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MULTIPLE-TASK SERVICES FOR THE DEPARTMENT OF ENERGY'S HYDROTHERMAL RESOURCES PROGRAM

FINAL REPORT

November 1980 - August 1982

Work Performed Under Contract No. DE-AC08-81NV10177

GRUY PETROLEUM TECHNOLOGY, INC.
Arlington, Virginia

Prepared for the
U.S. Department of Energy
Geothermal & Hydropower Technologies Division

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Section 1

INTRODUCTION

Gruy Petroleum Technology (formerly Gruy Federal) has been directly involved in the hydrothermal program of the Department of Energy since mid-1978. At that time an earth sciences task was added to the company's Atlantic Coastal Plain drilling program, contract ET-78-C-08-1558. Initially, the earth science team was principally involved in providing the Department of Energy (DOE) with a definition of the hydrothermal resource potential in the eastern United States. This work continued through September 1978, although the contract number was changed to DE-AC08-78ET28373.

An unsolicited proposal to extend this work through FY 1980 was accepted in October 1979, resulting in a one-year contract to provide "Multiple Task Support for the DOE's Hydrothermal Resources Program," contract DE-AC08-80NV10072. The contract provided technical support to the state-coupled resource assessment program for states in the eastern United States. Preliminary assessments of geothermal potential in several states were also prepared and a review of the utility of the major thermal data base in the east was completed.

In October 1980, Gruy was awarded a further three-year contract (DE-AC08-81NV10177) in connection with DOE's Hydrothermal Resources Program. The contract was funded for FY 81 and partially funded for FY 82. The contract has called for technical and administrative support in two general task areas: Resource Definition and Technical Assistance.

It is not anticipated that the contract will be funded IN FY 83, and this final report for it has therefore been prepared. The report discusses the work performed in both task areas during the contract's tenure. Technical direction from DOE during this period was provided by Robert Gray, Charles Bufe, and David Lombard of the DOE Geothermal & Hydropower Technologies Division (GHTD). This assistance is acknowledged with appreciation.

Section 2

RESOURCE DEFINITION ASSIGNMENTS

The Resource Definition task of Gruy Petroleum Technology's contract with DOE involved conducting research and technical analyses to define the geothermal resource potential in the eastern United States. Six subtasks were included in this task area.

Subtask 1: Geothermal Resource Characterization

Under this subtask, Gruy was to provide technical expertise and conduct research to characterize the geothermal resource potential in the eastern United States. The research team was principally involved in two data-processing assignments: collecting data for the U.S. Geological Survey's data base on eastern geothermal resources and reviewing temperature data of the Appalachian Basin. A complete list of activities pursued under Subtask 1 appear in Table 1.

Subtask 2: State-Coupled Liason

The company was to provide liason and conduct information-dissemination activities among the participants of the DOE State-Coupled Program. Participants included the University of Utah Rsearch Institute, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and various state resource-assessment teams. The activities of Subtask 2 are listed in Table 2. During the contract, Gruy was extensively involved in providing technical assistance to state teams preparing maps of the geothermal resources of their states and assisting state-coupled projects in the east.

At the time of termination of the contract, several state-coupled projects were still active in the east. Final reports on the definition programs in New England and the Atlantic Coastal Plain are being prepared, and the study of geothermal potential in the Albany-Saratoga Springs area of New York continues.

Subtask 3: Low-Temperature Geothermal Assessment

Subtask 3 specified that Gruy cooperate with USGS personnel involved in low-temperature geothermal resource assessment. Activities associated with this subtask are listed in Table 3. The USGS is preparing a circular on low-temperature geothermal resources. Low-temperature resources predominate in the east, so the survey looked to Gruy for considerable quantities of geothermal data. The circular will be published in late 1983.

TABLE 1

Resource Definition Subtask 1

GEOTHERMAL RESOURCE CHARACTERIZATION ACTIVITIES

Date	Activity
November 1980	Preliminary data collected for USGS low-temperature geothermal resource assessment was placed in a data file on eastern geothermal resources.
May 1981	Began review of geothermal potential in Appalachian Basin and Appalachian warm springs area.
June 1981	Discussed hydrology of Atlantic Coastal Plain at USGS offices.
July 1981	Transmitted bulk of the data on eastern springs systems to USGS.
August 1981	Prepared eastern geothermal assessment data at USGS Menlo Park offices.
September 1981	Made final data sheets and drafted report on low-temperature geothermal assessment for inclusion in a USGS circular.
October 1981	Completed review of temperature data in Appalachian Basin.

TABLE 2

Resource Definition Subtask 2

STATE-COUPLED LIASON

Date	Activity
November 1980	Visited site proposed for a geothermal well near Montezuma, New York. Assistance given to the New York State Energy Research and Development Administration (NYSERDA) on site selection and a drilling and testing program.
	Visited Ohio Geological Survey with University of Utah Research Institute (UURI) staff to provide assistance and technical information for the Survey's proposal for a state-coupled resource assessment project. Due to funding cutbacks, a contract was not issued.
December 1980	Commented on a draft RFP from NYSERDA regarding engineering of its geothermal well.
	Provided State of Delaware with cost data from Atlantic Coastal Plain drilling program.
January 1981	Assisted UURI Earth Science Laboratory in contacting eastern resource-definition teams concerning attendance at DOE-sponsored federal-state geothermal conference in Seattle, Washington.
	Attended the Seattle meeting and met with Ohio and Missouri state resource-assessment teams.
February 1981	Queried eastern resource-assessment teams concerning participation in a state-coupled resource assessment meeting to be held in May.
March 1981	Attended meeting of DOE, UURI, and NOAA representatives in Idaho Falls, Idaho to discuss preparation of state-coupled geothermal resource maps.

TABLE 2 (Continued)

Date	Activity
May 1981	Attended state-coupled resource assessment meeting in Boulder, Colorado.
	Assisted Virginia state-coupled team in initiating preparation of geothermal map of the state.
July 1981	Attended meeting of core group of state-coupled program to review progress on state map program.
September 1981	Provided Virginia Division of Mineral Resources with data on springs systems in the state.
	Transmitted data to UURI for use in their review of a geothermal market-shares assessment.
	Reviewed portions of the Texas geothermal map.
October 1981	Conducted review of Kansas and Nebraska geothermal maps.
	Began review of geology and drilling practices in the Auburn, New York, area in connection with the NYSERDA geothermal well program.
	Discussed development of a simplified geothermal map of Virginia with DOE Idaho and the Virginia Division of Mineral Resources.
November 1981	Attended meeting in New York to discuss well completion and stimulation relative to the proposed NYSERDA well.
	Discussed NYSERDA participation in the DOE well-stimulation program with DOE personnel.

TABLE 2 (Continued)

Date	Activity
February 1982	Reviewed Hawaii, Texas, and Wyoming geothermal maps.
March 1982	Discussed geology and well logs from NYSERDA geothermal well with the NYSERDA project manager.
May 1982	Attended the final state-coupled geothermal assessment meeting.

TABLE 3

Resource Definition Subtask 3

LOW-TEMPERATURE GEOTHERMAL ASSESSMENT ACTIVITIES

Date	Activity
November 1980	Began compilation of low-temperature geothermal data in eastern United States for USGS.
December 1980	Transmitted data on hydrologic characteristics of the DOE-sponsored Crisfield (Md.) geothermal well to USGS.
January 1981	Placed eastern data in a data file on eastern geothermal resources.
February 1981	Followed progress of USGS regional aquifier program on Atlantic Coastal Plain.
April 1981	Attended USGS meeting in Menlo Park, California. Low-temperature assessment program was updated at the meeting.
May 1981	Met with USGS personnel to discuss plans and progress on the project.
June 1981	Visited USGS offices to discuss hydrology of Atlantic Coastal Plain.
July 1981	Transmitted data on springs systems to USGS.
August 1981	Geothermal data for eastern United States entered into USGS computer-based data file.
September 1981	Final data sheets and locational adjustments made to eastern data. Draft report prepared for inclusion in USGS circular.
October 1981	Provided revised volumetric figures to USGS for eastern geothermal resources.
March 1982	Reviewed preliminary drafts of U.S.G.S. circular.

Subtask 4: User-Coupled Confirmation Drilling Program

Subtask 4 required Gruy to provide DOE with site-specific evaluations of geothermal potential. This information was used in connection with projects selected for funding under DOE's User-Coupled Confirmation Drilling Program. The company's activities under Subtask 4 were limited to transmitting a report during December 1980 on the geothermal potential in the area surrounding the Accomack County (Va.) industrial park and to reviewing the progress of user-coupled drilling projects in New York and Delaware. The Delaware Energy office was also given some assistance with their drilling program and some economic evaluations.

The geothermal well in Delware was not drilled as the State of Delware decided not to proceed. However, NYSERDA drilled a second deep geothermal test in the east in early 1982. Water of about 125^{o} F was encountered at about 4,700 feet. The well is currently shut-in waiting testing.

Subtask 5: ASTM Geothermal Coordination

Gruy was to coordinate with the American Society of Testing and Materials in the development of standards pertaining to geothermal energy sources. Activities in this area were concerned exclusively with the development of definitions of geothermal energy and geothermal resources. The activities related to this subtask are listed in Table 4.

Subtask 6: Topical Studies

The company was to conduct topical studies as requested by DOE and prepare reports on these studies in accordance with DOE's Uniform Contractor Reporting System.

One major topical study was completed. In August 1980, the U.S. Department of Defense requested that DOE identify and evaluate geothermal resources that might provide substitute energy at any of 76 defense installations. In followup, DOE assigned Gruy investigators the task of estimating the geologic characteristics and related economics of potential geothermal resources located at or near the installations.

From the geologic assessment, the investigators concluded that 18 of the 76 installations were located near possible geothermal resources. In addition, four geothermal resource configurations in the Atlantic Coastal Plain were considered to represent alternative geothermal resources available to East Coast bases.

The 18 locations and 4 resource configurations, together with 2 possible resources at the White Sands Missile Range and a potential resource at the Kings Bay (Ga.) submarine support base, were examined to determine the economics of substituting geothermal energy for part of all of existing oil, gas, and electrical usage at the installations. The study found that four installations appear to be co-located with possible geothermal resources which, if present, could provide

substitute energy at or below current market prices for oil. Geothermal energy substitution at six additional locations could become economically attractive under certain conditions.

These results are documented in a topical report, "Potential for Substitution of Geothermal Energy at Domestic Defense Installations and White Sands Missile Range" by C. A. Bakewell and J. L. Renner. It will be available from NTIS later in 1982 as report Number DOE/NV/10072-4. A limited number of advance copies are presently available and may be obtained from Technical Editor, Gruy Petroleum Technology, Inc., 2500 Tanglewilde, Suite 150, Houston, Texas 77063.

TABLE 4

Resource Definition Subtask 5

ASTM GEOTHERMAL COORDINATION

Date	Activity
April 1981	Prepared geothermal definitions for May meeting of the American Society of Testing and Materials (ASTM) Geothermal Committee.
May 1981	Attended meeting of ASTM Geothermal Committee. The terminology group, chaired by Gruy, proposed definitions of geothermal energy and geothermal resources.
June 1981	Prepared definitions of geothermal energy and geothermal resources for ASTM letter ballot.
July 1981	Prepared new material concerning geothermal definitions for ASTM Geothermal Committee.
January 1982	Attended the ASTM Geothermal Committee meeting in Houston. Definitions of geothermal resources and geothermal heat pumps were prepared.
February 1982	Definitions proposed at Houston meeting were transmitted to ASTM for sub-committee ballot. At the time of the preparation of this report, the definitions had been approved by sub-committee and were scheduled for full committee ballot.

Section 3

TECHNICAL ASSISTANCE ASSIGNMENTS

The contract specified that the Technical Assistance task area shall consist of providing assistance to prospective geothermal energy users through liason, information dissemination, reservoir analyses and engineering, and economic studies. Activities were distributed among three subtasks.

Subtask 1: Information Dissemination

Under Subtask 1, Gruy was to conduct formal presentations and seminars to disseminate relevant geothermal information to state, county, and local governments and to other interested parties as directed by DOE. During the year, papers were presented or data provided to nine separate agencies. All assignments conducted are listed in Table 5.

Subtask 2: Geothermal Reservoir Engineering

This subtask called for the development of analytic methods to predict the characteristics of geothermal reservoirs and interpret the results of flow tests from geothermal wells. No assignments were received in this area.

Subtask 3: Technical Assistance to Geothermal Users

The bulk of Gruy's technical-assistance activities were conducted under this subtask. The contract required Gruy to provide, at the request of DOE, technical assistance to prospective geothermal-energy users by assessing the technical and economic feasibility of the prospective user's resource. The assessments were to be site specific and include consideration of expected reservoir temperature, well productivity, reservoir extent, production-system and heat-extraction costs, and end-use requirements. Activities performed in this subtask area are listed in Table 6. Technical assistance was provided to five potential commercial users, six government agencies, and three military installations.

TABLE 5

Technical Assistance Subtask 1

INFORMATION DISSEMINATION ACTIVITIES

Date	Activity
November 1980	Presented a review of contract tasks to an eastern geothermal meeting at Coolfont, W. Va. Gave a brief overview of the geologic setting of potential eastern geothermal resources at the same meeting.
	Attended meeting at HUD to provide hydrologic and geologic information relative to district heating possibilities using the thermal energy of the earth.
December 1980	Assisted the National Geographic Society in preparation of a geothermal resources plate to appear in a special energy issue of the Society's magazine in February 1981.
	Provided the Indiana Department of Commerce with a summary of geothermal potential in Indiana.
	Provided Science Applications, Inc. in Oak Ridge, Tenn., information on the potential for electrical generation from geothermal resources in the eastern United States.
	Data on the temperature-gradient wells drilled on the Atlantic Coastal Plain were collected for transmittal to Johns Hopkins University.
January 1981	Information on drilling costs, logging, and coring procedures for Atlantic Coastal Plain geothermal wells was transmitted to the Delaware Energy office.
February 1981	Presented paper on "Estimating Geothermal Energy Costs in the Eastern United States" at annual meeting of the American Society of Heating, Refrigeration and Air-Conditioning Engineers.

TABLE 5 (Continued)

Date	Activity
February 1981	Scheduled meeting at Berkeley Springs, W. Va. to provide technical assistance in utilizing low-temperature geothermal resources near the community.
April 1981	Paper given on geothermal resources at annual meeting of the National Association of Science Teachers.
January 1982	Provided general information on the location of geothermal resources in the United States to a private citizen.
	Provided information on state regulations and National Conference of State Legislature's geothermal program to a potential user in South Carolina.
February and March 1982	Provided general and site-specific information on geothermal resources to the National Conference of Mayors.

TABLE 6

Technical Assistance Subtask 3

TECHNICAL ASSISTANCE TO PROSPECTIVE USERS

Date	Activity
November 1980	Informal hydrologic assistance given to a potential geothermal user as a consequence of the HUD meeting held the same month (Table 5).
January 1981	Began review of the economics of geothermal energy use at the Kings Bay (Ga.) submarine support base.
	Conducted assessment of the geology and hydrology at Dover Air Force Base as part of a technical-assistance project being directed by the Applied Physics Laboratory (APL) at Johns Hopkins University.
February 1981	Informal responses made to Raytheon Corporation regarding geothermal potential in Puerto Rico and to Westvaco Corporation concerning various geothermal sites in the eastern United States.
March 1981	Provided NYSERDA information on production capabilities of geothermal wells relative to drilling with air, mist, or mud.
	Provided information on the Crisfield geothermal test well to Solar Energetics, who is preparing a geothermal report on Dover Air Force Base under contract to APL.
	Met with technical assistance group at APL to discuss scheduling of joint technical assistance efforts.
	Completed the economic review of geothermal energy use at the Kings Bay submarine base.
April 1981	Provided data on geothermal potential at Norton Air Force Base to the U.S. Air Force.

TABLE 6 (Continued)

Date	Activity
April 1981	Presented briefing on geothermal resources with APL personnel to Burlington Industries in Greensboro, N.C.
May 1981	Provided information on the geothermal potential of numerous sites in the eastern United States to Burns and Roe, Linden Chemicals, and Westvaco Corporation.
June 1981	Prepared report on the geothermal potential in the Charleston (S.C.) area for APL.
July 1981	Provided information concerning geothermal resources in the east and several sites in the west to the Oregon Institute of Technology.
	Provided information to the State of Maryland on drilling, appropriations, and disposal of subsurface waters.
September 1981	Reviewed an upcoming geothermal article for National Geographic World.
	In conjunction with the National Conference of State Legislatures, assisted State of Maryland in developing legislation for groundwater-based heat pumps.
October 1981	Provided data on subsurface temperatures and thermal conductivity to an engineering firm investigating earth-coupled heating and cooling processes.
February 1982	Provided U.S. Agency for International Development with information on geothermal potential in the West Indies. Reviewed the study of geothermal potential at military bases with the U.S. Navy.
March 1982	Provided preliminary economic and engineering advice to the Delaware State Energy Office's user-coupled confirmation drilling program at Lewes, Del. In mid-summer, the state terminated its agreement with DOE and the proposed well will not be drilled.