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**THE GEOTHERMAL PROGRESS MONITOR: SYSTEM STATUS
AND OPERATIONAL EXPERIENCE**

By
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November 1983

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The MITRE Corporation
Metrek Division
McLean, Virginia

Technical Information Center
Office of Scientific and Technical Information
United States Department of Energy

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The Geothermal Progress Monitor

System Status and Operational Experience

**R. E. Gerstein
D. M. Medville**

November 1983

MTR-83W187

**SPONSOR:
Division of Geothermal and Hydropower Technologies
U.S. Department of Energy
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**The MITRE Corporation
Metrek Division
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McLean, Virginia 22102**

ABSTRACT

The Geothermal Progress Monitor (GPM) system was designed and implemented by MITRE for DOE's Division of Geothermal Energy (now the Division of Geothermal and Hydropower Technologies). This report summarizes MITRE's operational experience with the system during fiscal year 1983 and provides a qualitative assessment of its data sources.

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EXECUTIVE SUMMARY

The Geothermal Progress Monitor (GPM) is an information system designed and implemented by The MITRE Corporation on behalf of the Division of Geothermal and Hydropower Technologies (DGHT) of the U.S. Department of Energy (DOE). The GPM serves a dual function for DGHT and other members of the Interagency Geothermal Coordinating Council (IGCC), supporting effective management of the federal geothermal program and providing information for executive, legislative, statutory, and public needs.

The overall purpose of the GPM is to identify and quantify trends in the development and use of geothermal energy resources. Its general objective is to provide a quick-response, centralized, geothermal information collection, storage, analysis, and reporting system that tracks the development of geothermal energy in the United States and the world.

Data are collected via the GPM network and reported semi-annually as a Geothermal Progress Monitor Report. These reports receive wide distribution to organizations and participants in the GPM system and others in the geothermal industry. During calendar year 1983 two Geothermal Progress Monitor Reports were submitted to DOE for publication. Despite format variations, these reports maintained the overall objective of the system, i.e., they have identified and quantified trends in the development and use of geothermal energy.

The information sources for the GPM system include government or government-supported contractors and commercial or trade publications and contacts. At the Department of Energy, DGHT manages and coordinates activities in the system. The DOE Operations Offices in the West, through EG&G Idaho, are the main sources for direct reports from the field. In the Department of the Interior, the Geologic Division of the U.S. Geological Survey provides information about geothermal resources. The Minerals Management Service supplies DGHT, MITRE and the Lawrence Berkeley Laboratory with information about leasing, environmental assessments, and plans of operation.

The network of government-sponsored sources is supplemented by geothermal trade publications and newsletters to which MITRE subscribes. The MITRE Corporation's role is to integrate the assembled data, to maintain comprehensive project files, to prepare the GPM Reports, and to conduct trend and/or special analyses in support of the GPM.

1.0 INTRODUCTION

The Geothermal Progress Monitor (GPM) is an information system designed and implemented by The MITRE Corporation on behalf of the Division of Geothermal and Hydropower Technologies (DGHT) of the U.S. Department of Energy (DOE). The purpose of the GPM is to keep track of and to report significant events and trends in the U.S. geothermal industry and the federal geothermal program. The information sources of the GPM system are paper and computerized files maintained by a number of organizations throughout the United States. Trade and technical publications are also used to supplement the information-gathering network. Periodic reports from the GPM system consist mainly of manual and computerized analyses of the collected data. In addition, significant events and activities are usually highlighted.

The GPM serves a dual function for DGHT and other members of the Interagency Geothermal Coordinating Council (IGCC). The system supports effective management of the federal geothermal program and it provides information for executive, legislative, statutory, and public needs.

This paper summarizes the current status of the GPM system and MITRE's operational experience with it during fiscal year 1983. It includes a description of the mechanism by which information is gathered, integrated, and published as a Geothermal Progress Monitor Report.

1.1 Background

In 1978 the DOE geothermal energy program was recognized as a priority area for rapid energy technology development. The Division of Geothermal Resource Management (DGRM) was established in October of 1978 to promote geothermal energy technology and development throughout the nation. In February 1980, DGRM was merged back into the Division of Geothermal Energy (DGE, now DGHT), which continues the mandate of DGRM.

The design of the GPM began in 1975, when MITRE was asked to develop system concepts for monitoring the development and use of geothermal energy in the United States. The results of this study were published in February 1977 as MITRE report MTR-7307. No further action was taken until February 1979, when a panel of the DGRM Commercialization Workshop developed the rationale for a progress monitoring system and described a preferred approach for its development. The panel evaluated a number of concepts and in July 1979 MITRE was tasked to develop and implement the GPM.

MITRE's review of the background, approaches, and objectives provided a focus for discussion at a meeting of geothermal database managers convened by DGRM in August 1979. The results of this meeting served as a basis for developing an initial GPM design and a proposed first report of the GPM. The design and proposed first report were reviewed at a meeting of DGRM field elements in November 1979, and a consensus was reached to produce the GPM report on a trial basis for three issues. GPM Report Number 1 was issued in January 1980. The trial edition of these reports was successful enough to warrant publication of a fourth report in September, 1980.

Production of GPM Report Number 5 began in February 1981 and the report was issued in June 1981. Geothermal activities during the second half of 1981 were reported in GPM Report Number 6 (June, 1982). Material compiled throughout 1982 and the beginning of 1983 was reported in GPM Number 7 (April, 1983) while material gathered through the second and third quarters of 1983 was published in GPM Report Number 8.

1.2 Purpose and Objectives

The overall purpose of the GPM is to identify and quantify trends in the development and use of geothermal energy resources. To achieve this purpose, information from several sources is collected, analyzed for status indicators and trends, and reported to users. A schematic representation of the information network is given in Figure 1-1. The GPM provides a quick-response, centralized, geothermal information collection, storage, analysis, and reporting system that tracks the development of geothermal energy in the United States. It assists the Director of DGHT in reporting geothermal energy activities, status, and trends to other officials in the government, field members of state geothermal teams, and other interested parties in the geothermal industry.

A complex set of progress indicators from a wide variety of sources is summarized in the GPM to produce a coherent, timely, and accurate picture of the status and rate of geothermal energy development in the United States. Principal emphasis is placed on development of the geothermal resource and technological advances in the geothermal industry. The principal policy-oriented aim of the GPM is to assure that federal programs and policies meet the needs of the private sector in developing geothermal energy resources. The GPM also provides industry with information for its own geothermal development decision-making processes.

FIGURE 1-1
SCHEMATIC OF INFORMATION FLOW IN
THE GEOTHERMAL PROGRESS MONITOR

To summarize, the GPM carries out the following functions:

- Monitors and reports on geothermal development activities, status, and trends in the government and private sector by locating, quantifying, and analyzing public and private sector plans and actions
- Serves the program management and information dissemination functions of DGHT and the IGCC
- Serves as a national point of reference for reporting the pace of geothermal development
- Provides information concerning successful transfer of technology from the geothermal R&D program and the national laboratories to the private sector.

2.0 OPERATIONAL EXPERIENCE, 1983

The design of the Geothermal Progress Monitor system has been described in MITRE report MTR-80W075 (1981). Several topical areas have been identified including electric power plant development, direct heat applications, drilling, exploration, and leasing. These provide a comprehensive overview of the geothermal energy field. For each of these topics up to three types of information are developed: (1) events, or activities, (2) status, or the present situation, and (3) trends that are identified or synthesized from the first two types of information. The format is flexible enough to allow for the inclusion of chapters containing special analyses or information of particular interest and/or timeliness.

The collected information is reported periodically, as a Geothermal Progress Monitor Report. These reports receive wide distribution to organizations and participants in the GPM system and to others in the geothermal community through the Geothermal Energy category (UC-66) of DOE's Technical Information Center (TIC).

2.1 Geothermal Progress Monitor Reports

During calendar year 1983 two Geothermal Progress Monitor Reports were submitted to DOE for publication. The tables of contents of the two reports are reproduced as Tables 2-1 and 2-2. These reports have maintained the overall objective of the system; i.e., they have identified and quantified trends in the development and use of geothermal energy by synthesizing activity and status reports from the field. The format variations that have occurred have been introduced to maintain the interest of the readers of the reports. The format has also varied to allow for the incorporation or highlighting of the results of technology transfer activities being conducted at the national laboratories.

2.2 Technology Transfer

In response to increasing national interest in technology and technological innovation, GPM Report Number 8 was planned to include a section highlighting technology transfer activities from Geothermal Energy R&D programs to both the private and public sectors. In order to gather information for this section members of the technical staff of The MITRE Corporation met with past and current program participants in several of the national laboratories. These meetings had three principal objectives:

TABLE 2-1

REPRODUCTION OF THE TABLE OF CONTENTS
OF GPM REPORT NUMBER 7

FOREWORD

LIST OF ILLUSTRATIONS

LIST OF TABLES

1.0 INTRODUCTION

1.1 Summary and Guide to GPM Report Number 7

1.2 Background

1.3 Purpose and Objectives

2.0 STATE SUMMARIES

3.0 DRILLING AND EXPLORATION ACTIVITIES

3.1 Deep Well Completions - Status and Trends

3.2 Exploration

4.0 LEASES

4.1 Nineteen Eighty-Two Highlights

4.2 Recent Major Activities

5.0 DIRECT HEAT STATUS UPDATE

5.1 Statistical Summary

5.2 Status Summaries

5.2.1 States With Significant Geothermal
Development Activity

5.2.2 States With Moderate Geothermal
Development Activity

6.0 GEOTHERMAL ELECTRIC POWER DEVELOPMENT - SITE
STATUS SUMMARIES

6.1 Known Geothermal Resource Areas with High
Levels of Development Activity

6.2 Known Geothermal Resource Areas with Moderate
Levels of Development Activity

6.3 Known Geothermal Resource Areas with Low or
No Development Activity

7.0 DIRECTORY

TABLE 2-2

REPRODUCTION OF THE TABLE OF CONTENTS
OF GPM REPORT NUMBER 8

FOREWORD

LIST OF ILLUSTRATIONS

LIST OF TABLES

1.0 INTRODUCTION

1.1 Summary and Guide to GPM Report Number 8

1.2 Background

1.3 Purpose and Objectives

2.0 TECHNOLOGY TRANSFER

2.1 Legislative and Policy Directives Supporting
the Technology Transfer Function

2.1.1 The Stevenson-Wydler Technology Innovation
Act of 1980 (Public Law 96-480)

2.1.2 Department of Energy Order Number 5800.1

2.2 Technology Transfer of Geothermal Energy Research
and Development Programs

2.2.1 Technology Transfer Mechanisms

2.2.2 Examples of Successful Technology
Transfer Actions

2.2.2.1 Battelle Pacific Northwest
Laboratories

2.2.2.2 Lawrence Berkeley Laboratory

2.2.2.3 Los Alamos National Laboratory

2.2.2.4 Sandia National Laboratories

2.3 Sources of Additional Information

2.3.1 Office of Research and Technology
Applications

2.3.2 U.S. Department of Energy-Technical
Information Center

3.0 STATE SUMMARIES

TABLE 2-2 (Concluded)

REPRODUCTION OF THE TABLE OF CONTENTS
OF GPM REPORT NUMBER 8

-
- 4.0 DRILLING AND EXPLORATION ACTIVITIES
 - 4.1 Deep Well Completions - Status and Trends
 - 4.2 Recent Drilling and Exploration Activities - Reports by States
 - 4.3 Exploration
 - 5.0 ELECTRIC POWER PLANT DEVELOPMENT
 - 5.1 Recent Major Activities
 - 5.2 Existing and Planned Geothermal Electric Power Plants
 - 6.0 DIRECTORY
-

- To identify and discuss examples of successful transfer of geothermal R&D results to the private sector.
- To determine those institutional arrangements and program management methods/techniques which most effectively stimulate the involvement of industry and its desire to implement the technology advances of geothermal energy R&D programs.
- To gather views on the definition of technology transfer as it applies to geothermal energy.

Although specific details of the technology transfer process may differ from laboratory to laboratory, in general there is considerable agreement regarding the mechanisms used to effectively conduct technology transfer activities. Personal contacts, initiated at workshops, conferences, or meetings are considered to be one of the most effective mechanisms. In one instance it has led to a cooperative working arrangement between Battelle Pacific Northwest Laboratory (PNL) and Magma Power Company. At Sandia National Laboratories, Technology Review Panels comprised of industrial, governmental, and academic experts are another manifestation of the role of personal interactions in technology transfer activities.

Workshops are also a useful medium for technology transfer due to the multiplier effect of having several individuals with specialized training and interests involved in directed discussions, usually at the facility where these interests are being pursued. Some of the laboratories use direct mailings of their technical project reports to supplement the traditional Technical Information Center distribution. Project personnel are responsible for maintaining lists of interested parties in the private and public sectors to whom early transmission of project status or results may be of value.

Another mechanism for facilitating technology transfer is to involve the private sector as subcontractors and, if possible, as co-sponsors for hardware development. This has worked effectively in instrument development programs such as those at PNL, Los Alamos, and Sandia. Other opportunities include making laboratory test facilities available to the private sector and having laboratory personnel serve on committees of trade associations, professional societies and various consortia.

Throughout the various conversations between the MITRE staff and the laboratory personnel the comment most frequently made was that technology transfer worked best when there was a high level of personal interaction between the research and user communities.

As a result of the meetings held with laboratory personnel, a fairly comprehensive listing of technology transfer mechanisms was developed. This list is given as Table 2-3. These mechanisms represent a variety of overlapping approaches to technology transfer. The extent to which each is being used and the degree of success of each mechanism is dependent on a variety of factors. Among these are the types of technology being transferred (e.g., hardware, test results, software), the nature of the laboratory work program, and the laboratory's history of interacting with industry.

A more complete discussion of this subject may be found in GPM Report Number 8.

TABLE 2-3
TECHNOLOGY TRANSFER MECHANISMS

Employee Exchanges

Presentations at Technical Meetings

Publication in Scientific and Trade Journals

Direct Mailing of Technical Reports to Industry

Unreimbursed Consulting Services for Industry

Limited Reimbursable Work for Industry

Use of Industrial Facilities to Test Laboratory-Developed Hardware and Equipment

Technology Inventories Made Available to Industry (e.g., Applications Assessments)

Inventory of Laboratory Facilities Made Available to Industry and Use of These Facilities by Industry

Informal Interactions with Private Sector Personnel

Formal Visits to Discuss Research in Progress

Special Conferences and Workshops Held at Labs and Focused on Technology of Mutual Interest

Liaison with Industry Associations

Use of Industrial Advisory Committees/Technology Review Panels

Federal Laboratory Consortium for Technology Transfer

Laboratory Personnel Transferring to Industry or Forming New Companies

Licensing of DOE Patents to Corporations

Use of Technology Champions in Laboratories or Brokers Outside of Laboratories

3.0 QUALITATIVE ASSESSMENT OF THE GPM SYSTEM

The GPM system is dependent on the quality and reliability of its information and sources. Generally, the sources fall into two categories: government or government-supported contractors and commercial or trade publications and contacts. Section 3.1 discusses those organizations which are considered government contacts and section 3.2 describes the commercial and trade publications which are used to provide data input. The publishing offices of these trade journals are listed in the Appendix.

3.1 Government and Government-Supported Sources

The Department of Energy

The Division of Geothermal and Hydropower Technologies (DGHT) manages and coordinates activities in the GPM system. The GPM reports are prepared for and reviewed by DGHT. DGHT also serves as an information source for the GPM. Progress reports pertaining to DOE-funded projects are transmitted directly to DGHT and, in turn, forwarded to MITRE to be included in the GPM system.

The DOE Operations Offices in the West provide information to EG&G Idaho. This center transmits monthly reports of geothermal activities in the western states. The reports are comprehensive and include information about the center's activities as well as information supplied by state energy offices and other local entities. The reports are submitted to DGHT Headquarters and MITRE where the most significant elements are selected for inclusion in a GPM report.

The Department of the Interior

The Department of the Interior contributes substantial amounts of information to the GPM system. The Geologic Division of the U.S. Geological Survey (USGS) is responsible for resource assessment projects and reports its findings to DGHT, Lawrence Berkeley Laboratory (LBL), and the University of Utah Research Institute. The Minerals Management Service (formerly the Conservation Division of the USGS) provides information about leasing, environmental assessments, and plans of operation to DGHT, MITRE, and LBL. This data set is valuable in that it signals the level of private sector interest in a particular area and identifies the parties responsible for developing a prospect.

Lawrence Berkeley Laboratory

The Lawrence Berkeley Laboratory at the University of California also receives data from DOE, MITRE, TIC, trade journals, and direct telephone contacts. The primary role of LBL was to maintain the Geothermal Resource Areas Database (GRAD). This database was concerned with the physical characteristics of geothermal prospects. It has been upgraded by the inclusion of MITRE's GEOWELLS and GEOHEAT files.

MITRE

The MITRE Corporation's role in this system is to integrate the data assembled from the various sources and to maintain comprehensive project status files. The information is then available for the GPM reports, trend and/or special analyses. Figure 3-1 is a schematic representation of the information flow at MITRE.

3.2 Commercial and Trade Sources

Petroleum Information Corporation

The Petroleum Information Corporation (PIC) collects data on matters pertaining to the oil and gas industry. It operates on a subscription basis two vital geothermal data sources. The "National Geothermal Service" (NGS) is a weekly update of all geothermal drilling activity. The drilling information is presented in tabular form by state (California in turn is divided into regions) and includes completions, first reports, and progress reports. Each issue is usually introduced by a 2 to 4 page summary of the past week's events in the geothermal industry. Typically, these news summaries include information about exploration programs or plans, drilling successes or failures, announcements of power plants, direct heat projects, and lease sales. The NGS provides frequent, highly reliable information to the GPM system. It has been used extensively to construct and maintain the GEOWELLS data file at MITRE.

The second geothermal data source offered by PIC is the monthly Geothermal Well Completion Cards service. As the completion of a geothermal well is announced, the pertinent information relating to its location, owner, driller, physical characteristics, and drilling history is compiled on a 4 x 6 file card. These cards are distributed to subscribers and are a valuable cross reference to the weekly NGS newsletter. They have been used to verify information in the GEOWELLS data file.

NOTES:

C - Computer-based File
 I - Printed in GPM Reports
 II - Basis for Trend Analyses

III - Source for Special Analyses
 IV - Internal Project Reference

FIGURE 3-1
INFORMATION FLOW AT MITRE

The Geothermal Resources Council

The Geothermal Resources Council (GRC) is the professional association of the geothermal industry. It publishes the Geothermal Resources Council Bulletin 11 times per year. A typical issue includes a feature article about a potential resource area or some aspect of geothermal development (e.g., financing), an editorial, a survey of state and federal activities, and sections devoted to announcements of lease sales, reviews of publications, and notices of forthcoming meetings. The GRC Bulletin is generally reliable, and its feature articles provide authoritative insights into various aspects of the geothermal industry. The summary and survey information tends to confirm and, in some instances, enhance information reported by the DOE Regional Operations Offices.

The Geyser

"The Geyser" is an international geothermal energy newsletter published 18 times per year. Each four-page issue focuses on three or four major news items of interest to the geothermal community. It also includes short items such as drilling notices or impending lease sales. Although not as comprehensive as some of the other publications used by the GPM system, it does provide in-depth information about the activities and events included in each issue.

Geothermal Energy

Geothermal Energy is a monthly publication of Geothermal World Corporation. It is similar in nature to the GRC Bulletin, but seems to focus more on the international and business communities. Throughout the year it will publish special summary articles dealing with specific areas of geothermal development (e.g., annual drilling summary). Although there is significant intrinsic value to the information contained in Geothermal Energy, its printing and circulation schedule is somewhat erratic. This reflects on the timeliness of the information contained in each issue.

Direct Contacts

One aspect of geothermal progress monitoring is the determination of activities affecting geothermal power plant development. More than any other class of project, the information for this data set has been gathered by direct telephone contacts with developers and utilities. The initial information about new power-plant construction or additions may be derived from the more conventional

sources such as the newsletters or journals. It is sometimes necessary, however, to develop more detailed and more specific information. MITRE maintains a computerized data file named GEOWATTS which is a comprehensive listing of existing and proposed power plants. It contains identification data as well as data relating to plant size, plant type, estimated power-on-line date, and estimated plant cost. Additional information is collected and maintained in a site status file.

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APPENDIX

COMMERCIAL AND TRADE PUBLICATIONS USED BY THE GPM SYSTEM

The following is a list of the publishing offices of the trade journals and newsletters referred to in Section 3.2.

Petroleum Information Corporation
P.O. Box 2612
Suite 261-A
Denver, Colorado 80201
(303) 740-7100

Publications: National Geothermal Service (weekly)
Geothermal Well Completion Cards (monthly)

"The Geyser" Inc.
Geothermal Energy Newsletter
P.O. Box 1738
Santa Monica, California 90406

Publication: The Geyser (18 issues/year)

Geothermal Resources Council
P.O. Box 1350
Davis, California 95617

Publication: The Geothermal Resources Council Bulletin
(11 issues/year)

Geothermal World Corporation
5762 Firebird Court
Mission Oaks
Camarillo, California 93010

Publication: Geothermal Energy (monthly)

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