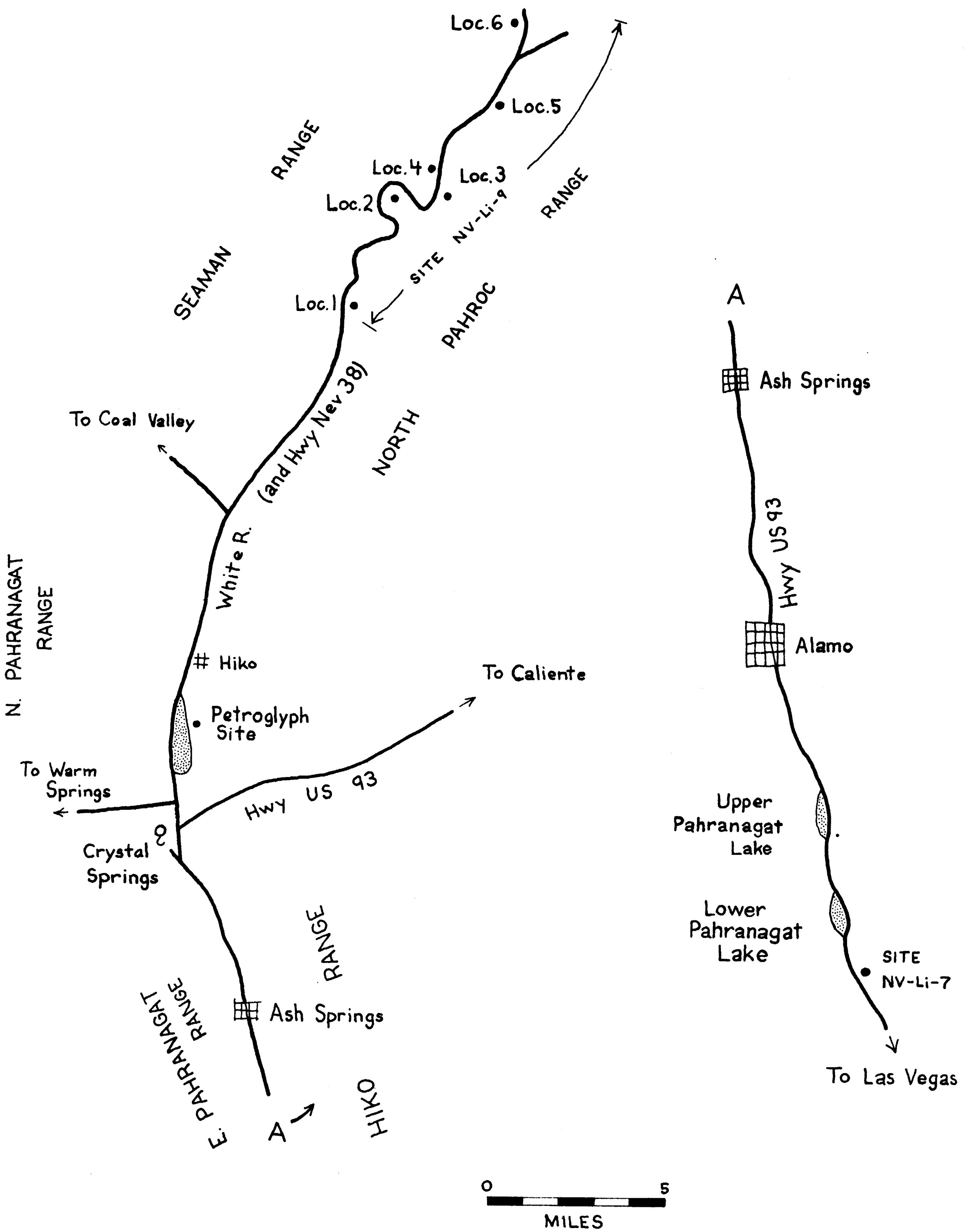
14. Site NV-Li-7. a, Loclaity 1; b, Locality 2; c, Locality 2; d, Locality 5; e, Locality 1; f, Locality 2.

15. Site NV-Li-7. a, Locality 3; b, Locality 2; c, Locality 2; d, Locality 2; e, Locality 2.

16. Site NV-Li-7. a, Locality 3; b, Locality 3; c, Locality 3; d, Locality 2; e, Locality 2.

17. Site NV-Li-7. a, Locality 3. These glyphs resemble closely in many details the costumed (?) atlatl-equipped men such as shown in Figs. 14a, c and 15d, and although they do not carry weapons these we think represent humans. b, Locality 2; c, Locality 2; d, Locality 2; e, Locality 2; possibly another highly stylized representation of a hunter holding a weapon; f, Locality 2.

18. Various petroglyph sites, Lincoln County, Nevada. a, site NV-Li-7, Locality 2; b, site NV-Li-7, Locality 2; c, site NV-Li-7, Locality 2; d, from unvisited site near Hiko Postoffice; e, site 15 miles south of Alamo, Lincoln County; f-g, like e; h, large boulder with four mountain sheep depicted. This sketch is based on photo in Townley (1970) and a kodachrome made by Dr. J. J. Cawley in 1968. Body areas are solidly pecked. Legs of large animal at right not apparent in the photographs.



Loc.6
Loc.5
Loc.4
Loc.3
Loc.2
Loc.1
SITE NV-Li-9
SEAMAN RANGE
NORTH PAHROC RANGE
White R. (and Hwy Nev 38)
To Coal Valley
N. PAHRANAGAT RANGE
Hiko
Petroglyph Site
To Caliente
To Warm Springs
Hwy US 93
Crystal Springs
E. PAHRANAGAT RANGE
HIKO RANGE
Ash Springs
A
A
Ash Springs
Hwy US 93
Alamo
Upper Pahranagat Lake
Lower Pahranagat Lake
SITE NV-Li-7
To Las Vegas
0
5
MILES

Fig. 1

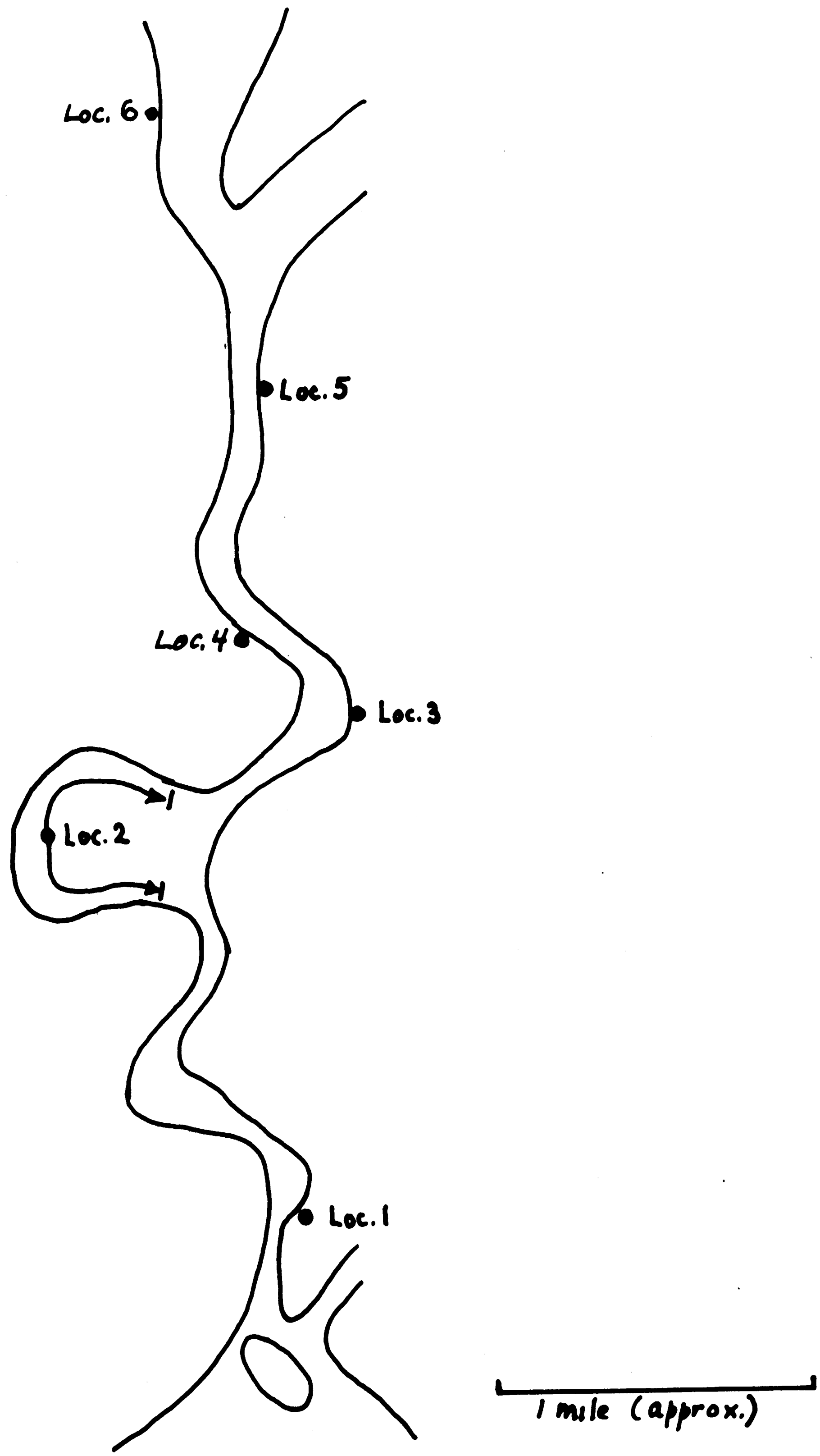


Fig. 2

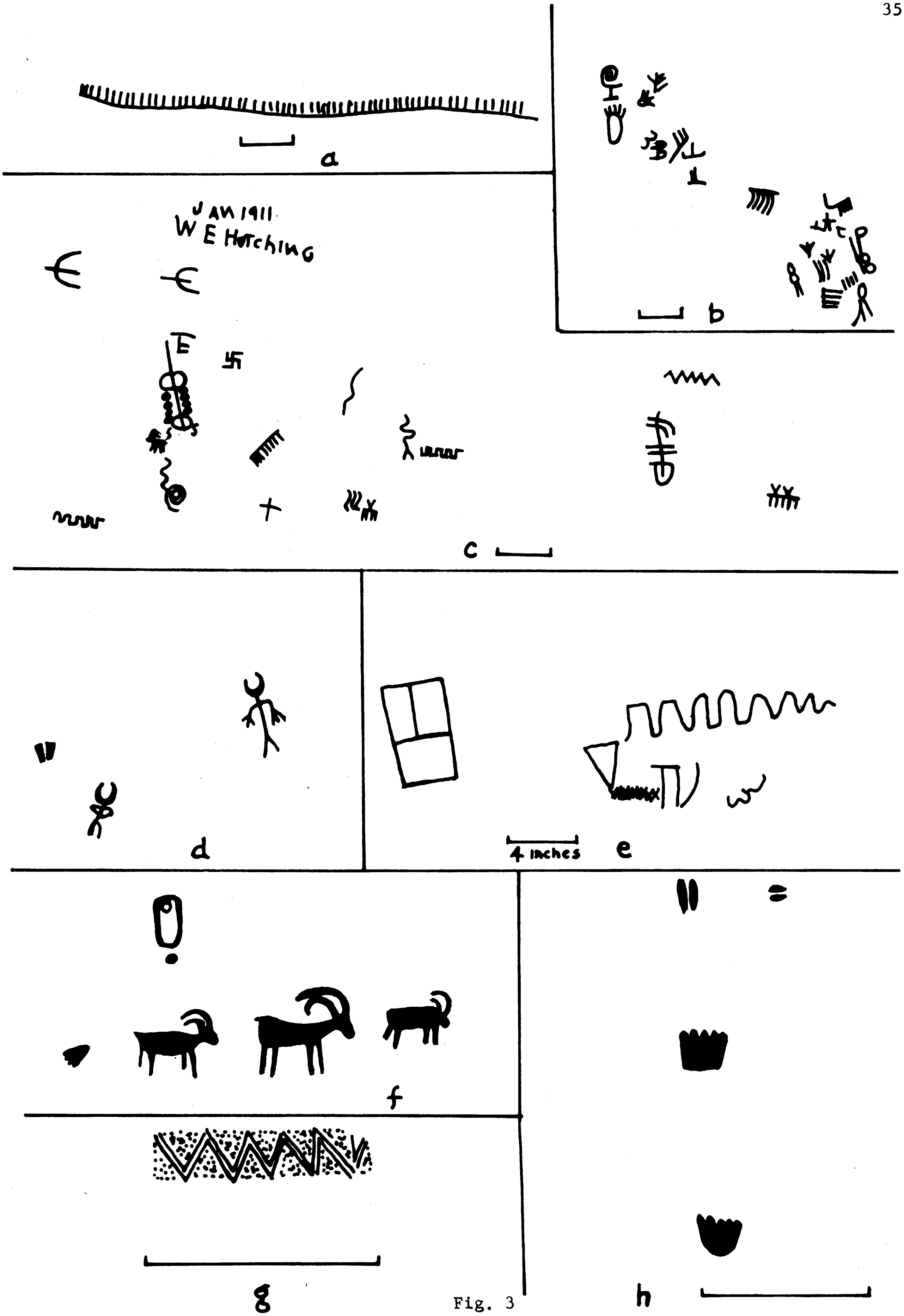


Fig. 3

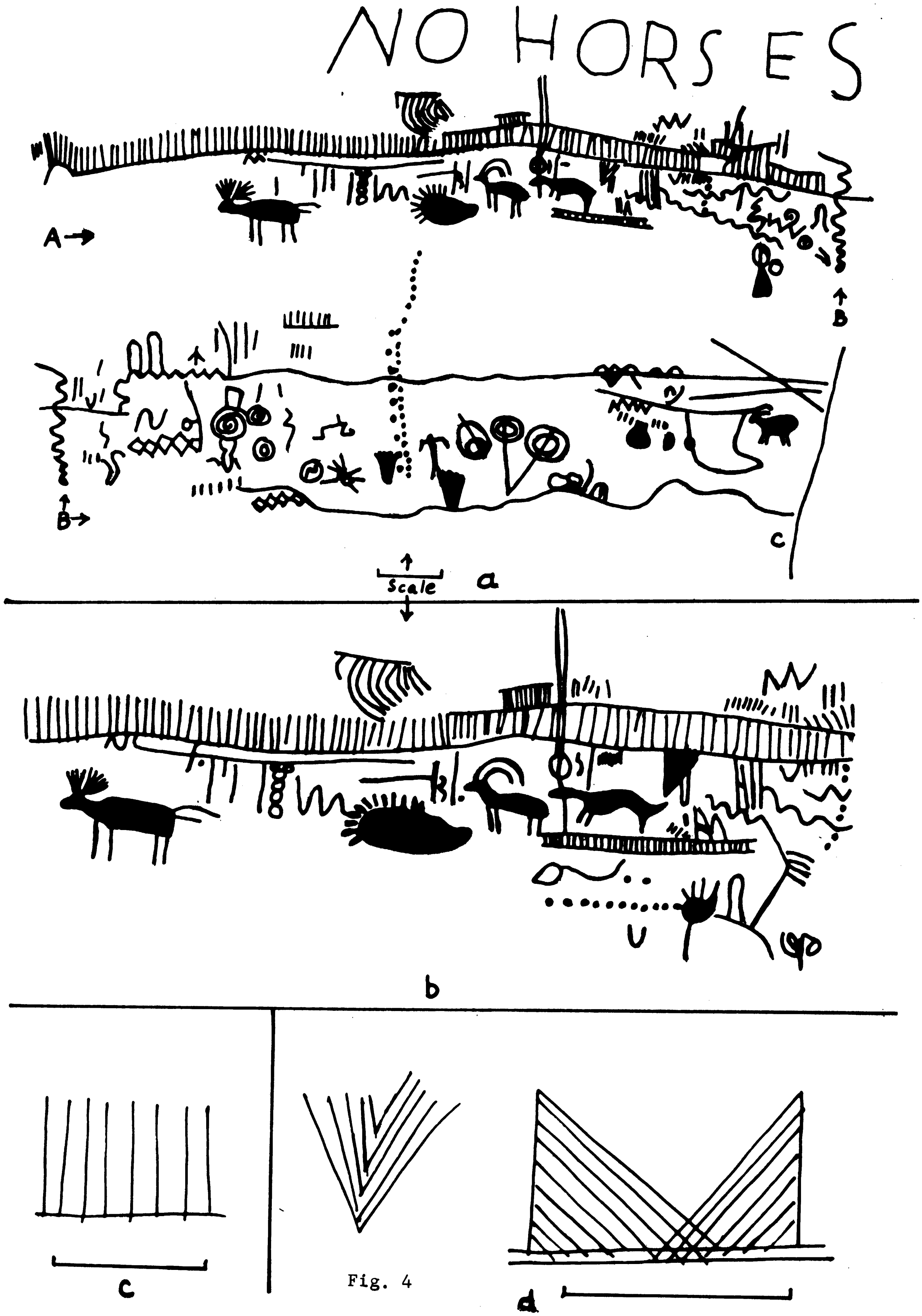


Fig. 4

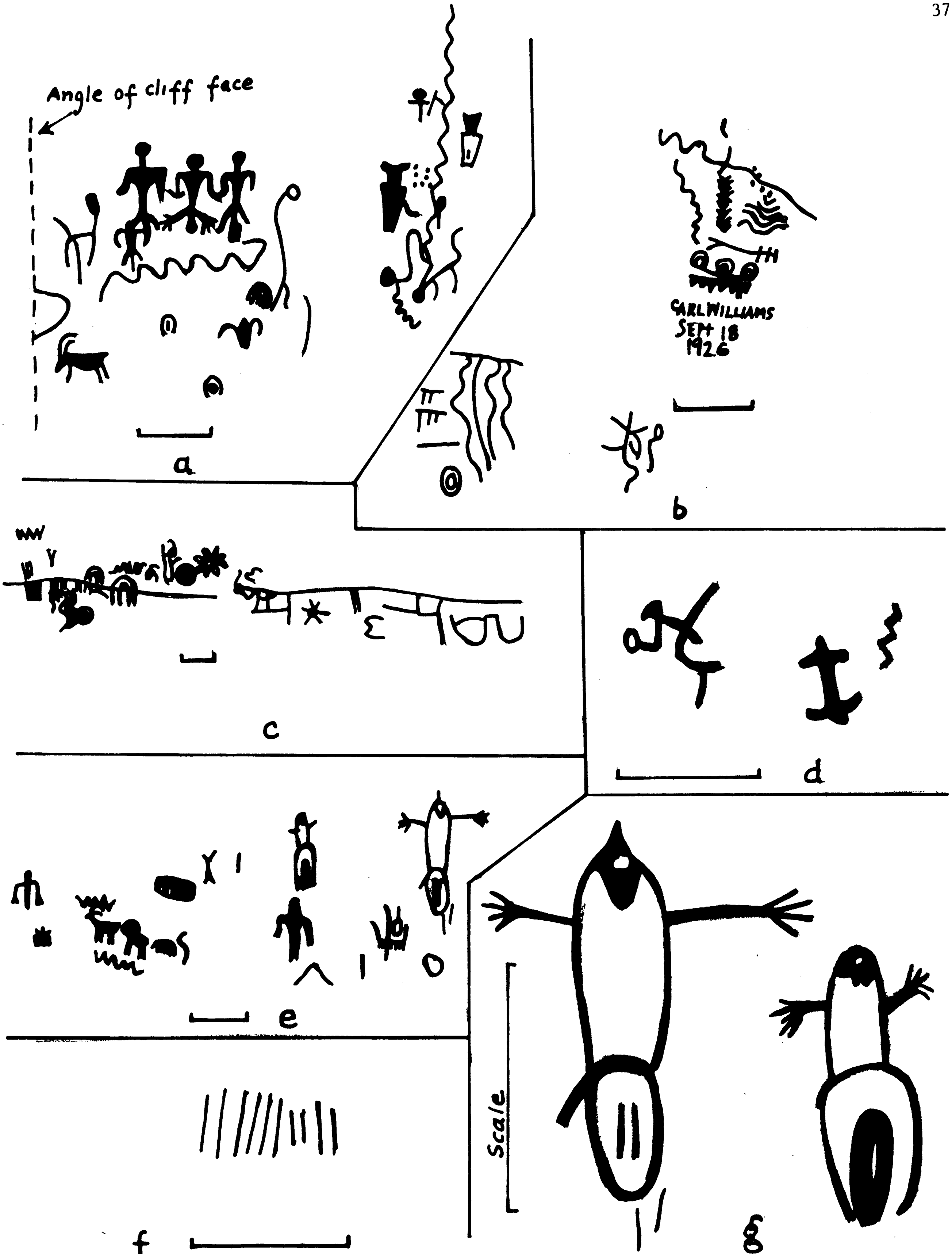

Angle of cliff face
a
CARL WILLIAMS
SEPT 18
1926
b
c
d
e
f
Scale
g

Fig. 5

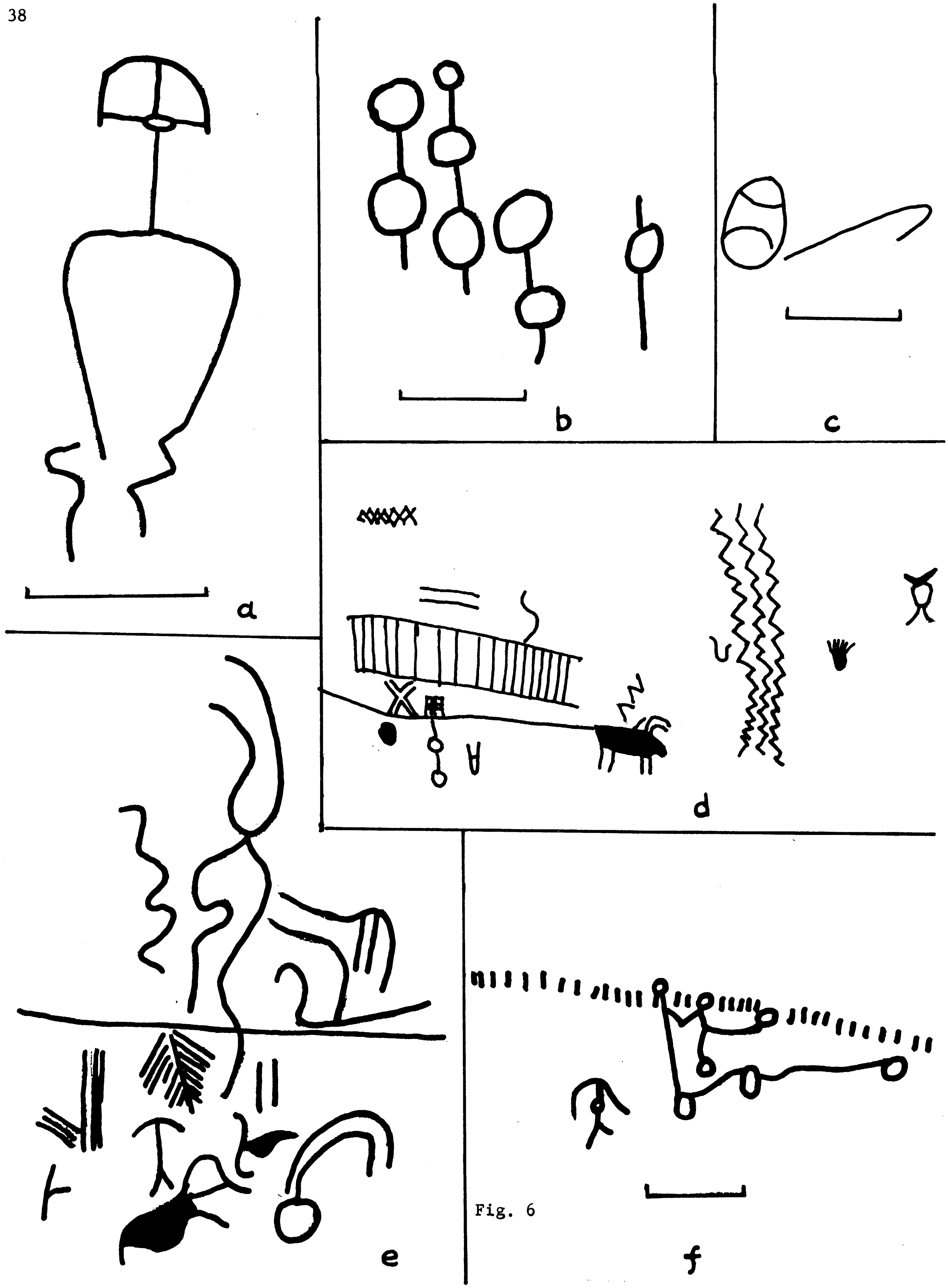


Fig. 6

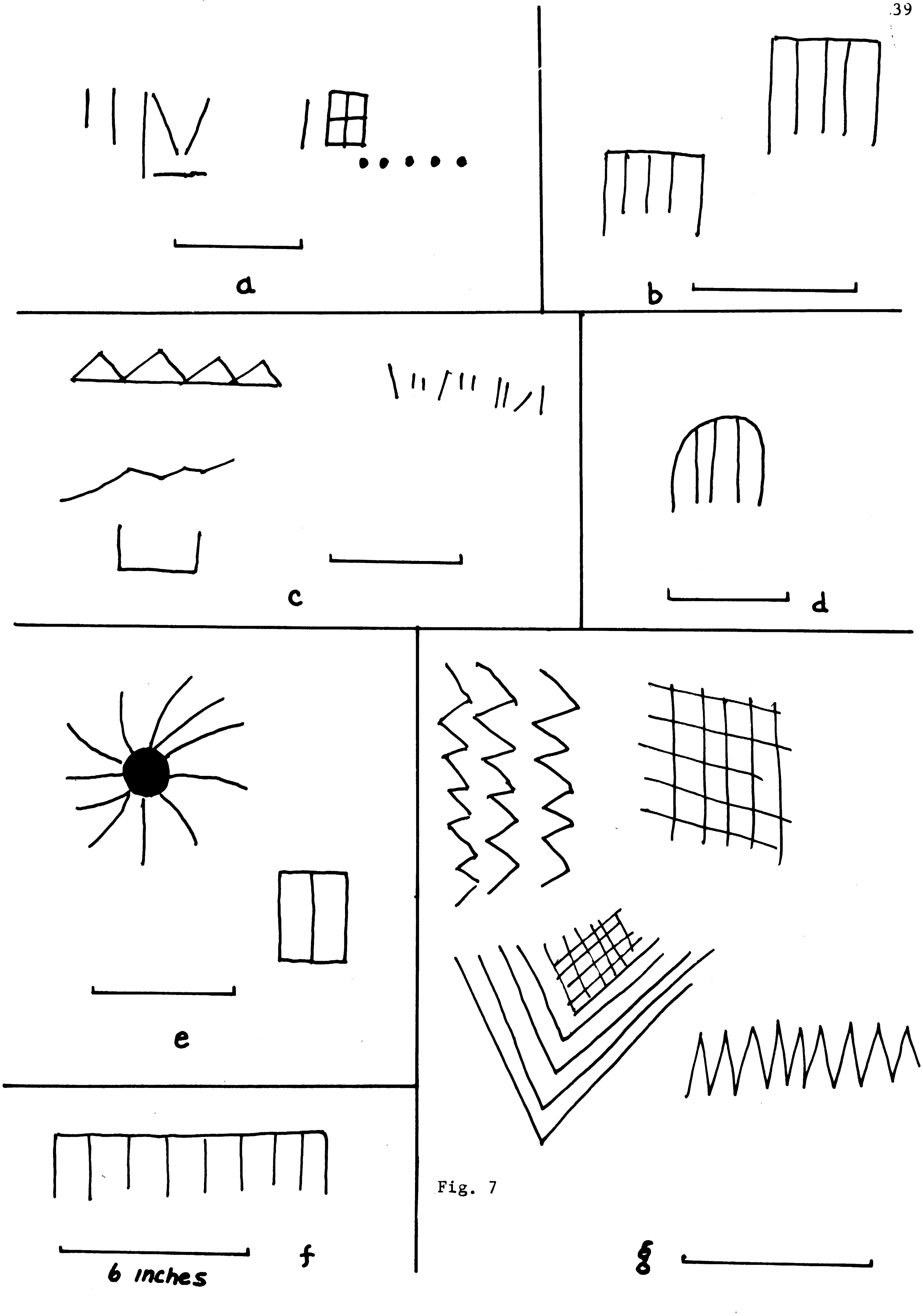


Fig. 7

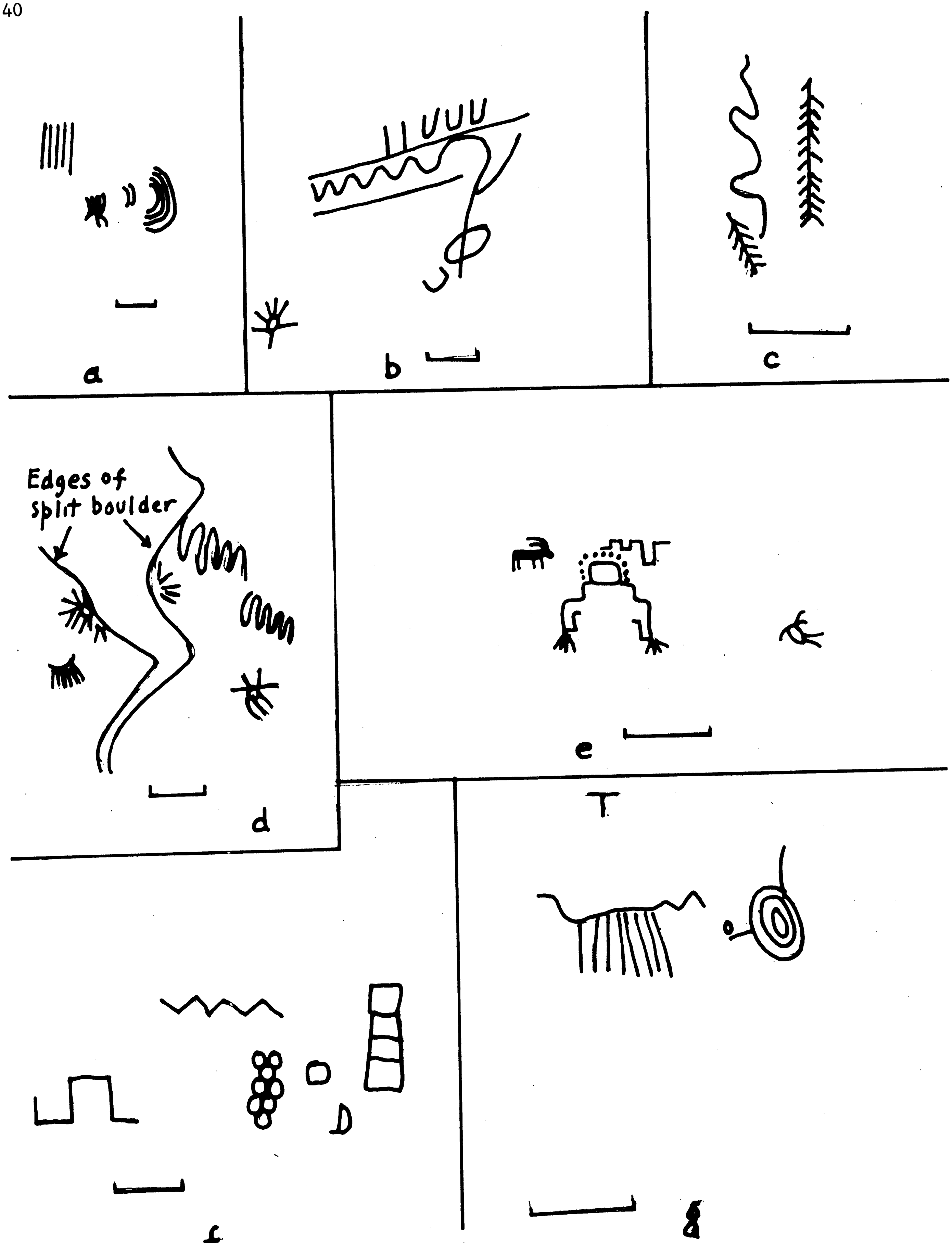


Fig. 8

Fig. 9

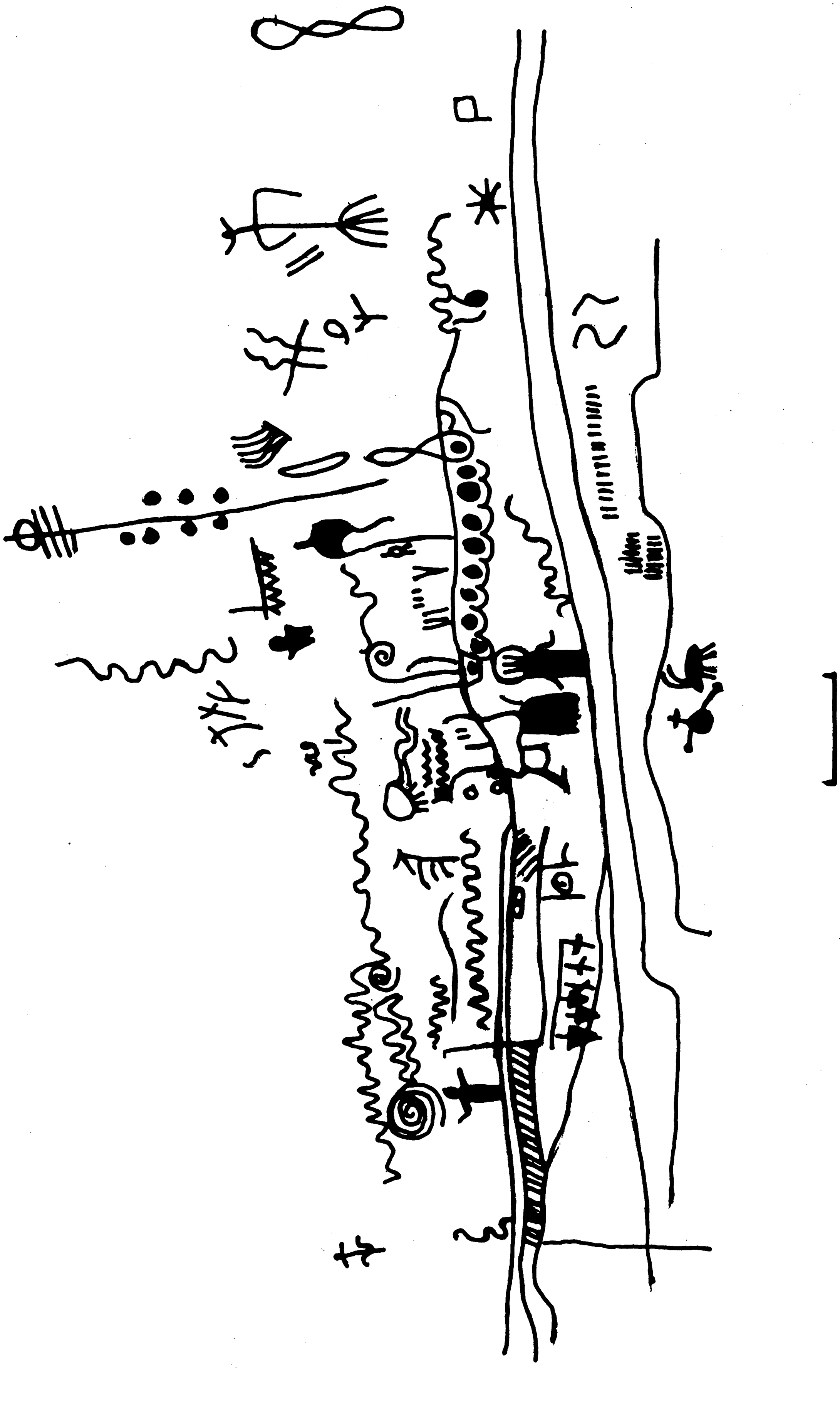


Fig. 10

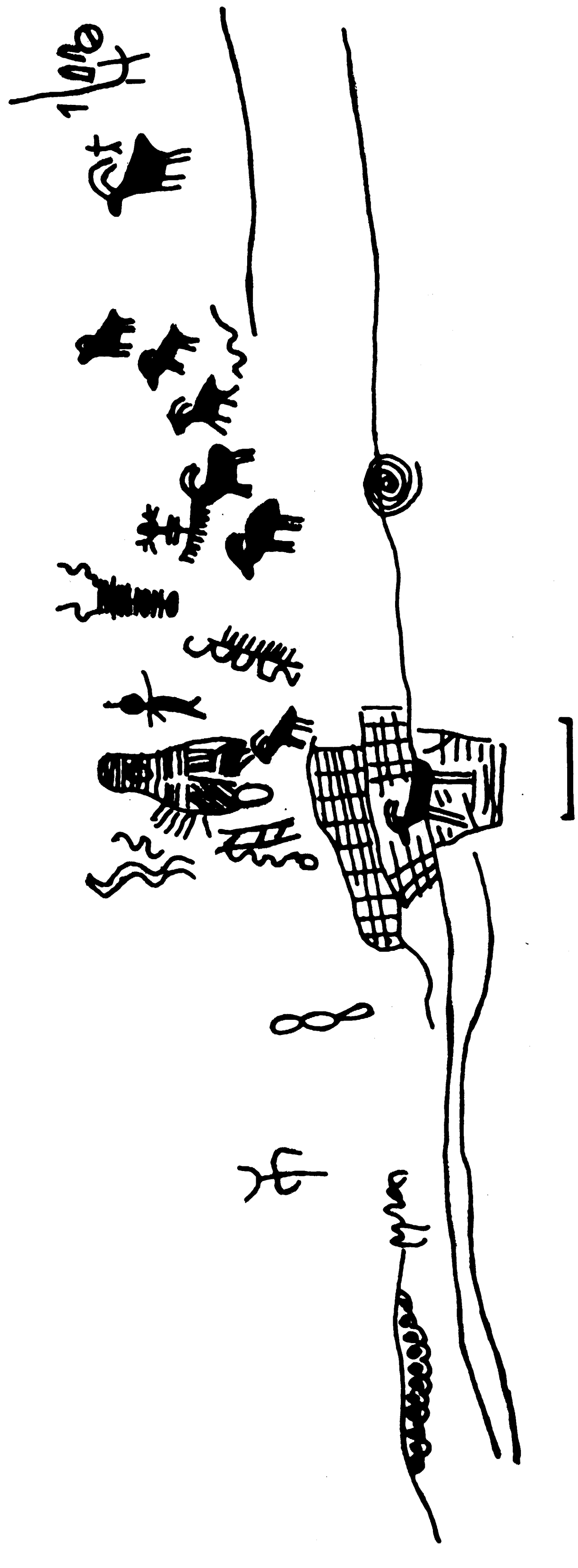


Fig. 11

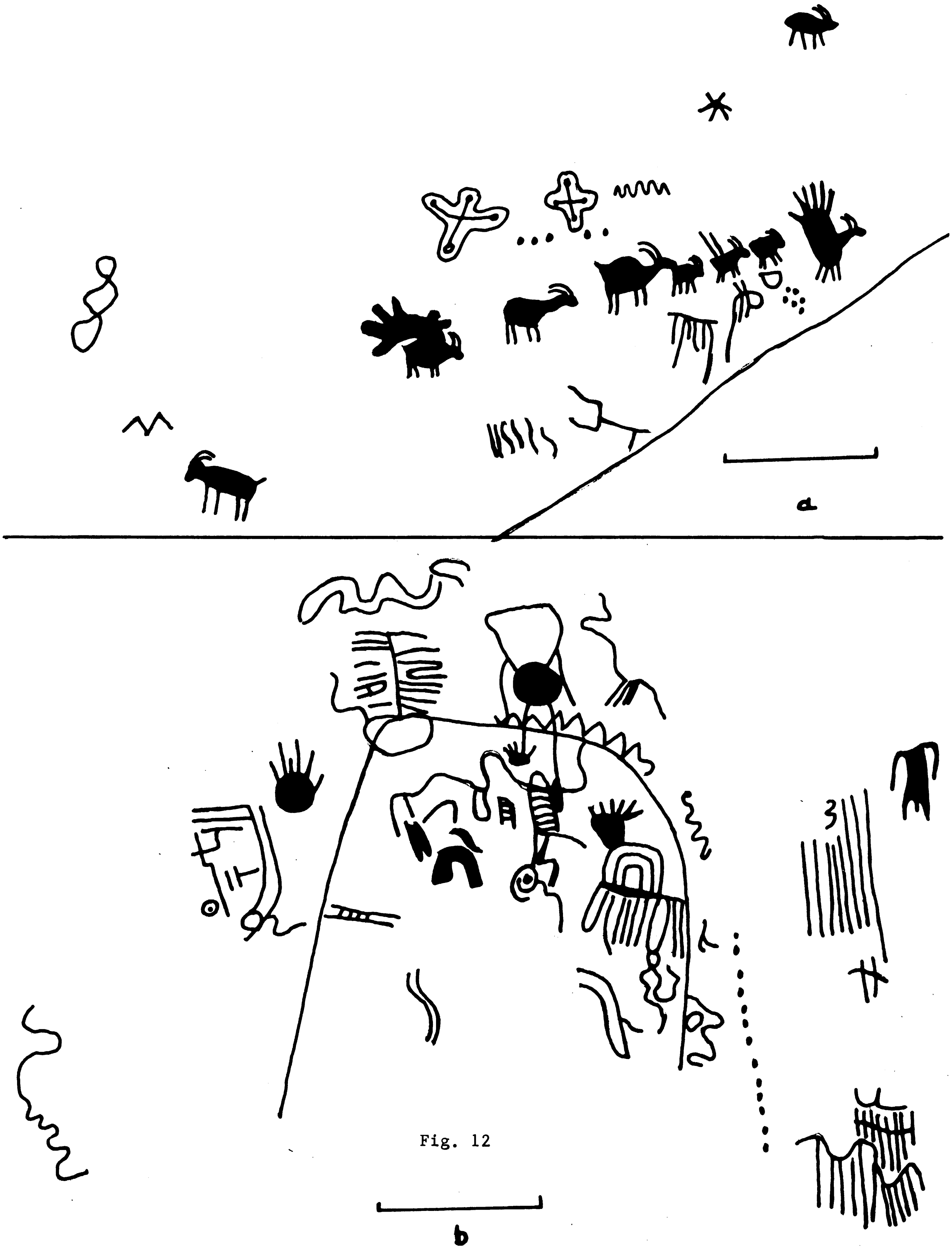


Fig. 12

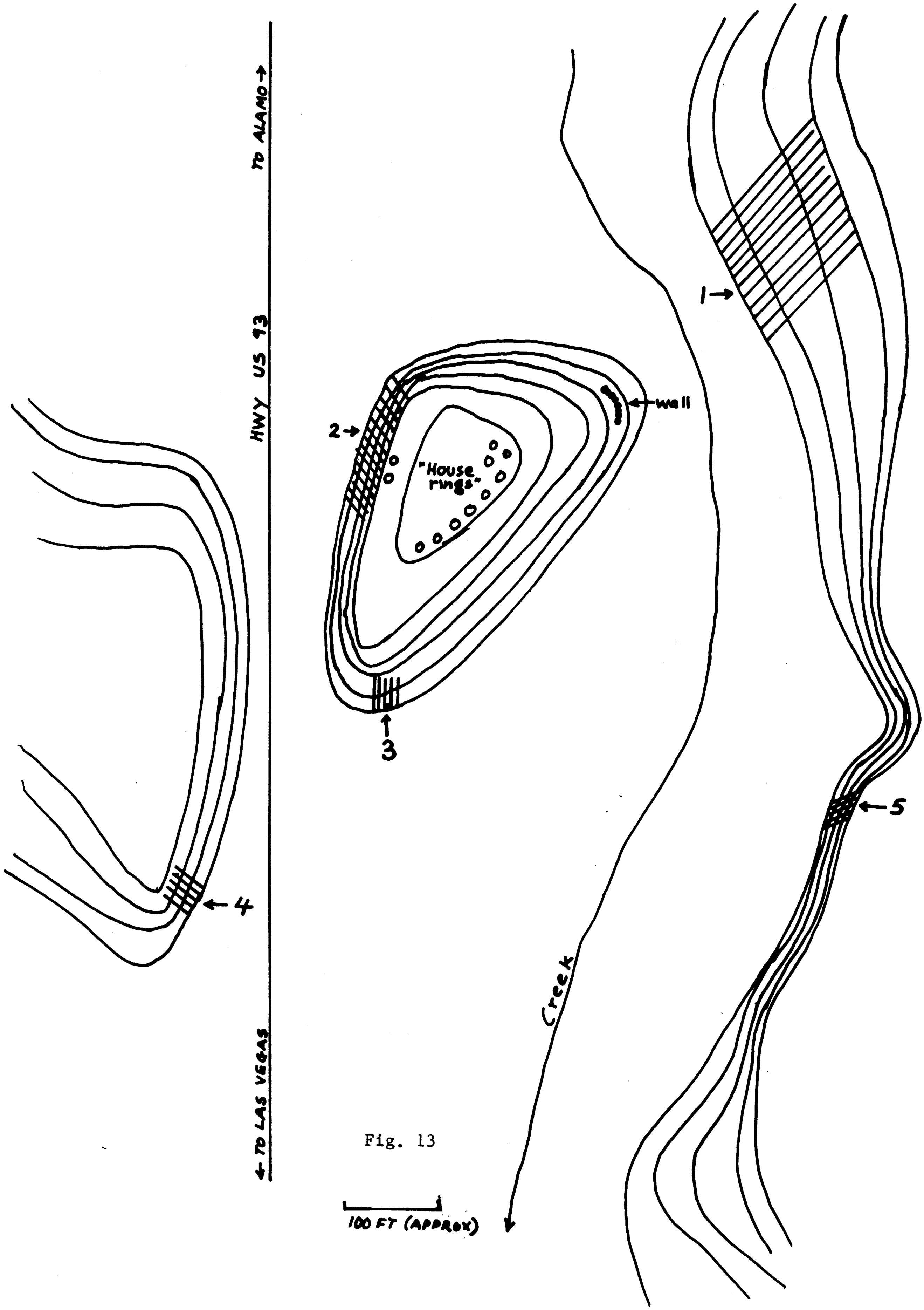

TO ALAMO
HWY US 93
TO LAS VEGAS
1
2
3
4
5
wall
"House rings"
Creek
100 FT (APPROX)

Fig. 13

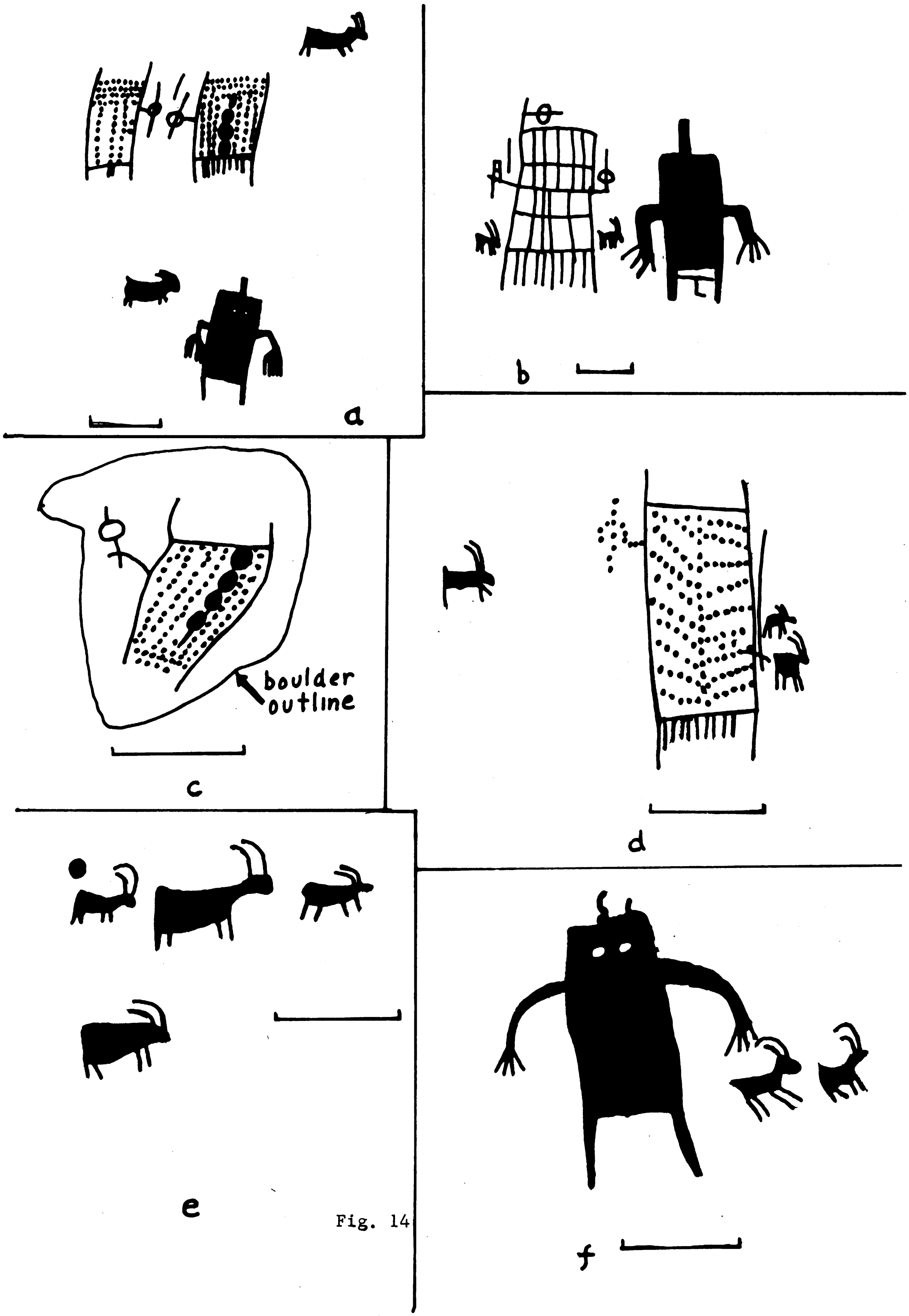


Fig. 14

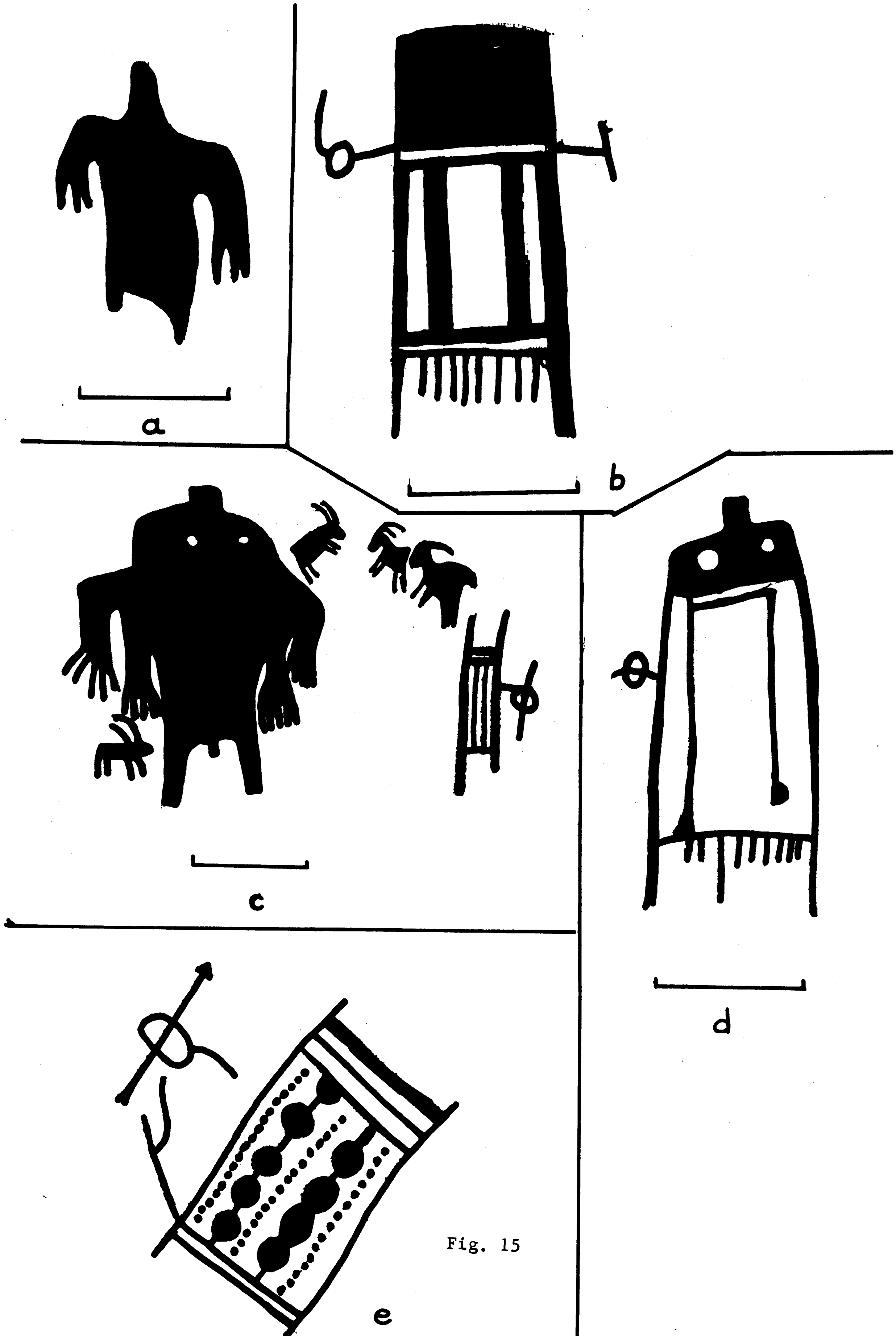


Fig. 15

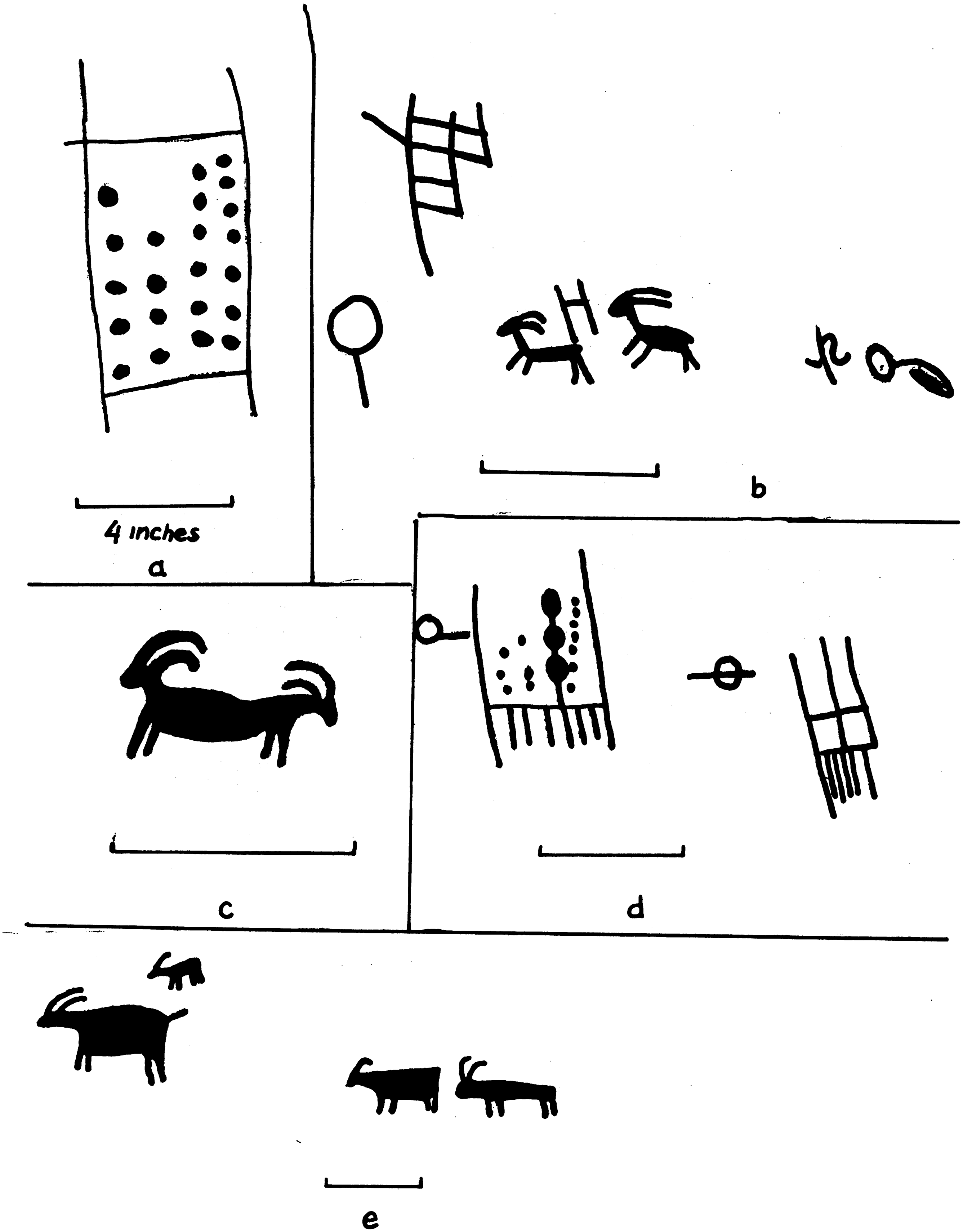


Fig. 16

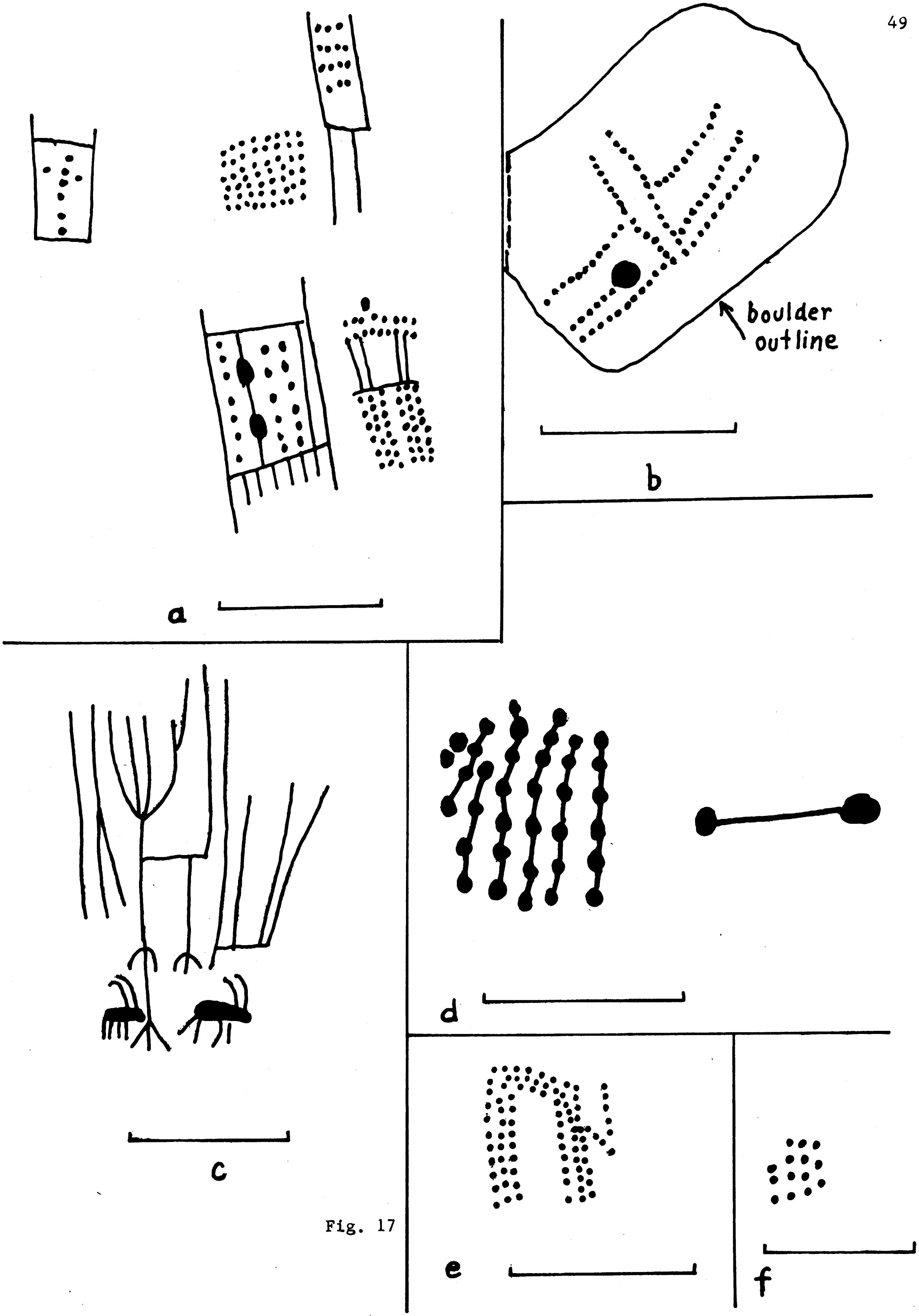


Fig. 17

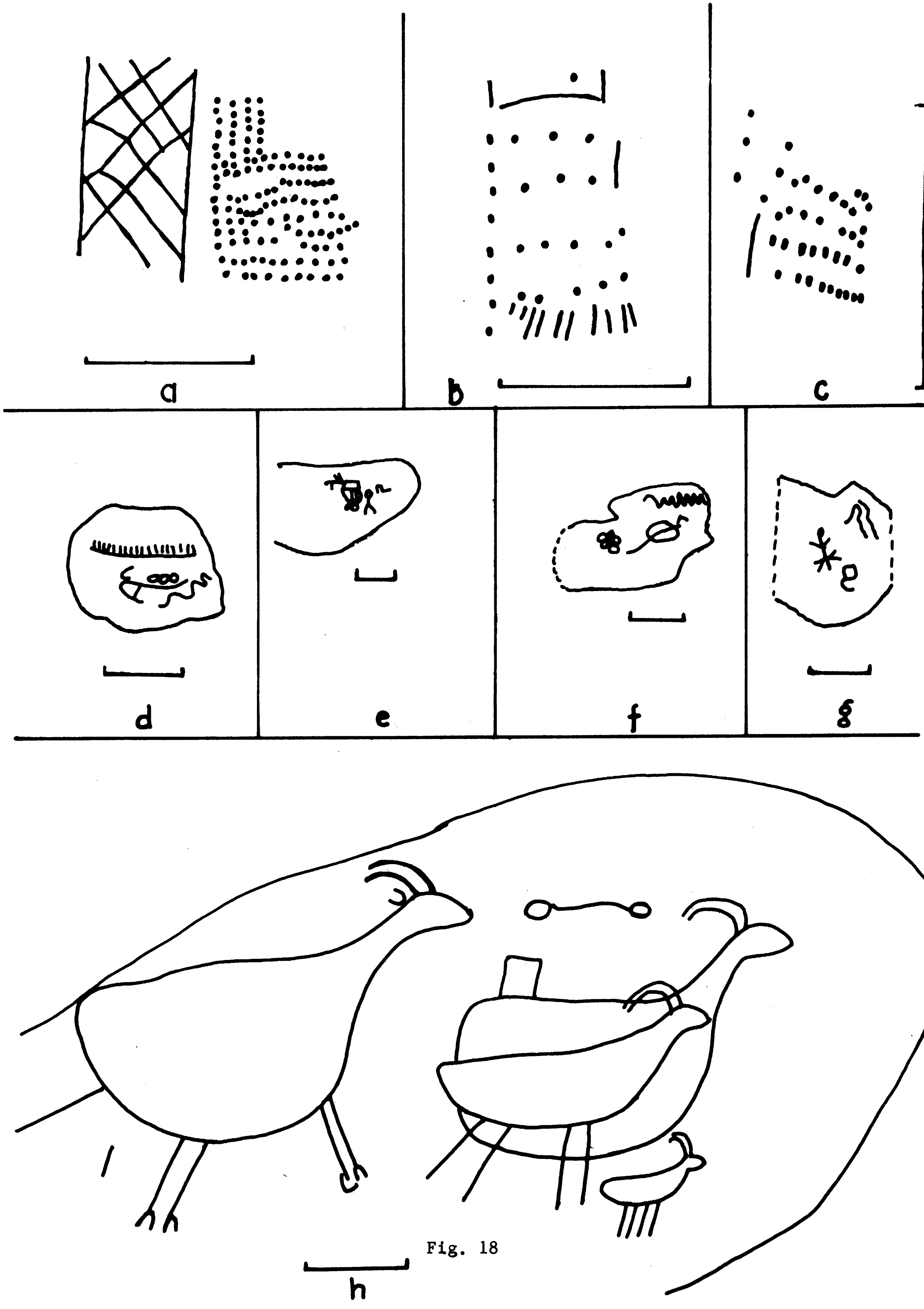


Fig. 18

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THE RECORD OF A HUNTING PRACTICE AT PETROGLYPH SITE NV-LY-1

Karen M. Nissen

At a large petroglyph site on the East Walker River south of the town of Yerington, Nevada an extensive survey was carried out during the summer of 1973. During the course of recording the rock designs, an interesting correlation of two elements was noted. A number of boulders in one area of the site exhibited mountain sheep, either shown in rows or singly, moving into a V-shaped design. It is possible that this design can be linked to an ethnographic practice recorded for numerous Great Basin groups (Angel 1881; Gilmore 1953; Hopkins 1883; Muir 1913; Steward 1933, 1938, 1941; Stewart 1941) as a method of hunting deer, antelope and mountain sheep. Lowie (1923) also described the same hunting method for the Cree and Hudson Bay groups in hunting buffalo. Brush or stone fences or lines of humans converging to lead into a pit or corral were made to force game driven from behind into the enclosures or pits, or to run at close range past ambushed hunters. The correlation of these two elements has not been seen in other petroglyph records of Great Basin sites (cf. Grant, Baird and Pringle 1968; Heizer and Baumhoff 1962; Heizer and Clewlow 1973; Steward 1929). It may be a unique petroglyph style feature of the prehistoric band occupying this valley (the band present when ethnographers visited the area was the Tö̆vusidö̆-kadö̆, "grass nut eaters"), or it may be that the V design was not observed in the carvings found at other petroglyph sites.

NV-Ly-1 is located at a sharp bend to the west of the East Walker River (see photos 1a-b and map of the site). A floodplain stretches from the river on the west to a basalt ridge which is literally covered with petroglyphs. The west slope of the ridge is quite steep and is strewn with a rough talus of boulders. The east side of the ridge is a more gradual slope dotted with boulders. To the east of the ridge is a low saddle bordered on the east by the lower hills of the Wassuk Range. At the southern end of the basalt ridge the river cuts steeply against the bank, effectively limiting easy access to or exit from the floodplain to the west of the ridge. The two ends of the saddle are fairly narrow, being approximately 75-100 feet at the north end and 150-200 feet at the south. The saddle itself is about 600 feet long. At the southeast end of the saddle the floodplain with rich riparian vegetation stretches out on the east side of the river. On the west side of the river a fairly steep cliff rises 30-40 feet to the valley floor from the river floodplain. Approximately 1000 feet northwest of the north end of the ridge and across the river are located at least three bedrock mortars. The area has been leveled and plowed for alfalfa fields and a skeet shooting range was put in just to the south of the bedrock mortar area. Apparently the area was once covered with lithic debris, but this was removed in the course of setting up the skeet shooting range.

The major concentrations of petroglyphs are located along the basalt ridge, in the saddle to the east of the ridge, and along the hillside at the northeast and southeast ends of the saddle. A few petroglyphs occur on boulders in the floodplain at the northwestern base of the basalt ridge, and two more are on boulders on the banks across the river to the southwest of the saddle. A series of six stone rings are located along the crest of the basalt ridge. To the south of these along the ridge crude stone walls have been constructed by piling three or more boulders to a height of two to five feet. At least two stone pits were constructed by removing rocks from the talus slope along the east side of the saddle. Over eight hundred boulders with petroglyphs were recorded and mapped at this site. The floodplain, the entire ridge, and large sample areas of the saddle and most of the petroglyphs on the hill at the southeast end of the saddle were recorded. Great Basin Abstract Curvilinear and Rectilinear, Representational and Scratched styles are present and appear mixed throughout the site. Scratched designs are the only definite form of superimposition that is present, and these were principally rectilinear. Only questionable presence of the Pit and Groove style was noted. Many of these seem to be natural pits which appear to have been smoothed and enlarged with abrasion.

The site is not in a pristine state of preservation. One main road and three branches of it cut through the saddle; piles of rocks, some with petroglyphs, have been bulldozed to the sides of the roads. A section corner at the south end of the saddle has boulders, some with petroglyphs, piled into a cairn surrounding the marker. In the late 1920's archaeological work was done at the site but this was never reported; at this time the stone circles were "excavated" and a huge pit near a large boulder covered with petroglyphs at the northwest end of the ridge was blasted open. A small trail leading up to the ridge from the southeast end of the ridge was also apparently cleared at this time; this can be seen in the photo of the ridge (photo 1b). The site was previously reported by Steward (1929) as site Pt. 202 and it may also be the same as his site Pt. 212. Heizer and Baumhoff also briefly visited and reported the site (1962:41-45).

Our work began on the site in the area near the stone circles along the ridge top where a number of mountain sheep petroglyphs were found. These sheep are all represented with a front-on view of the head, often with the ears depicted which is unusual. The bodies of the animals have flat backs with a rounded belly, closely paralleling Grant, Baird and Pringle's (1968:17-24) description of mountain sheep from their Transitional and Late periods in the Coso Range of southeastern California. Sheep heads are often represented, and these are also front-on views. As more sheep were recorded a pattern began to be observed on a number of the boulders. The sheep are often shown in a line moving in one direction across the boulder face (see photos 2a-b and figs. 1-13). It was noticed that the sheep were often moving towards a set of converging lines or a V-like design. The sheep are not always shown moving into the V, but in 13 out of 30 examples where mountain sheep are depicted this correlation of elements is found. The lines of the V are faint, often partially obscured either by lichen growth or patination, and they could be easily overlooked. Neither Steward's photos (1929:plates 57-64) nor the figures and photos in Heizer and Baumhoff (1962:Figs. 82-95, plate 8) show this V element in association with mountain sheep. In some cases the V occurs alone with no sheep but only abstract or sometimes anthropomorphic figures. Other depictions of the V at times have sheep horns within them (10 occurrences). At other times the sheep are the only petroglyphs on the rocks but the configuration of the rock itself often resembles the V in shape with two facets converging to a point with the sheep moving in that direction (11 examples). Another interesting feature of the depictions is the fact that the artists often took the total shape of the boulder into effect when pecking the designs. The converging lines could easily have been placed on one facet of the boulders, yet in a number of instances the point at which the lines actually converge is curved around the rock onto another face of the boulder, perhaps to attempt perspective (see photos 2a-c figs. 2,3,5,6,9-13). At times the design even continues onto adjacent boulders. Upon reviewing the literature on the rock art of California and Nevada it was found that this correlation of bighorn sheep and the V design was a unique one. Although mountain sheep are at times depicted with "fences" (Heizer and Clewlow 1973:fig. 130k) the V element is not otherwise recorded. This may be due to lack of observation of the V or it may be that here there is a unique association of the two elements at this site alone.

The relation of the V with the sheep is significant in the light of Muir's (1913) description of Northern Paiute hunting mountain sheep on nearby Mount Grant, approximately 10 miles east of the NV-Ly-1 petroglyph site. A sketch in the Muir volume (1913:321) shows hunters wearing mountain sheep head disguises crouching on a mountain top. His description of the hunt is as follows (1913:320-322):

> On the top of nearly every one of the Nevada mountains that I have visited, I have found small, nest-like inclosures built of stones, in which, as I afterward learned, one or more Indians would lie in wait while their companions scoured the ridges below, knowing that the alarmed sheep would surely run to the summit, and when they could be made to approach with the wind they were shot at short range.
>
> Still larger bands of Indians used to make extensive hunts upon some dominant mountain much frequented by the sheep, such as Mount Grant on the Wassuck Range to the west of Walker Lake. On some particular spot, favorably suited with reference to the well-known trails of the sheep, they build a high walled corral, with long guiding wings diverging from the gateway; and into this

> inclosure they sometimes succeeded in driving the noble game. Great numbers of Indians were of course required, more, indeed, than they could usually muster, counting in squaws, children and all; they were compelled, therefore, to build rows of dummy hunters out of stones, along the ridge-tops which they wished to prevent the sheep from crossing. And, without discrediting the sagacity of the game, these dummies were found effective; for, with a few live Indians moving about excitedly among them, they could hardly be distinguished at a little distance from men, by any one not in the secret. The whole ridge-top then seemed to be alive with hunters.

A similar type of corral with diverging wings was recorded by Steward (1941: 219) for the Nevada Shoshone in antelope hunting. Sarah Winnemucca (1883:55-57, 171) also describes antelope charming and the use of corrals as well as the stone piles, although she states that the latter were built to deceive the whites. Stewart (1941:366, 367) also notes the use of converging wing fences in antelope and mountain sheep hunting by the Pakwidokado in the area to the east of this petroglyphs site. Gilmore (1953:149) mentions mountain goat drives involving a "Medicine Man" or "Singer" who would direct the hunt among the Nevada Paiute. (Searching the literature on the distribution of mountain goats it appears that he is probably referring to mountain sheep, for mountain goats are restricted to the northern areas of the Rockies according to Gilbert). He describes quarter mile wings serving as a chute which narrowed near the entrance to a corral, and the people would spread out across the mountains to drive the animals toward the winged chute. Gilmore also mentions a round dance being held the day before the drive, which was not mentioned in other accounts of sheep and deer hunts. Lowie (1923:280-282) discusses a similar type of drive and impound used for driving buffalo in the plains by the Cree and near Hudson Bay.

The NV-Ly-1 site at present shows no signs of such a corral structure, but it appears that the idea of driving animals may be represented by the converging lines with the sheep between them in the petroglyphs. The petroglyphs may be a representation of hunting for sheep on Mount Grant, but in studying the site it appears as though the converging lines are more probably related to the petroglyph site itself. Heizer and Baumhoff (1962:43-44) discuss the possibility of the site being used in deer hunting. A fall migration out of the Sierra Nevada with the deer moving up the east side of the river would lead the animals through the saddle past hunters concealed in the stone walled blinds; the animals would be prevented from going around the southern end of the ridge onto the floodplain to the west by the steep cliff formed by the basalt ridge. A spring migration out of the Basin toward the Sierra Nevada would make the site an excellent spot for ambush. The deer moving along the east side of the river could be forced to move onto the floodplain west of the basalt ridge by placing a diversion fence across the northern entry to the saddle. The deer could then be forced toward the bend in the river by hunters hidden near the river. Here the steep cliff could prevent the deer from escaping other than by attempting to swim across the river. Looking at the floodplain from the crest of the ridge by the walls and stone circles it could be described as a V shape curving at the point where the river bends around the ridge. The saddle itself also appears as a V shape from the ridge as the northern end of the saddle is a fairly narrow point between the ridge and the hill at the northeast end where the road now enters the site. It too is a curving V, with the point at which the lines converge being a turn where the dry creekbed to the east enters the saddle. The southern entry to the saddle could also be seen as a V shape, with the river forming a barrier other than to the southeast along the floodplain. If the site is connected with deer hunting the animals could have been dispatched by hunters hiding in the tall grasses and tules near the river and by other hunters hidden in the walls and stone circles at the top of the hill.. An experiment was performed using a 33 pound test bow shooting a 29 inch arrow. From the ridge top near the stone circles the arrows hit about 30 to 50 feet to the west of the ridge on the floodplain, probably with enough force to wound an animal. A combination of the hunters on the ridge plus others below would be effective in dispatching the game. Only a few point fragments and flakes were found at the site. Those that were found were concentrated on the southern end of the ridge. Across the river from the south end of the ridge numerous chert and obsidian flakes and point fragments were found. The petroglyph site itself appears to have been cleared of all but the most hidden fragments of lithic remains by the recent visitors to the site. Trace element analysis of the obsidian showed there to be two and possibly three types of obsidian present at the site. One source has been definitely traced to the Bodie area, but the other type's source has not yet been identified (R. Berger personal communication). The saddle itself is nearly devoid of lithic debris, and this may be due to the actions of collectors. However, an arrow shot from the ridge near the circles was found to be powerful enough to reach the saddle but not with enough force to harm an animal to any degree. If hunters were also hidden in the two rings on the east side of the saddle as well as in the dry creekbed which runs into the north end of the saddle, the deer would probably attempt to flee by running up both hills and could then be killed by the hidden archers.

If mountain sheep were being hunted the situation would probably be slightly different. If the animals were to the west of the ridge on the floodplain and forced to the point where the river cuts against the sharp cliff of the ridge they would probably run up the steep talus slope at the southwest end of the ridge. Hunters hidden here behind the walls and in the rings as well as others hidden in the saddle and hills to the east could probably kill quite a few of the fleeing sheep. If the sheep were entering through the saddle it would present a different problem. The sheep could easily escape the hunters unless a barrier was created along the east side of the saddle. Either hunters or "stone men" could have been stationed here to force the animals to flee to the steeper slopes at the northern or southern ends of the saddle. If the southern end of the saddle was blocked off the sheep would attempt to escape up the steep slope to the east where scattered petroglyphs were found and recorded. Formerly there was a large population of mountain sheep in the Wassuk Range, and these sheep would winter near the water and lush vegetation of the river's floodplain. According to Muir, herds of fifty or more mountain sheep were observed by him during the winter months. If such herds did exist in the area they would have provided a source of food for the band living in the valley during the winter months when other types of food were scarce. At present no mountain sheep are known to visit the valley, but R. Alcorn, Department of Fish and Wildlife, Fallon, Nevada, told me that mountain sheep were being hunted in the Wassuk Range in the 1930's, and a herd is said to still exist in the area (Buechner 1960:Table 9).

The relation of the site to deer hunting is unclear. The deer in the area at the present seem to migrate only within the valley. Deer herds formerly migrated through this area from the Sierra Nevada. Hagerty (1969) conducted an archaeological study of the Pine Nut Mountains, which is the range of hills bordering the western side of the valley in which the site is located. His discussion is relevant: "A stone hunting blind complex has been found by tracing migratory deer movements from the Sierra Nevada into the Pine Nut Mountains." One site he studied in the eastern part of Douglas County (1970) has a hunting blind and two pits in a talus slope overlooking a saddle where the blind is located. The site is on a game trail above a spring and appears to be similar to the NV-Ly-1 site in some aspects. However, searches of the rock cliffs by Hagerty failed to yield traces of petroglyphs. The effects of ranch fences, roads and other factors have disturbed the migration patterns of the sheep and deer, and overkill by whites and Indians has eliminated the once great herds of antelope. Buechner (1960:20) noted a drastic reduction of bighorn sheep in the United States from an estimated 1.5 million in 1850 to approximately 15,000 by 1900. Under his discussion of the impact of the white man upon these numbers he says (Buechner 1960:16): "The unnatural decline of the bighorn sheep during the last fifty years of the nineteenth century resulted from several factors, two or more of which often interacted to effect specific reductions. Among these factors were excessive hunting, a disease known as scabies, competition from livestock, and restriction of winter range from various causes." He also notes that bighorn sheep may have been as numerous or more abundant than deer in some areas due to their adaptation to arid mountain habitats. The lack of knowledge of petroglyphs by Northern Paiute may be due to the swift destruction of large herds of game in the area by disease, overkill, and grazing by domestic sheep, horse and cattle. The few remaining animals would most productively be hunted singly by the lone hunters who survived the white onslaught. Petroglyph making may be related only to hunting of large herds of animals, either deer, antelope, or mountain sheep, when communal hunts could effectively be organized against large herds in winter grazing areas or along migration routes. With the reduction of the large herds such communal hunts would no longer be practicable, and only lone hunters would stalk the few remaining animals which were no longer able to follow the old migration routes. Sherman Lewis, who was raised in the Aurora area, reported to me that as a boy he saw antelope in the valleys and that there was an Indian-built antelope corral south of the NV-Ly-1 petroglyph site.

If deer and antelope were being hunted at the NV-Ly-1 site, it is difficult to explain the rarity of depictions of these animals. One clear pecked deer was depicted with mountain sheep below it on the same boulder (fig.7). The only other indications of deer at the site are what might be two deer pelts with the antlers attached pecked on two boulders near the stone rings (see Heizer and Baumhoff 1962:figs. 93b, e). Perhaps some of the abstract designs were used to represent deer and antelope rather than naturalistic depictions. Grant, Baird and Pringle (1968) have discussed the idea of a "sheep cult" which developed in the Coso Range area of eastern California and spread into the Great Basin with the Shoshonean migrations out of eastern California. Linguistic data indicate that such a migration occurred within the last millenia, bringing the Paiute and Shoshone into the Great Basin (Lamb 1958). At the same time the Representational style of petroglyphs may have been introduced to the area with the "sheep cult". The similarities in the sheep between the East Walker site and those of the Coso Range are striking. Perhaps the representational art was found to be ineffective in deer and antelope hunting.

At the NV-Ly-1 site the correlation between mountain sheep and the V element has been identified in thirteen instances. Muir's account of either the Pakwi or Tovusi hunting mountain sheep on Mount Grant at the turn of the century supports the idea of mountain sheep drives in the area. Curtis (1926, vol 15:71) recorded that the Paviotso used drives in hunting deer; he states: "Both deer and mountain sheep were driven between very long wings paralleling a game trail, and so into a corral." Stewart's (1941) data on deer, antelope and mountain sheep hunting for these groups is confusing. It seems that some of the data listed by him for the Pakwi should also be applied to the Tovusi who inhabited the area where the petroglyph site is located. That is, the hunting of mountain sheep on Mount Grant could have been either by the Tovusi or the Pakwi as this area appears to be on the border between the two bands. Steward (1941:221) shows an antelope corral used by the Ruby Valley Shoshone with brush converging wings leading to a circular enclosure. His discussion of antelope hunting also records the use of converging brush wings by the Shoshone of Reese River (1941:329). Here a corral of mountain mahongany with wing fences near a spring was used in hunting mountain sheep. Angel, in his History of Nevada, describes a method used in hunting deer which differs slightly from the wing fence and corral structures described in the antelope hunts. The following passage is from the section on the History of White Pine County, Nevada (Angel 1881:649): "Deer are more numerous in the mountains than when the county was first settled. In the month of May they migrate northward, and return southward in October, by regular trails. It was formerly the custom of the Indians to build long brush fences across these trails, in the shape of a letter V, thus forming a corral into which the deer collected, to be slaughtered there by hundreds. Since the Indians have become supplied with firearms, they do their deer slaying in detail, and no longer by wholesale operations; and, as a consequence, that animal is now more numerous than formerly." Thus, it appears that the impact of white technology also greatly altered the native methods of deer hunting. The early introduction of the rifle appears to have seriously changed the hunting patterns, and this may also be the reason for the apparent lack of knowledge of petroglyphs by the Great Basin groups who were interviewed by the ethnographers in the 1930's.

The connection of the converging wing fences and deer, antelope and mountain sheep hunting in the Great Basin exist. Whether the sheep moving into the V element noted at the NV-Ly-1 site represents the hunting of these animals at the petroglyph site or in the Mount Grant area where such a practice was described by Muir is unclear. However, the presence of the stone rings along the ridge and the pits to the east of the saddle as well as the stone walls seem to indicate that hunting occurred at the petroglyph site itself. The function of petroglyphs to the hunting of game is still unclear; they seem to be connected with a desire for success in the hunt, but they could also be purely historical records of hunts. However, only one of the sheep at the NV-Ly-1 site appears to be wounded (see fig. 12), and these appear to be scratches applied later to the sheep. It seems logical to assume that the petroglyphs represent a sort of "wishful thinking" which would correspond with ethnographic references to charming game by various hunt shamans. The hunting connection of this particular petroglyph site then seems to support Heizer and Baumhoff's suggestion of petroglyphs used in hunting magic. Admittedly, the evidence for this is derived from a small number of the total petroglyph elements at the NV-Ly-1 site and the elements discussed are only two of the elements in one of the styles (Representational). Perhaps the abstract designs are not related to hunting magic, but their location in conjunction with the Representational style and the hunting blinds seems to also infer a connection with hunting. This analysis is a small part of a larger study which has been conducted on this site and five others in the Carson sink and Bishop areas. The outcome of this larger analysis may well show many more correlations between elements within sites, and perhaps between different areas.

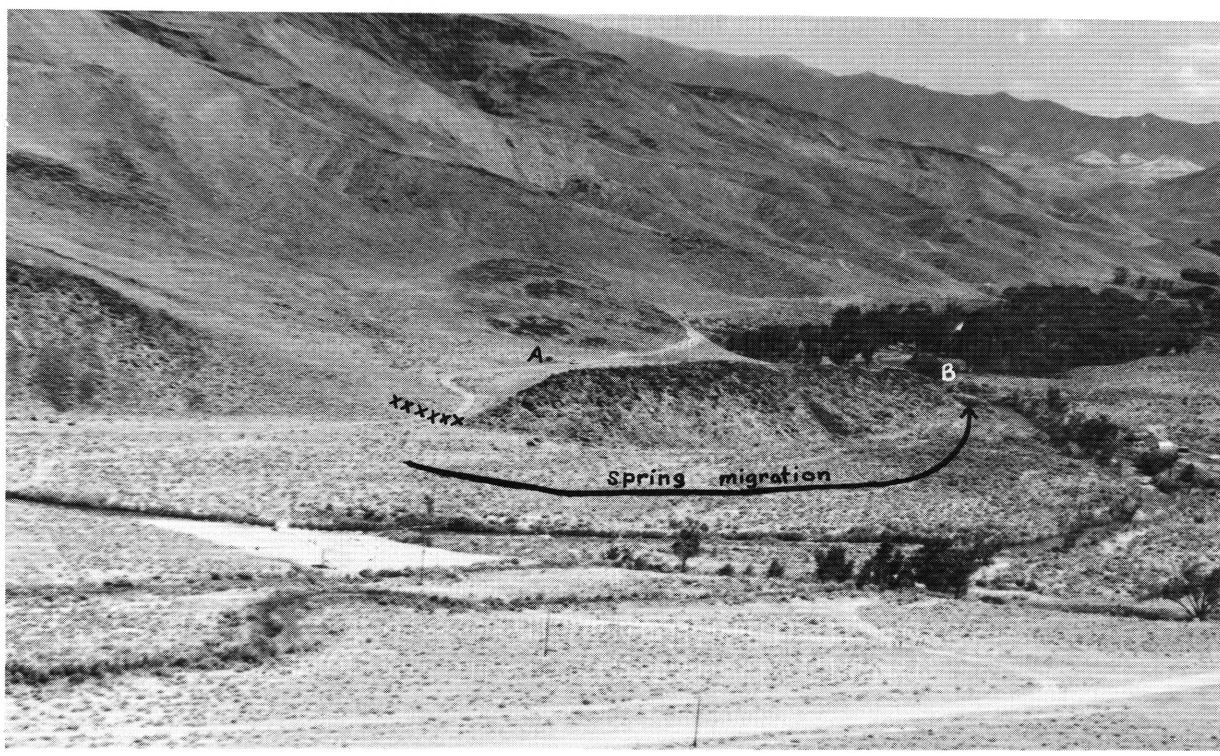
Student volunteers E. Blinman, R. Fleming, S. Grazianni, B. Hakim, T. Halligan, B. Park and D. Shimamura aided in the recording of the NV-Ly-1 petroglyphs.

PLATES

PLATE 1

a. View of site NV-Ly-1 looking southeast. Points A and B are reference points for orientation of the reader. The x's mark the line of a possible diversion fence. The stone circles and walls occur along the central and southern parts of the ridge between points A and B; the two circles to the east of the saddle occur in the talus slope above point A.

b. View of site NV-Ly-1 looking northwest. Points A and B are the same points indicated in Pl. 1a. The x's mark possible diversion fences at the northern and northeastern ends of the saddle. The white arrows point to the location of the stone circles and walls along the ridge and eastern slope of the saddle.



a

b

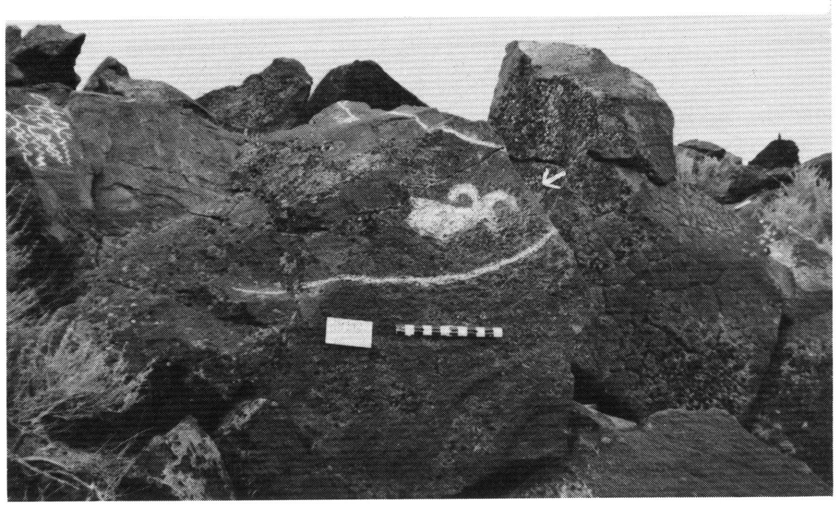
a. Boulder 23, grid unit NO W100, view SW (see fig. 6).

b. Boulder 23, grid unit NO W100, view SE (see fig. 6).

c. Boulder 23, grid unit NO W100, view NE (see fig. 6).

The arrow in the photographs points to the same edge of the boulder for orientation of the reader.

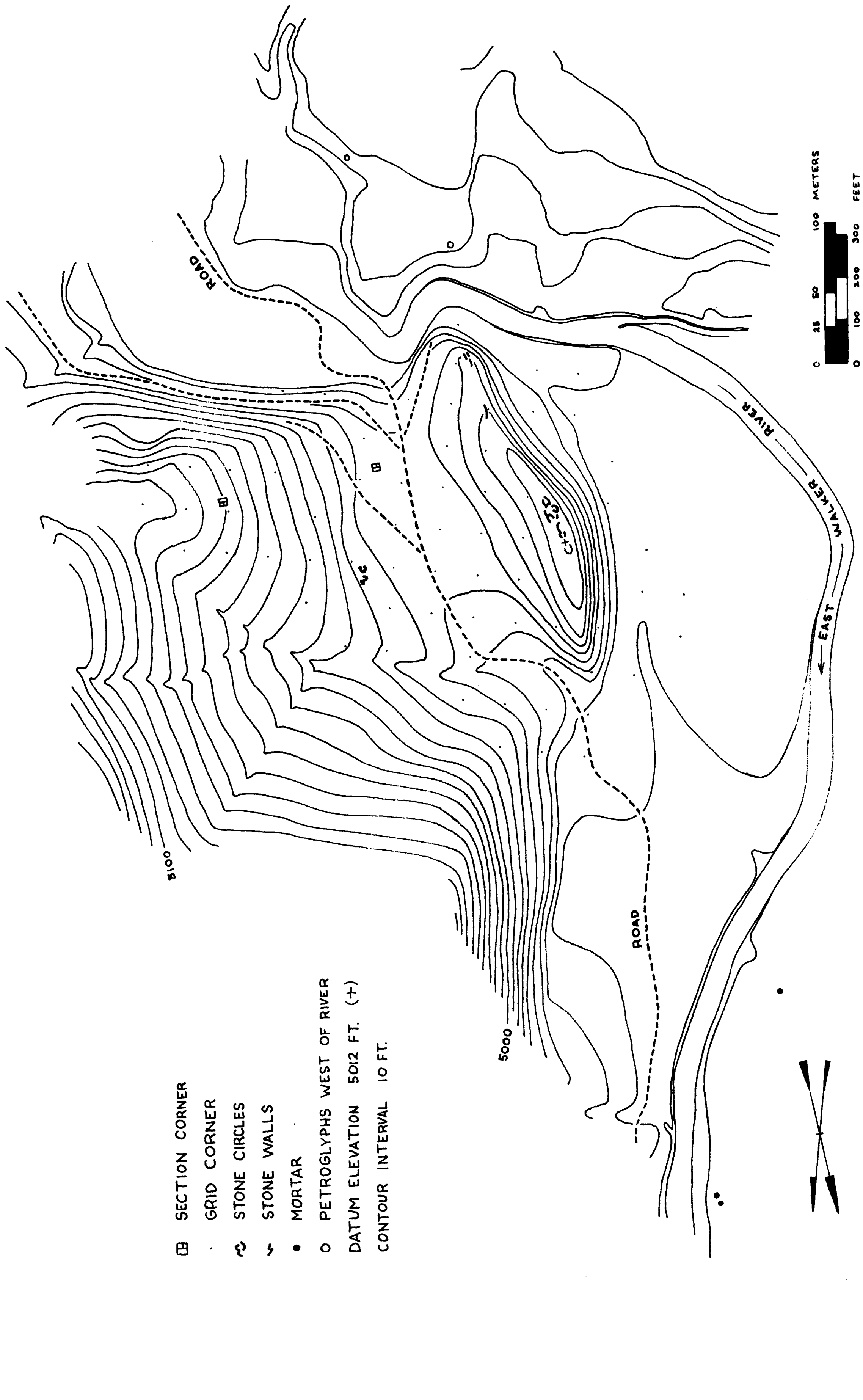
a



b

c

Plate 2


NV-LY-I
SECTION CORNER
GRID CORNER
STONE CIRCLES
STONE WALLS
MORTAR
PETROGLYPHS WEST OF RIVER
DATUM ELEVATION 5012 FT. (+)
CONTOUR INTERVAL 10 FT.
0 25 50 100 METERS
0 100 200 300 FEET
EAST WALKER RIVER
ROAD
ROAD
5100
5000

EXPLANATION OF FIGURES

Figures 1-18 were made from photographs of the boulders. Edges of the boulders are indicated by the thin ink lines. Figures 1, 3, 4, 7, 8, 14, 16, and 17 show the boulder outlines. The petroglyphs in the other figures covered several faces of the boulders so interpretive drawings were made, viewing the boulders as flat surfaces. Plate 2a-c shows the boulder from which figure 6 was drawn. The scale in the drawings indicates one foot. The coordinates in the figure descriptions indicate the grid units in which the boulder are located, using the southwest corner as the reference point.

Fig. 1: S100 E0 Boulder 48. A large mountain sheep moving toward converging lines. This boulder occurs among the stone circles. The curvilinear geometric figures which occur with the converging lines and the sheep may provide links to still other associations. All of the elements appear to have been pecked at the same time (based on patination), thus indicating contemporaneity of these curvilinear and representational designs.

Fig. 2: S100 E0 Boulder 48. This design was found on the other side of the boulder on which Fig. 1 is placed. This face of the boulder was badly eroded; presumably the V design originally continued across the top and bottom. The end of the V continues on to another face of the rock, and this edge is indicated by the thin line. Again, curvilinear elements occur with the representational designs.

Fig. 3: S100 E0 Boulder 51. This boulder occurs just to the west of boulder 48. The sheep and the V are again depicted, with the end of the V curving down to another face of the boulder. A human figure occurs with the sheep as well as a wavy lined rake element and another wavy line which is possibly a snake element. The boulder is badly eroded and also has lichen covering parts of it.

Fig. 4: S100 E0 Boulder 89. Mountain sheep moving within the converging lines. The lines do not actually converge to a point, but they move toward the point where the two angles of the boulder come to a point on the left. The sheep's legs are not clearly visible, possibly due to heavy erosion and patination of the rock surface.

Fig. 5: S100 E0 Boulder 36. The bodies of the sheep appear to be without legs other than stumps; this may again be due to the erosion of the rock surface. The end of the V curves around onto another face of the boulder. A wavy line occurs below the sheep.

Fig. 6: N0 W100 Boulder 23. A single sheep moving toward the converging lines. This is an interpretive illustration; when the petroglyph is seen on

the rock it appears to be oriented differently, giving the appearance that the end of the V curves down. It suggests that the persons making the petroglyphs took the shape of the rock into effect. Lichen and erosion of the boulder surface obscure parts of the design, and it is possible that other elements are represented in the areas covered by the lichen.

Fig. 7: N100 W100 Boulder 14. A unique boulder picturing both deer and mountain sheep. The deer is quite accurately portrayed with its forked antlers and ears depicted. It is moving toward the end of the boulder into a V shape represented by the top of the rock face and the pecked line below. It is associated with a tailed circle and irregular pecked dots. Below the deer and separated from it by the pecked line are seven mountain sheep which move toward a V which is formed by the facet to the left and the pecked line above. The mountain sheep appear crude in comparison to the deer except for the sheep head at the bottom. However, the sheep appear to be more worn and eroded, and lichen and scaling of the rock surface may account for this difference. The sheep and deer may be attributable to different artists.

Fig. 8: S400 E200 Boulder 30. Here a stylized sheep occurs on one face while many other geometric designs occur on other faces of the rock. On the right of the boulder a line is pecked and meets with the bottom face of the boulder to form a V. The legs of the sheep seem to be conventionalized, but this may be due to erosion.

Fig. 9: S400 E200 Boulder 14. This illustration is of a very complex boulder which has petroglyphs covering all faces of the boulder. The rock is very eroded and covered with a great deal of lichen; the sheep at the center of the bottom most likely has a head which is covered by the lichen. Other designs may also be obscured by the lichen. At least three V elements are represented, and one has the same cruving end seen in fig. 5. It is probable that all of the elements other than the Vs and the cross are sheep, but the poor condition of the boulder makes this unclear. It is also unclear if all of the sheep had legs represented or not. This view is an interpretive illustration of the boulder from the top as though the rock was flattened out.

Fig. 10: S400 E200 Boulder 59. Here the sheep and V again cover three faces of the boulder. Many of the sheep appear to be highly conventionalized, but again this may be due to erosion and lichen. A peculiar double headed sheep is represented to the right, but this may actually be two sheep, one behind the other. The V shape curves down in front of the line of sheep, and a U-shaped element occurs below which is similar to that seen in fig. 2.

Fig. 11: S400 E200 Boulder 57. The sheep and line in this petroglyph are carved on four faces of the boulder. Three of the sheep are represented with ears while the sheep to the left appear to be conventionalized, especially the one with the long horns. Again the boulder is eroded and has lichen on

it. The line above the sheep moves to the right and is ended with the line of dots. The base line of the boulder face curves up to meet the dots, in effect conveying a blunt V shape to the person looking at the rock.

Fig. 12: S400 E200 Boulder 90. Two mountain sheep moving toward a set of converging lines which appear on the opposite face of the boulder from the sheep. The lines may have been longer, but the boulder has scaled off near the lines and this may have "erased" part of the design. The three lines in the back of the upper sheep appear to have been added at a later date based on differential patination. The geometric designs again appear in association with the representational ones. The connected circles also appear in fig. 2.

Fig. 13: S400 E200 Boulder 86. The three sheep in this drawing are on one face of the boulder, the converging lines and tailed circle occurring on another face of the boulder. The point where the lines end is the bottom of the rock face.

Fig. 14: S400 E200 Boulder 85. Converging lines with a figure which may be a stylized sheep between them. The rock surface was not badly eroded or covered with lichen. It is similar to fig. 18.

Fig. 15: NO W100 Boulder 3. The V shape in this representation has a series of irregularly pecked dots within and outside the lines. It is similar to fig. 10 in having the dots above and below the lines. Whether the dots represent tracks, abstract sheep or something else cannot be determined.

Fig. 16: S300 E200 Boulder 17. Sheep head, probable stylized sheep and the V shape above them.

Fig. 17: S300 E200 Boulder 9. Sheep head with the V element below it.

Fig. 18: S400 E200 Boulder 47. The converging lines here have a non-representational figure between them. This may be a representation of sheep horns or possibly a stylized sheep.

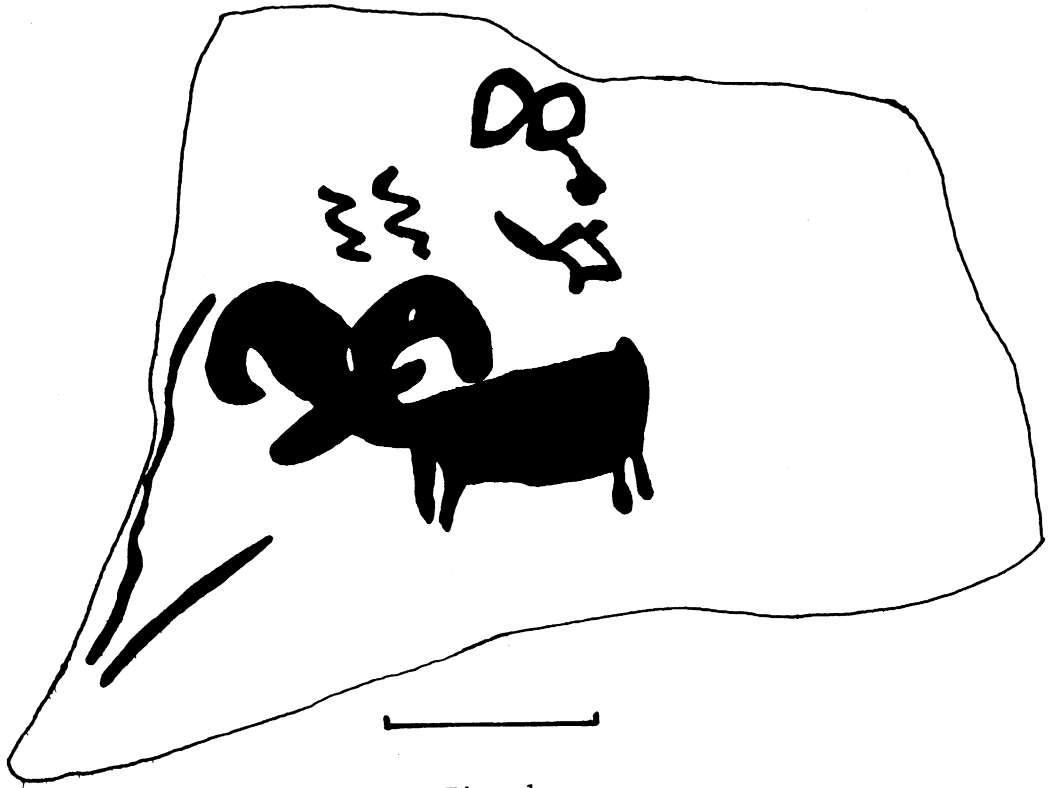


Fig. 1

Fig. 2

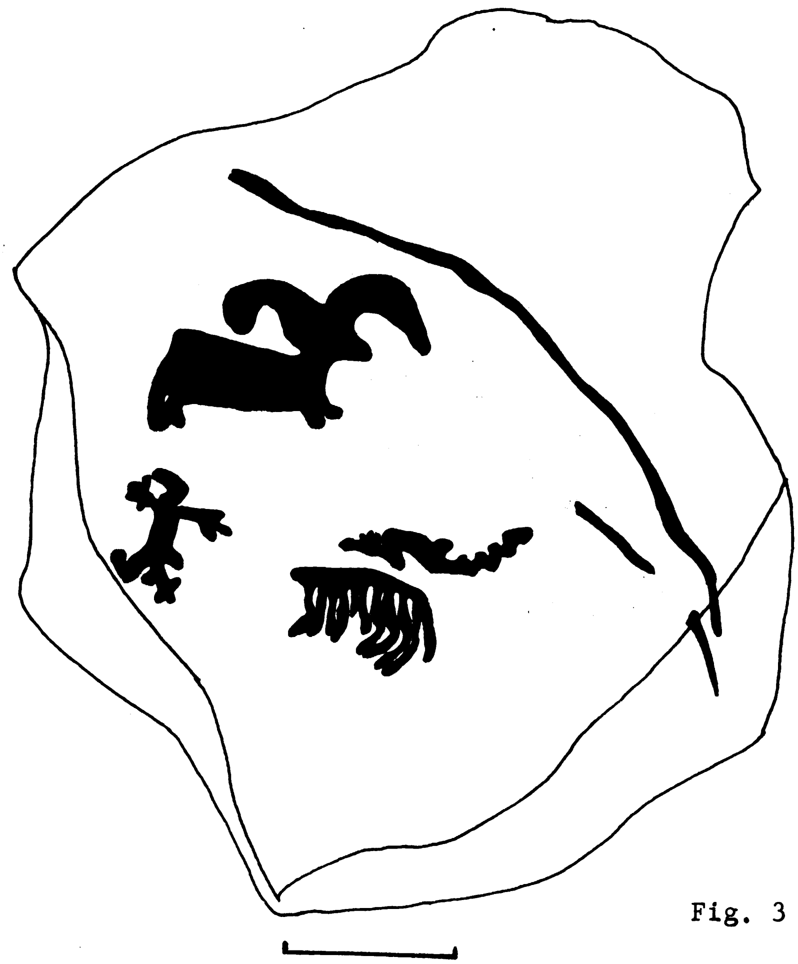


Fig. 3

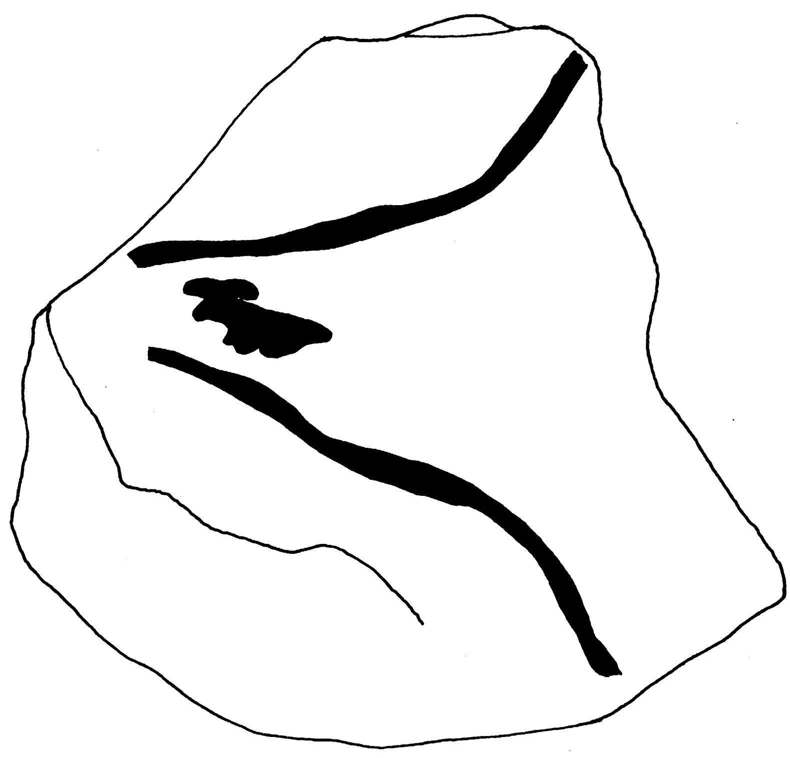


Fig. 4

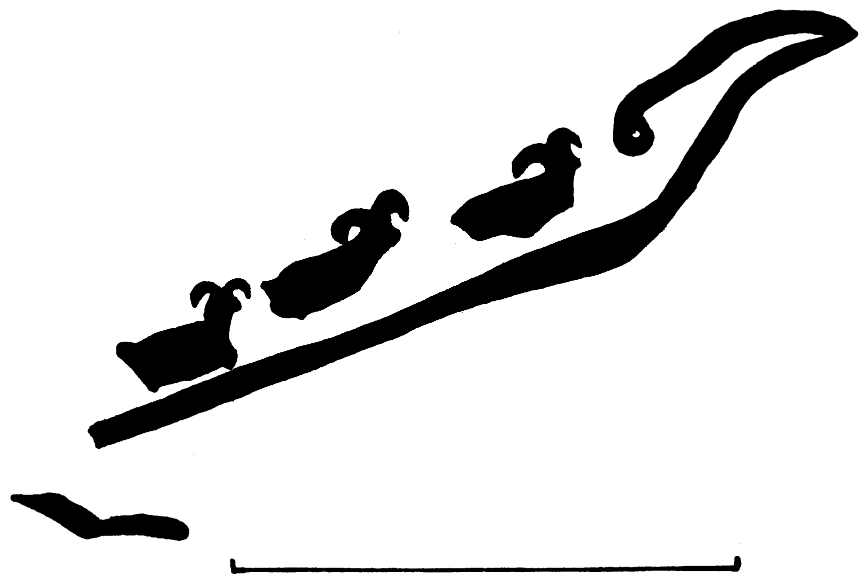


Fig. 5

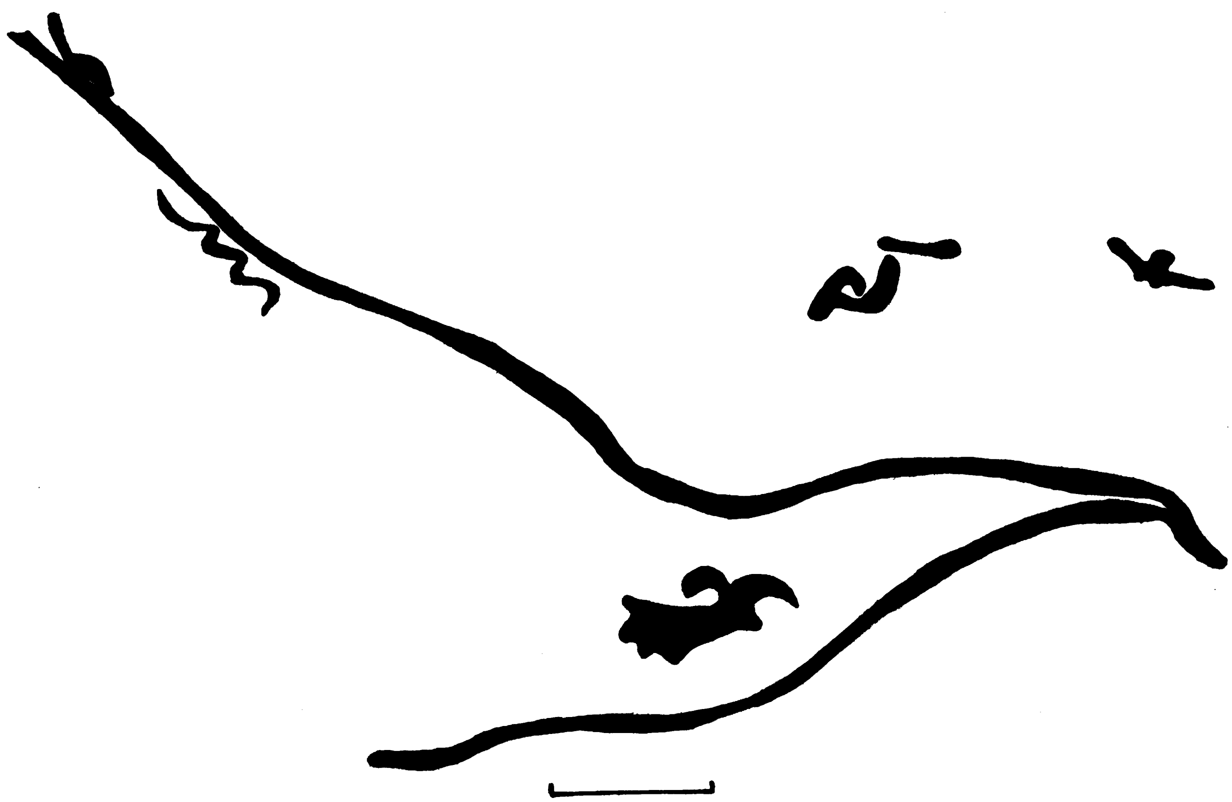


Fig. 6

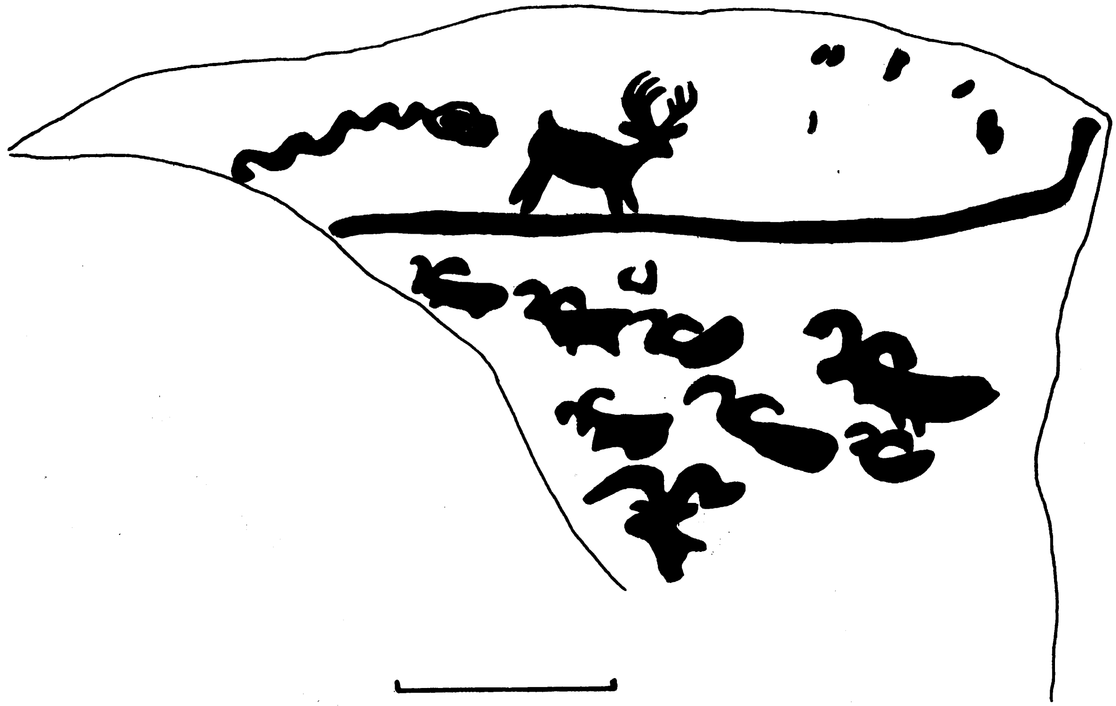


Fig. 7

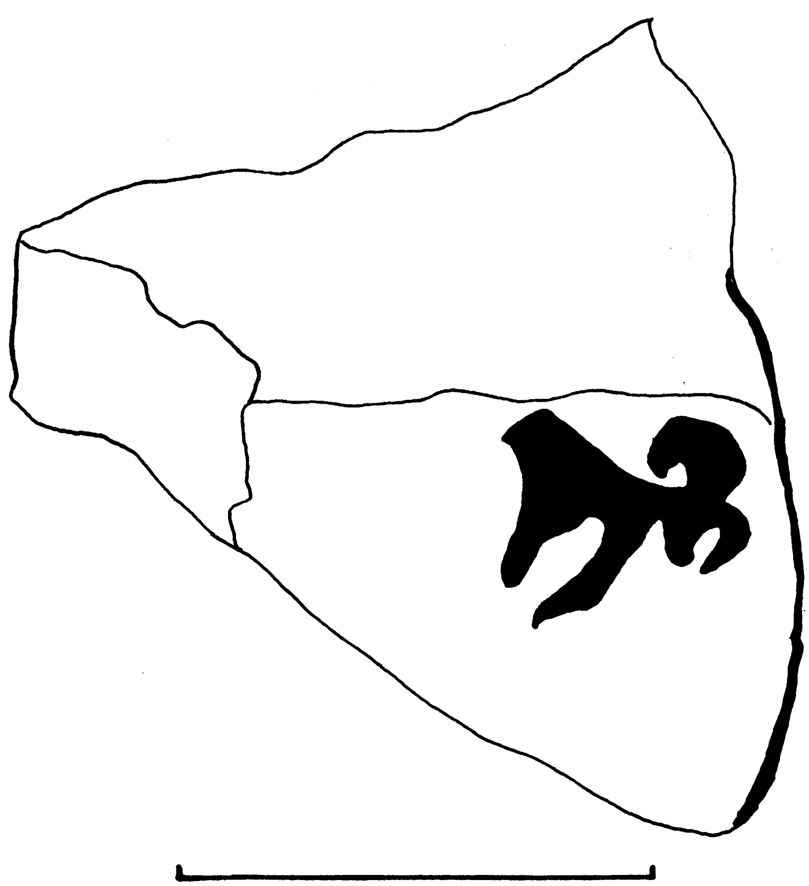


Fig. 8

Fig. 9

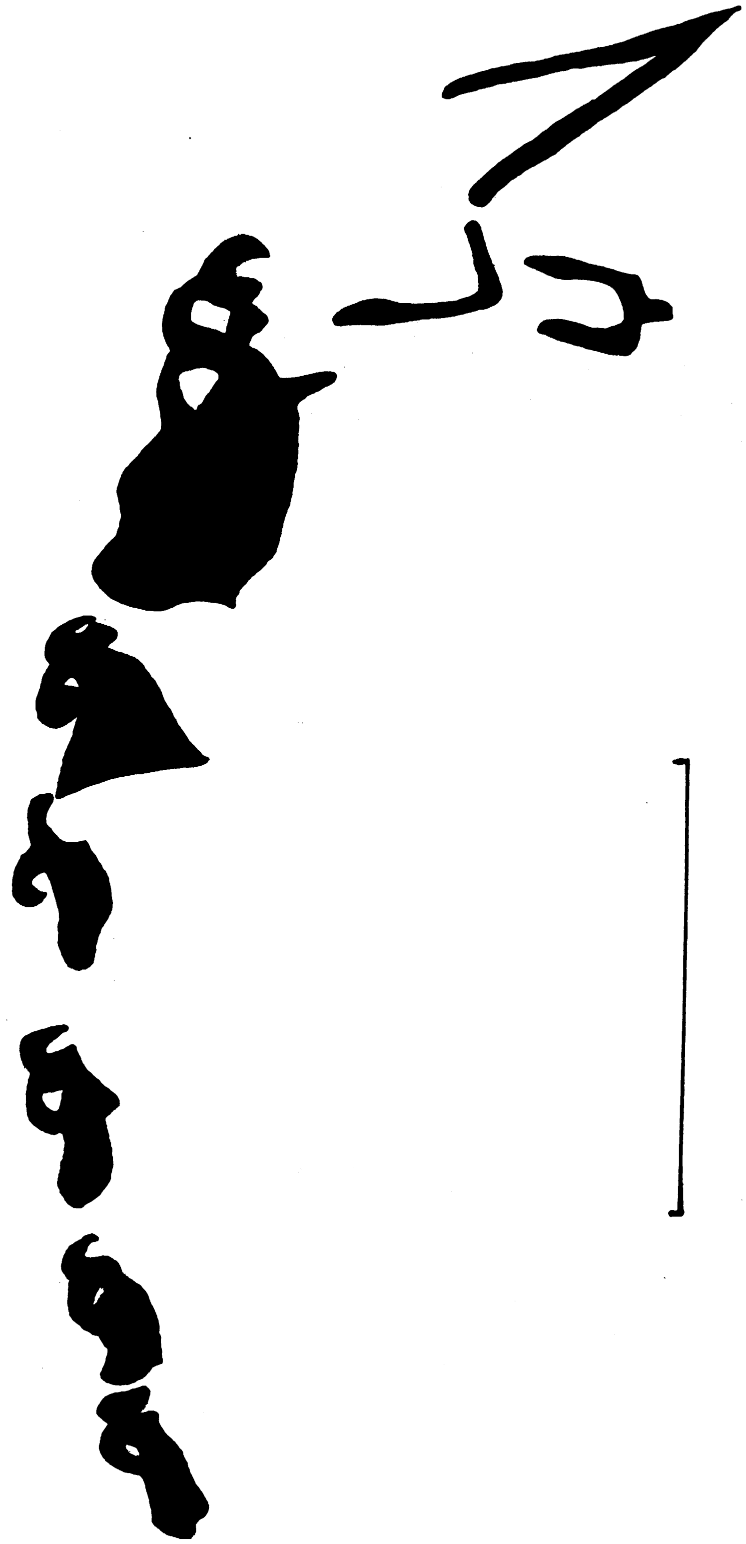


Fig. 10

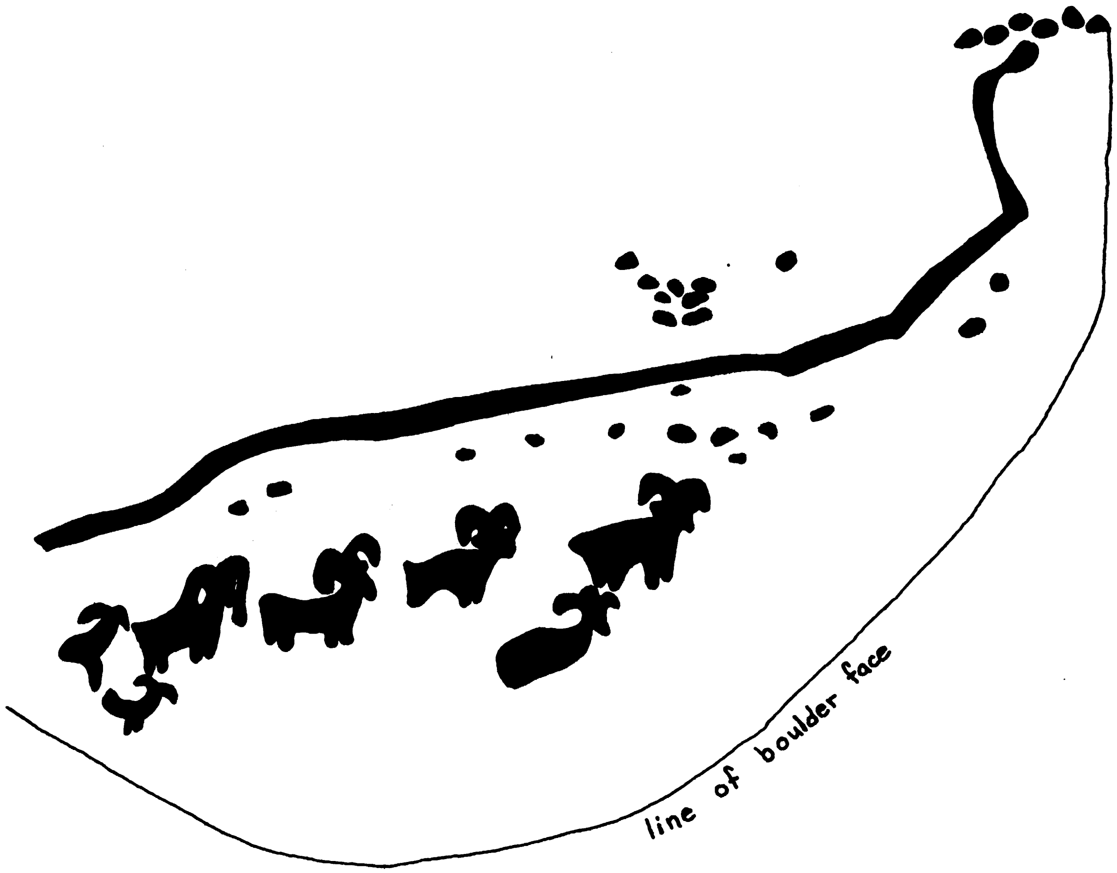


Fig. 11

Fig. 12

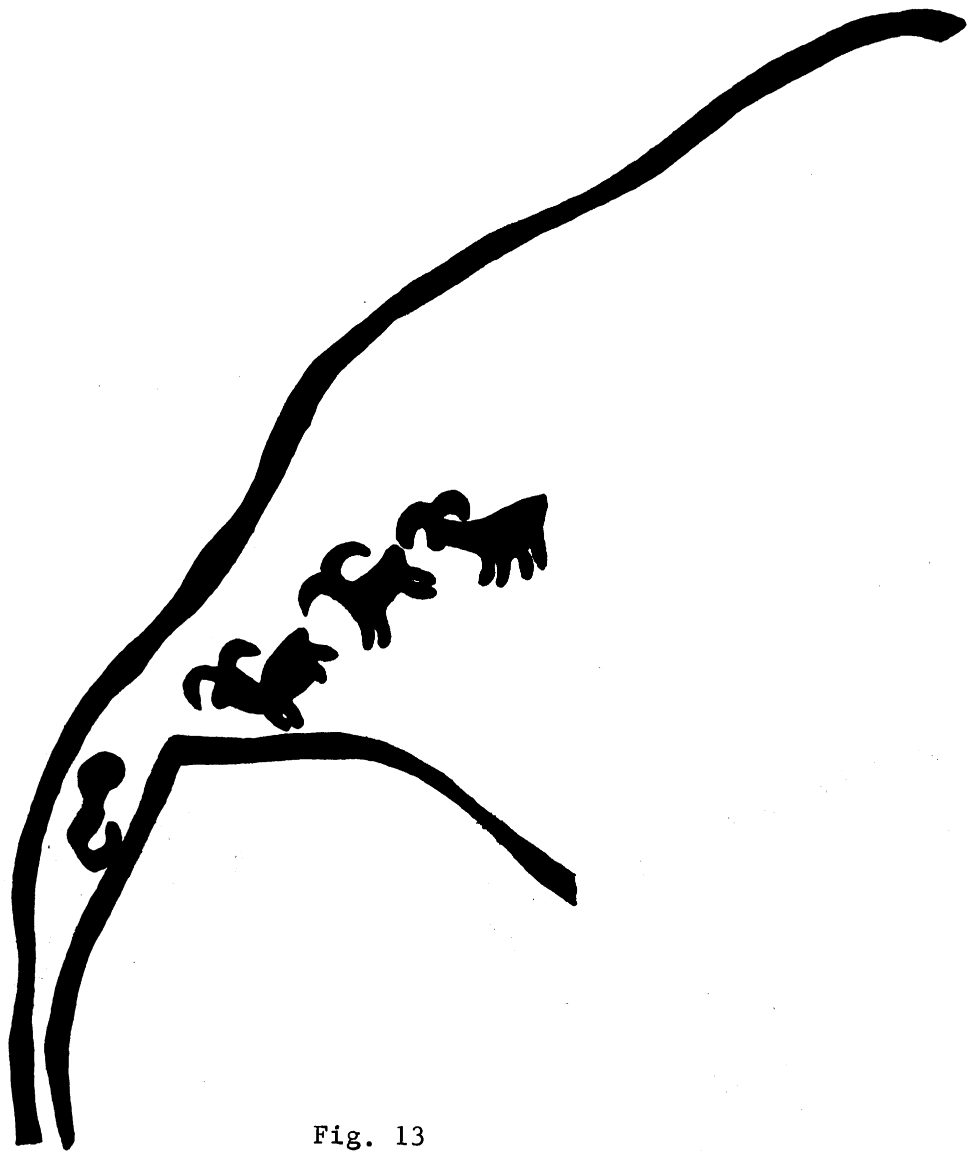


Fig. 13

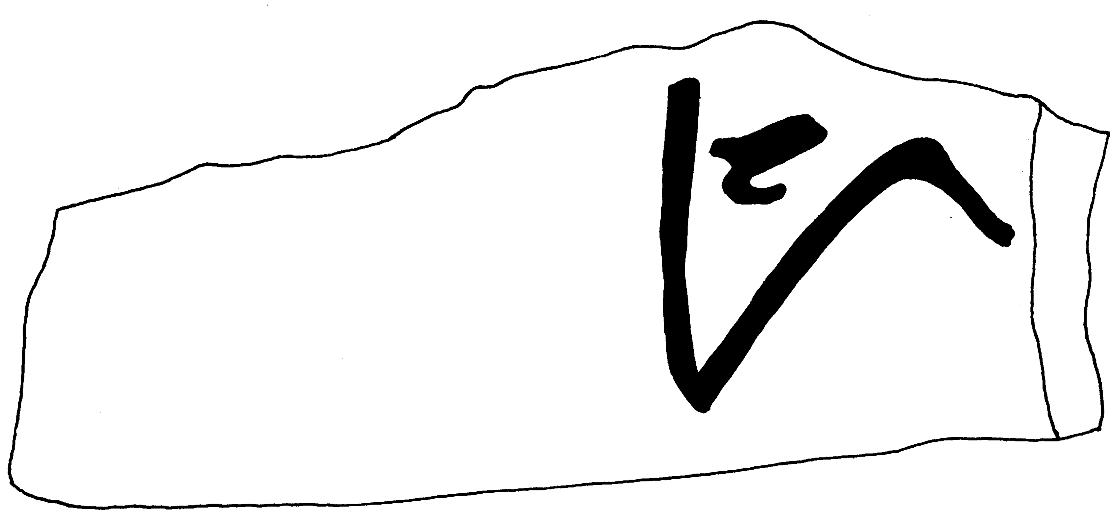


Fig. 14

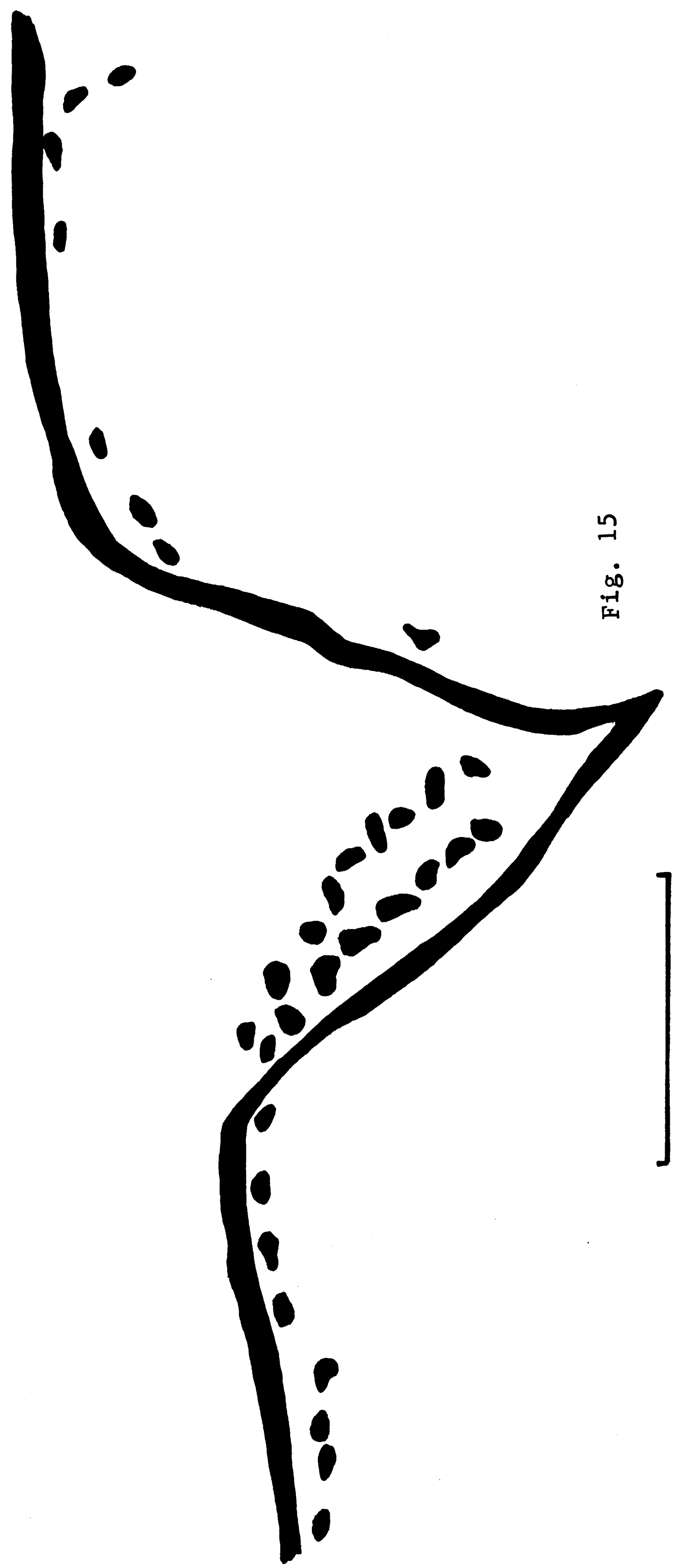


Fig. 15

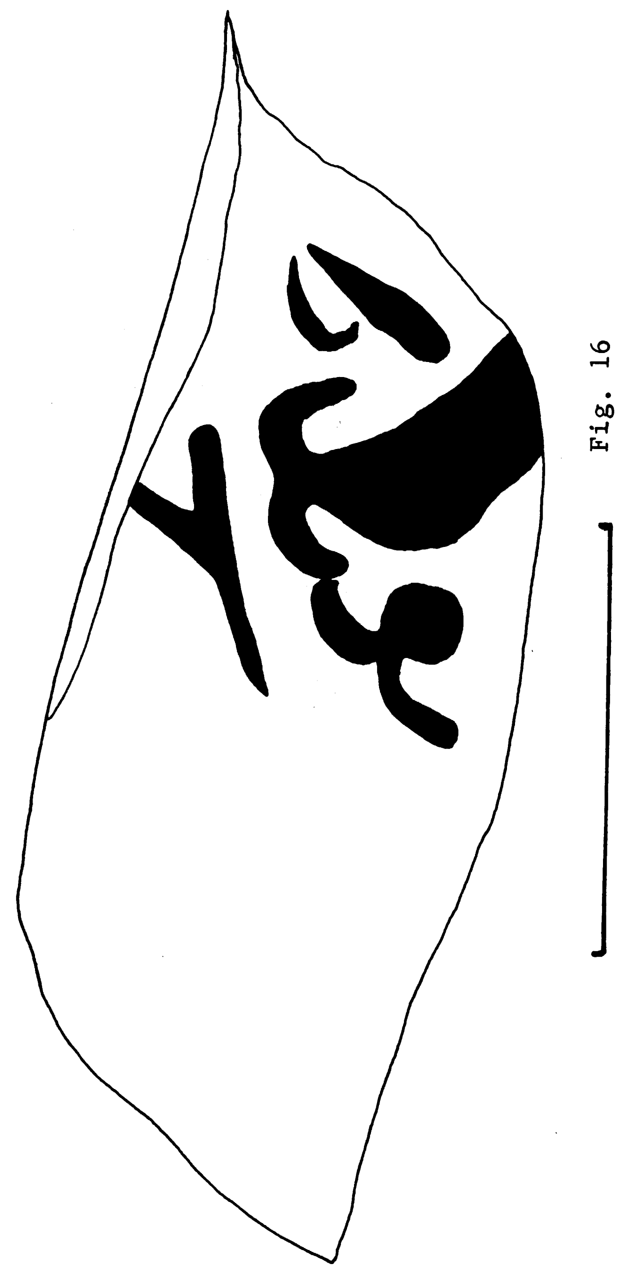


Fig. 16

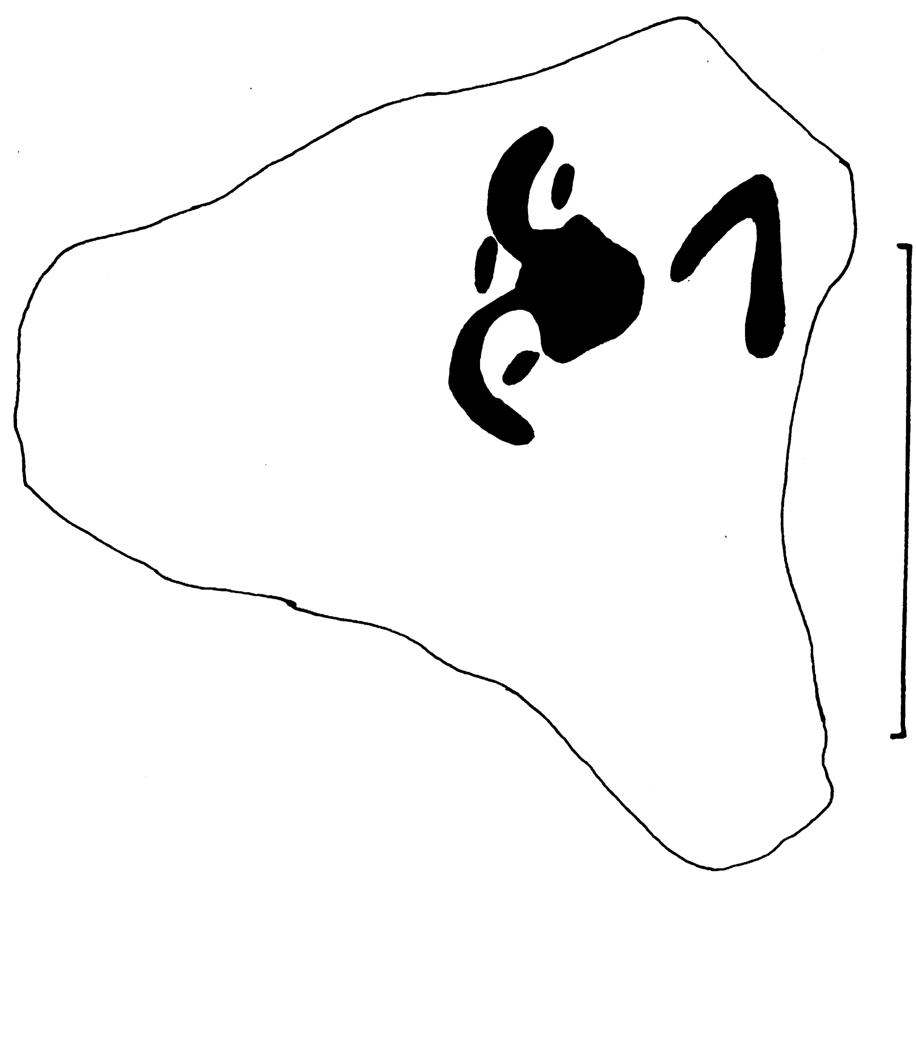


Fig. 17

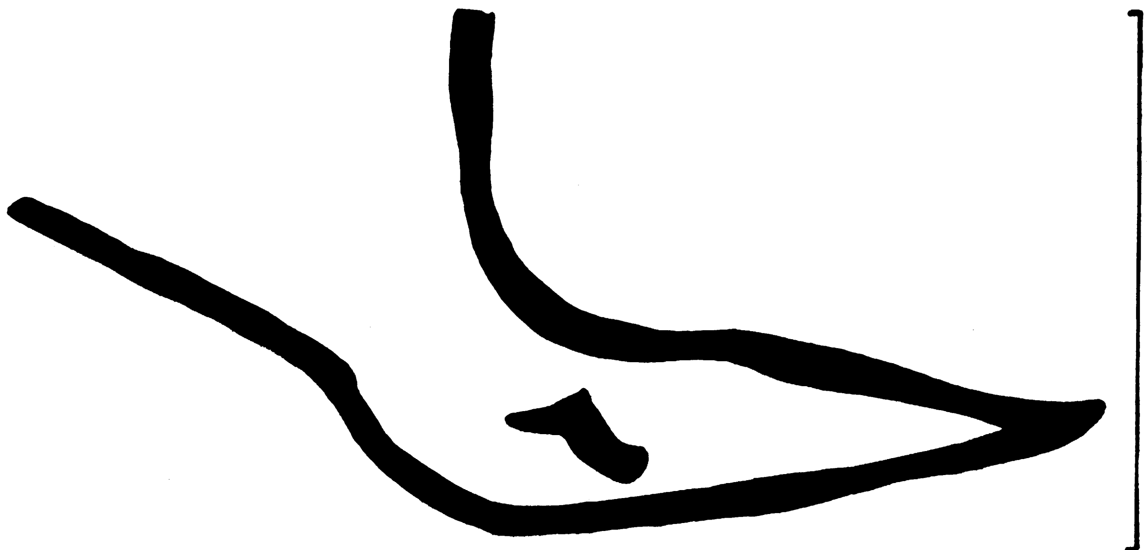


Fig. 18

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THE MANUFACTURE OF A PETROGLYPH: A REPLICATIVE EXPERIMENT

James C. Bard and Colin I. Busby

From a review of the literature (Grant 1967, Heizer and Baumhoff 1962, Mallery 1893, Rudner 1971, Steward 1929, Turner 1963, Willcox and Pager 1967) it was found that many authors had advanced the methods of abrasion, incision or pecking as the most likely means of executing petroglyphs. For instance, Grant (1967:12) stated:

> "Most petroglyphs are produced by rock pecking. This can be done in two ways--by striking the surface of the rock with a sharp piece of harder stone, or, for more precise control, by chiseling the rock, using a hammerstone to pound on the stone chisel. The design is usually started with a series of dots joined into lines by continued pecking. Flat tones are indicated by close all-over pecking or by abrading the surface (rubbing or scraping with a harder stone)."

Turner (1963:11) adds these further details:

> "Pecking was done by two methods: (1) hammerstone and chisel, which resulted in very accurate removal of the surface stone and equidistant placement of each pecked dint and, (2) sharpened hammerstone, which gives a sloppy appearance imposed by varieties of muscular coordination. Abrading or incising the surface rock, with another stone, stick, or bone, will produce deep lines and is graphically effective. In general this was not done where the stone was highly patinated and where even a lightly pecked line would stand out strikingly. In any case, the incising of elements takes considerably more time than does pecking, to judge by personal experience."

However, there exists little experimental data on how petroglyphs were made and the length of time it might have taken to produce them. What data that does exist on the subject is either only briefly mentioned or is quite often subjective and inadequate, with no real base (see Bock and Bock 1972). Occasionally the data is of a more scientific and quantitative nature. Sierts' (1968) article is an excellent example of the scientific approach and method.

The present replicative experiment was devised to help fill some of the gaps that exist in the knowledge about petroglyph manufacture with special reference to the different methods, materials, and with particular emphasis on the time and effort involved in their manufacture.

Raw Material Collection and Geological Identification

For the sake of replicative accuracy, care was taken to insure that only material that would have been available to the original petroglyph makers was used in the experiment. Since the authors were familiar with the Grimes Point petroglyph site (NV-Ch-3) in western Nevada, the raw materials for the experiment were collected in the vicinity of this site (see Heizer and Baumhoff 1962 for a description of this site). The basalt material collected was similar to that used at the Grimes petroglyph site and for comparative study, a slab of basalt from the Edwards Creek drainage area in the Desatoya Mountains, approximately 125 miles southeast of Grimes, was also obtained. The pecking tool raw material sample (except for some Texas chert nodules) was obtained near the vicinity of the site.

The rocks with suitable surfaces were selected primarily on the basis of ease of transport, e.g., the heaviest and largest basalt boulder or slab that could be lifted by one man. Prime consideration was given to surfaces which were relatively smooth, even, and heavily patinated. Many possible surfaces were rejected because they were either rough and pitted or lacked a weathered "patina" (the so called desert varnish). Others were rejected because they had large areas rendered unsuitable for use by cracking or exfoliation. The bulk of the collected materials was small tabular slabs of basalt with the appropriate surface characteristics. These slabs were later described by R. Leitz (personal communication) as hornblende andesites.

The pecking tools were collected from a number of localities in the vicinity of the site. Careful attention was paid to size, shape and to the condition of the proposed working end. Sub-rounded, water-worn, hand-sized cobbles with a fairly small surface area on the proposed working end were considered to be the ideal pecking tools. Tools fitting the criteria were easily grasped, comfortable to work with and could be manipulated with accuracy when directing the blow on the rock surface. The raw materials that were selected for the pecking tools are commonly referred to in the archaeological literature as rhyolites and basalts. These raw materials were subsequently identified by Leitz as hornblende andesites (commonly called brown basalt), silicified tuffs (referred to as rhyolite) and vesicular olivine basalt (commonly known as grey basalt).

Terminology

The two methods of fabrication used in the experiment were direct pecking and a process called pecking/grinding. In direct pecking, the pecking tool is brought sharply into contact with the rock surface with the total distance of travel being approximately eight centimeters. From observation, it was found that an average of 128 blows per minute could be delivered to the rock surface by this method. Treganza (1955:21) refers to this technique as "crumbling", and describes it as a "...Technique whereby a hammerstone is struck against a specimen, instead of the removal of a large or small flake as in the percussion or pecking method, a granular powder results from the blow."

In the pecking/grinding method, direct pecking is used but, instead of the pecking tool being lifted immediately away from the surface of the rock after contact, the tool is pulled or pushed along the surface of the rock, either towards or away from the person doing the pecking, for approximately two to five centimeters. This results in an abrasion/grinding process taking place on the petroglyph surface. After this abrasion/grinding, the pecking tool is lifted and the process is repeated. It was found that an average of 112 operations per minute could be completed with this process.

Since no definition of what constituted a finished petroglyph was found in the literature and as one could not be formulated by observation from weathered petroglyphs present at the Grimes site, it was necessary that an arbitrary definition would have to be decided upon. Therefore, for the purposes of the experiment, a petroglyph was judged to have reached completion when the desert varnish had been broken through to reveal the unweathered, dark grey basalt surface beneath.

Methodology

Using a template, a uniform design pattern was put on each slab of basalt with a light coat of spray paint. This design consisted of a "rake" element that had been previously described at the Grimes Site (Heizer and Baumhoff 1962:Fig. 40, Design L). The main element was found to be 6.5 inches long by 1.0 inches wide (Fig. 6). The surface area was calculated to be 18.5 $inch^2$ or approximately 47.0 $centimeters^2$. The process of manufacture, using one of the two methods and one of the four raw materials as a pecking tool, was timed throughout, from start to finish. The number of blows per minute, using each of the two methods, was obtained by the counting of the number of blows in a five minute time span. A mean for each method was calculated from the results and was later used in computing the total number of blows per surface for each of the two methods and for the various raw materials used. This rate was determined by observing the technique of one person and it was decided that in order to minimize the differences that would be caused by two different people working on the same petroglyph, one person would do all of the pecking and pecking/grinding for the experiment.

The pecking tools were measured and photographed both before and after their use in an experiment (Table 2). Generally, only one pecking tool was needed to complete the design. However, occasionally the raw material in use was flawed in some way and a second tool was substituted in order to complete the petroglyph.

The basalt surfaces were occasionally brushed when the dust produced by the various operations obscured the design features, but apart from this operation, no other actions were carried out.

Upon completion, the petroglyph was washed thoroughly to remove any rock dust still adhering to the surface and was left to dry. When dry, the design was chalked in to accentuate its features and was photographed with a medium red filter to further heighten the contrast.

As a further control on the experiment, a large boulder was used as a uniform (control) surface. By the method of direct pecking five strips 20.3 cm by 2.5 cm (8 inches by 1 inch) (Fig. 6) were pecked into the surface using the four different raw materials available. The results obtained from this uniform surface, allowed us to roughly calculate how many square centimeters could be pecked per minute under ideal conditions by each of the tool materials. By applying these results to the measurements of various prehistoric petroglyphs done on similar surfaces, it would be possible to estimate the number of man-hours that were employed in their execution.

Results

Direct pecking was employed on Surfaces A, B, C, D, H and I. As a group, the silicified tuffs were quite effective in pecking out the design. Surface C was accomplished in 35.0 minutes; Surface I required 36.0 minutes and Surface B, from the Desatoya Mountains, took 82.5 minutes from start to finish. A Texas chert nodule was found to be the most effective pecking tool, requiring only 30.0 minutes to execute the rake element design on Surface H. Less effective than either of the silicified tuffs or the Texas chert was the pecking tool of vesicular olivine basalt. This tool required 50 minutes to complete the petroglyph on Surface D. The least effective tools for direct pecking were found to be the hornblende andesites which required a total of 124.5 minutes in the completion of the design on Surface A (Fig. 1 and Table 1).

The method of pecking/grinding was employed on the remaining surfaces E, F, G, J, and K. Again it was found that the Texas chert was the most effective pecking tool requiring only 40.0 minutes to complete the design. Next in order of effectiveness was the vesicular olivine basalt, which took 65.0 minutes in the completion of the design. The hornblende andesite completed the design in 82.5 minutes. The silicified tuffs were found to be the least effective in the pecking/grinding method as they took 99.0 and 125.0 minutes respectively in completing the design (Fig. 2 and Table 1).

In executing the designs by the pecking/grinding method, the Texas chert, silicified tuffs and vesicular olivine basalt all required more time than in the direct pecking process. With the pecking/grinding method, only hornblende andesite tools showed a decrease in the time required to complete a petroglyph.

On the Uniform Surface direct pecking experiment, the Texas chert again proved to be the most effective, completing the line in 12.0 minutes. The silicified tuffs were the next most effective, taking 18.0 minutes and 22.0 minutes respectively. The vesicular olivine basalt required 44.0 minutes to peck out the line and the hornblende andesite required the maximum time of 55.0 minutes (Fig. 3 and Table 1).

As a general statement, it should be noted that these results were obtained under ideal laboratory conditions and not under the field conditions encountered by the aboriginal petroglyph makers. This does not mean that the data should be rejected entirely, but that careful consideration and thought should be employed when analyzing or applying this data to any situation outside of the laboratory.[1]

Inferences

From the experimental data and from observaton, it was possible to draw several inferences and conclusions that appear to be consistent with the results obtained.

First and most important, this experiment has shown that direct pecking is the most efficient means, both in terms of time and labor, of manufacturing a petroglyph when compared with the pecking/grinding method. The time needed to produce a design of some exactness if surprisingly short when a sufficiently hard material is employed as the pecking tool. Even with a "soft" tool material, the time required is still acceptably short. It can be inferred, based on this experimental data, that the aboriginal petroglyph producers, with the raw materials available in the vicinity of the Grimes Point site, used direct pecking, as the means of producing most if not all, of the petroglyphs present at the various areas in the site.

From observation, several of the petroglyphs manufactured in the experiment seemed to be easier to produce than others. This appeared to be due to material irregularities that were present on their surfaces. These irregularities include hairline fracture holes, and weaknesses in the rock due to stress. It is quite possible that the aboriginal manufacturers deliberately sought out surfaces with these irregularities in order to reduce the time and labor involved in making a petroglyph.

Again from observation, it was noticed that the basalt slabs had three distinct layers or "skins" present on their surfaces. The first layer consisted of the dark brown "desert varnish". Beneath this layer, a light brown layer was found, and underneath that layer was the pristine grey heart rock. A quite satisfactory petroglyph, in terms of contrast, can be made by just pecking through the "desert varnish" to the light brown or red layer beneath. It is entirely possible that many petroglyphs were made in this manner, thus time and labor involved would be minimized.

To account for the differences in the results for the silicificed tuffs, Leitz (personal communication) suggests that the submersion of the basalt slabs and boulders under the waters of Lake Lahontan may have induced chemical changes to occur in the basalt (see Morrison 1964 for a discussion of the geology of the area). That is, the rate of weathering for the basalt may have been increased due to the effects of the submersion. This effect of differential weathering, coupled with minor compositional differences among the basalt surfaces, and viewed from the perspective of technique variability from surface to surface, may help account for the differences between the similar raw materials. However, differences in technique from surface to surface do not seem to account for the results obtained by direct pecking between the surface of a Grimes Point boulder and a surface on a slab obtained from the Edwards Creek drainage area of the Desatoya Mountains (Fig. 4). Both are hornblende andesites and both were pecked using the direct pecking method with a silicified tuff as a pecking tool. The time required to peck a design on the Desatoya surface was roughly 2.3 times longer than the time required to peck the same design on a surface from the Grimes Point area. It would appear that the differences in the amount of surface weathering present on each of the two slabs could account for this time difference. While the Grimes Point slab had a dark brown patina of "desert varnish", the Desatoya basalt slab was relatively unweathered. That is to say, only a very light beige patina was present on its surface. From these results, one could infer that weathered rock material would be preferred to unweathered material, at least in the case of a basalt surface, for manufacturing a petroglyph.

According to Sierts (1968:282), wetting the surface with water, saliva or some other liquid tended to soften the surface, increase the visibility of the design outline and helped in the removal of loose particles. After the completion of the replicative experiment, a fresh slab of basalt was alternately wetted and pecked. Qualitatively speaking, the results of this exercise agree with Sierts. The work appeared to move along faster thus implying a softening of the surface; the dust was kept down, visibility of the design increased and the noise from the pecking operation was somewhat muffled. Hence, it is quite possible, that during the manufacture of a petroglyph, the surface was frequently wetted in order to increase efficiency and to decrease the time involved in its execution.

From a personal inspection of the various petroglyph sites in the Grimes Point area (see Heizer and Baumhoff 1962 for a full discussion), the authors found numerous rounded and end-battered cobbles of hornblende andesite present in close association with many of the petroglyphs. This would seem to imply that the petroglyph makers utilized these cobbles as pecking tools. This would appear to be supported by the fact that the surface rocks of hand size in the vicinity of the sites are sharp, angular, and irregularly shaped. Rounded cobbles would seem to suggest a stream or water environment which is not present or evident around the sites. However, the experimental data indicates that the best possible results would be obtained by using the silicified tuffs, "cherts" and "rhyolites"found in the area, rather than hornblende andesites or vesicular olivine basalt. Since only one or two "hard" pecking tools would be needed for a moderate-sized design, there would be no great hardship involved in procuring the pecking tools and transporting them to the work site. The authors propose that the silicified tuffs, "cherts" and "rhyolites" available in the area were used along with the various basalts present as pecking tools. At this site, the basalts were discarded and the cherts and rhyolites may have been reused as raw material in the manufacture of other chipped stone artifacts. This tool reuse would also account for the paucity of silicified tuff, "chert" and "rhyolite" tools at the sites, while the large number of hornblende andesite tools at the sites can be accounted for by the fact that they are totally unsuitable as a raw material in the manufacture of chipped stone artifacts. Scattered chert flakes have been found at NV-Ch-71 near the Grimes Point petroglyph site (Karen Nissen, personal communication) in association with the petroglyphs. These flakes could represent damage done to chert tools through use as pecking implements. While this evidence is scanty at best, it does seem to offer some, albeit meagre, support in favor of the hypothesis. Without question, further research is needed to disprove or validate this idea of raw material reuse.

Although this experiment was confined to one specific area and was limited in scope, its general outline and content could be expanded and applied to the study of other petroglyph areas. It would seem that each area would have to be tested individually due to the varying factors present at any given site. Undoubtedly, future research whether at the Grimes Point site or at other petroglyph sites, will shed more light on the mechanics and inferences that can be derived from the manufacture of petroglyphs through replicative means.

Acknowledgements

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Note

[1] The authors applied the data to a petroglyph locality near Walker Lake, Nevada. Two petroglyphs, LMA 2-30804 and 2-30800, from this area now deposited in the Lowie Museum of Anthropology, Berkeley, were measured in cm^2. For example, if LMA 2-30800 was produced by direct pecking, using as pecking tools, either hornblende andesite, red silicified tuff, white silicified tuff, or vesicular olivine basalt, the following time requirements for design completion were extrapolated, 69.3 minutes, 27.8, 22.8 and 55.7. Extrapolations of this sort are useful in a rough way, if factors such as varying stroke rate, fatigue, environmental conditions, and available raw material can be evaluated.

TABLE 1

Pecking Tool Material and Time Factor

Surface	Hornblende andesite	Silicified tuff (red)	Silicified tuff (wht)	Olivine basalt	Texas chert	Number of Blows*	Method
A	124.5					15,936	Direct Pecking
C		35.0				4,480	"
I			36.0			4,508	"
D				50.0		5,400	"
H					30.0	3,840	"
E	82.5					9,240	Pecking/ Grinding
F		125.0				14,000	"
G			99.0			11,088	"
J				65.0		7,280	"
K					40.0	4,480	"
US	55.0					7,040	Direct Pecking
US		22.0				2,816	"
US			18.0			2,304	"
US				44.0		5,632	"
US					12.0	1,736	"

US = Uniform Surface

* Number of Blows: Direct Pecking, 128 per minute

Pecking/Grinding, 112 per minute

TABLE 2

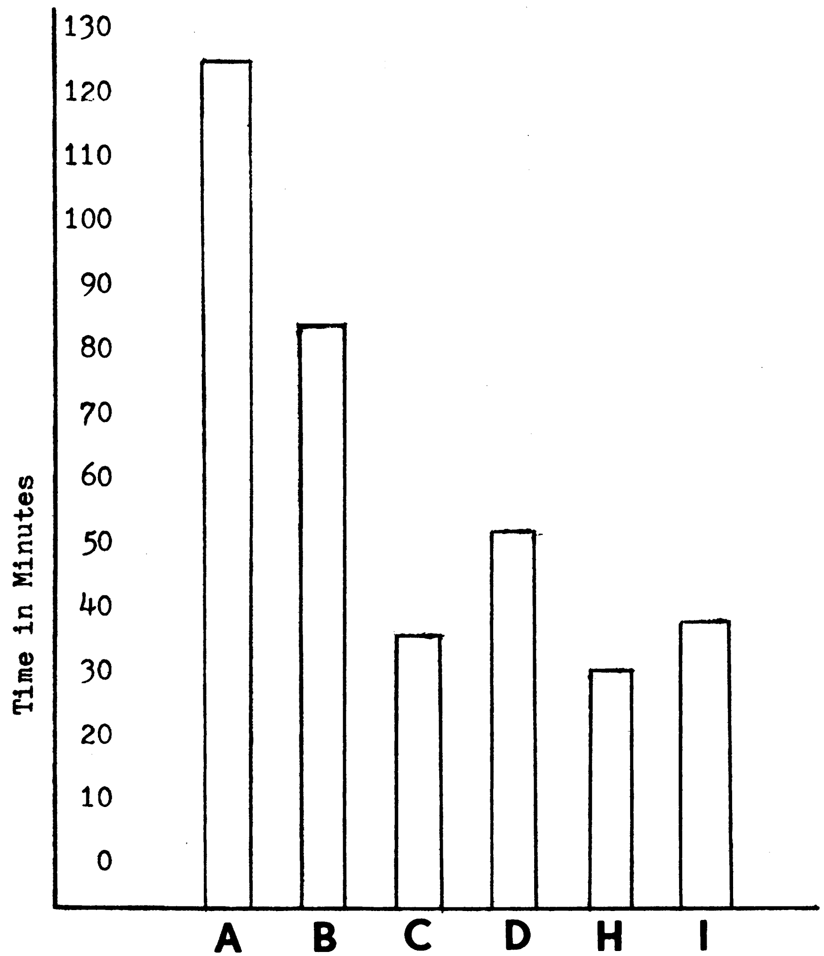
Before and After Measurements of Pecking Tools
(All measurements are in millimeters)

Number	Tool Material	Before		After		Change		Method*
		L	B	L	B	L	B	
1.	Hornblende andesite	74.0	60.0	67.0	59.0	7.0	1.0	DP
2.	" "	99.0	61.0	91.0	61.0	8.0	0.0	DP
3.	Silicified tuff (wht)	119.0	53.0	114.5	53.0	4.5	0.0	DP
4.	" " "	93.0	50.7	93.0	50.7	0.0	0.0	DP
5.	" " (red)	128.0	59.0	128.0	59.0	0.0	0.0	DP
6.	" " "	96.0	49.0	96.0	49.0	0.0	0.0	DP
7.	Olivine Basalt	112.0	55.0	104.0	55.0	8.0	0.0	DP
8.	Hornblende andesite	84.0	44.4	83.6	44.4	0.4	0.0	PG
9.	" "	89.6	50.5	89.4	50.5	0.2	0.0	PG
10.	Silicified tuff (red)	118.0	53.7	116.6	53.7	1.4	0.0	PG
11.	Texas Chert	101.4	74.5	101.4	74.5	0.0	0.0	DP
12.	Silicified tuff (wht)	94.8	70.1	94.8	70.0	0.0	0.0	DP
13.	Olivine Basalt	90.8	68.0	85.0	68.0	5.8	0.0	PG
14.	Texas Chert	113.8	56.6	110.9	56.6	2.9	0.0	PG
15.	Hornblende andesite	142.0	85.8	128.0	85.8	14.0	0.0	DP
16.	" "	81.6	54.4	71.0	54.4	10.6	0.0	DP
17.	Silicified tuff (red)	135.0	67.0	134.8	67.1	0.2	0.0	DP
18.	" " (wht)	108.7	72.8	108.0	72.8	0.7	0.0	DP
19.	Olivine Basalt	124.5	77.9	102.7	77.9	21.8	0.0	DP
20.	Texas Chert	93.0	48.0	92.7	48.0	0.3	0.0	DP

*Method: DP = Direct Pecking
PG = Pecking/Grinding

L = length
B = breadth

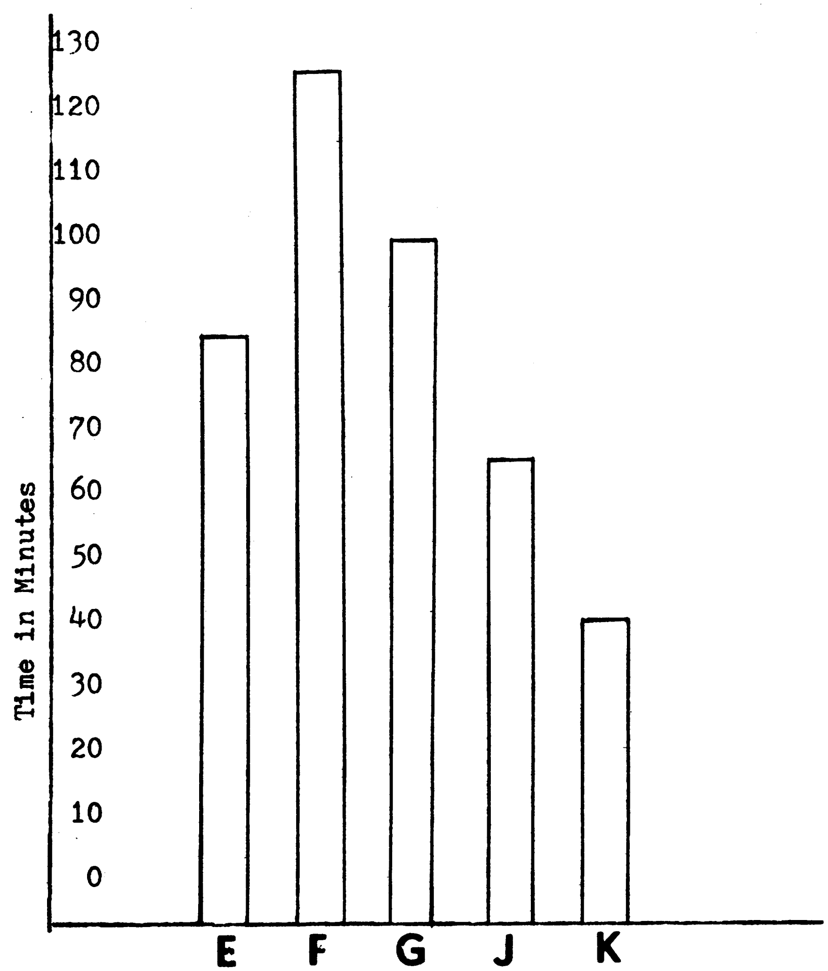
DIRECT PECKING ON BASALT SURFACES



Surface	Tools Used	Tool Material	Time
A.	1 & 2	Hornblende Andesite	124.5
B.	3	Silicified Tuff white	82.5
C.	5 & 6	Silicified Tuff red	35.0
D.	7	Vesicular Olivine Basalt	50.0
H.	11	Texas Chert	30.0
I.	12	Silicified Tuff white	36.0

Figure 1. Results of Direct Pecking on Basalt Surfaces

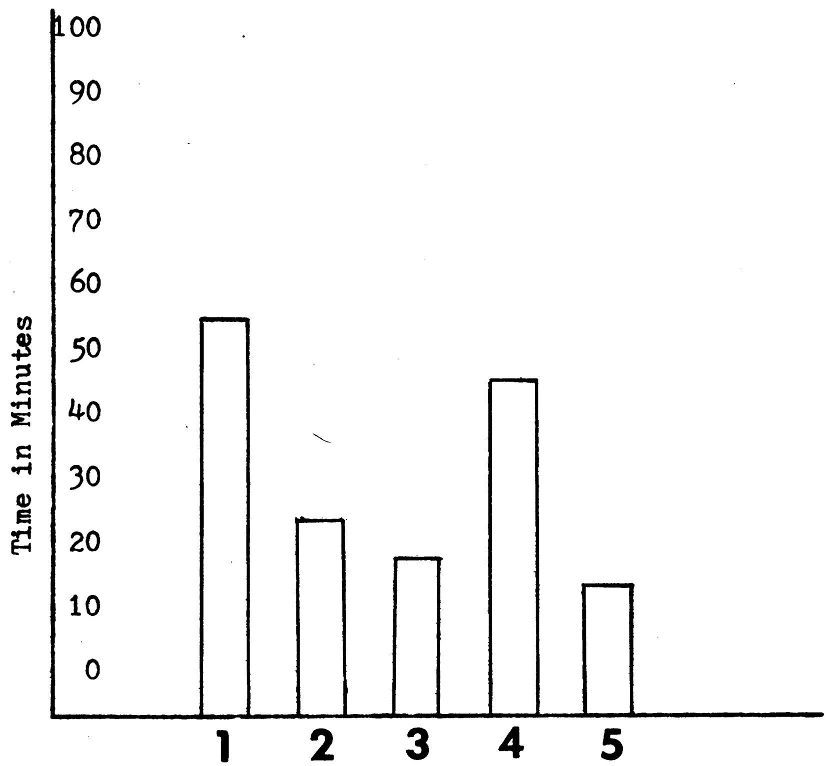
PECKING/GRINDING ON BASALT SURFACES



Surface	Tools Used	Tool Material	Time
E.	8 & 9	Hornblende Andesite	82.5
F.	10	Silicified Tuff red	125.0
G.	4	Silicified Tuff white	99.0
J.	13	Vesicular Olivine Basalt	65.0
K.	14	Texas Chert	40.0

Figure 2. Results of Pecking and Grinding on Basalt Surfaces

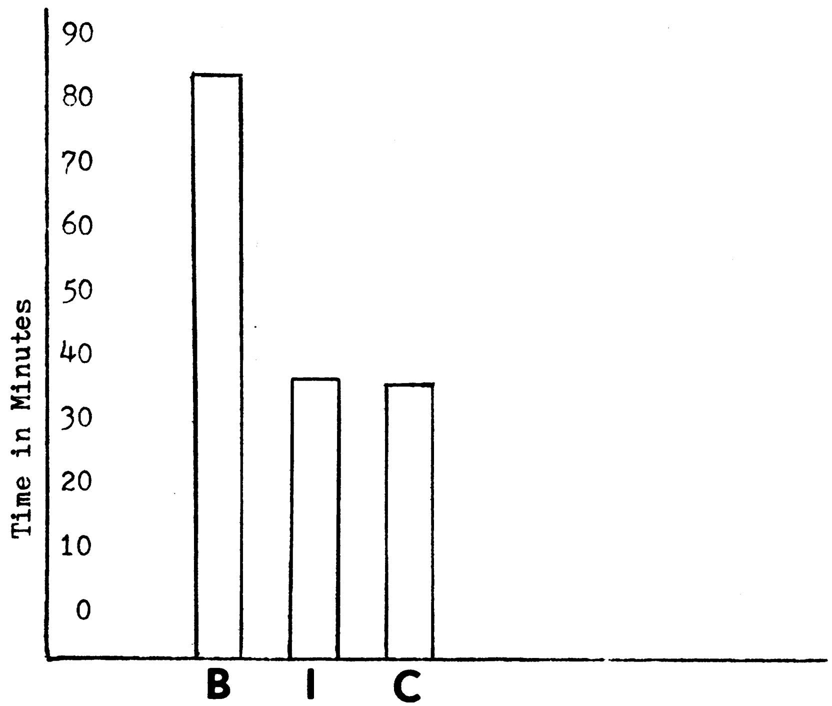
DIRECT PECKING ON A BASALT UNIFORM CONTROL SURFACE



Surface	Tools Used	Tool Material	Time
UC 1.	15 & 16	Hornblende Andesite	55.0
UC 2.	17	Silicified Tuff red	22.0
UC 3.	18	Silicified Tuff white	18.0
UC 4.	19	Vesicular Olivine Basalt	44.0
UC 5.	20	Texas Chert	12.0

Figure 3. Direct Pecking on a Basalt Uniform Control Surface

DIRECT PECKING ON BASALT SURFACES



Surface	Tools Used	Tool Material	Time
B. Desatoya Surface	3	Silicified Tuff white	82.5
I.	12	Silicified Tuff white	36.0
C.	5 & 6	Silicified Tuff red	35.0

Figure 4. Results of Direct Pecking on Basalt Surfaces

FIGURES

Figure 5. a, Pecking Tool #19, after use on Large Surface D (vesicular olivine basalt; face and end views); b, Pecking Tool #16, after use on Large Surface A (hornblende andesite; face and end views); c, Pecking Tool #17, after use on Large Surface B (silicified tuff; face and end views).

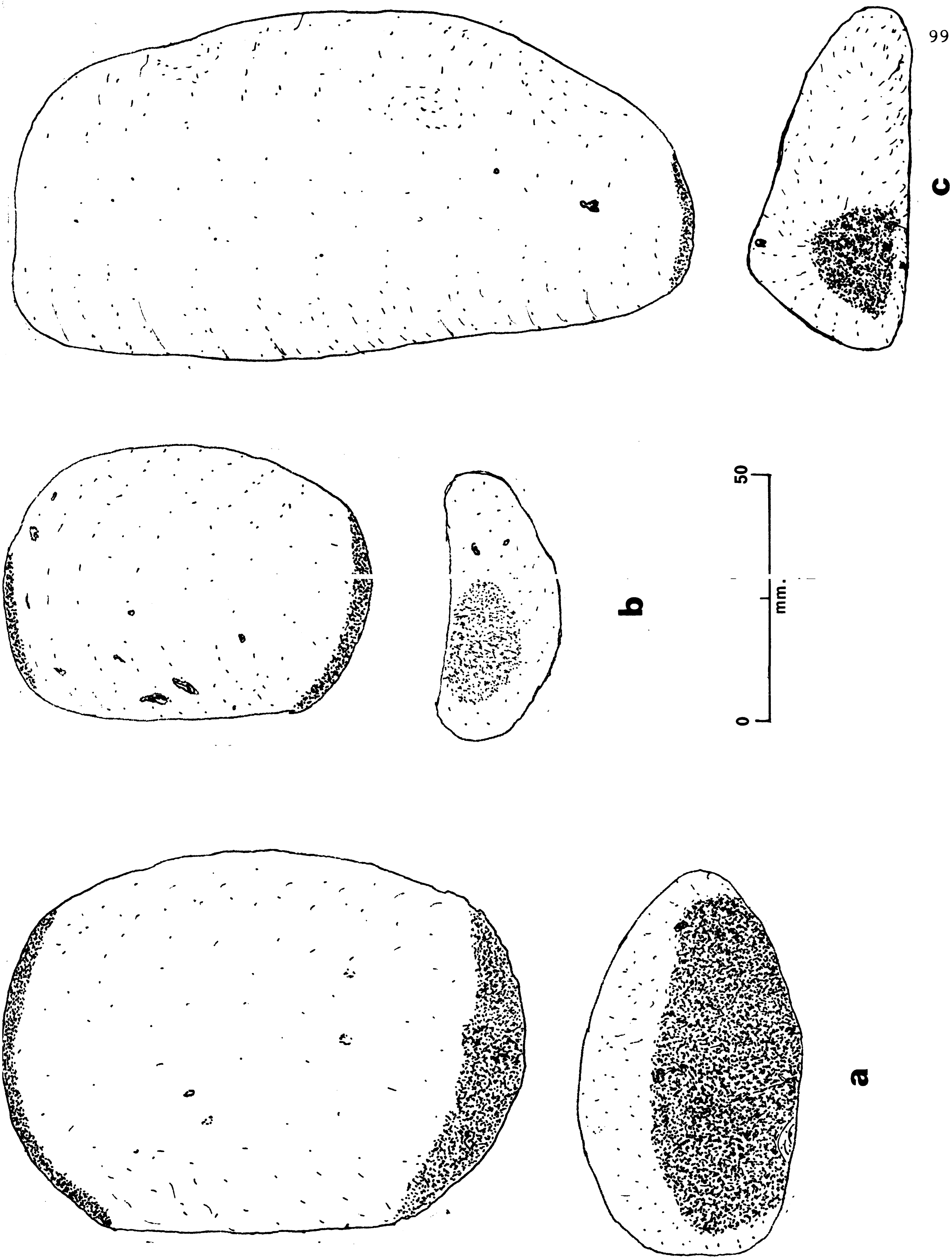
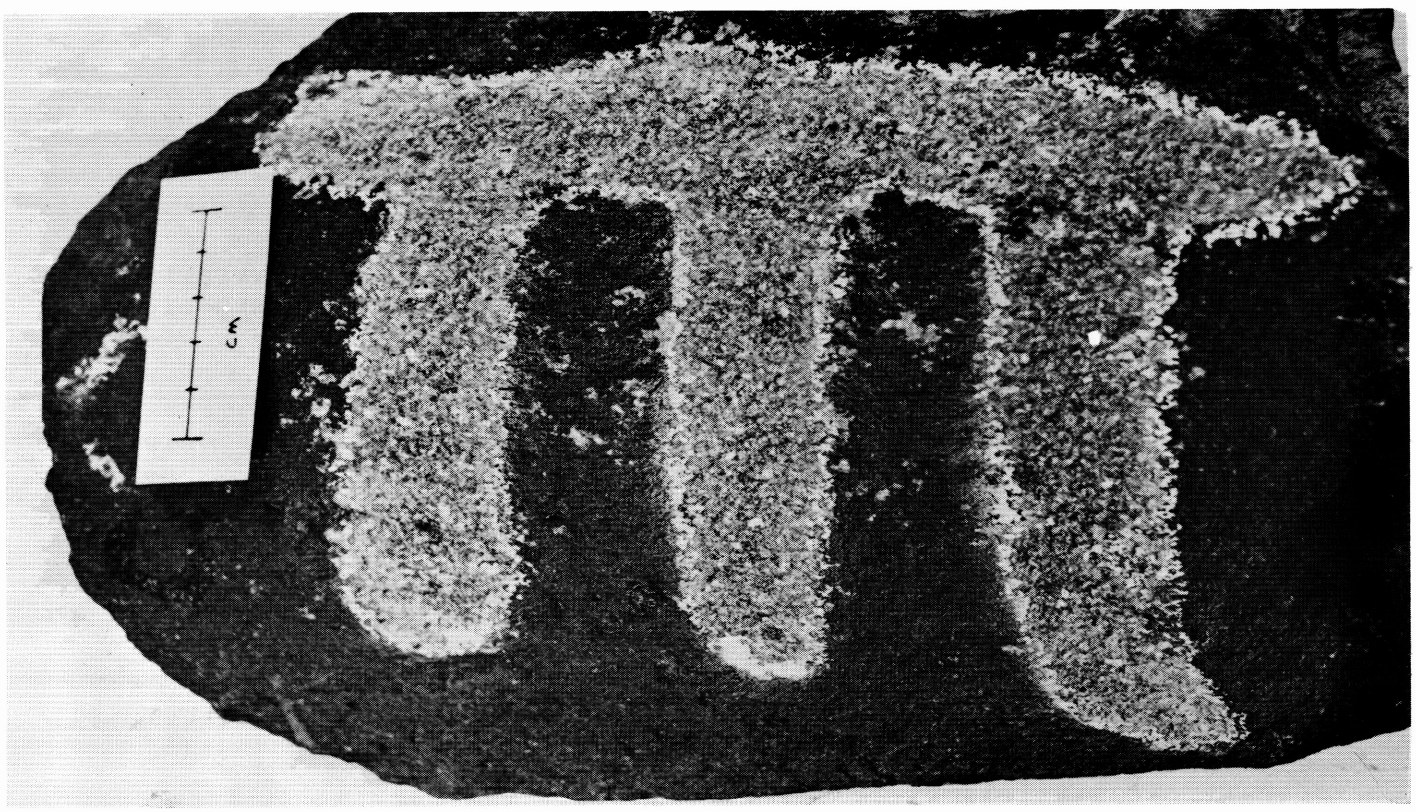


Figure 6. a, View of direct pecking experiment; b, finished petroglyph, Surface C.

a



b

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AN ATTEMPT AT COMPUTER ANALYSIS DETERMINATION OF CALIFORNIA ROCK ART STYLES

Mary Pori and Robert F. Heizer

In 1972-73 while one of us (RFH) was a Fellow at the Center for Advanced Study in the Behavioral Sciences, and the other (MP) was on the Computer staff of the Center, we decided to try to test some of the admittedly intuitive conclusions on petroglyph and pictograph style areas in California which had been proposed in a study then in press and now published (Heizer and Clewlow 1973). We thought the test to be a worthwhile undertaking since it might yield an independent check of the validity of the obviously broad categories of design elements into which the abundance of data from California rock art sites had been compressed. Our reasons for classifying all California pecked and painted rock art design elements into five classes or groups (Human, Animal, Circle and Dot, Angular, Curvilinear) have been stated elsewhere (Heizer and Clewlow 1973:9-10), and while we were not very comfortable in having taken this route, we nevertheless saw it as the only practicable one available to treat the very complicated mass of design element data. Some classification of rock art design elements is mandatory, the choices of how to accomplish this are wide, and for better or worse we decided on a scheme which seemed to us to be practicable. Our conclusions, based in part on element frequencies, and in part upon our intuitive assessment based on familiarity with the design elements of how the totality of forms of pecked or painted designs corresponded with geography, were represented in two maps on which petroglyph and pictograph style areas were shown (Heizer and Clewlow 1973:Maps 15, 16). These maps are reproduced here in Figs. 8 and 9.

Examples of statistical methods applied to petroglyph data for the purpose of differentiating styles within one site, or among a series of sites, are rare--among those known to us are the attempts by Lorandi di Gieco (1965), von Werlhof (1965:91-115), Maggs (1967), Heizer and Baumhoff (1962:198-199). None of these are like the analysis presented here.

One method of discriminating style areas of rock art is provided by the method known as multidimensional scaling. In order to illustrate the ways in which this technique can be applied to an archaeological problem, the results of scaling 37 California counties based on petroglyph elements and 23 California counties based on pictograph elements are presented.

We have information on the occurrence of pictographs in 23 California counties. Let us assign a unique identification number between 1 and 23 to each county. We base this assignment on an alphabetic ordering of the counties.

Thus,

1 = Amador
2 = Calaveras
3 = Fresno
.
.
.
23 = Tuolumne

The first step in scaling N objects is the computation of an N by N proximity matrix X. In this case our objects are California counties; for pictographs, N=23. A proximity matrix is simply a two dimensional array of numbers; the (i-j)th element of X, x_{ij}, is a measure of association between the ith and jth objects (counties).

In analyzing pictographs, we must first compute a 23 by 23 proximity matrix:

$$X = \begin{Bmatrix} x_{1\,1} & x_{1\,2} & x_{1\,3} & \cdots & x_{1\,23} \\ x_{2\,1} & x_{2\,2} & x_{2\,3} & \cdots & x_{2\,23} \\ \vdots & \vdots & & & \vdots \\ x_{23\,1} & x_{23\,2} & x_{23\,3} & & x_{23\,23} \end{Bmatrix}$$

where x_{ij} is a measure of how similar the ith and jth counties are. For example, x_{12} indicates the degree of similarity between Amador and Calaveras counties, while $x_{1\,23}$ indicates the degree of similarity between Amador and Tuolumne counties. A little thought reveals that the proximity matrix is symmetric, as $x_{ij} = x_{ji}$, e.g., the degree of similarity between Amador and Calaveras counties is identical to the degree of similarity between Calaveras and Amador coutnies. As is often characteristic of mathematical reasoning, what seems obtuse in the abstract, sounds like tautology when discussed in terms of a specific case. Many different measures of association have been suggested,[1/] and there are many unresolved problems in choosing such a metric. However, since it is not the purpose of this paper to enter into a discussion of the advantages and disadvantages of the various measures which could be used, we shall move on to a definition of the metrics actually used. Two different types of metrics were employed: (1) a modified version of the chi-square goodness-of-fit statistic; and (2) an indicator function indicating the number of similar categories.

1/ A summary of these can be found in Kendall and Stuart, 1959.

Specifically, assume that we have K different categories into which we can classify a given element. In the case of California rock art, K=5: human, animal, circle and dot, angular, and curvilinear. Let n_{ij} be the number of elements in the jth category found in the ith object to be scaled. For example, n_{32} is the number of elements in the second category (animal) found in the third county (Fresno, in the case of pictographs). Then for each pair of counties i and j, we can write a 2 by K table showing the number of elements in each category:

Category	1	2	K
County i	n_{i1}	n_{i2}	n_{iK}
County j	n_{j1}	n_{j2}	n_{jK}

Then we define the modified chi-square distance measure from county i to county j, x_{ij}, by

$$x_{ij} = \sum_{k=1}^{K} \left[\frac{\left(\frac{n_{ik}}{n_{+k}} - \frac{n_{i+}}{n_{++}} \right)^2}{\frac{n_{i+}}{n_{++}}} + \frac{\left(\frac{n_{jk}}{n_{+k}} - \frac{n_{j+}}{n_{++}} \right)^2}{\frac{n_{j+}}{n_{++}}} \right],$$

where

$$n_{+k} = n_{ik} + n_{jk},$$

$$n_{i+} = \sum_{k=1}^{k} n_{ik},$$

$$n_{j+} = \sum_{k=1}^{k} n_{jk},$$

$$n_{++} = \sum_{k=1}^{k} (n_{ik} + n_{jk}).$$

The chi-square metric is a true distance measure in that x_{ij} is close to zero if counties i and j are similar, while x_{ij} is large if counties i and j are very dissimilar ("far apart").

The indicator metric, w_{ij}, is defined in the following manner:

Let

$$I_{ijk} = \begin{cases} 1 \text{ if } n_{ik} = 0 \text{ and } n_{jk} = 0 \\ 1 \text{ if } n_{ik} < 0 \text{ and } n_{jk} < 0 \\ 0 \text{ otherwise} \end{cases}$$

Then $w_{ij} = \sum_{k=0}^{K} I_{ijk}$. Clearly, $0 \leq w_{ij} \leq K$. The indicator metric is an inverse distance measure, as $w_{ij}=0$ when counties i and j are similar on no categories (and, hence, are "far apart"), while $w_{ij} = K$ when counties i and j are similar on all categories (and, hence, are "close together").

Using one or the other of these formulas we can create an N by N proximity matrix giving the distance from each object to each of the N-1 other objects. Mathematically speaking, these N points will fit exactly in an Euclidean (N-1) dimensional space. Multidimensional scaling is a technique for approximating the true configuration of these N points in (N-1) dimensional space by a configuration of N points in a space of lower dimensionality, typically one or two dimensions. The approximating configuration is picked to maximize the goodness-of-fit between the true and approximate configurations. This technique is almost universally applicable for two reasons: (1), no assumptions are made about the underlying distribution of the N objects to be scaled. Many other methods demand that rigorous criteria, such as normality, be satisfied; and (2), multidimensional scaling is nonmetric in nature. All computations are based on the ranks of the distances rather than on the distances themselves.

To test the usefulness of this technique, we analyzed petroglyph data for 37 California counties and pictograph data for 23 California counties. The raw data consisted of the total number of recorded occurrences in each of 5 categories (human, animal, circle and dot, angular, and curvilinear) by county, as reported by Heizer and Clewlow, Jr., in _Prehistoric Rock Art in California_ (pp. 69-92). Figure 1 identifies the location of the counties under study. Figures 2-4 depict results for pictographs, while Figures 5-7 show results for petroglyphs. Three different measures of association were computed for both the petroglyph counties and the pictograph counties: (1), the modified chi-square metric based on all 5 categories (K=5) [See Figures 2 and 5]; (2), the modified chi-square metric based only on the angular and curvilinear categories (K=2) [See Figures 3 and 6]; and (3), the indicator metric, based on the human, animal, and circle and dot categories (K=3) [See Figures 4 and 7]. The first metric is based on all of the available data. The second and third metrics reflect the notion that the first three categories are somehow different from the last two. The first metric, based on all five categories of elements, would be assumed to give the best results, but at the same time some element categories are more strictly defined than others. Circle and Dot and Human are the least variable and most precise classes. The Animal group is generic in the sense that it includes lizards, snakes, deer, bighorn sheep and other life forms. If we assume that the petroglyph authors viewed these different animals as separate, rather than as equal and indistinguishable life forms, then we have imposed upon these distinct glyphs which may have had quite different meanings, a single label which conceals, or at least ignores, that variation which can be presumed the Indians were aware of. Least precise of our broad categories are the Geometric and Curvilinear groups which tend to be catch-all labels for a very wide variety of designs, none which are naturalistic, or at least recognizably so. For these reasons the second and third metrics are applied in order to see if these differences in "classificatory reality" will produce meaningful results.

In each application of the chi-square metric, the counties were scaled down to two dimensions (see Figures 2a, 3a, 4a, 5a, 6a, 7a under each main heading) and to one dimension (see Figures 2b, 3b, 4b, 5b, 6b, 7b). When the N counties are scaled down to one dimension, they can be ranked by the value of their one coordinate into a natural ordering from the largest to the smallest. We can then assign the rank of 1 to the county with the largest coordinate, 2 to the county with the second largest coordinate, ... , N to the county with the smallest coordinate. Figures 2c, 3c, 5c, 6c show the rankings of the counties superimposed upon their geographical locations.

Unfortunately, the scalings based on the chi-square metric do not yield any tight, distinct clustering schemes. The rankings do not appear to reflect geographic distances or geomorphic similarities.

The scalings based on the indicator metric do reveal tight, compact clusters (Figures 4a,7a). Unfortunately, little, if any, geographic sense can be made of these groupings (Figures 4b, 7b).

What conclusions can we draw from this? One possible conclusion is that the distribution of California rock art styles over time was not always along the same geographical lines. One must bear in mind that the results of a multidimensional scaling are only as good as the data put into it. One source of difficulty is in the definition of the design element categories. If the categories are well-defined, non-overlapping groupings, then there should be no problems. However, if the categories have been defined so that there is some question over which category a design falls into, then this fact will be reflected in the scalings. This does not appear to be the source of difficulty here. The main problem in securing better style distributions using the 5-class design type frequencies may lie either in too few available data, or in the lumping of too many different elements under too broad categories (especially those called Angular and Curvilinear), or in treating, as though they were equivalent, design elements from a wide time range where some elements had floruits of centuries and others perhaps of decades.

Examination of the counties which appear to be misplaced indicates that the counties which show the greatest deviation from their expected location are those with the fewest number of elements present. This could be rectified by additional sampling data from those counties. An entire branch of statistics is devoted to problems of sampling, and it is not the purpose of this paper to summarize the current literature in this subject. Nevertheless, a few general comments are called for. Assume that the probability of finding elements in one particular category is quite small. Then we would expect to find zero elements from that category in a small sample, while we would expect to find several elements from that category in a large sample. Such a discrepancy will result in a large apparent distance between the associated counties. In the data under consideration, the rarest category is the circle and dot (2.0% of the pictographs and 2.5% of the petroglyphs). In a sample of 50 pictographs we would expect to find one circle and dot element. Therefore, selecting a sample of at least 50 elements would make the expected number of elements in each category at least one. This is obviously a crude rule-of-thumb--many others could be suggested--nevertheless, it does suggest areas for further research and further study.

Analysis of Nevada petroglyph sites might be a logical next step. Heizer and Baumhoff (1962) identified 58 discrete petroglyph symbols or elements and catalogued their occurence at 71 sites in eastern California and Nevada. The Nevada sites display the same variation as those in the California sample in the total number of elements at each site: the smallest site contains only one element, while the largest site contains 705. The average number of elements per Nevada site is considerably higher: 68.89.

Unlike the California data those from Nevada data contain, for the most part, a sufficient number of occurences per site. While a detailed analysis might indicate the need of eliminating the very smallest sites from the analysis, this is not a major problem. The success of the analysis lies in a judicious choice of element categories. It is in this area that the interface between archaeology and statistics becomes important. 38 out of 58 elements occur fewer than 71 times. Ideally, we should like the expected number of occurences of each element per site to be at least 1. Therefore, we would attempt to aggregate some of the smaller categories by combining similar element types, e.g., combining the "mountain sheep" elements with the "sheep horn" elements to form a major class of element types. The statistician can be useful in suggesting the extent of aggregation required; the archaeologist, on the other hand, must indicate which aggregations make sense from a cultural point of view.

Careful aggregation of the data is one of the most important aspects of the analysis. Once this has been accomplished and an appropriate metric chosen (in view of the large number of elements, either the modified chi-square statistic or the product-moment correlation coefficient probably would be a wise choice of metric), the remainder of the analysis would proceed in the manner outlined above.

In summary, we have applied the concepts of proximity matrices and multidimensional scaling and have shown how they can be applied to one body of archaeological data. While the results are not very revealing, they, nevertheless hint at the power of the method and suggest areas in which further application might be beneficial.

Center for Advanced Study in the Behavioral Sciences
Stanford, California June 15, 1973

KEY TO PICTOGRAPH FIGURES

1 = AMA = Amador	2 = CAL = Calaveras
3 = FRE = Fresno	4 = IMP = Imperial
5 = INY = Inyo	6 = KER = Kern
7 = LAS = Lassen	8 = LAN = Los Angeles
9 = MRP = Mariposa	A = MOD = Modoc
B = MNO = Mono	C = MNT = Monterey
D = ORA = Orange	E = RIV = Riverside
F = SBA = Santa Barbara	G = SBR = San Bernardino
H = SCI = Santa Cruz Island	I = SDI = San Diego
J = SLO = San Luis Obispo	K = SIS = Siskiyou
L = STA = Stanislaus	M = TUL = Tulare
N = TUO = Tuolumne	

KEY TO PETROGLYPH FIGURES

1 = AMA = Amador	2 = BUT = Butte
3 = CAL = Calaveras	4 = CCO = Contra Costa
5 = ELD = Eldorado	6 = FRE = Fresno
7 = HUM = Humboldt	8 = IMP = Imperial
9 = INY = Inyo	A = KER = Kern
B = LAK = Lake	C = LAS = Lassen
D = LAN = Los Angeles	E = MAD = Madera
F = MRP = Mariposa	G = MER = Merced
H = MEN = Mendocino	I = MOD = Modoc
J = MNO = Mono	K = MNT = Monterey
L = NEV = Nevada	M = ORA = Orange
N = PLA = Placer	O = PLU = Plumas
P = RIV = Riverside	Q = SAC = Sacramento
R = SBA = Santa Barbara	S = SBR = San Bernardino
T = SCL = Santa Clara	U = SDI = San Diego
V = SNI = San Nicolas Island	W = SHA = Shasta
X = SIE = Sierra	Y = SIS = Siskiyou
Z = STA = Stanislaus	+ = TRI = Trinity
/ = TUL = Tulare	

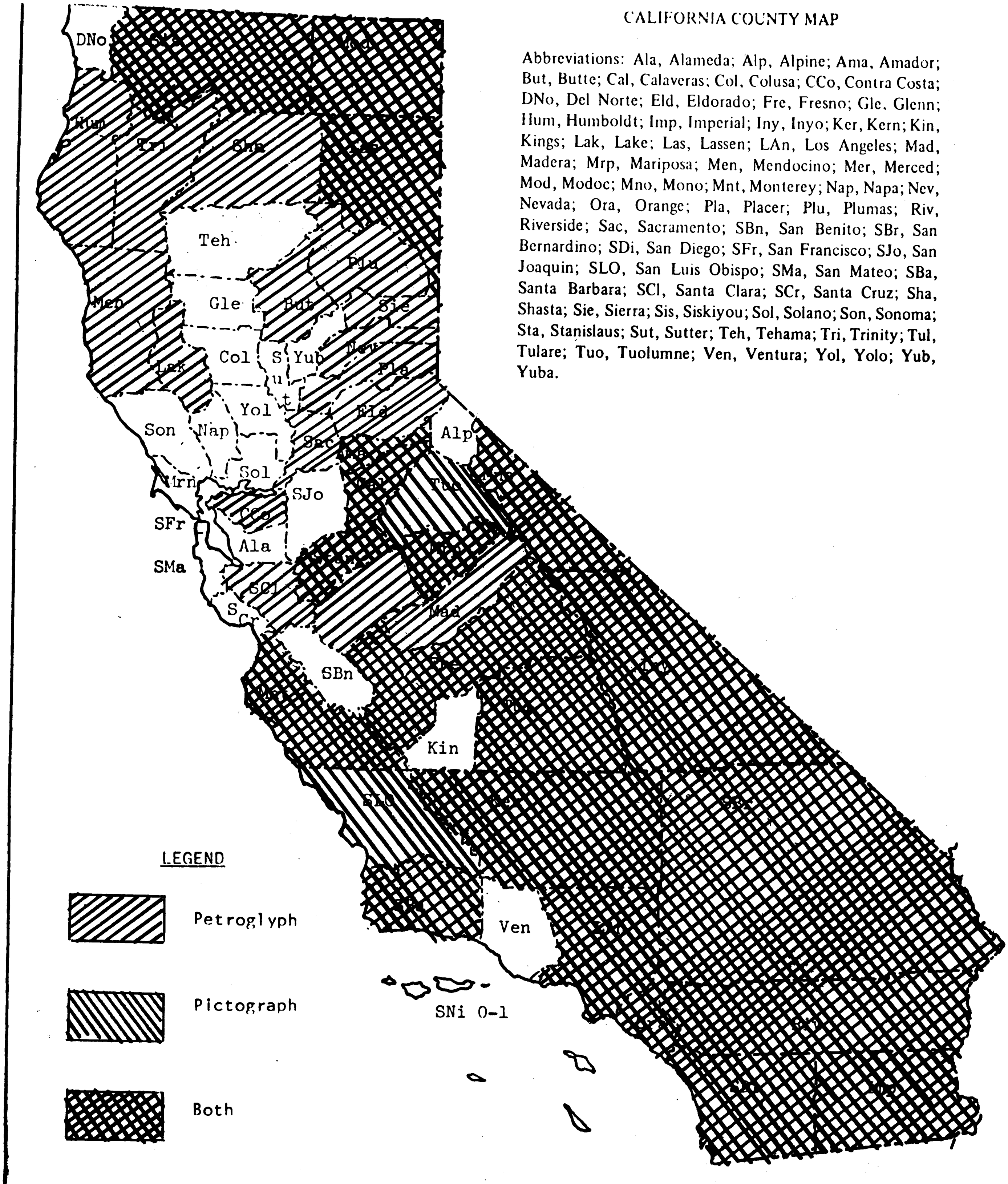

Fig. 1
California Counties Included in this Study

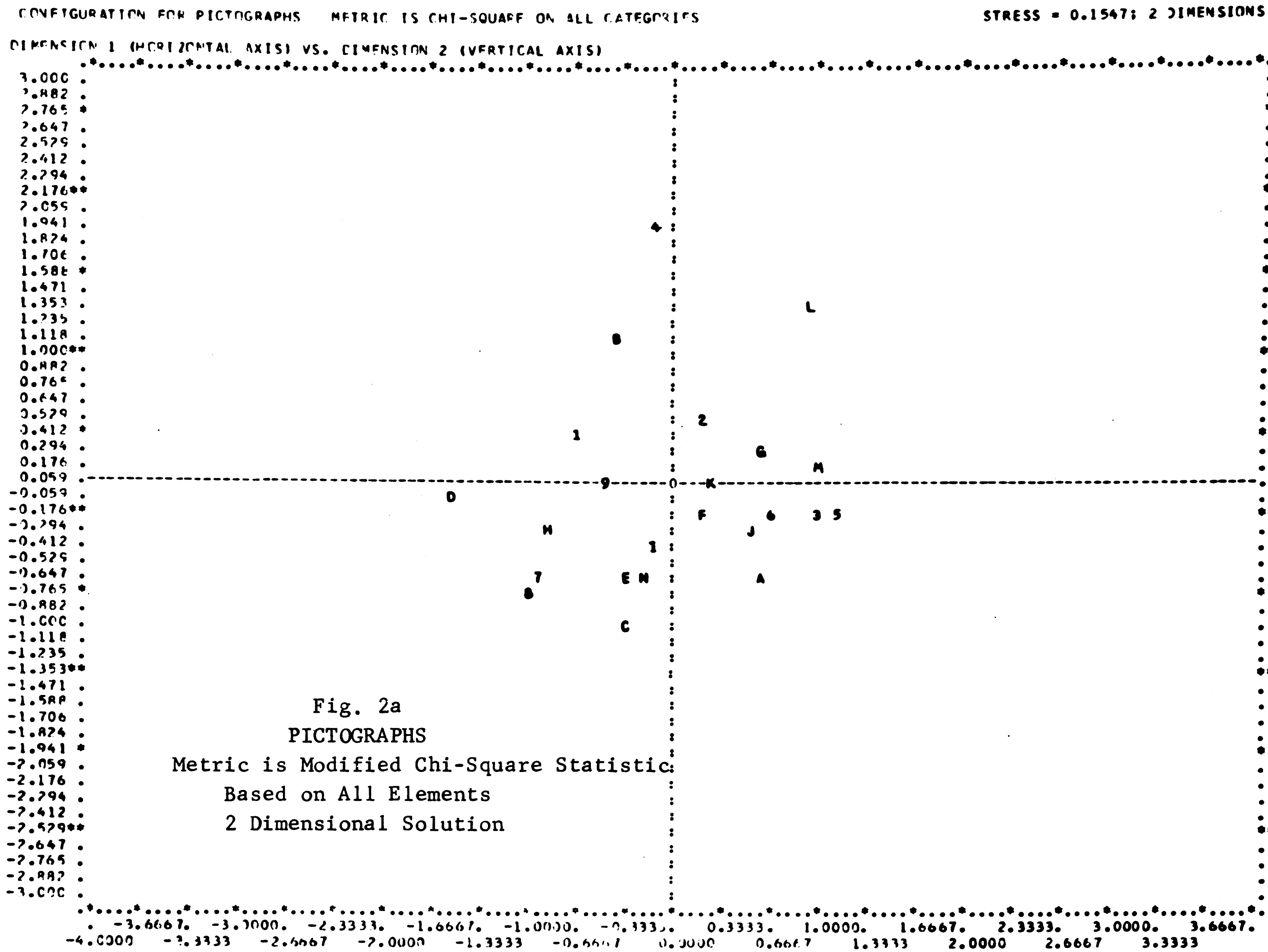

Fig. 2a
PICTOGRAPHS
Metric is Modified Chi-Square Statistic
Based on All Elements
2 Dimensional Solution

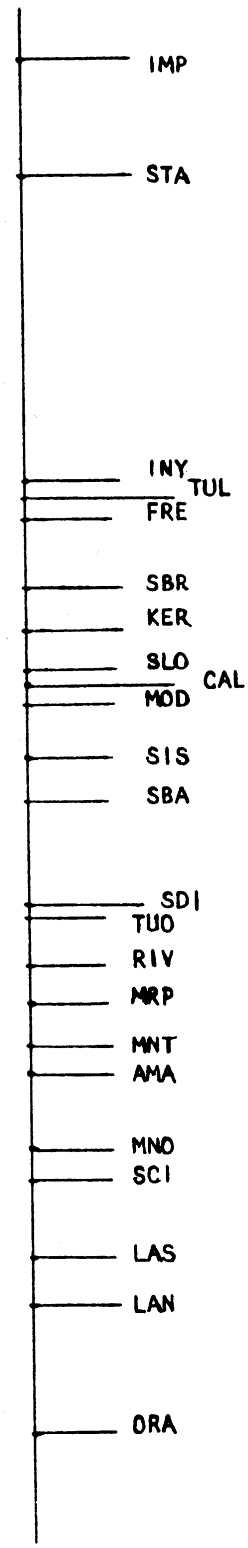

Fig. 2b
PICTOGRAPHS
Metric is Modified Chi-Square Statistic Based on All Elements
1 Dimensional Solution

CALIFORNIA COUNTY MAP

Abbreviations: Ala, Alameda; Alp, Alpine; Ama, Amador; But, Butte; Cal, Calaveras; Col, Colusa; CCo, Contra Costa; DNo, Del Norte; Eld, Eldorado; Fre, Fresno; Gle, Glenn; Hum, Humboldt; Imp, Imperial; Iny, Inyo; Ker, Kern; Kin, Kings; Lak, Lake; Las, Lassen; LAn, Los Angeles; Mad, Madera; Mrp, Mariposa; Men, Mendocino; Mer, Merced; Mod, Modoc; Mno, Mono; Mnt, Monterey; Nap, Napa; Nev, Nevada; Ora, Orange; Pla, Placer; Plu, Plumas; Riv, Riverside; Sac, Sacramento; SBn, San Benito; SBr, San Bernardino; SDi, San Diego; SFr, San Francisco; SJo, San Joaquin; SLO, San Luis Obispo; SMa, San Mateo; SBa, Santa Barbara; SCl, Santa Clara; SCr, Santa Cruz; Sha, Shasta; Sie, Sierra; Sis, Siskiyou; Sol, Solano; Son, Sonoma; Sta, Stanislaus; Sut, Sutter; Teh, Tehama; Tri, Trinity; Tul, Tulare; Tuo, Tuolumne; Ven, Ventura; Yol, Yolo; Yub, Yuba.

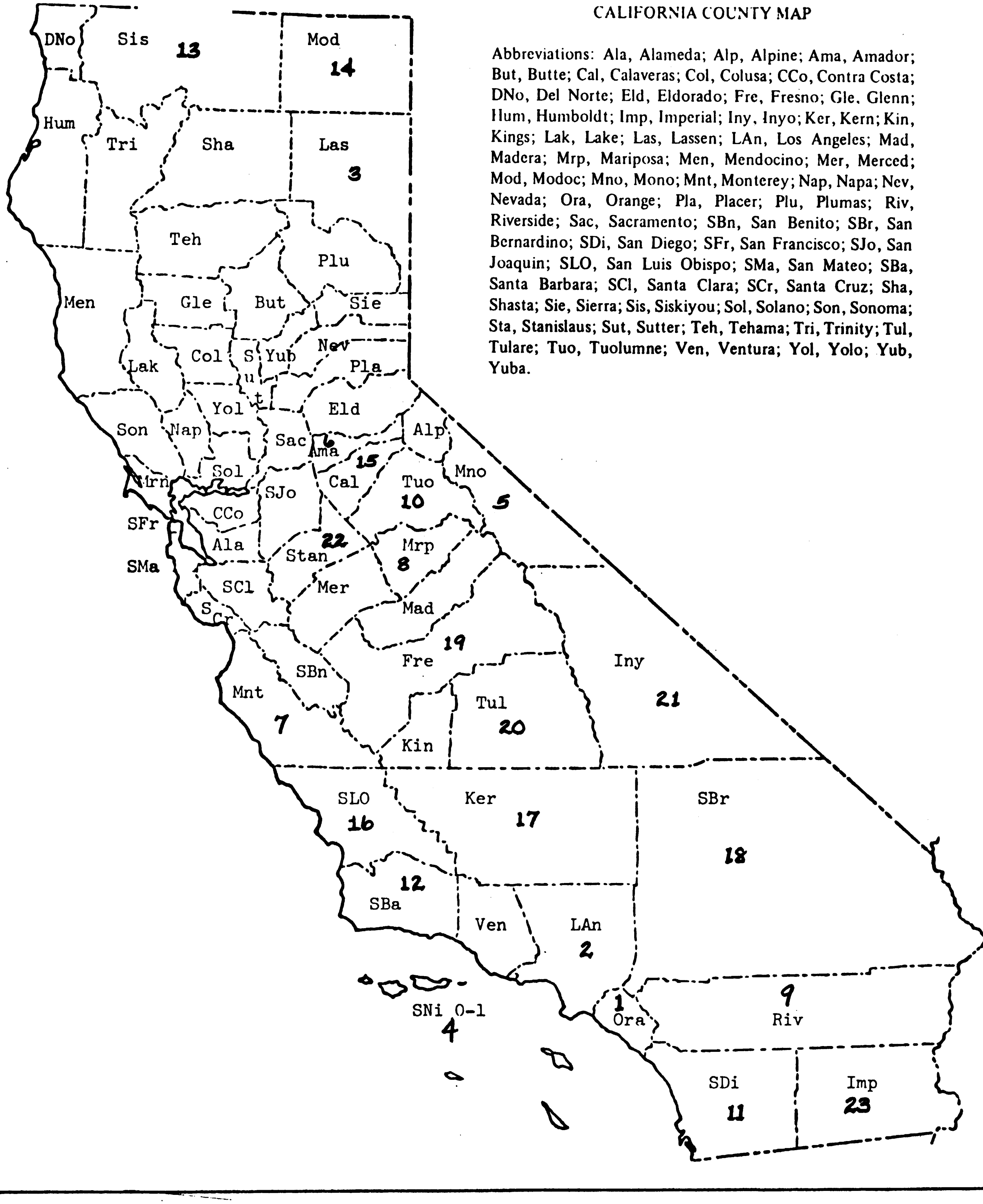

Fig. 2c
PICTOGRAPHS
Metric is Modified Chi-Square Statistic Based on all Categories
County Ranking Defined by 1 Dimensional Solution

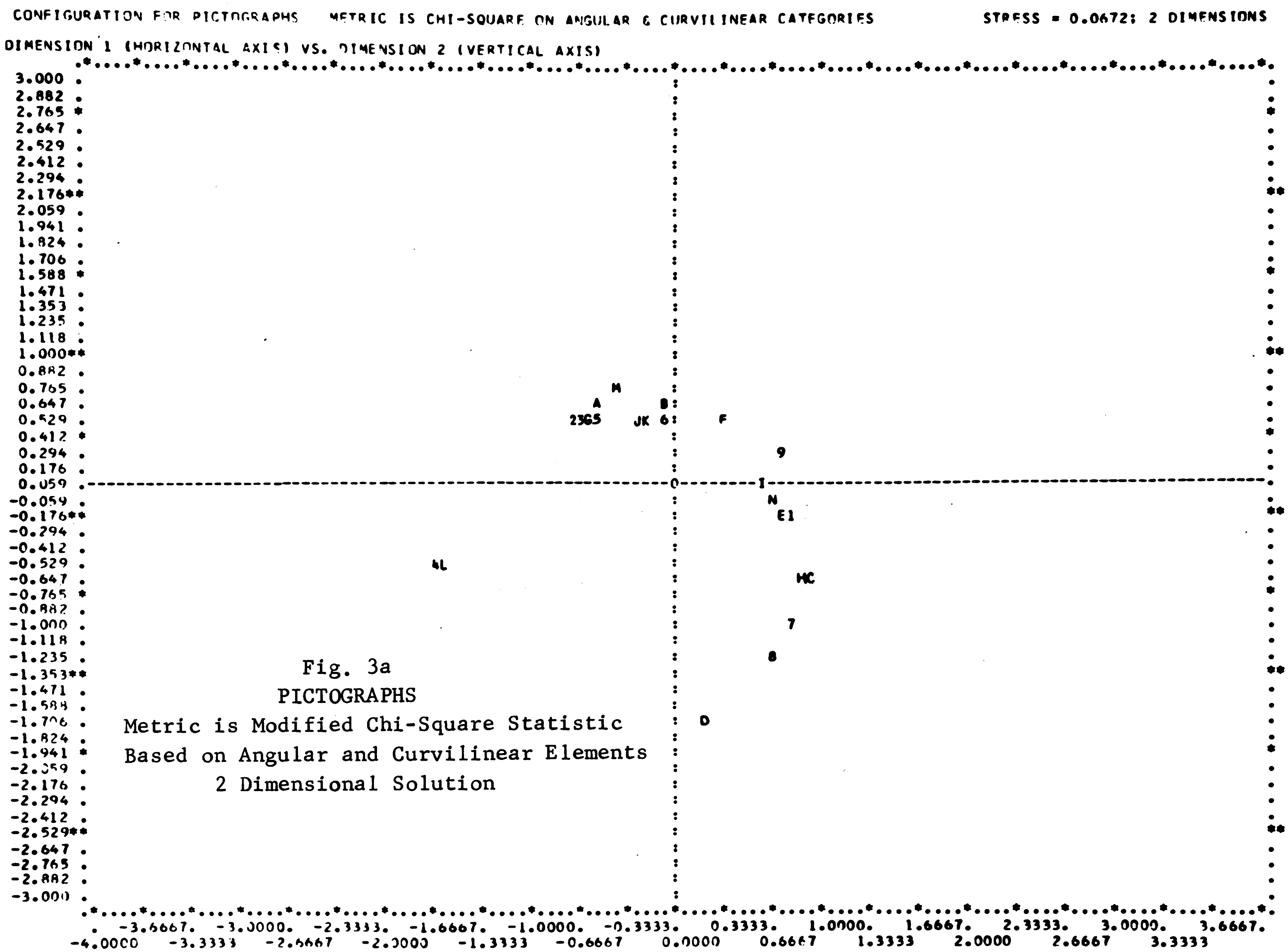

Fig. 3a
PICTOGRAPHS
Metric is Modified Chi-Square Statistic
Based on Angular and Curvilinear Elements
2 Dimensional Solution

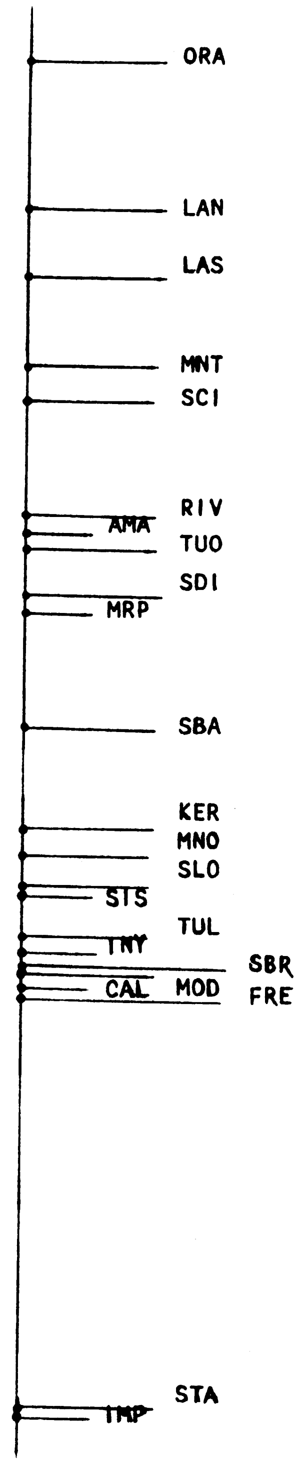

Fig. 3b
PICTOGRAPHS
Metric is Modified Chi-Square Statistic Based on Angular and Curvilinear Elements
1 Dimensional Solution

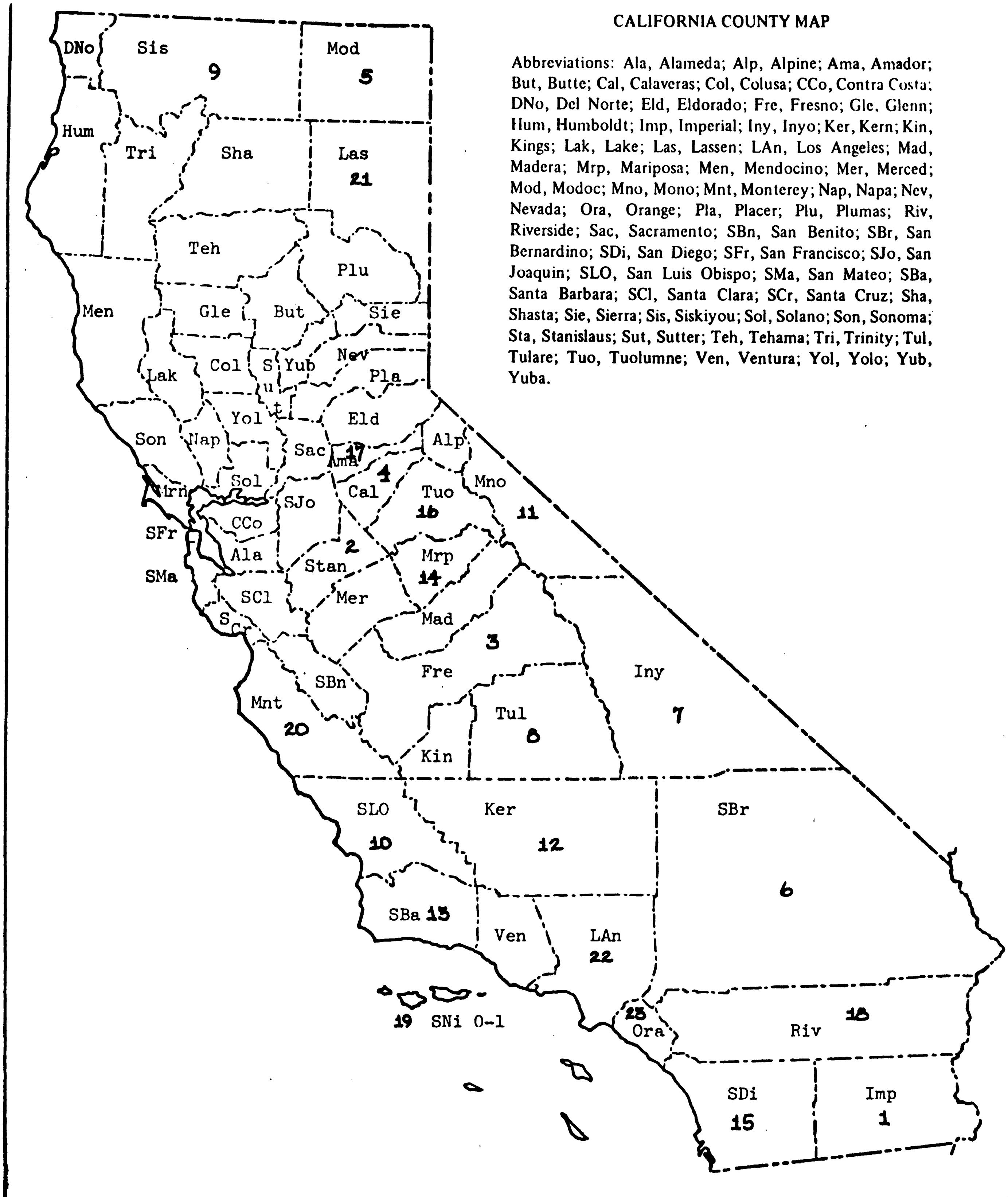

Fig. 3c
PICTOGRAPHS
Metric is Modified Chi-Square Statistic Based on Angular and Curvilinear Elements
County Ranking Defined by 1 Dimensional Solution

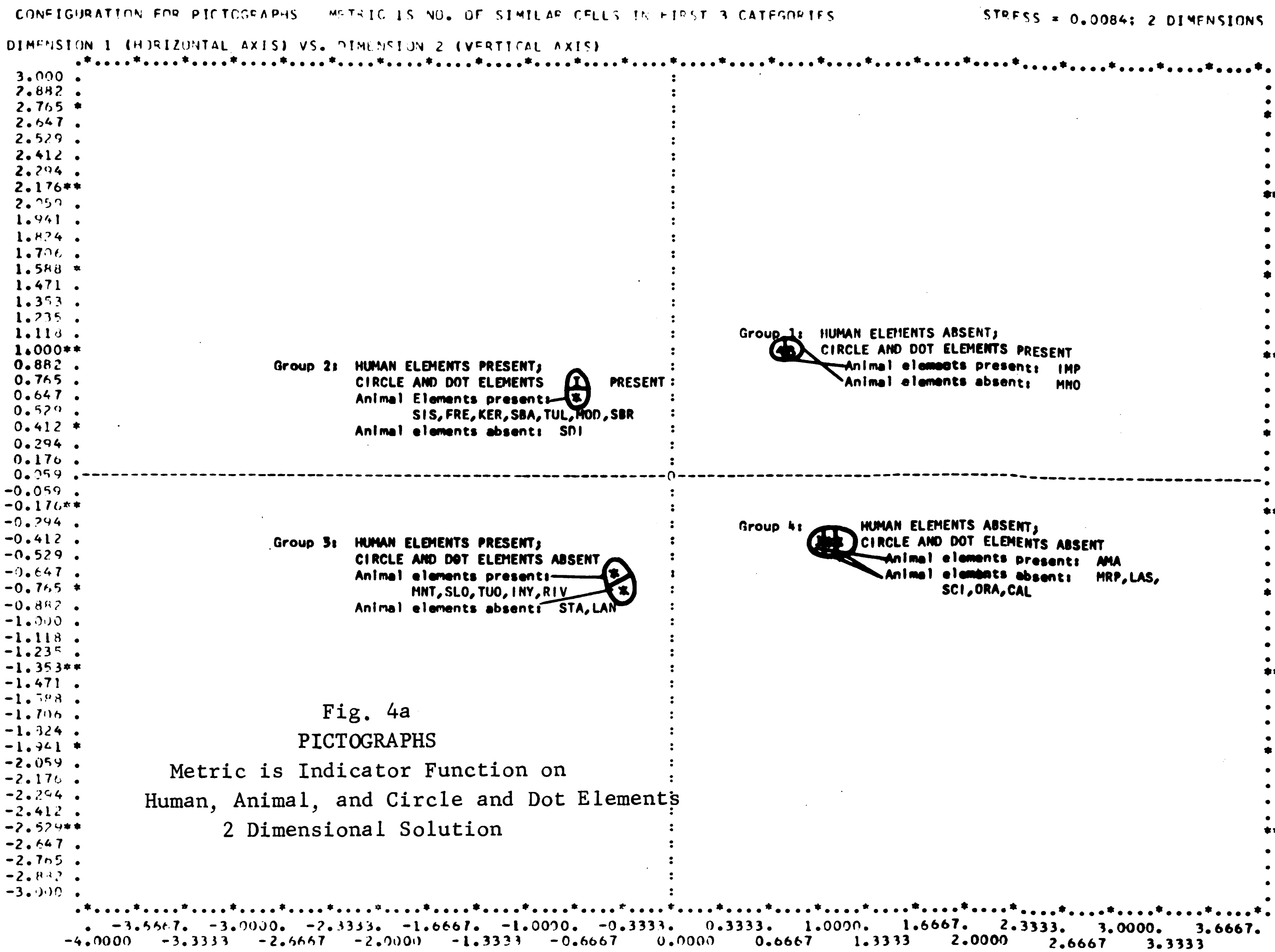

Fig. 4a
PICTOGRAPHS
Metric is Indicator Function on
Human, Animal, and Circle and Dot Elements
2 Dimensional Solution

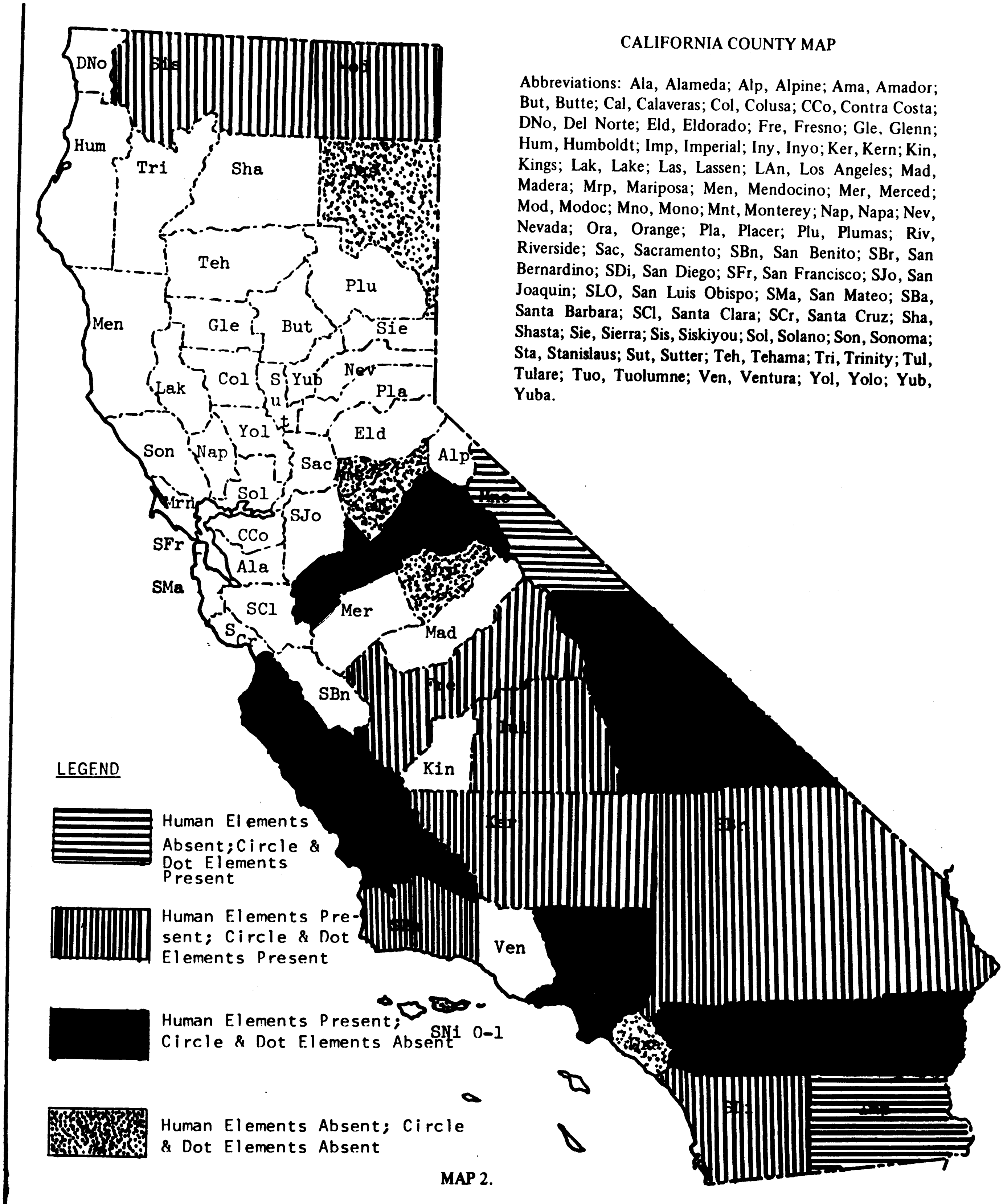

Fig. 4b
PICTOGRAPHS
Metric is Indicator Function on Human, Animal, and Circle and Dot Elements
Counties are Classified According to 4 Main Groupings from 2-Dimensional Solution

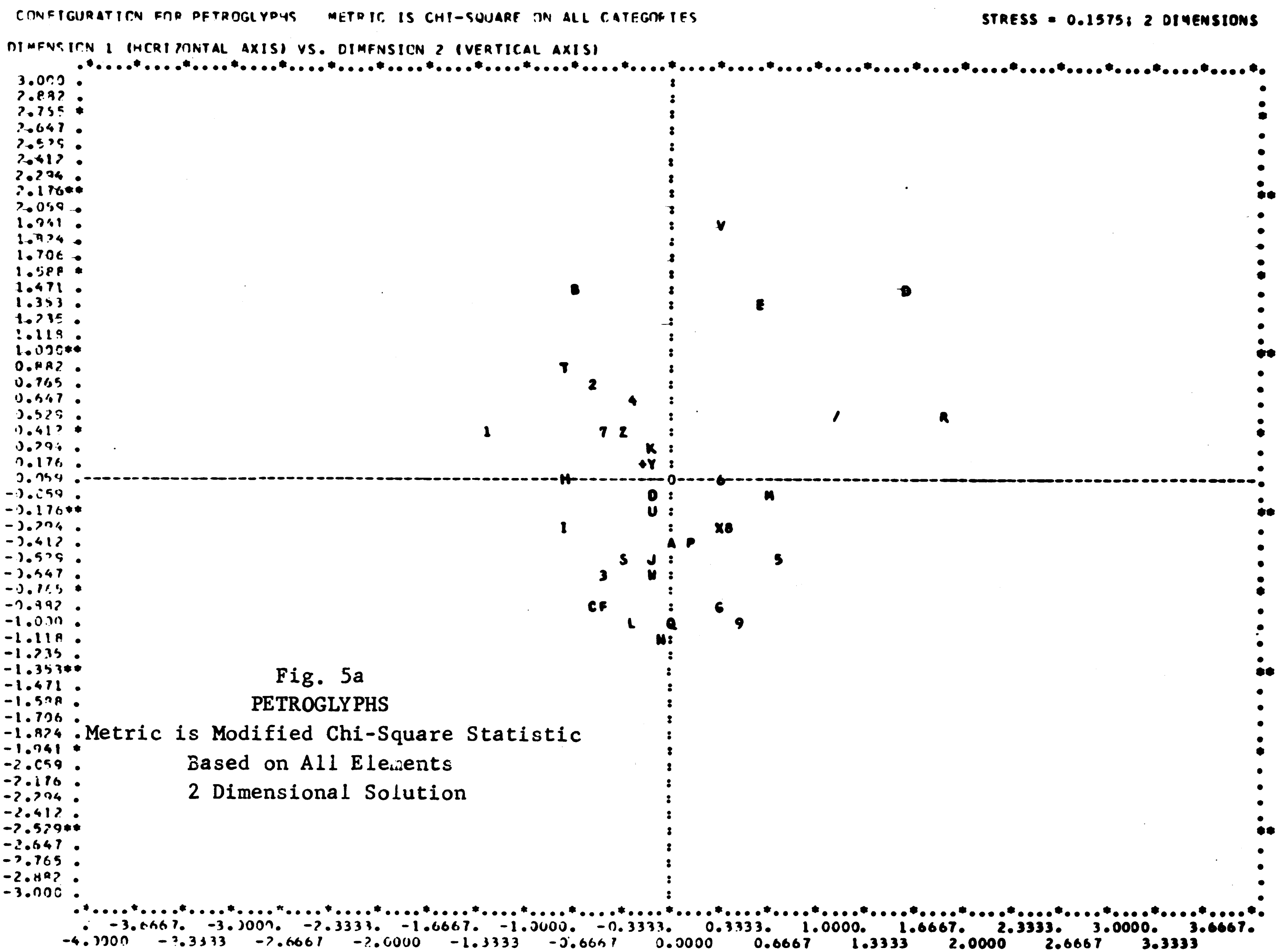

Fig. 5a
PETROGLYPHS
Metric is Modified Chi-Square Statistic
Based on All Elements
2 Dimensional Solution

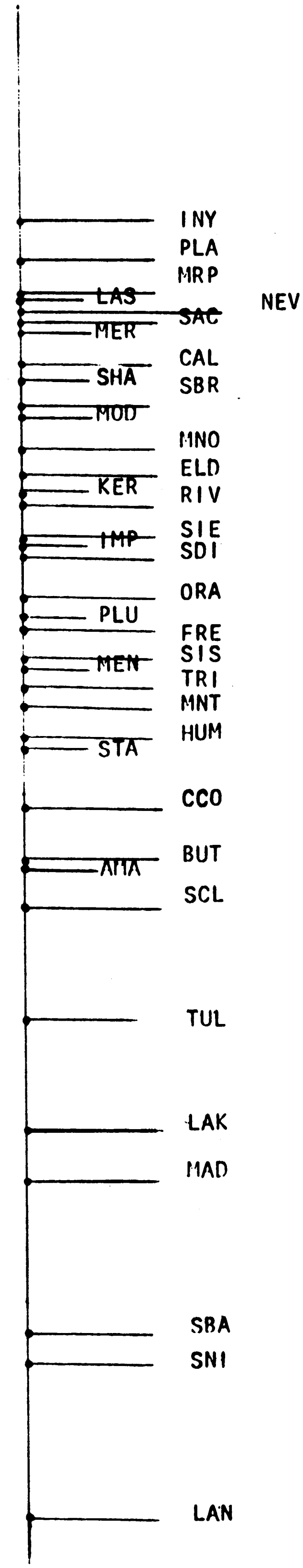

Fig. 5b
PETROGLYPHS
Metric is Modified Chi-Square Statistic Based on all Elements
1 Dimensional Solution

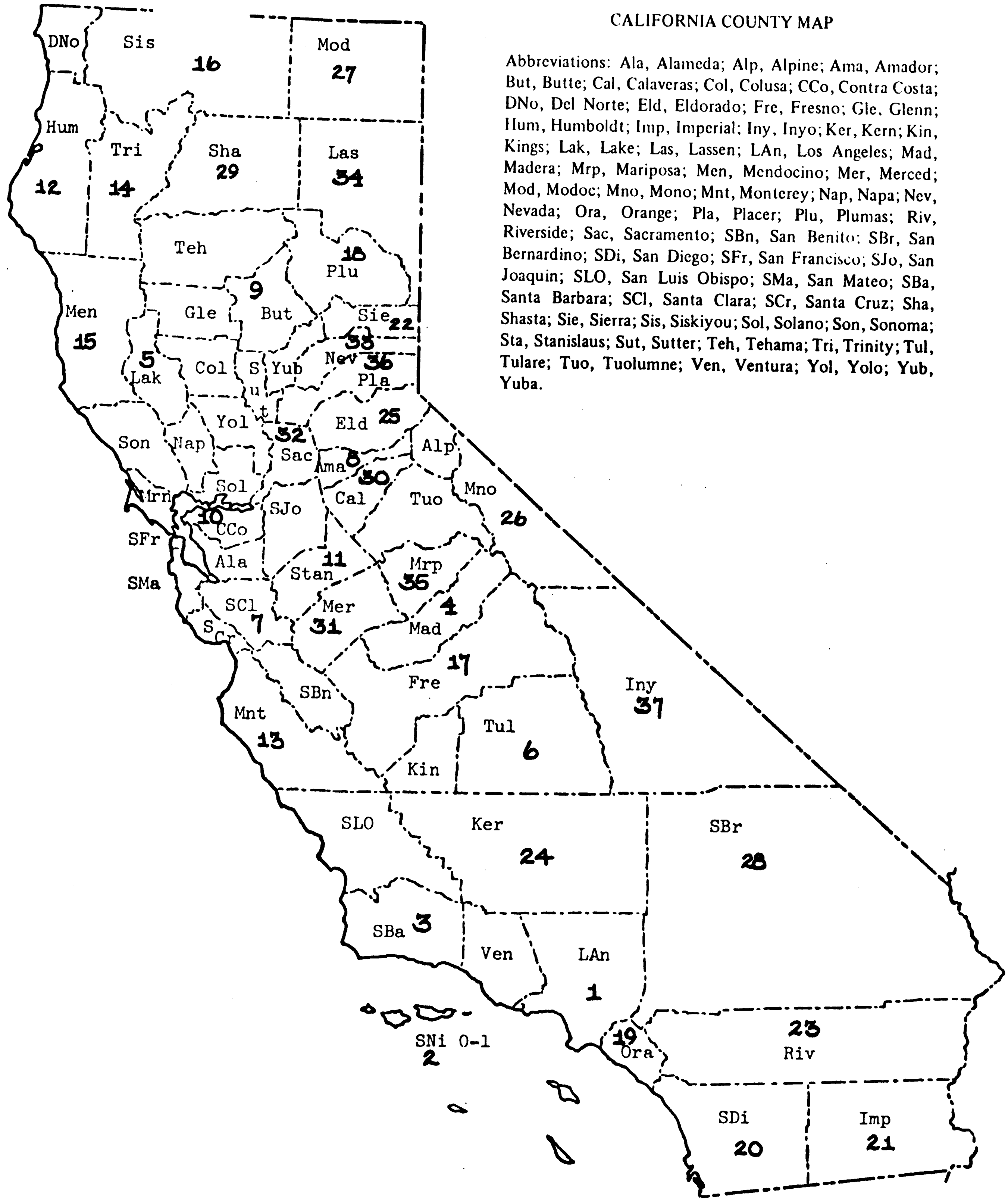

Fig. 5c
PETROGLYPHS
Metric is Modified Chi-Square Statistic Based on All Elements
County Ranking Defined by 1 Dimensional Solution

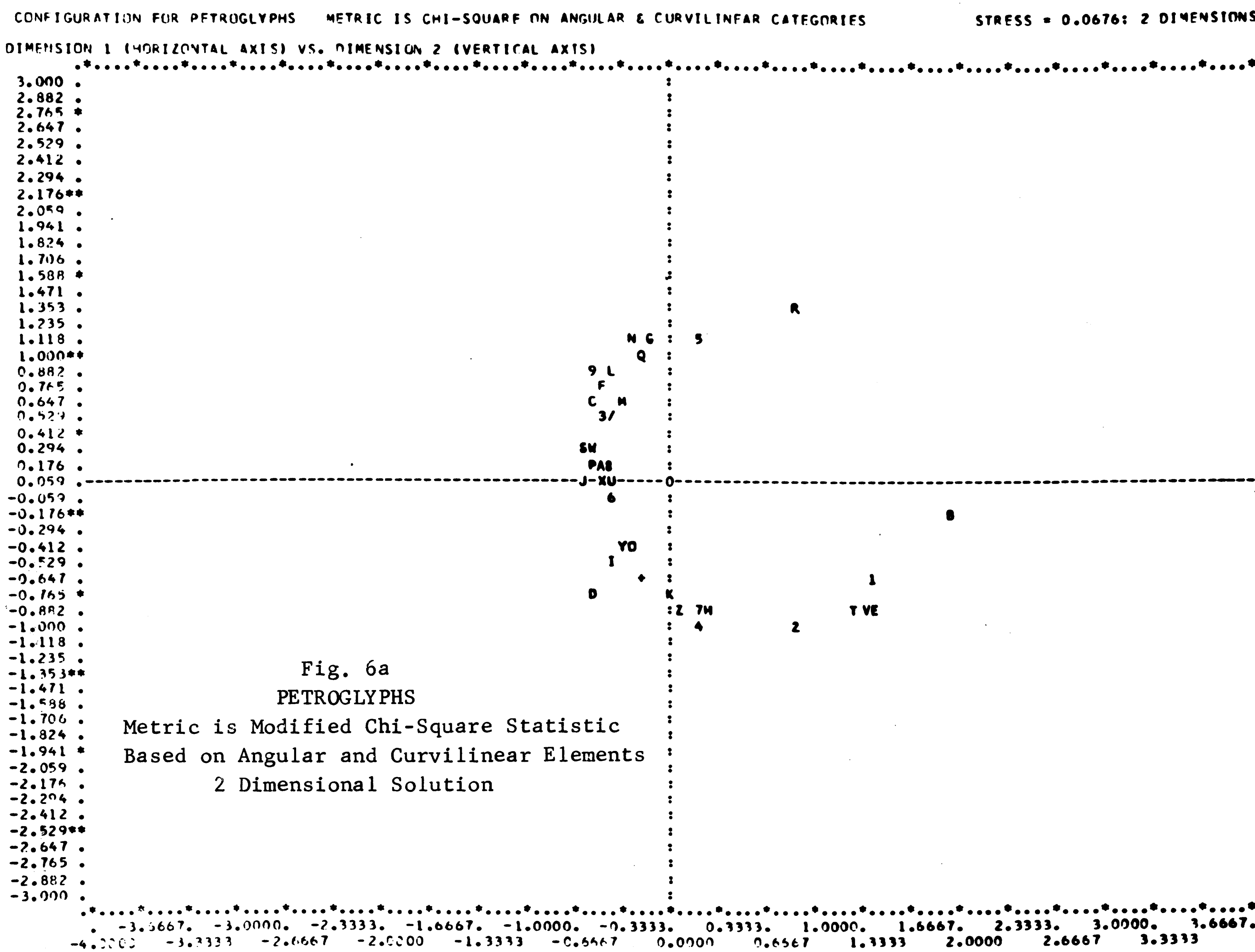

Fig. 6a
PETROGLYPHS
Metric is Modified Chi-Square Statistic
Based on Angular and Curvilinear Elements
2 Dimensional Solution

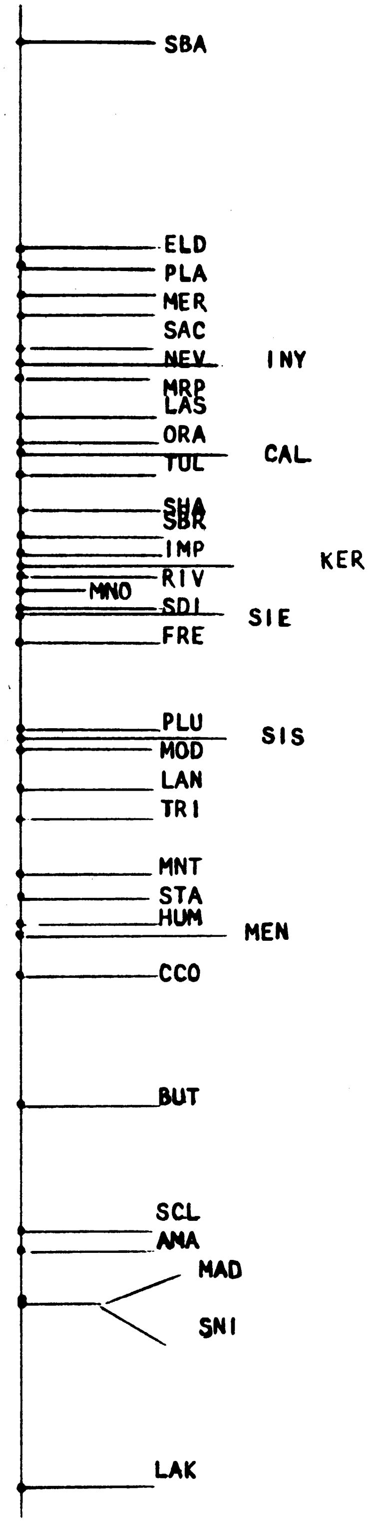

Fig. 6b
PETROGLYPHS
Metric is Modified Chi-Square Statistic Based on Angular and Curvilinear Elements
1 Dimensional Solution

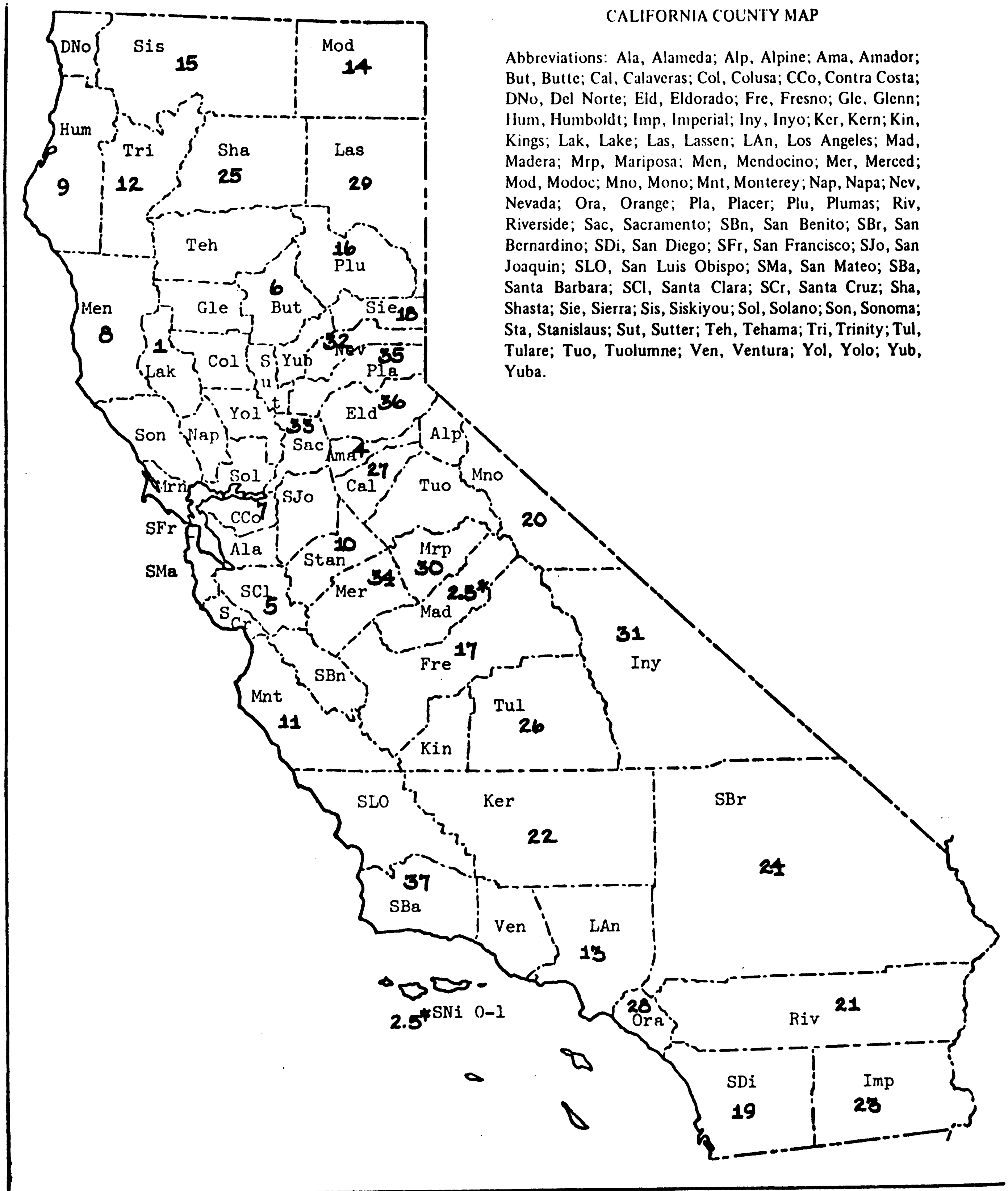

Fig. 6c
PETROGLYPHS
Metric is Modified Chi-Square Statistic Based on Angular and Curvilinear Elements
County Ranking Defined by 1 Dimensional Solution

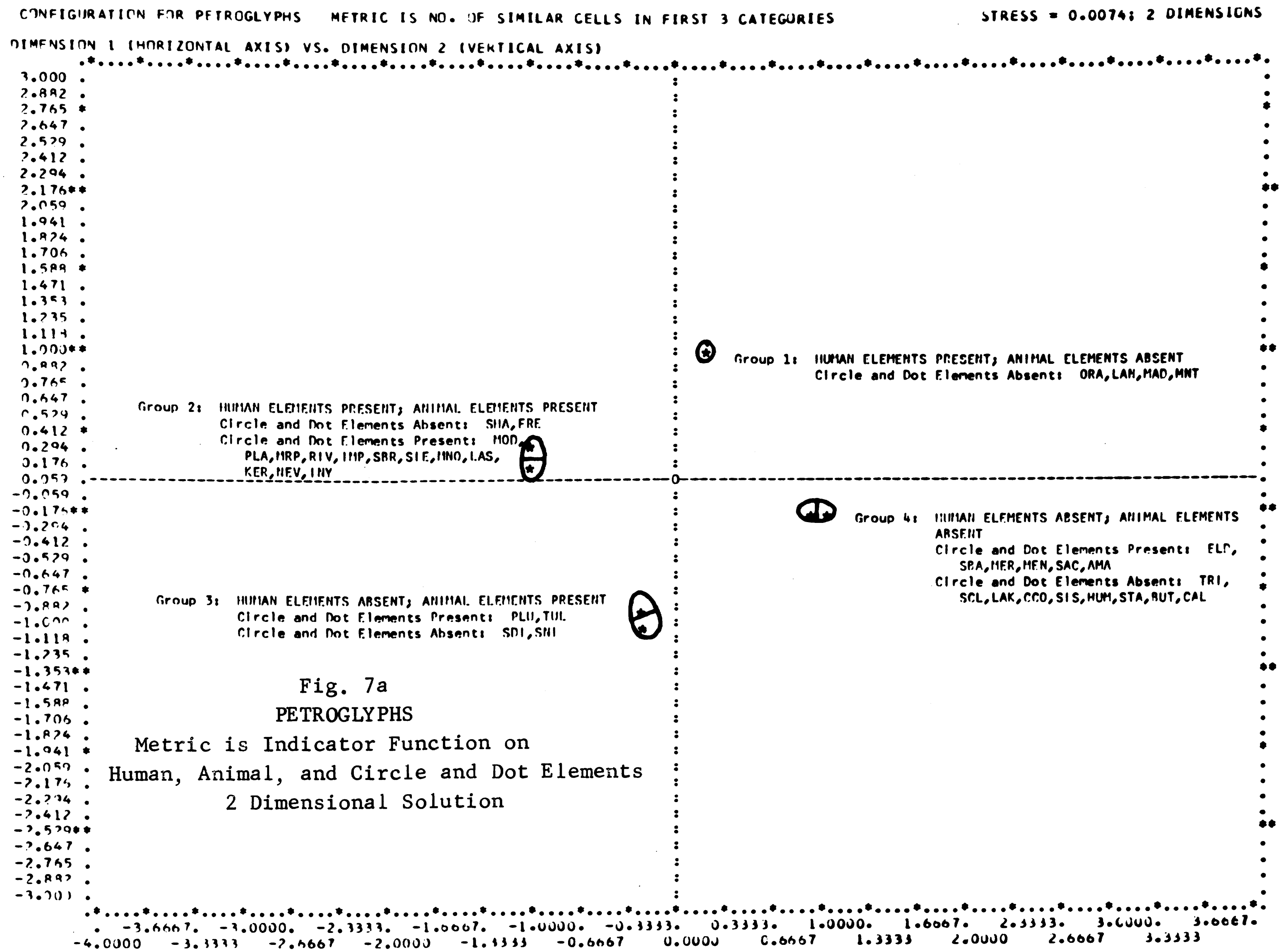

Fig. 7a
PETROGLYPHS
Metric is Indicator Function on
Human, Animal, and Circle and Dot Elements
2 Dimensional Solution

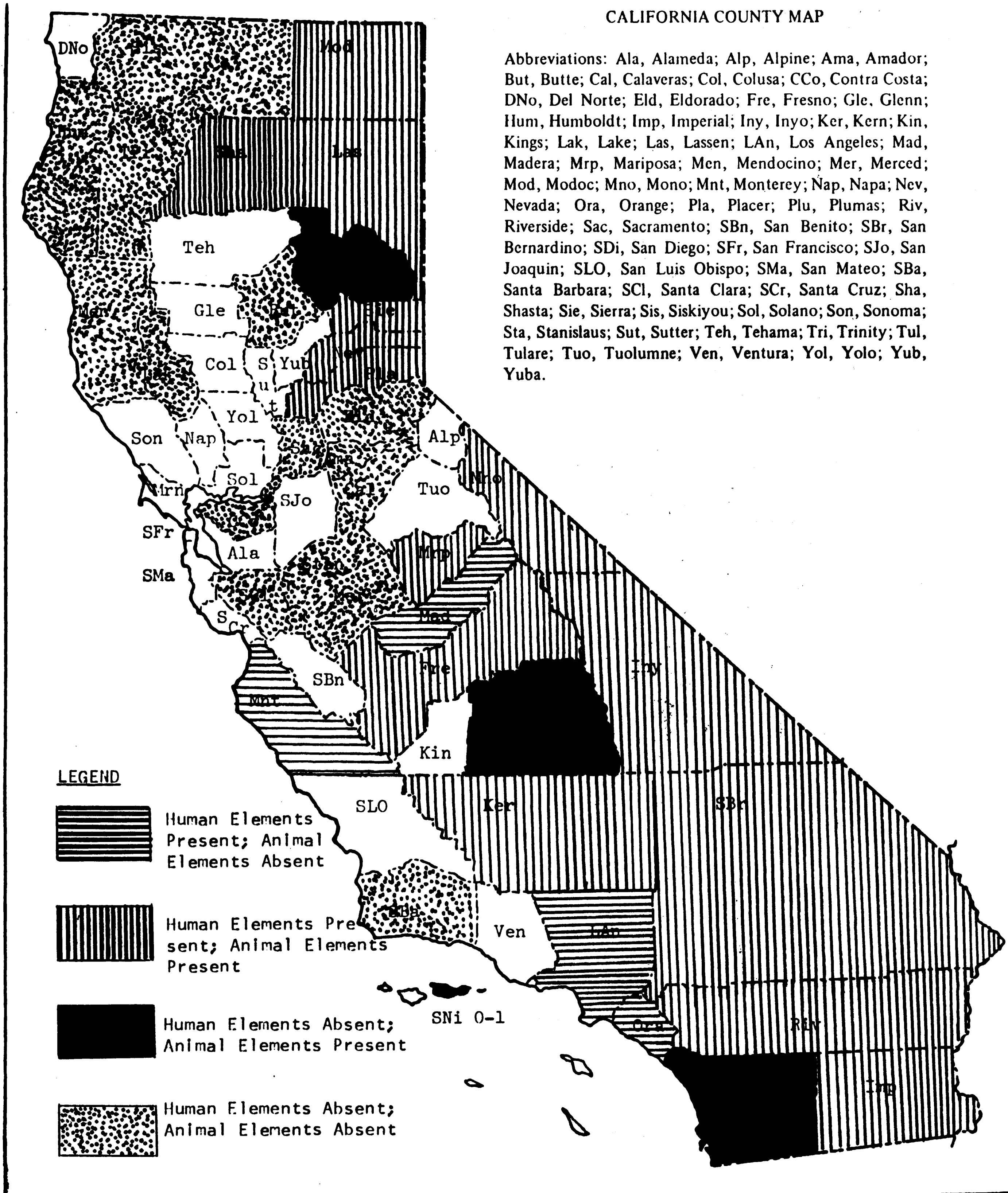

Fig. 7b
PETROGLYPHS
Metric is Indicator Function on Human, Animal, and Circle and Dot Elements
Counties are Classified According to 4 Main Grouping from 2-Dimensional Solution

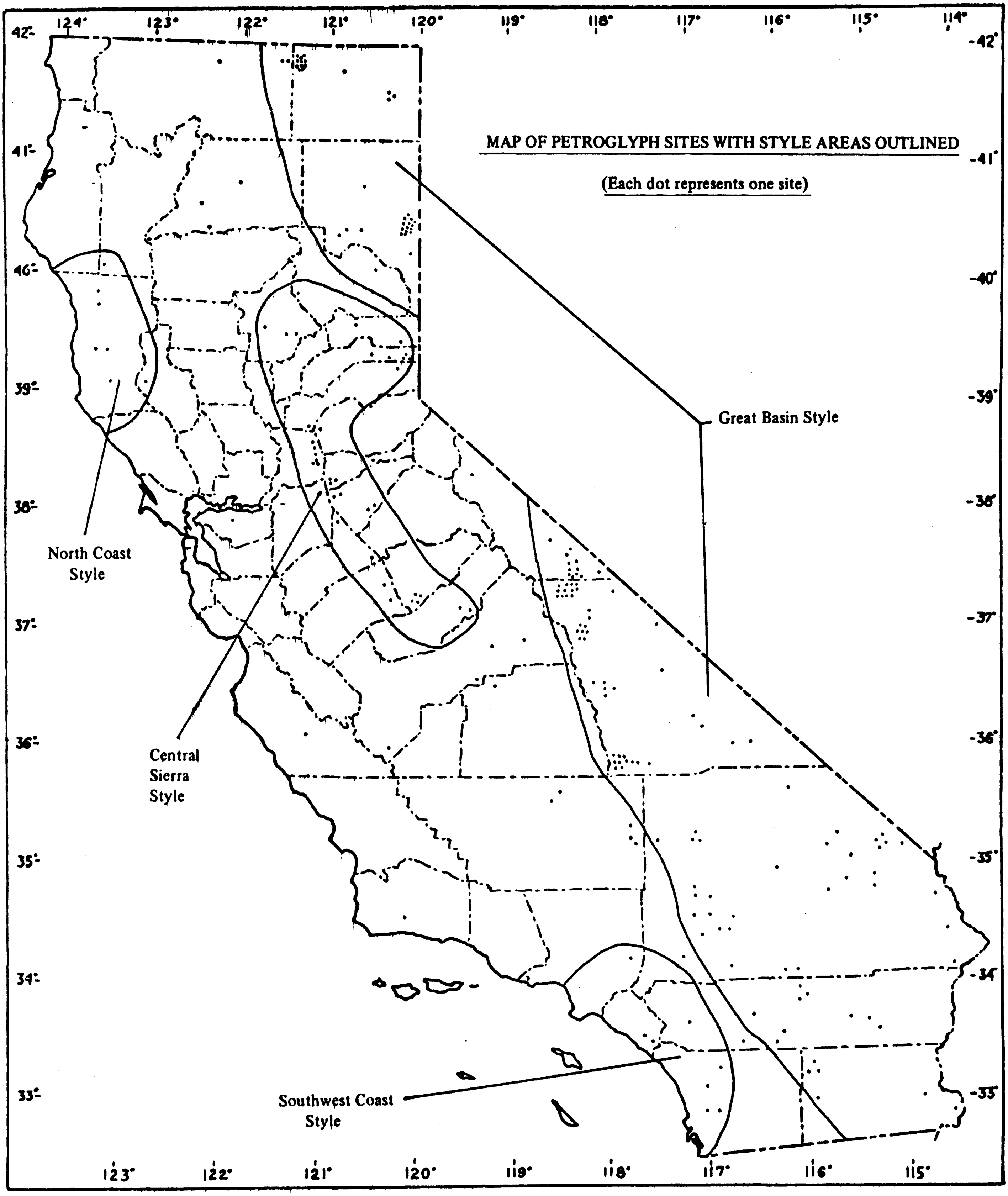

Fig. 8. California Petroglyph Style Areas (From Heizer and Clewlow 1973:Map 15)

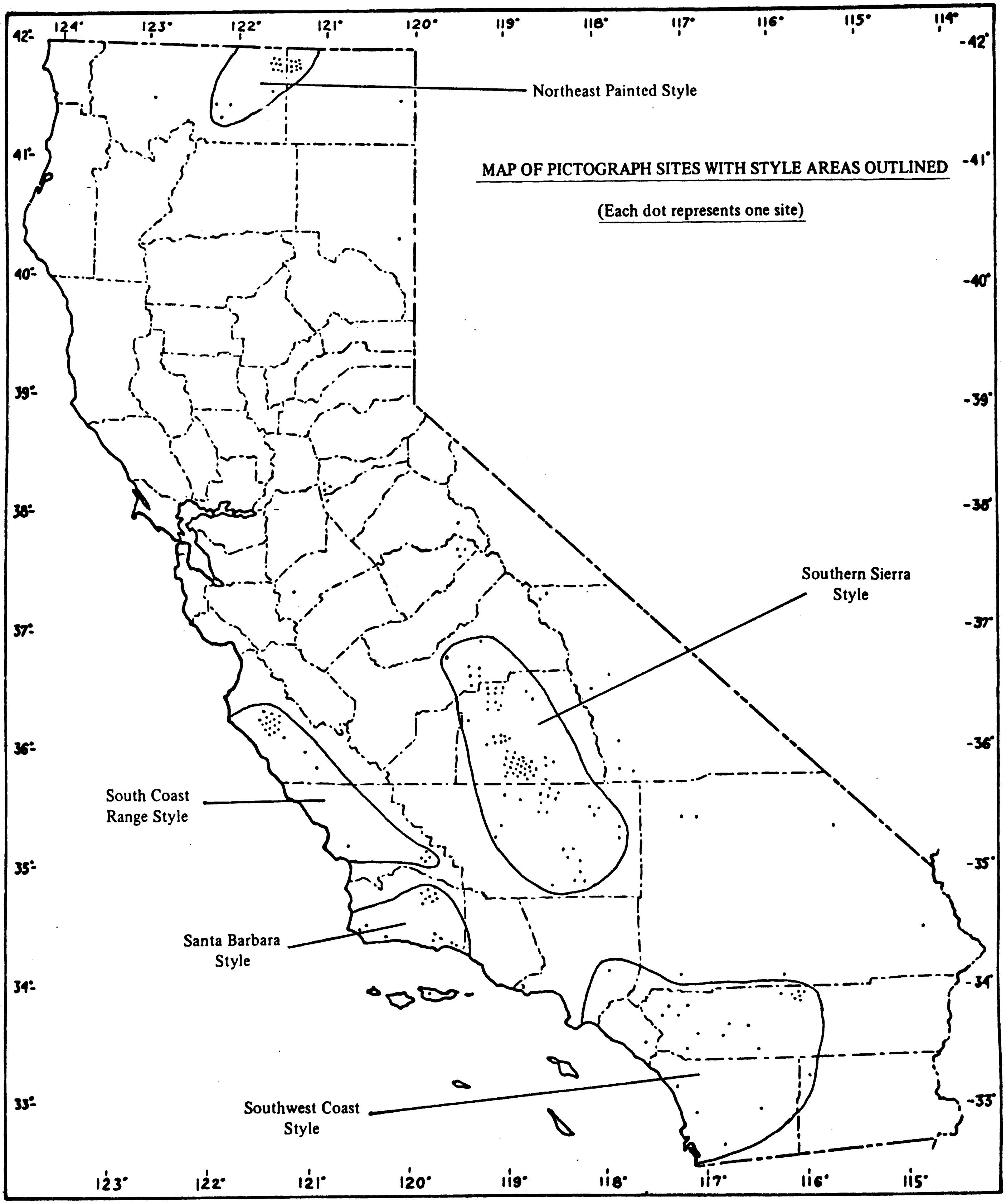

Fig. 9. California Pictograph Style Areas (From Heizer and Clewlow 1973:Map 16).

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