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**MASTER**

GRAD: A TOOL FOR PROGRAM ANALYSIS AND PROGRESS MONITORING

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## GRAD - A Tool for Program Analysis and Progress Monitoring

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## ABSTRACT

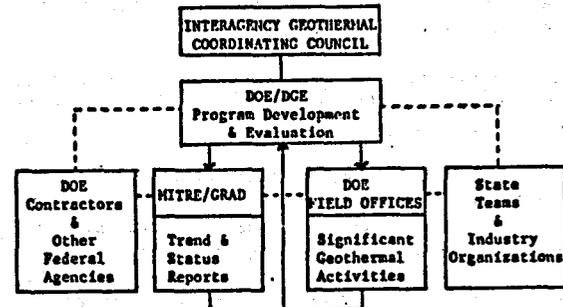
Information required for development, monitoring and evaluation of federal geothermal programs is extensive, and is needed on a timely basis to optimize the allocation of resources. This paper describes the development and operation of the Geothermal Resource Areas Database (GRAD). GRAD was created as part of the the National Geothermal Progress Monitor System in 1979. The database is organized around the concept of a geothermal area and provides broad coverage of geothermal development activities in the United States. Sixteen records, covering pre-lease, lease, and post-lease activities have been defined for each area. Data collected in the various subject areas are critically evaluated, and then entered into an on-line interactive computer system. The system is publicly available for retrieval and use.

Geothermal Progress Monitoring and Information Support

The responsibilities of federal agencies in encouraging geothermal development cover a full spectrum of activities including resources assessment, leasing of federal lands, reducing development costs and risks, sponsoring demonstrations, stimulating energy development, and regulating energy production. The National Geothermal Progress Monitor System (NGPMS) was established by the Department of Energy to support efficient management of federal geothermal programs and to meet reporting requirements for the Federal Geothermal Program. Information about geothermal development is provided to the public through the publication of the Geothermal Progress Monitor.

The NGPMS information network consists of program managers at DOE headquarters and regional offices, state resource and commercialization teams, industry organizations, and major DOE contractors. It is also assisted by other federal agencies involved in the assessment or regulation of geothermal energy. See Figure A. Geothermal Progress Monitor Information Flow. Two computerized information systems have been developed as part of the Geothermal Progress Monitor System. They include the Project Management System at

Figure A. Geothermal Progress Monitor Information Flow



MITRE, Washington, D.C. and the Geothermal Resource Areas Database (GRAD) at the Lawrence Berkeley Laboratory (LBL). Together, these databases provide an easily accessible information system for review of specific program activities.

The National Geothermal Information Resource Project

Primary objectives of the National Geothermal Information Resource Project\* at LBL are to reduce the cost of producing information on a timely basis and to provide a mechanism for systematic evaluation of data from diverse sources.

Current project activities include the development of a computerized Geothermal Resource Areas Database (GRAD) which summarizes the status of exploration and development at over 300 resource areas in the United States, and a supporting data collection effort.\*\* Information collected in the database are used as input in econometric models of geothermal development and to meet report requirements of federal programs.

\* Formerly the Geothermal Resource Information Database (GRID) Project.

\*\* A task which was completed recently is the development of correlation equations showing the viscosity, density, and enthalpy of selected materials (sodium, potassium, calcium, and chloride) in aqueous solutions under various geothermal environments.

This work was supported by the Assistant Secretary for Renewable Technology, Office of Renewable Technology, Division of Geothermal and Hydropower Technologies of the U.S. Department of Energy under Contract No. W-7405-ENG-48.

What kind of information is collected by GRAD?

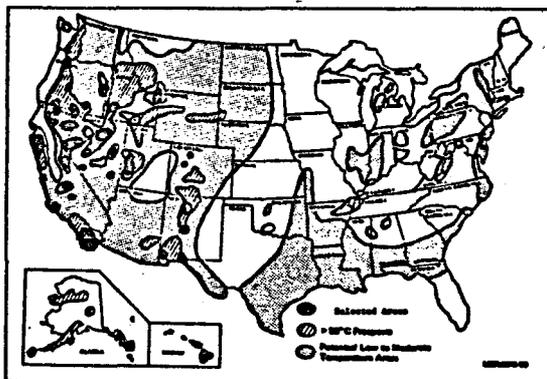
Program managers at various federal and state offices must monitor the status of specific projects and evaluate the effectiveness of particular programs in meeting agency goals. To do so, they must examine the relationship of individual initiatives to development activities at potential geothermal areas. This is frequently complicated by the fact that geothermal development is affected by a wide range of resource, technological, economic, environmental, and institutional factors. Sophisticated analytic models have been developed to model the complex interactions of government-sponsored RD&D on the development climate at each area. In addition, studies have been carried out to estimate the effects of geothermal development on various segments of the population and the natural environment.

In this context, GRAD provides an overview of development activities on a nationwide scale to facilitate monitoring and analysis of

- o leasing and drilling operations
- o power plant development
- o contribution to regional energy requirements
- o federal- and state-sponsored projects
- o geographical distribution of major technical, economic, and institutional uncertainties

The GRAD database is organized around the concept of a Geothermal Resource Area. A geothermal resource area in the database is defined to be an expanse of land associated with a geothermal reservoir that is currently utilized or might be developed in the near future. Areas are selected based on their resource potential as estimated by the U.S. Geological Survey, and in consultation with the Division of Geothermal Energy (DOE). Whenever applicable, the following features are taken into account in the definition of a Geothermal Resource Area: the extent of the reservoir, KGRA boundary lines, current and past leasing activity, plant construction activity, and usage and designation by federal or state agencies. Figure B shows the approximate locations of selected areas.

Figure B. Approximate Locations of Selected Geothermal Areas



How is this information organized?

Selection and organization of data for GRAD are based on a model of geothermal development on federal land prepared by Mitre Corporation, and on a similar analysis, by IBL, of resource development on state, private, and Indian Lands. Within each phase, discrete activities are identified for data collection. Along with information reported through the NGPMS network, a number of industry publications are reviewed for reports of current developments.

Sixteen records have been defined to provide a profile of development activities at each area.

Area Description	Feasibility Study
Permit	Financial Negotiations
Lease	Power Plant
Geothermal Well	Direct Applications
Exploratory Survey	Development Issues
Resource Evaluation	Laws and Regulations
Land Acquisition	Names and Addresses
Environmental Impact	References

Individual facts, e.g., lease number, well depth, plant name, are grouped together to form the data elements aggregated in each record.

Using GRAD

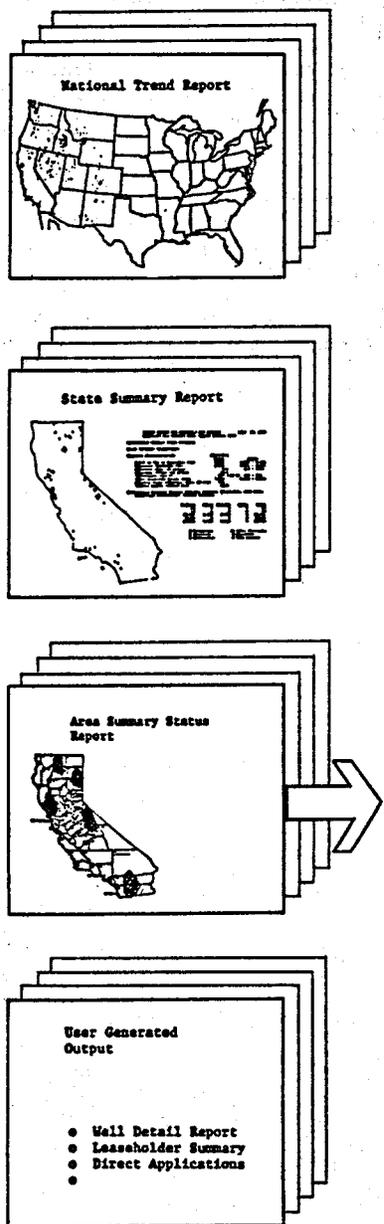
The GRAD database is implemented through the SPIRES data management system operating at Stanford University. This system was selected based on its capabilities for storage, indexing, retrieval, and presentation of data; and its accessibility, cost, and performance. Specialized software packages have been developed to ensure easy access to and retrieval of information in the database. Descriptions of individual protocols are provided in The User Guide. Users may enter the database directly and may format unique status reports through an interactive system of queries. The interactive feature of the database permits users to generate reports according to their information needs. A number of data output modes are illustrated in Figure C. General options that are available include:

- ALL. Every record in the appropriate portion of the database will be included in the output - all address records, all well records, etc.
- USER. This option allows the user to control all record selection and sequencing.
- STATE. Many protocols allow the user to select all records that involve selected states, e.g. all wells in California, all leases in Nevada, all companies with offices in New Mexico.
- COUNTY, CITY. Some protocols permit the selection of all records that involve selected counties (or cities) of a specified state.

- AREA, LEASE NUMBER, WELL NAMES, etc. Many protocols permit selection of all records associated with one or more geothermal areas.

Areas status reports, as well as special reports on leasing, drilling, and other topics are also available from GRID upon request.

Figure C. GRAD Data Output Modes



DRAFT ..... DRAFT ..... DRAFT ..... DRAFT ..... DRAFT

**STATUS REPORT FOR EAST MESA** NOV. 13, 1988  
 East Mesa KGRA, Imperial county, California

Development Status: Plant Operational

Major Markets: Electricity

Resource Characteristics

	Estimated Value	Range
Depth to Top of Reservoir (ft)	3,906	5,986 - 6,562
Reservoir Thickness (ft)	3,609	3,281 - 5,937
Reservoir Area (sq miles)	12.4	6.2 - 15.4
Reservoir Volume (cu miles)	8.7	
Temperature (deg F)	360 (182 C)	329 - 392
Total Dissolved Solids (ppm)	2,500	??? - ???
Electric Power Potential (MWe, 30 yrs)	360	
Thermal Energy (10 <sup>15</sup> Btu)	15.5	

Exploratory Surveys: Seismic Methods, Gravity, Geological, Heat Flow

Permits

Type	Nmbr. Filed	Nmbr. Approved	Latest Approval Date
NOI	0	0	???
APD	20	19	06/23/78
PDD	17	13	09/13/78
SEL	5	3	05/30/78
Total	43	35	???

Leasing

	Federal	State	Private	Other	Total
Nmbr. Leases	4	???	???	???	???
Nmbr. Leaseholders	4	???	???	???	???
Acres under Lease	18,729	???	???	???	???
Acres Withdrawn	0	???	???	???	???
Total Acres in Area	???	???	???	???	???

Total estimated size is 49,920 acres.

Drilling

30 Wells Spudded	17 Production	0 Idle, Suspended
29 Wells Completed	8 Injection	3 Abandoned
	2 Observation	0 Type Unknown

Well Statistics

	Average	Range	Nmbr. Wells Reporting
Depth (ft)	6,369	1,679 - 9,609	21
Sfc. Temp. (deg F)	280	280 - 280	1
Sfc. Flow (lb/sec)	48	7 - 117	6

Plants (Entries are Nmbr. Plants/Total Power)

Type	Operational	Under Constr.	Planned	Total
Electric Power (MWe)	1/11	0/0	2/114	3/125
Direct Use (10 <sup>15</sup> Btu/yr)	0/0.0	0/0.0	0/0.0	0/0.0
Total Plants (MWe Equivalent)	1/11	0/0	2/114	3/125

Major Organizations Involved in Area Development

Magma Power  
 Republic Geothermal  
 SDG & E

Note: ??? denotes Value Unknown

On a trial basis, GRAD is open to all members of the geothermal community. Access to GRAD is available to anyone with an account on the Stanford computer, either directly over the telephone or via Telenet.\* Direct dial access to the Stanford computer requires a terminal with a coupler for a telephone receiver; access via Telenet requires calling the local Telenet access point. Processing may occur on-line, with the resulting report displayed at the user's terminal, or printed at Stanford and mailed to the user; or off-line, (at night) and mailed to the user.

#### Future Activities

Data collection and analysis for GRAD are being carried out on a routine basis. Area status reports are being circulated among state resource and commercialization teams and representatives of the geothermal industry for review. An outreach effort to assist users in DOE field offices and state resource and commercialization teams is being implemented through a series of briefings and workshops. These meetings are also designed to elicit input for further development of both the GRAD database and the National Geothermal Progress Monitor System. In particular, work is underway to expand the database to include area-specific information on the development of direct heat applications.

The primary task of the project during 1982 will be maintenance of the GRAD database through continuing data collection, evaluation, and analysis activities. Development of two new databases has been proposed in support of program monitoring and development activities in the Division of Geothermal Energy.

A Federal-State Geothermal Facilities Database will monitor and evaluate the opportunities for geothermal utilization at public facilities that are co-located with identified geothermal resources. This database will provide a framework for interagency development to retrofit or relocate government-operated facilities.

The International Cooperative Research Database will monitor the progress of technical developments under bilateral and multilateral agreements. Research activities will be indexed by task and geographic location. Availability of the database will facilitate comparative evaluation of technical research in reservoir modelling, stimulation of hot dry rock and hydrothermal resources, utilization of saline brines, reservoir definition, deep drilling, and development of geothermal equipment and environmental abatement technologies.

\* Telenet is a public telecommunications network that makes it possible for computer users to use telephones to connect individual terminals with computers anywhere in the U.S.

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