DOE/NV/10072-5
(DE81030369)

MULTI-TASK SUPPORT TO THE DIVISION OF GEOTHERMAL ENERGY'S HYDROTHERMAL RESOURCES PROGRAM

Final Report

May 1981

Work Performed Under Contract No. AC08-80NV10072

Gruy Federal, Inc.
Arlington, Virginia

U. S. DEPARTMENT OF ENERGY

Geothermal Energy

DOE/NV/10072-5
(DE81030369)
Distribution Category UC-66a

Multi-task Support to the Division of Geothermal Energy's Hydrothermal Resources Program

Final Report

May 1981

Work Performed Under Contract No. DE-AC08-80NV10072

Gruy Federal, Inc.
Arlington, Virginia

Prepared for the
U. S. Department of Energy
Division of Geothermal Energy

Preface

Since June 1978, Gruy Federal, Inc. has, under contract to the Department of Energy's Division of Geothermal Energy, performed various tasks associated with the Division's program for the development of hydrothermal resources in 35 eastern states. This report discusses the work performed for DGE in FY 1980. During the year, tasks were conducted in two general areas of activity: information dissemination and assistance to DGE's state-coupled program.

Technical direction from DGE in FY 1980 was provided by Dr. Gerald P. Brophy and Robert A. Gray. This assistance is acknowledged with appreciation.

CONTENTS

TABLE

Information Dissemination Tasks

Information-dissemination tasks in FY 1980 included widespread distribution of a general report on eastern geothermal resources prepared in FY 1979; preparation of state-specific reports on geothermal resources in Illinois, Indiana, Michigan, and Minnesota; a survey of the geothermal potential at military bases throughout the United States; and other minor activities.

Eastern Geothermal Report Distribution. Over 200 copies of the report "Geothermal Resources of the Eastern United States," by J. L. Renner and T. L. Vaught, were sent to agencies and individuals involved in geothermal energy. The report discusses known and potential hydrothermal resources in the 35 states east of the Rocky Mountains, excluding the Dakotas, and is based on data found in the literature and in files at various state geological offices. It is available from the National Technical Information Service as report number DOE/ET/28373-T2 or from Gruy Federal, Inc., 2001 Jefferson Davis Highway, Suite 701, Arlington, Virginia 22202.

The eastern geothermal study found that known occurrences of geothermal energy in the eastern United States fall into four categories: warm spring systems, radioactive granitic plutons beneath thick sediment covers, abnormally warm aquifers, and deep sedimentary basins with normal temperature gradients. Warm springs with the most potential are found in the Appalachian and Ouachita Mountains and in the Trans-Pecos area of Texas. Radioactive, granitic plutons underlying thick, low-conductivity sediments are thought to occur beneath the Atlantic Coastal Plain. Abnormally warm aquifers, presumably caused by updip or fracture-zone movement of water, are found at several places in the Gulf Coastal Plain in Texas and Arkansas. An extensive area of thermal waters is also inferred to lie under the western third of Nebraska. Several deep basins exist where temperature gradients are no higher than normal but sediments are sufficiently thick to provide elevated temperatures near basement. However, these resources cannot be utilized unless the cost of drilling deep wells can be greatly reduced.

Undiscovered geothermal resources are most likely to exist in areas characterized by historical seismic activity or by high heat flow involving radioactive granitic plutons, low-conductivity sediments, deep circulation of ground water, or combinations of these factors. Radioactive granitic plutons are of importance only if covered by thick layers of low-conductivity sediments, and here the Atlantic Coastal Plain holds greatest promise. In general, conductivity in inland regions is too high to permit the generation of sufficiently high temperatures at reasonable depths by this mechanism. Deep circulation of ground water is possible under geological conditions similar to those in the folded Appalachians. Conditions in some portions of the Blue Ridge, the Piedmont, the Champlain Valley, and the Ouachita structural trend are favorable for this kind of occurrence.

Temperature Gradients in Michigan. The objective of the Michigan study was to assess the geothermal data base of the American Association of Petroleum Geologists. Although the AAPG's 1976 "Geothermal Survey of North America" has been used extensively in assessments of eastern geothermal potential, it is largely unverified.

A thorough review of the entire data base for the east would have entailed an unjustifiable dedication of resources; instead, a representative portion of Michigan was studied in detail. The area selected has relatively simple geology and extensive well data.

The study is reported by T. L. Vaught as "Temperature Gradients in a Portion of Michigan: A Review of the Usefulness of Data from the AAPG Geothermal Survey of North America." It will be available from NTIS later in FY 1981 as report Number DOE/NV/10072-1. Advance copies may be obtained from Technical Editor, Gruy Federal, Inc., 2500 Tanglewilde, Suite 150, Houston, Texas 77063.

Following is a summary of the study's findings:

- Special care should be taken when using the data file that accompanies the Geothermal Gradient Map of North America.

- Bottomhole temperatures in the shallow wells of the portion of Michigan studies are abnormally high.

- Upward movement of warm water, high heat flow and low-conductivity sediments may cause the high gradients. However, deeper holes yield lower gradients.

- Errors may have been made in reading and handling the temperature recording devices. Failure to reset maximum-reading thermometers or exposing them to elevated surface temperatures would produce readings higher than actual bottomhole temperatures.

- There is evidence that in many cases elevated bottomhole temperatures were mere guesses.

- The AAPG-USGS temperature-gradient maps can be useful guides for preliminary geothermal exploration, but the study shows that they cannot be used as conclusive indicators of geothermal potential unless substantiated by other geologic data.

Indiana Geothermal Assessment. The Indiana geothermal analysis is part of a series of investigations focusing on individual midwestern states. Discussed in the report are the general geology and indicators of geothermal resources in Indiana. It will be available from NTIS later in FY 1981 as report number DOE/NV/10072-3, "An Assessment of the Geothermal Resources in Indiana Based on Existing Geologic Data," by T. L. Vaught. Advance copies may be obtained from Gruy Federal's technical editor.

The State of Indiana has no reported warm springs. The relatively few major faults known in Indiana might serve as conduits for the upward movement of warm waters, but there is no evidence that this process is currently taking place.

Six thermal anomalies were reported in Indiana by W. S. Blatchley in 1901. However, the current study could not verify his information.

Heat flow values measured in Indiana are within the normal range for the eastern United States, from 0.97 to 1.41 HFU. However, to date only five heat flow holes have been drilled in Indiana, all in the northern half of the state. To obtain a better estimate of heat flow, more test holes are needed. The west central portion of the state would be the most interesting area, since the AAPG-USGS temperature gradient map suggests that gradients as high as 2°F/100 ft are present.

The southwestern portion of the state is also of interest because of the thick sediments present in the Illinois basin. Resource estimates based on deep holes drilled into this thick sedimentary section must be carefully considered in terms of the high costs associated with drilling and production from deep wells. Geothermal energy production rates may not be sufficient to cover these expenses. The hydrologic character of the deep sedimentary section is also an unknown factor.

Illinois Geothermal Assessment. As with Indiana, the geothermal potential of Illinois was studied as part of the series of state-specific assessments. A report on the study, "An Assessment of the Geothermal Resources of Illinois Based on Existing Geologic Data," by T. L. Vaught, will be available later from NTIS as report number DOE/NV/10072-2. Advance copies may be obtained from Gruy Federal's technical editor.

Geothermal potential in Illinois is similar to that of Indiana. The heavily faulted areas of southern Illinois may allow upward movement of

warm waters near enough to the surface for economic utilization. Although such movement is not known to be occurring today, such fluids are the likely source of the ore deposits found in Illinois.

Although deep sedimentary basins with normal or somewhat elevated temperature gradients are not considered a resource today, they may have future potential. In this respect, the thick sedimentary sequence in the Illinois basin may be a potential geothermal resource. The restrictions on its production are similar to those in Indiana.

Minnesota Geothermal Potential. An informal letter report concerning geothermal potential in Minnesota was prepared and transmitted to DGE. There appears to be no geothermal potential in Minnesota in the present energy environment. Reports of thermal waters in northeastern Minnesota are erroneous.

Geothermal Potential at Military Installations. In September 1980, a task was added to Gruy Federal's hydrothermal support contract to conduct a comprehensive study of the geothermal potential at United States military bases. This task was a followup to an earlier preliminary ranking of geothermal potential performed as a task under the original contract.

The preliminary study was documented in an informal report by J. L. Renner to DGE in Washington, "Geothermal Potential at Major Military Installations in the United States."

In the followup study, geologic characteristics affecting geothermal potential at selected installations were determined. Preliminary geothermal energy systems were then designed at the installations with promising geology, and economics were calculated based on these designs.

A final report on this study, "Geothermal Energy Substitution Potential at Domestic Defense Installations and White Sands," by C. A. Bakewell and

J. L. Renner, report number DOE/NV/10072-4, has been prepared. As with the state-specific reports, it will be available from NTIS later; a limited number of copies are presently available from Gruy Federal's technical editor.

Other activities. Other information-dissemination activities included participation by J. L. Renner on ASTM Committee E-45, Geothermal Resources and Energy. Mr. Renner chairs the subcommittee on terminology. The editorial and art departments of the National Geographic Society were also provided with assistance in the compilation of a geothermal map, part of an energy atlas which was published as a special issue of The National Geographic Magazine in February 1981.

Assistance to DGE's State-Coupled Program

Assistance to DGE's state-coupled program involved consultations with many separate agencies concerning the presence of geothermal resources and the activities necessary to initiate their development. These visits are listed in Table 1.

Table 1
State-coupled program consultations by J. L. Renner

Date	Agency	Purpose
October 30-31, 1979	DOE-DGE	Eastern geothermal information exchange. Presented overview of geothermal potential in eastern United States
November 11, 1979	Dunn Geoscience	Review resource-definition program in capital district of New York. With DGE Program Manager.
December 12, 1979	Alabama Geological Survey	Review of Alabama state-coupled program results to date. With DGE Program Manager.
January 22-25, 1980	State-coupled program meeting	Annual meeting of those involved with state-coupled geothermal programs. Presented overview of geothermal potential in eastern United States.
February 5, 1980	New York State Energy Research and Development Authority	Discuss potential for geothermal resources in western New York and the possibility of drilling a deep well. With DGE Program Manager
March 5-6, 1980	Oak Ridge Associated Universities, Institute for Energy Analysis	Discuss methodology of ORAU program on geothermal resources in the Tennessee Valley region. With DGE Program Manager.
March 27, 1980	North Dakota Geological Survey	Discuss methods of presenting geothermal data on geothermal resource maps of Great Plains states.
May 29, 1980	Oak Ridge Associated Universities, Division of Geothermal Energy	Participation in program review of ORAU geothermal program.
June 11, 1980	Virginia Division of Mineral Resources	Assist in planning for a geothermal resources potential map of Virginia.

Table 1: State-coupled program consultations (continued)

Date	Agency	Purpose
June 23, 1980	Virginia Division of Mineral Resources	Discuss geothermal map preparation procedures with Mineral Resources and NOAA personnel.
June 30, 1980	NASA, Wallops Island, Virginia	Provided data on geothermal resources.
July 2, 1980	Maryland legislature	Provide information to state legislature committee considering amendments to state geothermal act. Meeting co-hosted by National Conference of State Legislatures geothermal project.
September 10, 1980	DOE/DGE	Meeting of state-coupled geothermal resource assessment teams held in conjunction with Geothermal Resources Council national meeting.

Activities Planned for FY 1981

In FY 1981 Gruy Federal is continuing to provide technical and administrative support to DGE for its hydrothermal resources program. The work includes tasks in two general areas: resources definition and technical assistance.

The resource definition task will include geothermal definition efforts where state-coupled teams are not presently active, liaison and information dissemination among state-coupled agencies in the east, and assistance to the U. S. Geological Survey in its ongoing assessment of low-temperature resources in the United States.

The technical assistance task includes provision of assistance to prospective geothermal users through liaison, information dissemination, reservoir engineering, and economic studies. The Gruy staff will also be available to make presentations of geotechnical information concerning geothermal resources to state, county, and local governments and others interested in the development of eastern geothermal resources.

☆U.S. GOVERNMENT PRINTING OFFICE: 1981-740-145/2444