Title
INTERNATIONAL GEOTHERMAL INFORMATION EXCHANGE. THE GRID PROGRAM

Author
Harris, F. Allen

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International Geothermal Information Exchange. The GRID Program

F. Allen Harris and
Sidney L. Phillips

October 1976

Lawrence Berkeley Laboratory University of California/Berkeley

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by

F. Allen Harris
CCMS Activities
U.S. Environmental Protection Agency
Washington, D.C.

Sidney L. Phillips
Lawrence Berkeley Laboratory
University of California
Berkeley, Ca. 94720

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Introduction

The need to utilize domestic energy sources which are so essential to our health and economic well-being cannot be questioned. Based on the availability of energy sources, both developed and developing nations must modify plans for expanding or building industrial capacity, and improving transportation systems. A very delicate balance exists between acceptable energy sources and those with imposed conditions which stifle and impede needed progress.

Many developed and developing nations are resolved to become energy independent of foreign sources to the extent possible. A most promising new domestic energy source - geothermal - while not yet well understood will surely play a significant role in the energy economy of the future. There exists a worldwide research and development activity in geothermal energy with the objective of stimulating and facilitating the early and significant utilization of geothermal energy for electrical power production and other uses.

Just as important as research, development and commercialization is the collection and dissemination of current information about geothermal science and techology. It is the case in the geothermal field - and understandably so because the field is undergoing so rapid a growth - that there are many gaps in what is termed "public knowledge" about geothermal energy. New techniques have been developed for research that should be widely applied for exploration and utilization; basic scientific data may be applied to predictive modeling thereby saving much time and effort; some geothermal resources may not be made productive by any current technology; other

resources may be utilized quickly without the necessity for further development work. To fill these information gaps is necessary and urgent; if the gaps are not filled, there is the penalty of unnecessary duplication and expense in research, and the additional expense, not often measurable in monetary terms, that needed geothermal energy sources cannot be utilized.

The prompt international exchange of new information and data relative to the development and utilization of geothermal resources is of great practical importance. This is a principal objective of the Lawrence Berkeley Laboratory's geothermal data program, which I will now discuss.

Categories of Information Available to Users

The Lawrence Berkeley Laboratory is sponsored by the U.S. Energy Research and Development Administration to establish a National Geothermal Information Resource (GRID) as an information analysis center. See Figure 1. In performing this information analysis function, GRID (1) acquires and stores worldwide data in machine-retrievable format, (2) evaluates and analyzes information in special areas of geothermal science and technology, (3) disseminates information and data on a worldwide basis.

The objective of GRID is mainly to compile and disseminate evaluated data on geothermal science and technology. For this purpose, we have found it convenient to classify geothermal information into the following six major categories: (1) exploration, (2) utilization, (3) institutional considerations, (4) environmental aspects, (5) reservoir characteristics, and (6) physical chemistry. See Figure 2.

GRID Data Categories

EXPLORATION considers geological, geochemical, geophysical and hydrological methods, as well as drilling, resource assessment and land-use factors involved in locating and evaluating high temperature geothermal resources.

National Geothermal Information Resource (GRID)

-- ERDA Information Analysis Center

-- Acquires and stores worldwide data in machine-retrievable format

-- Evaluates and analyzes information in special areas of geothermal science and technology

-- Disseminates information and data on worldwide basis

Figure 1

GRID Data Categories

EXPLORATION considers geological, geochemical and geophysical methods, as well as drilling, resource assessment and land-use factors involved in locating and evaluating high temperature geothermal resources.

PHYSICAL CHEMISTRY deals with the basic thermodynamic, thermophysical, and kinetic data at elevated temperatures and pressures of sodium chloride, silicates, rock-solution interactions and isobutane.

UTILIZATION encompasses the development and production of a geothermal reservoir for both electrical and non-electrical uses: hot water (brine) transport; space, process, and agricultural heating; power generation; corrosion, erosion and scaling; resource evaluation.

ENVIRONMENTAL considers aspects to the air, land and water environments of geothermal energy utilization: subsidence, hydrogen sulfide, metals, boron, ammonia, silica, seismicity, noise and land-use.

INSTITUTIONAL covers Federal, state and local organizational, legal and regulatory considerations in the development of geothermal energy: land-use, exploration and production, operating regulations, developmental incentives, sale of geothermal power and fluid transport.

RESERVOIR ENGINEERING includes reviews and evaluation of data relevant to the development and production of wells: porosity, artificial stimulation, natural recharge, artificial recharge, modeling, well tests and measurements.

Figure 2

PHYSICAL CHEMISTRY deals with the basic thermodynamic, thermophysical, and kinetic data at elevated temperatures and pressures of sodium chloride, silicates, rock-solution interactions and isobutane.

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Such data are needed, for example, in the intelligent design of geothermal power plants, and to predict and understand the behavior which may be used for either electrical or other applications, (e.g., process heat).

Current Projects

As shown in Fig. 3, 3A, 3B, the current GRID projects include the following: (1) subsidence bibliography, (2) hydrogen sulfide bibliography, (3) basic properties of sodium chloride solutions, (4) brine treatment and (5) brine chemistry numerical data file.

Those organizations or individuals interested in these projects and

Current Projects

Subsidence

Hydrogen Sulfide

NaCl Basic Properties

Study of Brine Treatment

Brine Chemistry Numerical File

East Mesa KGRA File

SDG&E/ERDA Data Logger

Other

Figure 3

Example of bibliographic printout on worldwide geothermal exploration

Figure 3A

DESCRIPTORS- AMPLIFIERS; DESIGN; FABRICATION; MAGMA; PHOTODIODES; RADIOMETERS; SUBTERRENE PENETRATORS; TEMPERATURE MEASUREMENT; THERMAL RADIATION.

201

STOREY 74
EXPLORATION/DRILLING

TITLE- GEOTHERMAL DRILLING IN KLAMATH FALLS, OREGON.

AUTHOR- STOREY, D.M.

REFERENCE- GEOTHERM. ENERGY, MAG., V. 2 (11), P. 61-63(1974).

DESCRIPTORS- DRILL RIGS; AIR ROTARY RIGS; CABLE RIGS; SPACE HEATING; COMMERCIAL WELLS; RESIDENTIAL WELLS; COSTS.

202

SUTKO 75
EXPLORATION/DRILLING

TITLE- BIT NOZZLE CHANGES COULD IMPROVE DRILLING HYDRAULICS.

AUTHOR- SUTKO, A.A.;SIFFERMAN, T.R.;HADEN, E.L.;WAHL, H.A. [CONTINENTAL OIL CO., PONCA CITY, OKLA. (USA)].

REFERENCE- OIL GAS J., V. 73 (7), P. 102-106(1975).

DESCRIPTORS- DRILL BITS; DRILLING HYDRAULICS; RESEARCH PROGRAMS; DRILLING DATA; DRILL CHARACTERISTICS.

203

URBAIN 75
EXPLORATION/DRILLING

TITLE- TAPPING GEOTHERMAL FORMATIONS IN EL SALVADOR CALLS FOR INNOVATIONS.

AUTHOR- URBAIN, C. [FORAMINES, S.A.].

Example of brine chemistry numerical data in GRID file

Figure 3B

WELL RRGE-1
RAFT RIVER GEOTHERMAL FIELD
LOCATION-- T15S, R26E, SEC 23, 31
CASSIA COUNTY, STATE = ID. COUNTRY = USA

SC=RAFT RIVER-1A
SAMPLE TYPE WATER

WELL INFORMATION
OWNER--ERDA, AEROJET NUCLEAR COMPANY
DATE DRILLED-- 4 JAN 75 - 31 MAR 75

WELL DATA
DEPTH ----- 1521 METERS
TEMPERATURE 146 C AT 1521
PRESSURE, SHUT-IN-- 170 PSI - HOT, SHUT-IN.
2003 PSI - AT BH.
FLOW INFORMATION-- 650 GPM--AVERAGE.
PRODUCTION INTERVAL-- 1326-1494M
RESERVOIR LITHOLOGY-- RESERVOIR IN TUFF WITH INTERMITTENT INTERBEDDED SI LTSTONE.

SAMPLING INFORMATION
DATA ARE COMPILATION OF CHEM ANALYSES TO 30 SEP 75.

BRINE DATA
UNITS-- PPM UNITS FOR GASSES-- ML/L AT STP

CONSTITUENT	CONCENTRATION	COMMENT
SIO2	91.00	
CL	605.0	
F	5.400	+-.3
HCO3	71.00	AS CACO3
CO3	----	NO
NA	359.0	
K	25.00	
CA	51.00	
MG	1.900	
H2	.5300	
HE	2.7000E-02	
N2	31.90	
O2	.1000	
AR	.6600	
CO2	5.800	

BIBLIOGRAPHIC DATA
SOURCES--
KUNZE 75B

OTHER NOTES
DATA CURRENT--30 SEP 75

Figure 3B

other GRID activities will obtain additional information by contacting:

National Geothermal Information Resource
Lawrence Berkeley Laboratory
Bldg. 90-3117
Berkeley, Ca. 94720
U.S.A.
Tel. (415) 843-2740, X5818 or X5980
FTS 451-5818, 451-5980

International Information Exchange

GRID asks the cooperation of geothermal specialists throughout the world in sending new data or publications for inclusion in our computer files. Cooperating specialists are provided GRID and other work and services at no cost. There is currently an existing program between ERDA/GRID and the National Research Council/Ente Nazionale per l'Energia elettrica in Italy under which data exchange has already taken place.

Documentation File (GEODOC)

The GRID documentation file, GEODOC, is a computer-based file which contains descriptive cataloging and indexing rules for all GRID documents. This file (along with other GRID files) is managed by the Berkeley Data Base Management System (BDMS).

Each record in the GEODOC file contains descriptive cataloging, abstracting, and indexing information corresponding to a single document. The information within a given record is subdivided into computer retrievable "data elements". Figures 4 and 5 lists the definition of all the data elements which may appear in a GEODOC record. Some data elements, e.g., Author's name, can occur repeatedly within a record and an "m" in the third column of Figure 4 indicates that such multiple occurrences are allowed. The "LBL Tag" for each data element is shown in the left hand column of Figures 4 and 5. These tags are used to label the data elements within a

Table I. OEODOC Data Elements

LBL Tag	INIS Tag	m*	n*	Data Element Definition
SC	008			document short code: unique identifier for document
TY				type of document/bibliographic levels/literary indicator
DES-CAT		m	n	delineates information for one bibliographic level
BL	009			bibliographic level indicator
PT	200			primary title (translated into English if necessary)
PS	201			primary subtitle (translated into English if necessary)
TA	620			title augmentation
L	600			language (for non-English document)
OT	230			original title (non-English) or journal/series title
OS	231			original subtitle (non-English) or journal/series subtitle
ED	250			edition
CODEN				journal CODEN
AUTHORS		m	n	delineates author-affiliation group
AU	100	m		author's name
AN	100			author note (ed., comp., eds., comps.)
AA	100	m		author's affiliation
AC	700			affiliation code
CE	110	m		corporate entry
CC	710			corporate code
DG	111			academic degree
SPO		m		sponsor
SPC				sponsor code
SCN		m		sponsor contract number
RN	300			report or patent number
SN	310	m		secondary numbers
INT	320			International Standard Book Number or Patent Code
PUB	402			publisher
PUP	401			place of publication
PUD	403			publication date
COL	500			collation (volume, issue, page)
N	610			note
COT	210			conference title
COP	211			conference place
COD	213			conference date
AV				availability and price

Figure 4

Table I. GEODOC Data Elements (Continued)

LBL Tag	INIS Tag	m*	n	Data Element Definition
REL-REF		m	n	delineates information for one related reference.
RL				relator
RLR				relationship and reference
RSC				related short code
ABSTRACT		m	n	delineates one abstract
ABS				abstract
ABSO		m		abstract source
INDEX		m	n	INDEX.1 general indexing. INDEX.2, 3,...N splits
CQ		m		category/qualifier
TICC		m		TIC category
DE	800	m		descriptor from thesaurus
DD	800	m		data descriptor from thesaurus
ID	m			identifier
PD	810	m		proposed descriptor
CONTROL			n	internal LBL data elements
LA		m		local availability
BR				borrow/return
DCSO		m		descriptive catalogers initials, date and comment
AISO		m		abstractor-indexers initials, date and comment
DATA-FILE		m		data file name
POT		m		data descriptor for potential data
IN		m		data descriptor for included data

*m-This data element may have multiple entries
*n-This data element contains no value and need not be entered on input. It serves to delineate a group of data elements.

Figure 5

record.

The GEODOC cataloging rules are standardized and are modeled after those of the International Nuclear Information System (INIS) of the International Atomic Energy Agency. The GEODOC data elements have been chosen to correspond as closely as possible to those used by INIS to facilitate worldwide information exchange with other data bases using INIS rules.

The GRID records are permanently stored on magnetic tape; temporary storage on disc files is also utilized for when faster access than tape is desired. Multiple copies of the data are stored on back-up tapes to provide for possible computer system crashes or failure of the storage medium, e.g., breakage of the magnetic tape.

We have found that a computerized data base has numerous advantages in the manipulation of large amounts of data. For example, selective retrieval and editing of bibliographic citations is made trivial through the use of BDMS. Figure 6 shows several of the data element keys (indexes) which can be searched for a specific topic, e.g., Author, thus facilitating the generation of various quick indexes to the citations.

Essentially all the records have a category called "Descriptors" which contains key words to describe the data content of the article. This enables one to retrieve all the citations that deal with a particular property; for example, one may retrieve all the records that deal with sodium chloride viscosity. At the present time, searches are allowed on only one descriptor at a time; later we expect to have the capability of performing a Boolean search. This will permit a file search with a string of operations, e.g., to find all the stored citations that deal with density and sodium chloride solutions at $25^{o}C$ and pressures greater than 100 bars. All "Descriptors" used are listed in a thesaurus of controlled terms. Other data elements

0 0 0 0 4 6 0 0 5 0 2 4

BOOK	COLLECT	DRAWING	FILM	MAP	PHONO.	J ART.	PATENT	REPORT	COMPUT
B	C	D	F	G	H	J	P	R	T

Type of Record

/

ANAL	MONOGR	SERIAL	COLL
A	M	S	C

Biblio. Level

/

CONF	DICT	N DATA	THESIS	STAND	BIBLIOG	PR.REPT.	ABSTRACT
K	L	N	U	W	Z	Y	E

Literary Indicator

NATIONAL GEOTHERMAL INFORMATION RESOURCE

GENERAL FORM

GRID WORKSHEET

☐ OF ☐

SHORT CODE (SC)	
DES. CAT. SOURCE (DCSO)	
DOCUMENT TYPE (TY)	

PERMITTED BIBLIOGRAPHIC LEVEL: A or M

BIBLIOGRAPHIC LEVEL (BL)	
PRIMARY TITLE (PT)	
PRIMARY SUBTITLE (PS)	
TITLE AUGMENTATION (TA)	
LANGUAGE (L)	
ORIGINAL TITLE (OT)	
ORIGINAL SUBTITLE (OS)	
EDITION (ED)	
AUTHOR (AU)	
AUTHOR NOTE (AN)	
AUTHOR AFFILIATION (AA)	
AFFILIATION CODE (AC)	
CORPORATE ENTRY (CE)	
CORPORATE CODE (CC)	
ACADEMIC DEGREE (DG)	

Rev. January 1976

Figure 6

are also derived from controlled authority files such as INIS.

Summary of Current Status of Data

After reviewing the current geothermal resources information in light of the data requirements, some general observations are appropriate. While data currently available are satisfactory in some respects, there are still inadequacies. The optimum future data activities should include (Figure 7):

(1) Laboratory measurements of the thermodynamic and transport properties of materials likely to be encountered in geothermal resource systems. The data are needed in areas including prediction of the operating parameters of electrical and non-electrical plants, and in modeling reservoirs. ERDA and USGS laboratories are currently actively engaged in these studies on basic scientific information.

(2) Compilations of information on known geothermal resource areas of the world. Urgent needs include numerical data on surface water chemical analyses, reservoir fluid physical and chemical properties, well logging, and geophysical measurements. These data are valuable for many uses including: reservoir assessment, correlating theoretical models with actual reservoirs; indicating corrosion, erosion, and scaling problems which migh arise; providing a basis for research and development of materials (e.g., piping) which come in contact with geothermal fluids. Currently, such worldwide data are not readily available in one data center for general dissemination.

(3) Data for the evaluation of economically viable worldwide geothermal energy resources. The information is important in assessing the potential for geothermal energy to produce electricity, and for other uses (e.g., space heating). The U.S. Geological Survey recently issued a report on Assessment of Geothermal Resources of the United States - 1975.

(1) Laboratory measurements of the thermodynamic and transport properities of materials likely to be encountered in vapor-dominated and hot-water (brine) systems. The data are needed in areas including prediction of the operating parameters of electrical and non-electrical plants, and in modeling reservoirs. ERDA and USGS laboratories are currently actively engaged in these studies on basic scientific information.

(2) Compilations of information on known geothermal resource areas within the United States. Urgently needed are numerical data on surface water chemical analyses, reservoir fluid physical and chemical properties, and geophysical measurements. These data are valuable for many uses including: correlating theoretical models with actual reservoirs; indicating corrosion, erosion, and scaling problems which might arise; providing a basis for research and development of materials (e.g., piping) which come in contact with geothermal fluids. Currently, such U.S. data are not readily available for general dissemination.

(3) Evaluation of the economically viable geothermal energy resource of the U. S. The information is important in assessing the potential for geothermal energy to produce electricity, and for other uses (e.g., space heating). The U. S. Geological Survey recently issued a report on Assessment of Geothermal Resources of the United States - 1975. (Ref. 6).

(4) Measurements on environmental aspects of geothermal energy exploration and utilization, particularly centered around background data. This will permit an accurate differentiation of environmental effects due to utilization of geothermal energy from the naturally occurring effects. This is currently an active area, for example, the subsidence network in Imperial Valley, California, (Ref. 16).

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Conclusion

In conclusion, the increased recognition over the past five or more years that the petroleum resources of the world are finite and being exhausted at an ever increasing rate, has resulted in the current unprecedented research and development program to utilize domestic energy resources such as geothermal. It is imperative that evaluated information be provided to all interested nations from a data center such as the National Geothermal Information Resource - information urgent both to electrical and non-electrical uses if we are to make a rational progress toward timely utilization of geothermal energy. Such a task can be best accomplished only by the cooperation and input of those who can provide needed data to GRID.

Thank you.

This report was done with support from the United States Energy Research and Development Administration. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the United States Energy Research and Development Administration.

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TECHNICAL INFORMATION DIVISION
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720