Title

WORKPLAN FOR FY1978 TO FY1982 INCLUDING A COMPUTERIZED REPORTING AND MONITORING SYSTEM FOR GEOTHERMAL ENERGY DEVELOPMENT

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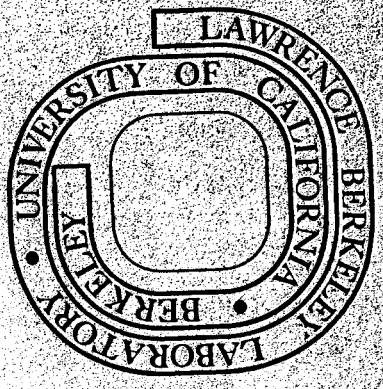

DISCLAIMER

LBL-8483
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Workplan for FY1978 to FY1982

Including

A Computerized Reporting and Monitoring System

For

Geothermal Energy Development

By

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Abstract

It is proposed that the on-going compilation and critical evaluation of data be expanded to include a computerized system for monitoring and reporting the development of geothermal resources from the discovery phase to power on-line. Data would be covered which is site-specific and therefore unique to the geothermal area. Computer printouts are to contain a listing of each geothermal site which will be classified according to the status of development for producing electrical power. The result of the work will consist of a report containing a description of the data at each site and recommendations for additional data needs in technological, economic, or institutional areas. The computerized system will allow for ease in updating and remote accessing by off-site users.

Contents

1. Introduction

The past five years have seen a greatly expanded effort for geothermal power production. New research data is available on the basic properties of aqueous electrolyte solutions and minerals to elevated temperatures and pressures; materials have been developed for highly corrosive resource fluids; processes to control scale formation are under active research; and plans are available to construct power plants. However, the data is widely scattered and largely unevaluated, thereby impeding the analysis for predictions of power production in the decades 1980, 1990 and beyond the year 2000.

The National Geothermal Information Resource (GRID) project of the Lawrence Berkeley Laboratory was initiated in 1974 with the objective of compiling both basic and site-specific data on the following major aspects of geothermal energy utilization:

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

PHYSICAL CHEMISTRY covers evaluation and correlation of the thermodynamic, thermophysical and volumetric properties of aqueous electrolytes to elevated temperatures and pressures.

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; plant construction.

ENVIRONMENTAL considers aspects to the air, land and water environments

of geothermal energy utilization: subsidence, hydrogen sulfide, metals, boron, ammonia, 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 CHARACTERIZATION includes data relevant to the development and production of wells: porosity, stimulation, natural recharge, artificial recharge, modeling, well tests and measurements.

The GRID bibliographic database (EXP) currently contains over 500 annotated references to data; the site-specific file (ENCON) has site-specific information on over 20 geothermal prospects. For projections of power on-line, the ENCON file provides data to include the following: reservoir temperature; reservoir salinity; scaling potential; corrosion tests; fluid chemistry; electric power potential; drillability; well flow rate; lease holder; and land use factors. See Appendixes I and II for examples of computer output from the EXP and ENCON files.

The Department of Energy (DOE) is the lead agency for coordinating the Federal Geothermal Energy Program (FGEP). The objective of this program is to stimulate both private and local power authorities to develop geothermal energy resources as reliable, operationally safe and environmentally acceptable for electrical power production and/or direct utilization as a heat source. The objectives of the FGEP require that DOE be cognizant of the development requirements of each major identifiable geothermal prospect. It is proposed that compilations of site-specific data by GRID be expanded

and utilized to monitor the progress of geothermal power from the discovery phase to power on-line. The development of scenarios for power on-line will be revised continually as new data is received and as current data is evaluated and revised.

2. Objective and Scope of the Monitor Database

The objective of the database is:

1. To compile information and numerical data for each major geothermal prospect. The data will include that which is measured or estimated (e.g., calculated, inferred, extrapolated); estimated values will be identified as such by an appropriate tag. This is a current on-going activity.

2. To evaluate the data with the idea to recommend values that can be used as reference data for each site.

3. To establish a computer-aided classification file of major U.S. geothermal prospects which lists each site according to the degree of development toward commercial power production.

4. To develop a list of activity indicators for monitoring the progress of power production with the idea that these will serve as a basis for prospect classification.

5. To examine new state-of-the-art electric power technologies developed within and outside the geothermal energy field which may enable a significant reduction in the cost of geothermal power production.

6. To make recommendations for new or additional site-specific data needs where necessary for each prospect.

3. Database Content

The amount of data available varies for each site; some prospects have been well-studied and data needs for power production have been identified. Other sites are not well-developed and much information is lacking.

a. Classes of Geothermal Prospects

The initial computerized database would cover the major geothermal areas listed in Table 1. Three reservoir systems are represented: hot water, steam and geopressured. Other prospects (e.g., Bieber, CA; Strawberry, WY) will be added as the database builds up.

The current status of these geothermal sites is listed by the following six activity categories:

Class 1: Undiscovered resources identified from surface manifestations, geophysical exploration and shallow drilling for heat flow or other data.

Class 2: Unexploitable by current technology or due to institutional impediments. This class includes areas where there has been deep exploratory drilling, but where there is currently no known activity.

Class 3: Exploitable resources in which there is significant surface exploration but no current commercial development. These resources are institutionally exploitable from legal and environmental standpoints.

Class 4: Commercial development resources are those being actively developed to produce electric power. Deep drilling is underway and a utility has been identified as a potential purchaser of the electric power.

Class 5: Construction resources are those in which feasibility has been determined, plant design has been completed, environmental reports

Table 1. Initial list of geothermal prospects for proposed database.

Acadia Parish, LA
Alvord, OR
Baker Hot Springs, WA
Beowawe, NV
Beryl, UT
Brady Hot Springs, NV
Brawley, CA
Brazoria, TX
Bruneau-Grandview, ID
Calcasieu Parish, LA
Cameron Parish, LA
Chandler, AZ
Corpus Christi, TX
Coso Hot Springs, CA
Cove Fort-Sulfurdale, UT
Dixie Valley, NV
Dunes, CA
East Mesa, CA
Geyser Bight, AK
Geysers, CA
Glass MT., CA
Heber, CA
Hot Springs Cove, AK
Kenedy County, TX
Lassen, CA
Leach, NV
Matagorda County, TX
Mono-Long Valley, CA
Monroe-Joseph, UT
Morgan Springs, LA
Mt. Hood, OR
Puna, HI
Raft River, ID
Roosevelt Hot Springs, UT
Ruby Valley, NV
Safford, AZ
Salton Sea, CA
Soda Lake, NV
Steamboat Springs, NV
Surprise Valley, CA
Thermo, UT
Vale Hot Springs, OR
Valles Caldera, NM
Weiser-Crane Creek, ID
West Yellowstone, MT

have been made, financing arranged, construction permits obtained, and a final commitment is expected to produce electric power.

Class 6: Power production is the category for geothermal prospects producing electric power.

b. Activity Indicators

Activity indicators are tags used as keys for providing machine generated indexes on the current status of data to power on-line for each geothermal prospect. See the list of keys in Table 2 which are arranged in a sequence of geothermal development to power production. The activity indicators and those designated as milestones are assigned to each prospect on the basis of available information, and thus are useful in subsequent analysis, e.g., expected time required for power production for a specific site. The activity indicators are used for prospect classification.

c. Enablement Factors

The technical development factors are those scientific or engineering developments which permit a prospect to achieve power on-line by a specified time. These factors include both results of geothermal energy research, and developments in a related field (e.g., petroleum) which is useful to geothermal. Examples are new methodology for preventing or controlling scale formation in hot water reservoirs and development of methods to increase the flow rate from production wells. Table 3 lists typical enablement factors. Some prospects will require institutional action, e.g., a change in local laws; examples are given in Table 3.

Table 2. Initial Major Activity Indicator Descriptors

Class (1)	*Prospect Area Identified
	*Resource Study
	*Prospecting Permit
	*Exploration Notice of Intent
	*Leasing EIS
	*Lease Land Acreage
	*Land Use Permit
	*Geophysical Data
	*Shallow Drilling
	**Land Use Approval
Class (2)	*Confirmed Anomaly
	*Deep Drilling Permit
	*Utility Identified
	*Drilling Plan Review
	*Deep Drilling
	*Reservoir Testing
	*Road Building
	*Well Tests
	*Assessment of Prospect
	*Confirmed Bottomhole Temperature
	*Well Abandonment
	**Site Exploration and Characterization
Class (3)	*Public Hearing
	*Power Plant Forecast, MWe
	*Corrosion/Scaling Tests
	*Risk Factors
	*Fluid Composition
	*Further Road Construction
	*Production Well Flow Rate
	*Injection Wells System
	*Operations Plan Approval
	**Confirmed Reservoir
Class (4)	*H_2S Abatement
	*Pipelines Construction
	*Substation
	*Transmission Lines Study
	*Access Roads
	*Plant Permit
	*Site Permit
	*Net MWe Output
	*Busbar Cost
	*Water Availability
	*Loan Guarantee
	*Environmental Impact Report

**Milestone

*Flash Cycle Identified
**Site Expansion

Class (5)

*Utility Commitment
*Feasibility Studies
*Design Facilities
*Brine Handling
*Settling Pond
*Field Flow Rate
*Steam Turbine Generator
*Equipment and Material Ordered
*Notice of Intent (NOI)
*Application for Certification
**Power Plant Construction

Class (6)

*Transmission Lines Construction
*Hydrogen Sulfide Abatement
*Cooling Water
*Utility Purchaser
*Public Utilities Commission
*Start-up
**Power on-line

**Milestone

Table 3. Typical enablement factors for prospect development to power on-line.

Exploration Geophysics
Drilling Technology
Well Completion
Fluid Treatment
Scaling Control
Materials Development
Reservoir Stimulation
Down-Well Pumps
Conversion Technology
H_2S Emission Control
Spent Fluid Disposal

Legislation
Regulations
Legal Actions
Public Opinion Survey
Lease Data
Drilling Permits
Tax Incentives
Environmental Review

4. Output Formats and Databases

Two computer files are maintained: a bibliographic database (EXP) containing indexed and annotated references to publication, and a file (ENCON) containing reference information and data. The ENCON file stores data on the following: (a) prospect class, (b) activity indicators, and (c) enablement factors. As mentioned above, the ENCON and EXP databases are already established. These computer-assisted outputs are described briefly in the following section.

Computer-generated output formats would be one of the following 5 forms: (1) an energy conversion file (ENCON) containing current numerical values and information, (2) a bibliography to geothermal exploration and evaluation literature (EXP), (3) prospect classification listing, (4) activity indicator database, and (5) an enablement file.

ENCON File

The data contained in the ENCON file is useful as reference data for normalization and analysis of forecasts for power on-line to the decades 1980, 1990 and beyond.

The data cover three main categories: technical, economic and institutional. Technical refers to engineering and scientific data obtained from instrumental measurements; permeability, temperature and fluid flow rate are examples of technical data. Economic information is largely costs, for example, the busbar cost of electricity. Where cost values are not available, then data which can be used in cost analysis, e.g. scaling, drillability, land improvements, are provided. The third major category is institutional, to include information on environmental impact reports and exploration

permits. The data element definitions for the ENCON file are given in Table 5.

EXP Bibliography

The second portion of this work contains an annotated bibliography to information on the exploration and evaluation of geothermal energy areas for electric power potential. This compilation covers mainly the time span from 1970 to 1978, with references to material obtained from the published literature. The information covered deals with the following seven major aspects of geothermal energy data: (1) geophysics, (2) geochemistry, (3) geology, (4) hydrology, (5) land-use factors, (6) exploratory drilling, and (7) site evaluation for power on-line.

A bibliographic reference contains a record number; a mnemonic; and headings for title, author, reference and descriptors. The Author heading is either the name of the author(s) of the publication, or a corporate entry. See for example Appendix I. Besides the reference, indexes can be machine-generated, for example:

Author index contains two parts: (1) Author Short Code is an alphabetical listing of the last name of the first named author of each publication, followed by the last two digits of the year of publication, and the title and record number. The digits are followed by a letter when there is more than one publication in a single year for an author or authors of the same last name. This index may also list Author Affiliation Short Codes when the publication does not identify a person as an author. (2) Author is an alphabetical listing of all persons named as authors with their publications, and the corresponding record numbers.

Table 5. Data element definitions for the Energy Conversion File (ENCON)

General Information: The name, location, developer and site descriptive material of the geothermal area.

Reservoir Parameters: Selected fluid data, including reservoir fluid temperature, flow rate and steam quality.

Operational Parameters: Data on projected or actual power plant operations to include plant size, O & M cost, and well spacing.

Hot Water Transmission: Information on piping and piping materials used in the transmission of steam and/or hot water.

Field Baseline Data: Surface measurements to infer the reservoir properties for power production and downhole logging.

Environmental Aspects: Contains gas, reservoir fluid and subsidence data, and information on environmental reports for regulatory purposes.

Reservoir Engineering: Rock properties as determined on samples obtained from the reservoir to include porosity, permeability and thermal conductivity.

Land Use Factors: Data on land to include accessibility, proximity to market, needed land improvements (e.g., roads, clearing), and availability of fresh water.

Legal Aspects: Includes leasing, tax laws and emissions information.

Injection Well: Covering flow rate, stimulation and power requirements for spent disposal by fluid injection.

Author Affiliation index is an alphabetical listing of each author's affiliation at the time of publication to include also the publication title and record number in the References section.

Descriptors index is an alphabetical listing of descriptive terms for each publication, together with both the title and record number in the References section.

The bibliographic file is managed by the Berkeley Database Management System (BDMS) to provide for data retrieval and indexing using key words.

A third format will be developed for storage and retrieval of the classification of geothermal prospects according to activities which are stored using BDMS; a typical query and machine response are given in the following samples:

Example 1

```
  Query:  Find Prospect Class =(2)
Terminal Response: Found 7 Records
  Query:  List Prospects
Terminal Response (or printout):
  List of Class (2) Prospects:
       Alvord, OR - Record 2
       Bieber, CA - Record   50
       Bruneau-Grandview, ID - Record   9
       Cove Fort-Sulphurdale, UT - Record   15
       Lassen, CA - Record  25
       Surprise Valley, CA - Record   40
       Marysville, MT - Record   51
```

Example 2

```
  Query: Find Activity Indicator=Exploratory Deep Drilling
         Not Prospect=California
Terminal Response: Found 11 Records
  Query: List Prospects, Depth
Terminal Response (or printout):
       Alvord, OR -------One Well
       Beowawe, NV-------Rossi #21-19 (5680 Ft)
                         Ginn #1-13 (9563 Ft)
                         Other Wells will be listed
       Brady Hot springs, NV------Well List printout
       Bruneau-Grandview, ID------Well List printout
       Puna, HI-------------------Well List printout
```

Raft River, ID----------Well List printout
Weiser-Crane Creek, ID-----Well List printout
Chandler, AZ----------Well List printout
Cove Fort-Sulphurdate, UT--Well List printout
Roosevelt Hot Springs, UT--Well List printout
Valles Caldera, NM---------Well List printout

Example 3.

Query: Find Enablement Factor=Scale Control
Not Prospect=Salton Sea; Brawley
Terminal Response: Found 4 Records
Query: List
Terminal Response (or Printout):
Coso Hot Springs, CA
Beowawe, NV
Brady Hot Springs, NV
Roosevelt Hot Springs, UT

5. Data Analysis

The database will be developed and data evaluation will be done by staff of the National Geothermal Information Resource in coordination with the GRID Technical Advisory Committee and other recognized geothermal experts.

Analysis by GRID for development of scenarios on power production is not a part of this work. The data compiled as a result of the work described herein will be made available to all interested groups and their projections included in the file system. A listing of typical federal, state and local sources of information is given in Table 6.

Table 6. Typical Data sources

Organization	Kind of Information Available
Bureau of Land Management	Lease Sale; Environmental; Certify Plant and Site
U.S. Forestry Service	EIA/EIS, Drilling Permit
U.S. Geological Survey	Notice of Intent to Conduct Exploration; Drill Permit; Certify Plant and Site, Geotherm
U.S. Fish & Wildlife Service	Leasing; Environmental; EAR
Federal Power Commission	Certify Plant and Site; Process Plant and Transmission Line EIA/EIS
Area Geothermal Supervisor	Environmental; Leasing; Drilling; Lease Compliance
State PUC	Plant and Transmission Line EIA/EIS
State	Environmental Reports; Drilling Permits; Certify Plant and Site; Issue Permits; Drilling EIA/EIS
County	EAR/EIS; Lease Sales; NOI

6. Other Work in Geothermal Monitoring

There are a number of valuable generally available assessments of geothermal power both under way and completed. These are either regional assessments and forecasts, or national assessments. Most are bound volumes and quickly out of date.

The scenarios of power on-line provide valuable information and will be included in the proposed computerized database:

Assessment of Geothermal Resources of the United States - 1975 (Circ. 726) is valuable, authoritative and provides comprehensive reference data, including geology, chemistry and wells, which is widely used for site evaluations. The data for a large number of prospects is available via the GEOTHERM database. However, data, for example, on scaling, corrosion and institutional factors are not readily obtained from the report. An update is expected in 1979.

Site-Specific Analysis of Geothermal Development issued in three volumes by Mitre-Mitrek under contract to DOE/DGE is a comprehensive work covering scenarios of geothermal power production in the United States. With minor modifications, the projections for 37 major prospects are included in the second annual report of the Interagency Geothermal Coordinating Council. The forecasts of power on-line utilize data that is inferred or default values as well as measured values.

Geothermal Energy Prospects for the Next 50 Years was prepared by the Electric Power Research Institute. It includes calculated hydrothermal electricity potential in the U.S. and over 20 other nations to the years 1985, 2000 and 2020. Calculations are based in part on site-independent data such as a uniform temperature gradient, and heat capacity.

Geothermal Handbook was prepared by the U.S. Fish and Wildlife Service. It contains detailed information and data on geothermal sites in the western U.S., including location, development status through January 1976, and projected drilling to 1977. Valuable data is included on environmental aspects of geothermal exploration and power production.

Proceedings, First Geopressured Geothermal Energy Conference contains detailed and comprehensive information covering the origin, resource assessment, reservoir research and technology, utilization and legal and environmental aspects of geopressured systems. Newer information is available in proceedings of second and third conferences.

Analysis of Requirements for Accelerating the Development of Geothermal Energy Resources in California published in 1977 summarizes resource potential estimates for major California prospects. A scenario for power production to the year 2020 is given, including the current status of each prospect. This work and two preceding publications provide extensive data on geothermal areas in California.

Geothermal Energy, Research, Development and Demonstration Program, Second Annual Report, April 1978, summarizes the current status of geothermal energy power potential and includes data on well drilling, resource characteristics, and a development scenario.

7. Remote Access to the Computer System at LBL

There are three communication networks with direct connections into the LBL computer system: Telenet, Tymnet and the Arpanet. Remote computer communication with any of the three networks is recommended over FTS or the Bell Telephone System for the following reasons:

1) Improved transmission quality
2) Economical
3) The networks perform internal checks on the validity of data transferred prompting re-entry if a line is lost.

Telenet, Tymnet

Telenet and Tymnet are commercial networks that operate similarly; the user dials a nearby phone number, types a password(s) and/or identifier(s) and then logs onto the LBL system just as one would on a local direct-dial connection. Therefore, the remote user is directly communicating with the LBL system via his/her own terminal. Access to the LBL system is unrestricted and all one needs is a valid LBL account and the phone number of the nearest Telenet or Tymnet access port available from the Customer Service for Tymnet at 408/446-6180 and the Customer Service for Telenet at 202/637-7900.

Arpanet

The Arpanet network provides indirect timesharing access to remote computers called remote hosts by means of a computer-to-computer link. Thus, one logs into one machine on the network to gain access to other machines.

Computers on the Arpanet network are dived into three classes based upon their accessibility through the network. TIPS are small machines with network access capabilities but without enough computing power of

their own to be used for general timesharing. USERS are timesharing systems which have been set up to access other machines but may not be accessed via other points on the network. SERVERS are systems which can be used to access other machines on the network and are accessible via the network. LBL is an operational server and is known as host node number 34.

During an Arpanet communication, control programs are executed at the local host, where the connection is initiated and at the remote host, the site of execution of a server control program. Although there are no direct charges for the use of the network, interactive job charges accumulate on the remote host (LBL) and on the local computer host.

An unique feature of the Arpanet network is its special operation mode called File Transfer Protocol (FTP). The FTP is a special mechanism which permits the transfer of data files from a remote computer on the network to a local computer for the local processing of data independent of the remote computer.

8. Project Organization and Management

The progress and monitoring data evaluation and computer file system will have as its locus the National Geothermal Information Resource (GRID), a group within the Information and Data Analysis Department (IDAD) of the Lawrence Berkeley Laboratory. The staff are all technical and scientific, including geothermal energy background, and include a chemist, computer specialist, biophysicist, chemical engineer, two petroleum engineers, mechanical engineer, and descriptive cataloguer specialist. The resource personnel include the GRID Technical Advisory Committee, IDAD staff, and senior geothermal specilists.

Task Description

Task 1: Information Compilation on Prospects

Information will be collected for each of the 45 prospects from published and unpublished reports, from other databases, by visits and other contacts. A diligent effort will be made to ensure completeness. Duplication of effort will be avoided by including the work of others in the GRID database. The result of Task 1 is an indexed and annotated bibliography to references in the geothermal literature; these are coded and stored using the Berkeley Database Management System. This task is in progress; a sample printout in a condensed format is shown in Appendix I.

Task 2: Site-Specific Data

Task 2 is the compilation of numerical values and information for each geothermal prospect using references to the information compiled by Task 1. The data is stored in our energy conversion (ENCON) file using the LBL CLIO interactive text-editing system. The data is tagged to indicate calculated

or inferred values. Changes in any of the data can be made quickly by editing out old values and inserting new ones. For example, an inferred or default value will be changed to an actual field measurement, thereby increasing the quality of the data. See Appendix II for an example of a printout from the GRID ENCON file.

Task 3: Computer System for Storing, Retrieving and Monitoring Data

Under Task 3, a file definition table will be developed for the initial major prospects which will provide computer-generated information to include the following: (1) a listing of each prospect by class; (2) a listing of prospects under each activity indicator; (3) a listing of each prospect by enablement factor. By this task, it is expected that remote access to the database will be provided, e.g., via TELENET.

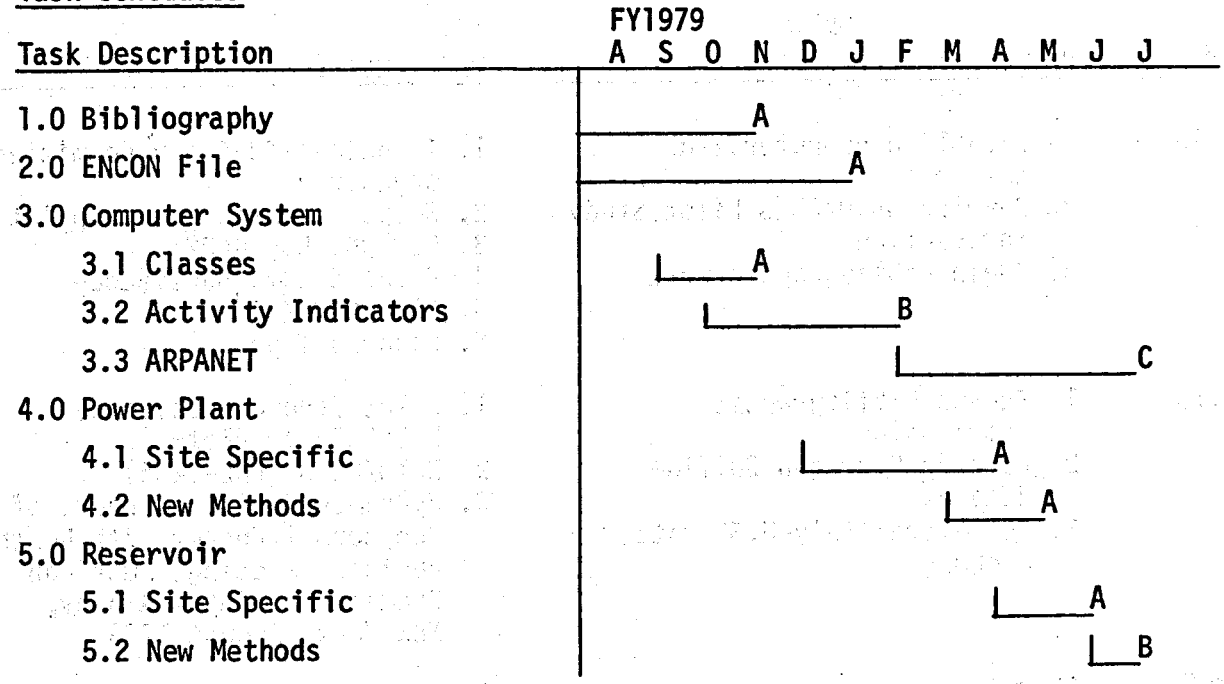
Task 4: Evaluation of Power Plant Data

Task 4 is the critical evaluation of data relevant to power plant operation and construction for each site. Both site-specific and site-independent data will be evaluated, e.g., scaling control. Factors that would permit promotion of a prospect to a class higher than current will be covered as enablement factors.

Task 5: Evaluation of Reservoir Data

Task 5 is the evaluation of data on reservoir properties for each site. Both site-specific and relevant research data are included, for example, state-of-the-art in reservoir stimulation and well testing.

Task Schedules



Major Milestones

0A. DGE Work Plan approved
1A. Bibliography complete for 15 sites
2A. Data extraction complete for 15 sites
3A. File definition table for prospect classification
3B. File definition table for activity indicators
3C. File remote access
4A. Data evaluation summary for power plants
4B. State-of-the-art data evaluation for power plants
5A. Data evaluation summary for reservoirs
5B. State-of-the-art data evaluation for reservoirs

TASKS - FY1975-FY1982

FY	Principal Task	Major Milestone
1975	1. Establish computerized database 2. Develop NATO/CCMS Pilot Study interaction 3. Begin bibliographic work	1. Technical Advisory Committee organized 2. Scope established, pamphlet 3. GEODOC, LBL-4432 4. Pilot Study, Subsidence 5. NATO/CCMS/Pisa 6. Socorro Tape
1976	1. Expand bibliographic compilation 2. Develop Hydrogen Sulfide database 3. Formalize Italy-U.S. data exchange	1. Pilot Study, Subsidence LBL-3220 complete 2. NATO/CCMS (LBL-5295) 3. Hydrogen Sulfide Aspects of Geothermal Energy, 7th Northeast Regional Meeting, American Chemical Society, Albany, New York, August 1976
1977	1. Output printout to users 2. Expand Compilation 3. Data evaluation	1. Informal bibliography 2. Begin Non-Electrical file 3. Begin evaluation 4. Standards for Multilateral & Worldwide Exchange of Geothermal Data Mathematical Geology, Vol. 9, No. 3, p.259-263, 1977
1978	1. Bibliographic output to users (EXP file) 2. Establish energy conversion (ENCON) file for 15 prospects 3. Gas chemistry file output to users 4. Subsidence bibliography update 5. Establish subsidence data file 6. Evaluate site-specific data	1. EXP file on-line and providing listings for users 2. NATO/CCMS report, LBL-6869 3. ENCON and subsidence data files established 4. Gas chemistry file on-line (UCID-4033, UCID-4035) 5. Site-specific data evaluation initiated 6. First Annual Report, LBL-7803
1979	1. Prospect bibliography expansion 2. ENCON file expansion to 45 areas 3. Prospect monitoring database 4. Site-specific data evaluation 5. Gas chemistry file expansion	1. Monitoring database on-line 2. Data evaluation 3. LBL report on prospect monitoring 4. Prospect area computerized map 5. Output to users

FY	Principal Task	Major Milestone
1980	1. Expand monitoring database to cover all major prospects 2. Develop computer-assisted methods to evaluate site-specific data 3. Develop database management system for numerical data 4. Remote access to GRID	1. LBL report on prospect monitoring, revision 1 2. Expansion of EXP and ENCON files 3. New methods for packaging output to users
1981	1. Update monitoring file 2. Remote access to GRID 3. Add Hot Dry Rock and Magma systems 4. Output packaging improvements	1. LBL report on monitoring, revision 2 2. Site-dependent data handbook 3. Computer-generated geothermal area maps
1982	1. Expand monitoring database 2. Provide reference data for each geothermal prospect 3. Computer-assisted modeling of geothermal power production	1. Monitoring report, revision 3 2. Computer-assisted modeling developed

Project Control Plan

A monthly progress newsletter covering significant results, expected activities and other information will be submitted at the end of each month. In FY1979, three reports will be prepared:

1. A report summarizing the current status of data for 15 prospects (January 1979)
2. A bibliography to exploration and assessment literature (December 1978)
3. A report covering forecasts for power on-line (September 1979)

Performance review is formalized through frequent project meetings, by weekly reviews with the Information and Data Analysis Department head, and by yearly review by the Technical Advisory Committee. The generally limiting resource is availability of manpower, commonly allocated by fractions of individual time and overall priorities.

Financial control is by detailed monthly expenditure reports.

Information Dissemination

Information dissemination is by LBL reports, computer printouts, attendance at conference and by personal contact. Reports are reviewed by recognized experts and consultants prior to issuance.

Literature References

1. Assessment of Geothermal Resources of the United States - 1975, Circular 726, D.E. White and D.L. Williams, eds., U.S. Geological Survey, Reston, VA, (1975), 155 pages. Available from National Technical Information Service, Springfield, VA.

2. Geothermal Energy, Research, Development and Demonstration Program, Second Annual Report, DGE/ET-0039/1, IGCC-3, Interagency Geothermal Coordinating Council, April 1978. Published by U.S. Department of Energy, Assistant Secretary for Energy Technology, Division of Geothermal Energy, Washington, D.C. 20545.

3. Geothermal Prospects for the Next 50 Years, ER-611-SR, Vasel W. Roberts, Program Manager, Special Report, February 1978, Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94304.

4. Site-Specific Analysis of Geothermal Development - Scenarios and Requirements, Vol. II, DGE/4014-3, R. Trehan, A. Cohen, J. Gupta, W. Jacobsen, J. Leigh and S. True, Metrek Division of The Mitre Corp., April 1978.

5. Geothermal Handbook, NP-21172, U.S. Fish and Wildlife Service, Geothermal Project, Washington, D.C., June 1976.

6. GEOTHERM Database, J.A. Swanson, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025.

7. Site-Specific Analysis of Geothermal Development - Data Files of Prospective Sites, Vol. III, HCP/T4014-01/3, F. Williams, A. Cohen, R. Pfundstein, S. Pond, Metrek Division of The Mitre Corp., February 1978.

8. Geothermal Energy: National Proposal for Geothermal Resources Research, W.J. Hickel, 1972, University of Alaska, College, AK.

9. Recommended Research Program in Geothermal Chemistry, R.N. Lyon and G.A. Kolstad, comps., WASH-1344, USAEC Division of Physical Research, Washington, DC 20545, Oct. 1974. (Now U.S. Department of Energy, Office of Basic Energy Sciences.)

10. Thermodynamics and National Energy Problems, June 10-12, 1974, Arlie House, Warrenton, VA, National Academy of Sciences, Washington, D.C.

11. A Manual for Cataloging and Indexing Documents for Database Acquisition, LBL-4432, Rev. 1, July 1978. Schwartz, S.R., Phillips, S.L., Perra, J.J.

12. Geothermal Thesaurus, LBL - 4841, April 1976. Perra, J.J. and Herr,J.J.

13. BDMS - Berkeley Database Management System User's Manual, Version 2.0 LBL - 4683, Rev. 1. Richards, D.R.

14. Legal and Institutional Impediments to Geothermal Energy Resource Development. A Bibliography, TID-3365.

15. Geothermal Energy and The Law, Draft Report, C.D. Stone, NSF-RA-S-75-050, University of Southern California, Los Angeles, CA, Sept. 30, 1975.

16. Proceedings First Geopressured Geothermal Energy Conference, M. H. Dorfman and R.W. Deller, eds., Center for Energy Studies, University of Texas at Austin, Austin, TX, June 2-4, 1975.

Appendix I. Example of Printout from Geothermal Exploration Bibliographic Database (EXP)

ERMAK 77
EXPLORATION/LAND-USE FACTORS

TITLE- A SCENARIO FOR GEOTHERMAL ELECTRIC POWER DEVELOPMENT IN IMPERIAL VALLEY.

AUTHOR- ERMAK, D.L. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- A SCENARIO FOR GEOTHERMAL ELECTRIC POWER DEVELOPMENT IN IMPERIAL VALLEY. CALIFORNIA UNIV., LIVERMORE, CALIF., 1977, 58 P..

DESCRIPTORS- TEMPERATURE MEASUREMENTS; POWER GENERATION; CHEMICAL COMPOSITION; AIR QUALITY; HYDROGEN SULFIDES; FLUID FLOW; ENVIRONMENTAL EFFECTS; LAND USE; FORECASTING; GEOTHERMAL WELLS; DRILLING; INJECTION WELLS; CALIFORNIA; BRAWLEY KGRA; IMPERIAL VALLEY; SALTON SEA; EAST MESA KGRA; HEBER KGRA; THE GEYSERS; MAPS; TABLES; DIAGRAMS.

LAYTON 76
EXPLORATION/LAND-USE FACTORS

TITLE- A DESCRIPTION OF IMPERIAL VALLEY, CALIFORNIA FOR THE ASSESSMENT OF IMPACTS OF GEOTHERMAL ENERGY DEVELOPMENT.

AUTHOR- LAYTON, D.;ERMAK, D. [CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.].

REFERENCE- A DESCRIPTION OF IMPERIAL VALLEY, CALIFORNIA FOR THE ASSESSMENT OF IMPACTS OF GEOTHERMAL ENERGY DEVELOPMENT. UCRL-52121, CALIF. UNIV., LIVERMORE, CALIF., 1976, 225 P..

DESCRIPTORS- SEDIMENTARY ROCKS; TECTONICS; GEOLOGIC SETTING; CLIMATIC EFFECTS; TEMPERATURE MEASUREMENTS; ENVIRONMENTAL EFFECTS; AGRICULTURE; FISHES; BIRDS; GROUND WATER; SOCIO-ECONOMIC FACTORS; ECONOMICS; WELLS; EVAPORATION; PRESSURE MEASUREMENTS; DRILLING; PESTICIDES; HERBICIDES; SOILS; CROPS; INSECTS; FERTILIZERS; AIR QUALITY; WATER QUALITY;

CHEMICAL ANALYSIS; STORED ENERGY; BRAWLEY KGRA; CALIFORNIA; EAST MESA KGRA; HEBER KGRA; IMPERIAL VALLEY; SALTON SEA; GLAMIS KGRA; DUNES KGRA; POWER GENERATION; MAPS; TABLES; DIAGRAMS; GOVERNMENT REGULATIONS; LEGAL ASPECTS; FORECASTING; SALINITY; FLOW RATES; HYDROGEN SULFIDES.

JET PROPULSION LAB 76
EXPLORATION/EVALUATION

TITLE- GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA, STATUS REPORT. APPENDIX.

AUTHOR- CALIFORNIA INST. OF TECH., PASADENA (USA). JET PROPULSION LAB..

REFERENCE- GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA, STATUS REPORT. APPENDIX. JPL DOCUMENT 5040-25, ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION, SACRAMENTO, CALIF., 1976, P. A1 - E3.

DESCRIPTORS- FAULTS; GEOLOGIC SETTING; ROCKS; VOLCANCES; TEMPERATURE MEASUREMENTS; HOT SPRINGS; AIR QUALITY; LAND USE; LEASES; LEGAL ASPECTS; GEOTHERMAL WELLS; DRILLING; MAGNETIC SURVEYS; GEOTHERMOMETRY; CALIFORNIA; OREGON; GLOSSARY; TABLES; GEYSERS GEOTHERMAL FIELD; CALISTOGA KGRA; KNOXVILLE KGRA; LITTLE HORSE MOUNTAIN KGRA; LOVELADY RIDGE KGRA; WITTER SPRINGS KGRA; IMPERIAL VALLEY; BRAWLEY KGRA; DUNES KGRA; EAST MESA KGRA; FORD DRY LAKE KGRA; GLAMIS KGRA; HEBER KGRA; SALTON SEA KGRA; BODIE KGRA; COSO HOT SPRINGS KGRA; MONO-LONG VALLEY KGRA; RANDSBURG KGRA; SALINE VALLEY KGRA; BECKWOURTH PEAK KGRA; GLASS MOUNTAIN KGRA; LAKE CITY-SURPRISE VALLEY KGRA; LASSEN KGRA; WENDEL-AMEDEE KGRA; SESPE HOT SPRINGS KGRA.

RAMACHANDRAN 77
EXPLORATION/LAND USE FACTORS

TITLE- ECONOMIC ANALYSES OF GEOTHERMAL ENERGY DEVELOPMENT IN CALIFORNIA. VOLUME 1.

AUTHOR- RAMACHANDRAN, G.;ALICH, J.A.,JR.;CROOKS, G.;MILLER, K.A.;MILLER, R.K.;MYERS, D.R.;RAO, M. [STANFORD RESEARCH INST., MENLO PARK, CALIF. (USA)].

REFERENCE- ECONOMIC ANALYSES OF GEOTHERMAL ENERGY DEVELOPMENT IN CALIFORNIA. VOLUME 1. SAN-115 P 108-1 (VOL. 1), STANFORD RESEARCH INST., MENLO PARK, CALIF., 1977, 139 P..

DESCRIPTORS- TABLES; MAPS; DIAGRAMS; CALIFORNIA; POWER GENERATION; FORECASTING; ECONOMICS; COSTS; HYDROGEN SULFIDES; IMPERIAL VALLEY; MONO-LONG VALLEY KGRA; THE GEYSERS; HEBER KGRA; EAST MESA KGRA; BRAWLEY KGRA; NILAND; COSO HOT SPRINGS KGRA; TRANSMISSION LINES.

LA MORI 76
EXPLORATION/EVALUATION

TITLE- HYDROTHERMAL GEOTHERMAL RESOURCES AND GROWTH IN UTILIZATION, IN ENERGY TECHNOLOGY III. COMMERCIALIZATION.

AUTHOR- LA MORI, P.N. [ELECTRIC POWER RESEARCH INSTITUTE, PALO ALTO, CALIF. (USA)].

REFERENCE- HYDROTHERMAL GEOTHERMAL RESOURCES AND GROWTH IN UTILIZATION, IN ENERGY TECHNOLOGY III. COMMERCIALIZATION. GOVERNMENT INSTITUTES, INC., WASHINGTON, D.C., 1976, P. 103-114.

DESCRIPTORS- FORECASTING; POWER GENERATION; TABLES; DIAGRAMS; HOT SPRINGS; CALIFORNIA; IMPERIAL VALLEY; UTAH; IDAHO; NEW MEXICO; THE GEYSERS; NILAND; BRAWLEY KGRA; VALLES CALDERA GEOTHERMAL FIELD; MONO-LONG VALLEY KGRA; COSO HOT SPRINGS KGRA; ROOSEVELT HOT SPRINGS KGRA; HEBER KGRA; EAST MESA KGRA; COVE FORT-SULPHURDALE KGRA; RAFT RIVER KGRA; ENERGY RESERVES; TEMPERATURE MEASUREMENTS; DIRECT ENERGY UTILIZATION.

SMITH 76
EXPLORATION/DRILLING

TITLE- SUMMARY OF 1975 GEOTHERMAL DRILLING WESTERN

UNITED STATES.

AUTHOR- SMITH, J.L.;MATLICK, J.S. (REPUBLIC GEOTHERMAL, INC., SANTA FE SPRINGS, CALIF. (USA)).

REFERENCE- GEOTHERM. ENERGY MAG., 1976, V. 4 (6), P. 28-31.

DESCRIPTORS- MAPS; CALIFORNIA; IMPERIAL VALLEY; TABLES; THE GEYSERS; TEMPERATURE MEASUREMENTS; GEOTHERMAL WELLS; OREGON; NEVADA; IDAHO; UTAH; NEW MEXICO; HAWAII; BRAWLEY KGRA; EAST MESA KGRA; HEBER KGRA; CASTLE ROCK SPRINGS; RAFT RIVER KGRA; ROOSEVELT HOT SPRINGS KGRA; VALLES CALDERA GEOTHERMAL FIELD.

JET PROPULSION LAB 76B
EXPLORATION/EVALUATION

TITLE- GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA. STATUS REPORT.

AUTHOR- CALIFORNIA INST. OF TECH., PASADENA (USA). JET PROPULSION LAB..

REFERENCE- GEOTHERMAL ENERGY RESOURCES IN CALIFORNIA. STATUS REPORT. JPL DOCUMENT 5040-25, CALIF. INST. OF TECH., PASADENA, CALIF., 1976, P. 1-1 - 6-13.

DESCRIPTORS- GEOLOGIC SETTING; DRILLING; ECONOMICS; LEASES; LEGAL ASPECTS; GEOTHERMAL POTENTIAL; GEOTHERMAL RESOURCES; GEOTHERMAL WELLS; POWER GENERATION; NON-ELECTRICAL; BECKWOURTH PEAK KGRA; SALINE VALLEY KGRA; GLASS MOUNTAIN KGRA; WENDEL-AMEDEE KGRA; GLAMIS KGRA; BODIE KGRA; FORD DRY LAKE KGRA; RANDSBURG KGRA; SESPE HOT SPRINGS KGRA; CALIFORNIA; MONO-LONG VALLEY KGRA; COSO HOT SPRINGS KGRA; LAKE CITY-SURPRISE VALLEY KGRA; IMPERIAL VALLEY; HEBER KGRA; EAST MESA KGRA; LASSEN KGRA; SALTON SEA; BRAWLEY KGRA; LITTLE HORSE MOUNTAIN KGRA; LOVELADY RIDGE KGRA; WITTER SPRINGS KGRA; THE GEYSERS; KNOXVILLE KGRA; CUNES KGRA; MAPS; TABLES; DIAGRAMS; ENVIRONMENTAL IMPACT REPORTS; FORECASTING; HOT DRY ROCK; VAPOR-DOMINATED SYSTEMS; HOT WATER SYSTEMS; UTILIZATION; GLOSSARY; SPACE HEATING; GOVERNMENT REGULATIONS.

MEIDAV 76
EXPLORATION/EVALUATION

TITLE- A COMPARISON OF HYDROTHERMAL RESERVOIRS OF THE WESTERN UNITED STATES. TOPICAL REPORT 3.

AUTHOR- MEIDAV, H.T. (GEONOMICS, INC., BERKELEY, CALIF. (USA)).

SANYAL, S.

REFERENCE- A COMPARISON OF HYDROTHERMAL RESERVOIRS OF THE WESTERN UNITED STATES. TOPICAL REPORT 3. ERRI ER-364, ELECTRIC POWER RESEARCH INST., PALO ALTO, CALIF., 1976, 170 P..

DESCRIPTORS- GEOLOGIC SETTING; LITHOLOGY; ROCKS; SEDIMENTATION; VOLCANISM; TEMPERATURE MEASUREMENTS; FLUID FLOW; DRAWDOWN; WATER TABLE; DRILLING; MATHEMATICAL MODEL; THEORETICAL TREATMENTS; COMPUTER CALCULATIONS; FORECASTING; SITE SELECTION; COSTS; DEPTHS; WELL SPACING; PRESSURE MEASUREMENT; GEOTHERMAL RESOURCES; VAPOR-DOMINATED SYSTEMS; HOT WATER SYSTEMS; GEOTHERMAL WELLS; FLOW RATES; INJECTION WELLS; CHEMICAL ANALYSIS; POWER POTENTIAL; DISCUSSION; EVALUATION; FIELD DATA; UNITED STATES; CALIFORNIA; IDAHO; NEW MEXICO; NEVADA; WYOMING; MEXICO; YELLOWSTONE KGRA; HEBER KGRA; EAST MESA KGRA; RAFT RIVER KGRA; MONO-LONG VALLEY KGRA; BRUNEAU KGRA; BRADY-HAZEN KGRA; ROOSEVELT HOT SPRINGS KGRA; BRAWLEY KGRA; DUNES KGRA; LAKE CITY-SURPRISE VALLEY KGRA; BEOWAWE KGRA; STEAMBOAT SPRINGS KGRA.

ERMAK 77B
EXPLORATION/EVALUATION

TITLE- POTENTIAL GROWTH OF ELECTRIC POWER PRODUCTION FROM IMPERIAL VALLEY GEOTHERMAL RESOURCES.

AUTHOR- ERMAK, D.L. (CALIFORNIA UNIV., LIVERMORE (USA). LAWRENCE LIVERMORE LAB.).

REFERENCE- POTENTIAL GROWTH OF ELECTRIC POWER PRODUCTION FROM IMPERIAL VALLEY GEOTHERMAL RESOURCES. UCRL-52252, LAWRENCE LIVERMORE LAB., LIVERMORE, CALIF., 1977, 29 P..

DESCRIPTORS- DIAGRAMS; MAPS; TABLES; CALIFORNIA; IMPERIAL VALLEY; SALTON SEA KGRA; BRAWLEY KGRA; HEBER KGRA; EAST MESA KGRA; BOTTOM HOLE TEMPERATURES; FLOW RATES; HYDROGEN SULFIDES; LAND USE; NON-CONDENSIBLE GASES; POWER GENERATION; SALINITY; SITE SELECTION; WELL REPLACEMENT RATE.

WILLIAMS 78
EXPLORATION/EVALUATION

TITLE- SITE-SPECIFIC ANALYSIS OF GEOTHERMAL DEVELOPMENT-DATA FILES OF PROSPECTIVE SITES VOL III.

AUTHOR- WILLIAMS, F.;COHEN, A.;PFUNDSTEIN, R.;POND,

REFERENCE- SITE-SPECIFIC ANALYSIS OF GEOTHERMAL DEVELOPMENT-DATA FILES OF PROSPECTIVE SITES VOL III. HCF/T4(14-01/3, THE MITRE CORP., 1976,

DESCRIPTORS- MAPS; TABLES; ARIZONA; CALIFORNIA; HAWAII; IDAHO; LOUISIANA; MONTANA; NEVADA; NEW MEXICO; OREGON; TEXAS; UTAH; WYOMING; WASHINGTON; BRAWLEY KGRA; COSO HOT SPRINGS KGRA; EAST MESA KGRA; GEYSERS CALISTOGA KGRA; GLASS MOUNTAIN KGRA; HEBER KGRA; LASSEN KGRA; MONO-LONG VALLEY KGRA; SALTON SEA KGRA; SURPRISE VALLEY KGRA; ALVORD KGRA; CASTLE CREEK KGRA; MOUNT HOOD KGRA; RAFT RIVER KGRA; VALE HOT SPRINGS KGRA; CARNE CREEK KGRA; YELLOWSTONE KGRA; BEOWAWE KGRA; BRADY-HAZEN KGRA; COVE FORT-SULPHURDALE KGRA; LEACH HOT SPRINGS KGRA; ROOSEVELT HOT SPRINGS KGRA; STEAMBOAT SPRINGS KGRA; THERMO HOT SPRINGS KGRA; BACA LOCATION NO. 1 KGRA; PUNA GEOTHERMAL FIELD; BAKER HOT SPRINGS GEOTHERMAL FIELD; CHANDLER GEOTHERMAL FIELD; SAFFORD GEOTHERMAL FIELD; ACADIA PARISH; BRAZORIA COUNTY; CALCASIEU PARISH; CAMERON PARISH; CORPUS CHRISTI COUNTY; KENEDY COUNTY.

CHEMICAL AND ENGINEERING NEWS 78
EXPLORATION/EVALUATION

TITLE- POWER PLANT FOR GEOTHERMAL ENERGY TO BE BUILT.

AUTHOR- WALL STREET JOURNAL.

REFERENCE- CHEM. ENG. NEWS, V. 56 (31), P. 23(1978).

DESCRIPTORS- CALIFORNIA; BRAWLEY KGRA; COSTS; POWER GENERATION; WASTE DISPOSAL.

MATHIAS 75
EXPLORATION/EVALUATION

TITLE- THE MESA GEOTHERMAL FIELD-A PRELIMINARY EVALUATION OF FIVE GEOTHERMAL WELLS.

AUTHOR- MATHIAS, K.E. [BUREAU OF RECLAMATION, BOULDER CITY, NEV. (USA)].

REFERENCE- PROCEEDINGS-SECOND UNITED NATIONS SYMPOSIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. CALIF. UNIV., BERKELEY, CALIF., 1975, V. 3, P. 1741-1747.

DESCRIPTORS- PERMEABILITY; TEMPERATURE MEASUREMENT; CASING; FLUID CHEMISTRY; WELLS; WELL HEAD PRESSURE; INJECTION WELLS; FLOW RATE; IMPERIAL VALLEY; EAST MESA KGRA; PHOTOGRAPHS; TABLES; GRAPHS; CARBON DIOXIDE.

MATLICK 75
EXPLORATION/GEOCHEMISTRY

TITLE- EXPLORATION FOR GEOTHERMAL AREAS USING MERCURY - A NEW GEOCHEMICAL TECHNIQUE.

AUTHOR- MATLICK, J.S., III [ARIZONA STATE UNIV., TEMPE (USA). DEPT. OF GEOLOGY].

BUSECK, P.R. [ARIZONA STATE UNIV., TEMPE (USA). DEPT. OF CHEMISTRY].

REFERENCE- PROCEEDINGS-SECOND UNITED NATIONS SYMPSOIUM ON THE DEVELOPMENT AND USE OF GEOTHERMAL RESOURCES. VOLUME I. CALIFORNIA UNIV., BERKELEY, CALIF., 1975, P. 785-792.

DESCRIPTORS- CALIFORNIA; MONO-LONG VALLEY KGRA; EAST

Appendix II. Typical Site-Specific Data (ENCON)

NATIONAL GEOTHERMAL
INFORMATION RESOURCE

Energy Conversion File
Surprise Valley
August 1978

DATA ELEMENT	DATA ENTRY
General Information	
Record Number-	7
Site Name-	Lake City-Surprise Valley KGRA
Location-Country-	United States
State-	California
County-	Modoc
Project Life-Years/Output	2100 MWe/30yrs. (Jet Propulsion Lab 76B)
Site Developer-Federal-	U.S. Geological Survey (Hot Line 75D)
State-	California Division of Oil & Gas (Hot Line 75D)
Industrial-	Magma Energy Inc., Gulf Oil, Getty Oil, Dow Chemical, Southern Union Production Co., American Thermal Resources (Hot Line 75E, Williams 78)
Site Description-	Mountain valley, some grazing, small towns (Williams 78)
Terrain-	
Areal Extent-	292 km^2 (Meidav 76)
Nearest Community-	Lake City, 16 km (Williams 78)
Access Roads-	Highway 299, 16 km from site (Williams 78)
Comments-	Administrative delays hindering development (Williams 78), Reservoir Volume, 250 km^2 (White 75)
Reservoir Parameters	
Fluid Temperature-	110-225°C (Williams 78), >200°F for Phipps 1 (Hot Line 72), >150°C for Phipps 2 (Hot Line 74B), 104-180°C Quartz (Hot Line 75D), 175°C best estimate (White 75)
Well Cost-	
Field Flow Rate-	
Well Life-	
Noncondensible Gas Content-	
Steam Quality-	
Wellhead Temperature-	
Fluid Rate-	
Enthalpy-	
Operational Parameters	
Plant Size-	
Plant Cost-	
Power Cost to Load Center-	
Power Cycle (Flashed, Binary)-	
O & M Cost-	
Well Spacing-	
Parasitic Power-	
Well Replacement Rate, Per Year (Infield Drilling)-	
Heat Transfer Coefficient, U Factor-	
Heat Rejection (Wet Cooling; Dry Cooling)-	
Make-up Water Cost-	
Wet Bulb Temperature-	
Hot Water Transmission (Direct Utilization)	
Pipe-	
Pipe Material-	

DATA ELEMENT	DATA ENTRY
Pipe Fitting Material-	
Welded Pipe Connections-	
Valves-	
Insulation-	
Material-	
Installation-	
Thickness-	
Casing-	
Material-	
Installation-	
Site Work-	
Pipe Installation-	
Anchor Pad Material-	
Support Installation-	
Site Clearing and Grading-	
Pumps-	
Material-	
Installation-	
Comments-	Forest Products: Kraft paper, crude tall oil, turpentine, lumber (Hornburg 78)
Field Baseline Data	
Thermal Water Temperature-	48-97°C (Jet Propulsion Lab. 76B)
Thermal Water Flow Rate-	50-500 L/min (Meidav 76)
Inferred Reservoir Temperature-	174°C SiO_2 (Williams 78), 220°C (Reed 75)
Electrical Resistivity Low-	
Heat Flow-	
Thermal Gradient-	
Gravity Survey Value-	-190 to -165 mg Bouguer (Anderson 72)
Seismic Noise Correlation-	Associated noise in Alluvium (Eng 74)
Pumping Power Required-	
Scale Control-	
Fouling Factor-	
Corrosion Control-	
Well Logging Data-	
Well Test Data-	Penetration rates slowed by high head waters in upper 300 m of Goodwin 1-11, caused cementing difficulties; after cementing 24.4 cm casing at 390 m, penetration rates increased markedly (Hot Line 74C)
Drilling Mud Types-	
Acoustic Log-	
Temperature Log-	
Caliper Log-	
Electrical Resistivity Log-	
Dipmeter-	
Log Interpretation-	
Bottom Hole Pressure-	
Well Drilling Data-	See Table 1
Well Completion Type (Slotted; Open)-	
Depth to Production-	*1000 m (Williams 78), -2150 m (Meidav 76)
Wellhead Pressure-	
Materials Used-	
Piping-	
Valves-	
Throttle Plates-	
Producing Wells, Number-	
Non-Producing Wells, Number-	9 (abandoned or idle) (Hot Line 75D)

DATA ELEMENT	DATA ENTRY
Comments-	Bedrock beneath the valley is faulted and tilted (Woods 74)
Environmental Aspects	
Gas Data-	
Sample Date-	
H_2S-	
CO_2-	
Other-	
Fluid Data-	
Sample Date-	
Boron-	
Total Dissolved Solids-	
pH-	
Silica-	
Bicarbonate-	
Carbonate-	
Sulfate-	
Waste Water Disposal Method-	
Pre-Disposal Treatment Method-	
Subsidence-	
Environmental Impact Report-	Completed (Williams 78)
Environmental Impact Statement-	
Comments-	Clean ambient air (Williams 78)
Reservoir Engineering	
Recharge Source-	Spring & streams from Warner Mountains (Reed 75)
Rock Porosity-	
Reservoir Rocks-	Grabben, Rhyolites (Reed 75)
Thermal Conductivity-	
Permeability-	
Land Use Factors	
Well Spacing-	
Land Improvements Needed (Clearing, Grading, Roads, Parking)-	
Existing Land Use-	Forest and agricultural use (Jet Propulsion Lab. 76B)
Physical Conditions (Climate, Accessibility)-	
Land-Use Planning-	
Fresh Water Supply (Fire Protection, Cooling Tower, Drinking)-	No consistent supply, surface lakes very alkali (Jet Propulsion Lab. 76B), runoff from Warner Mountains, streams, springs, artesian wells (Hot Line 75D)
Water Rights-	
Proximity to Markets/ Transmission Lines-	40 km to 800 kv DC S.C.E. line (Williams 78)
Legal Aspects	
Pre-Leasing Procedures-	Variance permit, Dept. of Public Works (Jet Propulsion Lab. 76B)

DATA ELEMENT	DATA ENTRY
Exploration Permits-	
Leasing-	
Lease Holders-	See Table 2
Royalty Payment-	
Restrictions-	
Depletion Allowance-	
Government Regulations-	
Loan Guarantee-	
Primary Term Duration-	
Renewal Leasehold Periods-	
Work Requirements-	
Data Monitoring-	
Water Laws-	
Pollution Control-	
Reinjection Control-	
Air Laws-	
Emissions Control-	
State Income Tax-	
Federal Income Tax-	
Bond Interest-	Premiums around $8,000 (Jet Propulsion Lab. 76B)
Injection Well Data	
Fluid Flow Rate-	
Well Stimulation-	
Reinjection Power Required-	
Comments-	

Note: A preceding * indicates inferred, calculated or planned.

TABLE 1

WELL DRILLING DATA

WELL NAME	-	COMPANY	-	DEPTH	-	COMP. DATE
GOODWIN 1-11(A)	-	AMERICAN THERMAL RESOURCES	-	2135 M	-	12/20/74
SURPRISE VALLEY 1-ST(S)	-	GULF OIL CORP.	-	2085 M	-	09/12/73
SURPRISE VALLEY 2-ST(A)	-	GULF OIL CORP.	-	1982 M	-	10/22/73
CEDARVILLE 1(A)	-	MAGMA ENERGY, INC.	-	224 M	-	07/25/62
PARMAN 1(S)	-	MAGMA ENERGY, INC.	-	655 M	-	07/20/59
PARMAN 2(S)	-	MAGMA ENERGY, INC.	-	600 M	-	07/26/59
PARMAN 3(S)	-	MAGMA ENERGY, INC.	-	28 M	-	08/09/62
PHIPPS 1(S)	-	MAGMA ENERGY, INC.	-	386 M	-	09/17/62
PHIPPS 2(S)	-	MAGMA ENERGY, INC.	-	1508 M	-	12/26/72
		(WITHAM 76, HOT LINE 750)				

REMARKS:
(P) = PRODUCIBLE
(S) = SUSPENDED
(A) = ABANDONED
(O) = OBSERVATION
(I) = INJECTION

TABLE 2

LEASE HOLDERS

BIDDER	ACRES	TOTAL BIDS $	BID/ACRE $
GETTY OIL CO.	1,586.52	29,747.25	18.75
GETTY OIL CO.	2,527.76	19,590.14	7.75
DOW CHEMICAL	2,527.76	7,965.00	3.15
DOW CHEMICAL	2,083.36	6,565.00	3.15
GETTY OIL CO.	1,799.52	22,943.88	12.75
SOUTHERN UNION PRODUCTION CO.	2,586.46 (HOT LINE 75E)	55,686.48	21.53

Appendix III. Selected Contents of Report on Current Status of Site-Specific Data

NATIONAL GEOTHERMAL INFORMATION RESOURCE

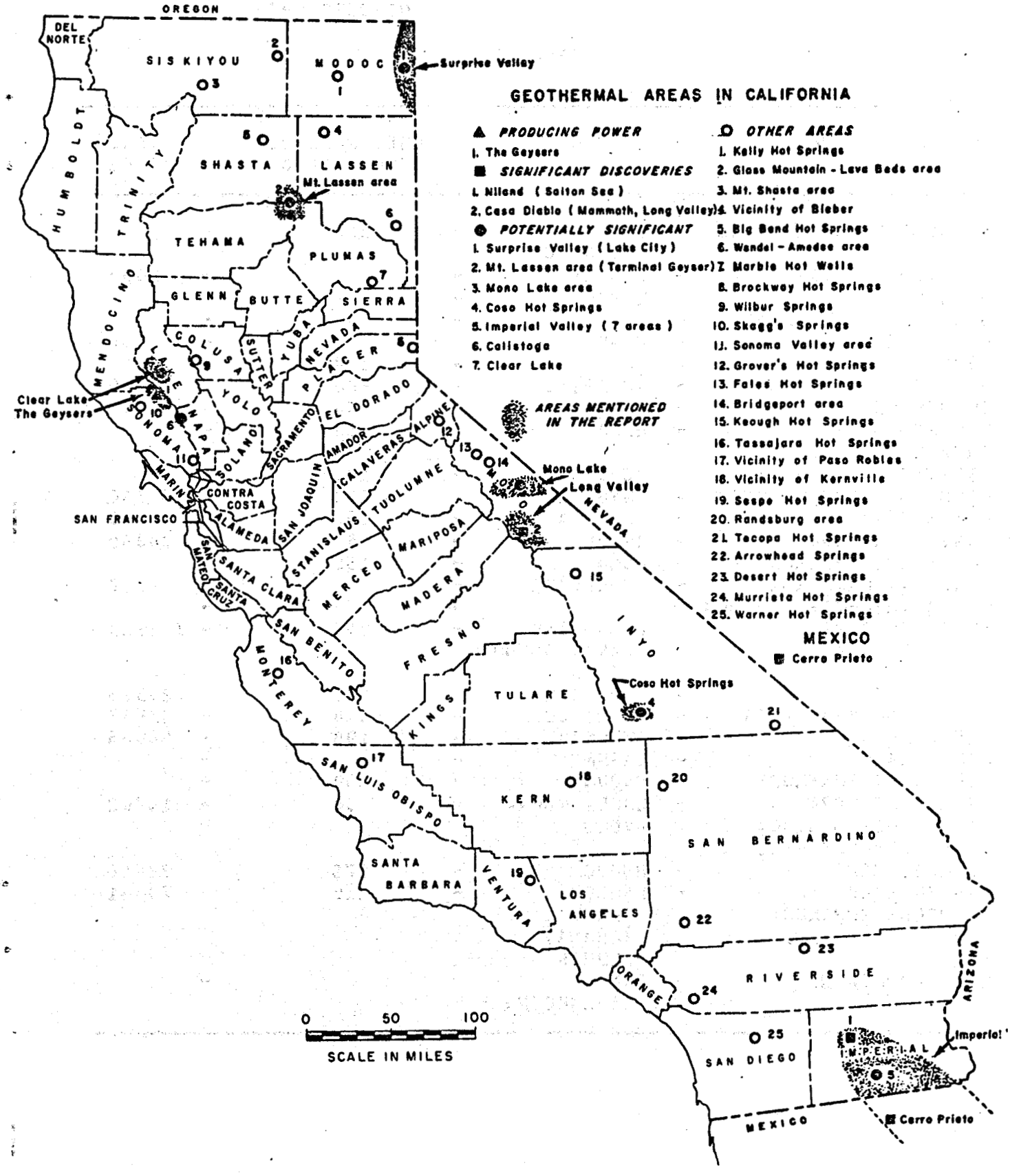
ENERGY CONVERSION FILE
NOVEMBER 1978

INDEX TO PROSPECTS

NOTE: A PRECEDING * INDICATES IN PREPARATION

Appendix III. Typical Contents of Report on Current Status of Data

- Map of Area
- Current Status, Including
  - Deep Drilling
  - Permitting
  - Organizations Involved
- Impediments
- Power Potential
- Direct Utilization Potential
- Recommendations for Research/Development



NATIONAL GEOTHERMAL
INFORMATION RESOURCE

ENERGY CONVERSION FILE
CALIFORNIA
RESERVOIR TEMPERATURES
OCTOBER 1978

TABLE 1

GEOTHERMAL AREA	COUNTY	EST. RESERVOIR TEMP. DEG C	TOTAL ACRES
ARROWHEAD HOT SPRINGS	SAN BERNARDINO	220	
BECKWOURTH PEAK KGRA	PLUMAS		2650
BIEBER	LASSEN		
BIG BEND HOT SPRINGS		140	
BODIE KGRA	MONO		640
BORDER		160	
BRAWLEY KGRA	IMPERIAL	200	26865
BRIDGEPORT	MONO	50	
CALISTOGA	NAPA	160	
CASA DIABLO HOT SPRINGS	MONO	178	
COSO HOT SPRINGS KGRA	INYO	220	51760
DUNES KGRA	IMPERIAL	135	7680
EAST MESA KGRA	IMPERIAL	180	38365
FALES HOT SPRINGS	MONO	150	
FORD DRY LAKE KGRA	RIVERSIDE		7687
FOUTS (REDEYE) SPRINGS		150	
(THE) GEYSERS-CALISTOGA KGRA	MENDOCINO, LAKE, SONOMA, NAPA	240	374910
GLAMIS KGRA	IMPERIAL	135	25505
GLASS MOUNTAIN KGRA	SISKIYOU	210	33287
HEBER KGRA	IMPERIAL	190	58568
HONEY LAKE	LASSEN		
KELLY HOT SPRINGS	MODOC	130	
KNOXVILLE KGRA (ONE SHOT MINING)	LAKE, NAPA, YOLO	150	14702
LAKE CITY-SURPRISE VALLEY KGRA	MODOC	175	72446
LASSEN KGRA (MORGAN SPRINGS)	LASSEN, SHASTA, TEHAMA, PLUMAS	210	78641
LAVA MOUNTAINS	SAN BERNARDINO		

NATIONAL GEOTHERMAL INFORMATION RESOURCE

ENERGY CONVERSION FILE

CONTINUATION OF TABLE 1

GEOTHERMAL AREA	COUNTY	EST. RESERVOIR TEMP. DEG C	TOTAL ACRES
LITTLE HORSE MOUNTAIN KGRA(CRABTREE HOT SPRINGS)	LAKE	150	1196
LOVE LADY RIDGE KGRA (COOK SPRINGS)	COLUSA	140	6879
MAMMOTH	MONO	165	
MENLO	MODOC		
MONO-LONG VALLEY KGRA	MONO, MADERA	220	460256
NEWBERRY	SAN BERNARDINO		
RANDSBURG KGRA	SAN BERNARDINO	125	12880
RED'S MEADOW	MONO	165	
SALINE VALLEY KGRA	INYO		3200
SALT SPRING (2)		150	
SALTON SEA KGRA	IMPERIAL	340	95824
SESPE HOT SPRINGS KGRA	VENTURA	155	7034
SKAGG'S HOT SPRING		155	
SODA SPRING		150	
SUSANVILLE	LASSEN	60	
SULFUR BANK MINE	LAKE	185	
TECOPA	INYO		
TUSCAN (LICK) SPRINGS		140	
WENDEL-AMEDEE KGRA	LASSEN	140	17292
WESTMORELAND	IMPERIAL		
WILBUR HOT SPRING	COLUSA	135	
WITTER SPRINGS KGRA (SARATOGA SPRINGS)	MENDOCINA, LAKE	140	18152

Table 1. Summary: Surprise Valley - Lake City [Class (2)]

Activity	Data	Comment
Bottomhole Temperature	110°C to 225°C, 175°C best estimate	Not confirmed
Total Dissolved Solids	Expected to be low	Not confirmed
Scaling Tests	———	Not confirmed
Reservoir Chemistry	———	Not confirmed
Deep Drilling	9 wells	All idle or abandoned; last drilling in 1974
Drillability	Penetration rate slowed by high head waters; marked increase after cementing	Data from one well
Number of Acres	72,446 acres	Private, state, federal
BLM Acres Leased	10,500 acres	Last leasing in June 1975
Permitting Status	———	———
Power Plant Status	No current construction plans	———
First 50 MWe	1986	Optimistic date
Major Impediments to Power Production	Probable low reservoir temperature; high drilling costs	Binary cycle
Direct Utilization	Forest products (paper, turpentine, tall oil)	Plant design and cost estimate needed
Estimated Cost of Electricity	40 to 60 mills/kWh	———
Estimated Direct Utilization Cost		———

California/Surprise Valley - Lake City

The Surprise Valley-Lake City geothermal field is in Modoc County in the extreme northeastern portion of the state; it is about 30 miles (50 km.) from both the Nevada and Oregon borders. The KGRA contains 72,500 acres of federal, state and private land. The last leasing by BLM was in June 1975, and involved about 10,500 acres leased to Getty Oil Co., Southern Union Production Co. and Dow Chemical Company.

Deep drilling began in 1962 by Magma Power; the "Phipps - 1" with a temperature reported to exceed 97°C at 1267 ft. (335 m). Subsequent drilling in 1972 and 1974 by Magma Energy, Gulf Oil and American Thermal Resources was done for a total of 9 wells. Reported temperature for "Phipps - 2" was 150°C at 1376 m. Surface thermal water analysis for the silica quartz geothermometer gives temperatures from 104°C to 180°C. The U.S. Geological Survey has estimated the best value for the bottomhole temperature is 175°C. A utility to purchase the electric power has not yet been identified.

In summary, the major impediments to electrical power production are considered to be the remoteness from marketing areas, low bottomhole temperature and drilling costs. There has not been significant activity for utilization of geothermal energy since about 1975, and all wells are currently on idle status. Data is needed on the reservoir chemistry to include bottomhole temperature, fluid flow rate, pH, dissolved solids, H_2S content, scaling tests and well drillability. See Table 1 for additional summary data.

Recommendations

Utilization for power production might be examined to include the following three perspectives: (1) Generation of electricity by binary cycle

technology utilizing the results of recent research in developing heat exchangers and organic fluids (e.g., isobutane mixtures) for driving turbines (Ref. 1, 2). Computer modelling is used to simulate binary cycle power production, and could be applied to Surprise Valley-Lake City using best estimated values for the reservoir chemistry. (2) Electric power production at the 1 MWe level might be generated for local use. The idea of small power plants was discussed at a conference in The Azores (Ref. 3). (3) Results of new research on transmitting electric power over large distances might indicate lower costs for a plant at Surprise Valley.

Besides electric power, direct utilization for forest products may be an attractive alternative (Ref. 4). A feasibility study similar to that for Susanville and Raft River could provide information on this alternative.

References

1. Starling, K.E., West, H., Iqbal, K.Z., Hsu, C.C., Malik, Z.I., Fish, L.W., Lee, C.O., "Resource Utilization Efficiency Improvement of Geothermal Binary Cycles, Phase II", ORO-4944-7, University of Oklahoma, Norman, OK, Final Report, June 15, 1976-Dec. 31, 1977.

2. Elliott, D., "Flash Versus Binary at Heber", from 6th Meeting of the Center for the Analysis of Thermal/Mechanical Energy Conversion Concepts, Washington, D.C., July 27, 1977.

3. "World's First Small Geothermal Power Unit Developed", Geothermal Energy Mag., 5 (10), p. 29 (1977); "Small Plants", Geothermal Report, p. 2, Aug. 15, 1975.

4. Hornburg, C.D., "Feasibility of Developing Geothermal Energy Industrial Complexes", p. 189-202, in Proceedings: NATO-CCMS Conference on the Economics of Direct Uses of Geothermal Energy, Washington D.C., June 21-23, 1977, (July 1978).

TABLE 3.

FEDERAL LEASING

	Noncompetitive Leases Issued in FY1978		Total Noncompetitive Leases Issued by 9-30-78		Competitive Leases Issued in FY1978		Total Competitive Leases Issued by 9-30-78	
	Number of Leases	Acreage	Number of Leases	Acreage	Number of Leases	Acreage	Number of Leases	Acreage
Alaska								
Arizona								
California								
Colorado								
Hawaii								
Idaho								
Nevada								
New Mexico								
Oregon								
Utah								
Washington								
TOTALS								

TABLE 2.

Geothermal Area	County	Number of Wells Drilled Exceeding 2000 Feet		
		10/1/75-9/30/76	10/1/76-9/30/77	10/1/77-9/30/78
East Mesa	Imperial	5	4	
Salton Sea	"	2	-	
Heber	"	3	3	
Brawley	"	2	2	
Westmoreland	"	1	3	
Coso Hot Springs	Inyo	-	1	
Geysers-Calistoga	Lake	8	9	
Geysers-Calistoga	Sonoma	17	22	
Mono-Long Valley	Mono	1	-	
Lassen	Lassen	-	-	