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GEOTHERM - GEOTHERM RESOURCES FILE

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ABSTRACT

GEOTHERM is a computerized geothermal resources file operated by the U.S. Geological Survey. The file was designed to be used in geothermal resource assessment and to provide a rapid, efficient and economical means of disseminating geothermal data.

GEOTHERM consists of three sub-files dealing with geology and production of geothermal fields, analytical data, and drilling records. The file was used to support the 1978 U.S.G.S. geothermal assessment and is currently used in the ongoing Department of Energy state-cooperative geothermal project. All data in the file are available to anyone on request.

INTRODUCTION

GEOTHERM is a computerized file created and presently operated by the U.S. Geological Survey as part of its Geothermal Research Program (Swanson, 1977a, 1977b). It was initiated as part of the International Geothermal Information Exchange Program (IGIEP) at the First Geothermal Implementation Conference in New Zealand in 1974. Its objective is to provide for the prompt exchange and dissemination of new geothermal information and data (Clark and others, 1976). GEOTHERM contains information concerning the physical characteristics, geology, geochemistry, and hydrology of national and some international geothermal resources. The data include published information and data from other computer files, personal communications, and compilations by various government and private organizations.

GEOTHERM is not a software package but a file which uses the data storage and retrieval system GIPSY (General Information Processing System). GIPSY is a program developed at the University of Oklahoma (Addison and others, 1969; University of Oklahoma, 1975, 1977) which provides utilities for the input, retrieval, manipulation, presentation, and maintenance of information composed of numeric, codified, or natural language data. GIPSY is operational on the U.S.G.S. IBM 370/155 computer in Reston, Virginia.

Since its inception, GEOTHERM has existed as a public file. With this in mind, the philosophy of the file has been to provide standardized, well-documented data. Each data item in the present format is designed both for further manipulation and for visual presentation. Therefore, GEOTHERM data can be used for subsequent computer processing or for printed output.

PURPOSE

GEOTHERM was created for use in the characterization and assessment of geothermal resources and to provide a central location for a potentially large volume and variety of data. Recent interest in geothermal energy has caused a vast proliferation of geothermal resource data. Using the GIPSY retrieval program, GEOTHERM can make highly selective and rapid data retrievals in an assortment of output modes that would be difficult to accomplish using conventional techniques (figs. 1 and 2).

The U.S.G.S. has been active in geothermal assessment and has recently published an assessment of these resources in the United States (Muffler, 1979). GEOTHERM played an active role in this study in the areas of data acquisition, editing, manipulation, and display. GEOTHERM is also being used by the Department of Energy for a state-cooperative project to produce state maps illustrating low-temperature geothermal resources (see "Applications").

RECORD NO.	0015939
COMPILER	MARINER, R. H.
COMPILATION DATE	79/03
COMPILER AFFILIATION	U.S. GEOLOGICAL SURVEY
COMPILER CROSS INDEX	15
NAME OF SAMPLE SOURCE	UNNAMED HOT SPRING NEAR HARNEY LAKE
COUNTRY	UNITED STATES
STATE/PROVINCE	OREGON
COUNTY	HARNEY
TOWNSHIP	27S
RANGE	29.5E
SECTION	36
QUARTER SECTIONS	NE OF SE
SAMPLE SOURCE TYPE	SPRING
SAMPLE TYPE	W
TYPE OF ANALYSIS(S)	W
COLLECTION DATE	1931/08/21
SAMPLE TEMPERATURE	59.
REFERENCE	PIPER AND OTHERS, 1939
UNITS USED FOR ANALYSIS	PPM
SIO2	92.
NA	622.
K	12.
CA	13.
MG	3.0
FE(TOTAL)	0.03
CL	562.
HCO3	601.
CO3	N
SO4	140.
NO3	0.5

Fig. 1 Chemical analysis record of a spring from Harney County, Oregon.

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GEOTHERMOMETERS (C)
   CATION
     NA-K-CA (1/3).......... 179
     NA-K-CA (4/3).......... 141
     NA-K.................... 167
   SILICA
     ADIABATIC.............. 124
     CONDUCTIVE............. 126
     CHALCEDONY............. 99
     CRISTOBALITE........... 76
     OPAL.................... 7

RESERVOIR PROPERTIES          MINIMUM       MAXIMUM       MOST LIKELY     MEAN          STD. DEV.
   SUBSURFACE TEMP (C)        99 (D)        179 (I)       126 (A)         135           17

                        UNCODED TEMPERATURE INDICATES SUBJECTIVE JUDGEMENT
     A) QUARTZ CONDUCTIVE                F) CRISTOBALITE                  K) SULFATE GEOTHERMOMETER
     B) QUARTZ CONDUCTIVE, PH-CORRECTED  G) AMORPHOUS SILICA              L) SURFACE TEMPERATURE
     C) QUARTZ ADIABATIC                 H) NA-K                          M) WELL TEMPERATURE
     D) CHALCEDONY                       I) NA-K-CA                       N) MIXING MODEL
     E) CHALCEDONY, PH-CORRECTED         J) NA-K-CA, MG-CORRECTED         O) RENNER AND OTHERS, 1976

                              MINIMUM       MAXIMUM       MOST LIKELY     MEAN          STD. DEV.
   DEPTH TO TOP (KM)          0.5           2.0           1.5
   THICKNESS (KM)             1.0           2.5           1.5             1.7           0.3
   SUBSURFACE AREA (KM**2)    1             3             2               2.0           0.4
      BASED ON: STANDARD ESTIMATE

   VOLUME (KM**3)..........   3.3        STD. DEV. =  0.9
   THERMAL ENERGY(10**18 J).  1.08       STD. DEV. =  0.34

COMMENTS: LOW SURFACE TEMPERATRE AND HIGH FLOW RATE SUGGESTS THAT SURFACE TEMPERATURES MAY BE NEARER TO
  MINIMUM ESTIMATE OR THAT THE WATER MAY BE MIXED.

REFERENCES: DUFFIELD AND FOURNIER, 1974; REED, 1975

COMPILED BY: BROOK, C.

FORT BIDWELL AREA , CALIFORNIA
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Fig. 2 Partial field record of Fort Bidwell Area, California (Mariner and others, 1978). Geothermal reservoir volume and energy, and all means and standard deviations were calculated from data in GEOTHERM.

SCOPE

GEOTHERM is currently composed of three sub-files or section: Section A, Geothermal Fields/ Areas (fig. 2), Section B, Sample data/Chemical analyses (fig. 1), and Section C, Geothermal Wells/ Drill holes. Due to space limitations, samples of the forms are not included here. Format information can be sent upon request.

Section A: Geothermal Fields/Areas - This sub-file includes data on locality, surface manifestations, industrial developments, subsurface temperatures and dimensions, basic chemistry, thermal energy, general geophysics, geology, and other related information of a geothermal field or area. This sub-file contains approximately 510 records. Of these, 290 of the field records cover geothermal fields from the 1975 U.S.G.S. Geothermal Assessment (White and Williams, 1975; Renner, 1976), and 220 records are from the 1978 U.S.G.S. Geothermal Assessment (Muffler, 1979; Mariner and others, 1978), some of which are updated versions of the 1975 data.

Section B: Sample data/Chemical analyses - This sub-file includes chemical analysis data from thermal springs and wells. Space is provided for three types of analyses - water, condensate, and gas. Data items include source identification, locality, sample description, collection conditions, and physical and chemical characteristics of the fluids. This sub-file contains 4600 records on wells and springs in the United States (Table 1), New Zealand, and Mexico.

Section C: Geothermal Wells/Drill holes - This sub-file contains physical data from wells drilled for geothermal production or development. Information includes depth, casing, flow rates, and other physical data. The 436 records currently in this sub-file were provided by the U.S.G.S. Conservation Division, and are an inventory of geothermal wells and drill holes in the United States.

The scope of the file is obviously concentrated on data related to hydrothermal convection systems. However, GEOTHERM has the flexibility to include other sub-files as deemed necessary. The information in GEOTHERM is public and no proprietary data can be stored.

SPECIFICATIONS

Each basic record on GEOTHERM consists of information furnished on a single reporting form. Each record is assigned a unique record number and each bit of information on the form is identified by a unique label. All records are stored on disk in one location and can be easily searched, indexed, or sorted by item label. Some of the file specifications are as follows:

- numeric data are all converted to metric units
- all numeric fields in the file are formatted alike so they can be retrieved and manipulated as an array
- the file allows variable amounts of significant figures
- qualification codes exist for numeric data (Example: L = less then, E = estimate, and T = trace)
- locality information is required (latitude and longitude preferred)
- documentation is provided in the form of a reference to the sources of information and the name and affiliation of the person who compiled the record (some of the organizations that have sent information are listed in Table 1).

Table 1. Contributors of U.S. Spring and Well Data

State	No. Recs.	Organization
Alaska	83	Geophysical Institute, Univ. of Alaska, Fairbanks; U.S.G.S.
Arizona	220	Bureau of Geology and Mineral Technology, Tucson; U.S.G.S.
California	1429	Division of Mines and Geology, Sacramento; U.S.G.S.
Colorado	249	Colorado Geological Survey, Denver
Hawaii	288	Hawaii Inst. of Geophysics, Univ. of Hawaii, Honolulu
Idaho	94	Department of Water Resources, Boise; U.S.G.S.
Montana	82	Bureau of Mines and Geology, Butte
Nevada	758	Bureau of Mines and Geology, Reno; U.S.G.S.
New Mexico	367	New Mexico Energy Institute, Las Cruces; U.S.G.S.
Oregon	216	Oregon Dept. of Geology and Mineral Resources, Salem; U.S.G.S.
Texas	29	U.S.G.S.
Utah	1055	Utah Geological and Mineral Survey, Salt Lake City
Washington	212	Battelle Pacific Northwest Laboratory, Richland
Wyoming	79	University of Wyoming, Dept. of Geology, Laramie

APPLICATIONS

In January 1979 the U.S.G.S. published the second assessment of the geothermal resources of the United States (Muffler, 1979). GEOTHERM's contribution to the 1978 assessment can be considered a model for the application of a resource data file. The file was used for two aspects of the assessment, the intermediate- to high-temperature convective resources (Brook and others, 1979), and a first-time comprehensive assessment of the low-temperature resources of the United States (Sammel, 1979). GEOTHERM's role in the assessment was in the following areas:

(1) Data acquisition and filing - Over 2000 records of warm springs and wells were entered into the file for use in the assessment of low-temperature areas, and 220 records from intermediate- to high-temperature geothermal areas were added to the file.

(2) Data editing and maintenance - Changes or additions to records were easily made with the GIPSY update program.

(3) Map plots - Over 60 maps with various scales and projections were produced using coordinates stored in GEOTHERM.

(4) Data calculations and manipulations - The data in GEOTHERM were used in many operations including geothermometric calculations, gradient calculations, statistics, determinations of volume and contained heat, point graphs, and regressions. In addition, estimates of recoverable heat and work available were calculated (fig. 2) for the intermediate- and high-temperature systems.

(5) Data display - GEOTHERM was important for rapid retrieval, sorting, and display of data. An open-file report of the intermediate- and high-temperature systems was published using a printout from GEOTHERM (Mariner and others, 1978) (fig. 2).

Other agencies are also involved in geothermal resource assessment; the Department of Energy is currently involved in a program to produce state maps depicting low-temperature geothermal resources(Grim and others, 1978). DOE has made cooperative agreements with the concerned states to produce these maps. The first phase of this state-coupled program is to compile information on thermal wells and springs from the various sources and to enter the data into the GEOTHERM file. Much of the information currently on the sample file has been entered by these state agencies (Table 1). The GEOTHERM staff will also work closely with the National Oceanographic and Atmospheric Administration, which will produce some of the maps.

GEOTHERM has provided information to private industry, government agencies, and foreign governments, beyond the work on the assessments mentioned above. There were only 6 requests for information in 1976, 21 in 1977, 39 in 1978, and 29 for the first half of 1979. This increase in requests for data reflects the growing importance of geothermal energy and the part that GEOTHERM can play in meeting the need for this type of information.

AVAILABILITY

Currently, computer retrievals from GEOTHERM are made using the batch mode so that the file is not available on a timeshare basis. Plans are being made to place GEOTHERM on General Electric's Mark III Information Services Network. At that time the file will be available by computer terminal to subscribers of that system.

Retrievals are available in a variety of formats which include tape, punched cards, listings, and tables. To obtain information from the file, it is necessary to send a letter of request specifying the exact information wanted. The present policy is to charge the requester for the computer time used running the retrieval.

The mailing address for requests is: Project GEOTHERM, Mail Stop 84, U.S. Geological Survey, Menlo Park, CA 94025.

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