GEOTHERMAL ENERGY

Engineering Methods for Predicting Productivity and Longevity of Hot-Dry-Rock Geothermal Energy Reservoir in the Presence of Thermal Cracks

A low temperature heat, man-made geothermal energy reservoir underlying the Jemez Plateau has been drilled by the Los Alamos Scientific Laboratory. By using cooling stresses, new cracks were formed along the surfaces of the initial hydraulic fracture system, propagating far beyond the cooled region. Both the heat transfer surface and the heat energy available to a fluid circulating through the crack system were therefore increased, and continue increasing as energy is withdrawn from the goethermal reservoir.

The objectives of this study are to show how the initial hydraulic fracture zone can be extended through thermal elastic cracking of the adjacent hot-dry-rock, to develop methods for predicting the productivity and longevity of a reservoir and to establish a basis for a future comprehensive experimental and analytical study of hot-dry-rock treated as elastic-plastic material.

PRINCIPAL INVESTIGATOR: Dr. Y. C. Hsu, Department of Mechanical Engineering, University of New Mexico.

Evaluation of Geothermal Potential of the Basin and Range Province of New Mexico

Geothermal anomalies are commonly characterized by recently active volcanism, high heat flow, young hydrothermal mineral deposits, hot springs or wells, seismic activity and extensional tectonics. There are 60 such known anomalies in New Mexico, with varying degrees of energy resource potential. (STATE-Coupled)

This interdisciplinary, interinstitutional project is assessing the energy potential of virtually all these known areas, excepting only areas being currently investigated by other researchers or developed by private industry. The assessment is being accomplished through detailed and reconnaissance geologic mapping, compilation of tectonic maps, deep electric-resistivity surveys, electromagnetic soundings, gravity and magnetic measurements, chemical and isotopic studies of fresh and altered rocks and thermal waters, petrologic studies and radiometric dating. The results will provide the basic information needed by land owners and industry for making decisions on investment for geothermal exploration.

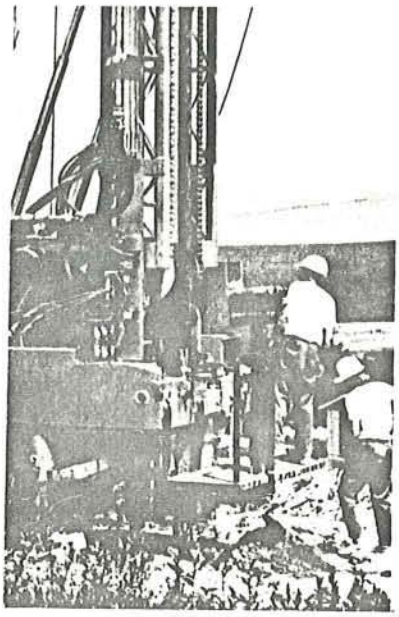
PRINICPAL INVESTIGATORS: Dr. Jonathan F. Callender, Dr. Douglas G. Brookins, Dr. Wolfgang E. Elston, Dr. George R. Jiracek, Dr. Albert M. Kudo, Dr. Gary P. Landis and Dr. Lee A. Woodward, Department of Geology, University of New Mexico, and Dr. Chandler A. Swanberg, Departments of Physics and Earth Sciences, New Mexico State University.

Seismic Exploration for Shallow Magma Bodies in the Vicinity of Socorro, New Mexico

Recent geophysical observations suggest the existence of shallow bodies of molten or partially molten rock beneath the Rio Grande rift near Socorro. Such areas may prove suitable for geothermal energy development. The objective of this project is to confirm the location of these shallow magma bodies through seismic exploration and to help localize the best areas for testing the geothermal potential of the region.

PRINCIPAL INVESTIGATORS: Dr. Allan R. Sanford and Dr. John W. Schlue, Department of Geoscience, New Mexico Institute of Mining and Technology.

Geological Investigation of the Socorro Geothermal Area



The Socorro area has both geological and geophysical characteristics of a major geothermal system. This project is helping to support the detailed geologic mapping needed for delineating the most favorable areas for geothermal exploration as well as providing the stratigraphic framework for estimates of drilling depths and aquifer characteristics. It is also supporting the dating of volcanic rocks necessary for unraveling the complex overprinting of similar rocks of different ages and for establishing the patterns of volcanism in space and time. Chemical analyses conducted under this study are helping to characterize the types of magmas involved in the several eruptive periods.

PRINCIPAL INVESTIGATOR: Dr. Charles E. Chapin, New Mexico Bureau of Mines and Mineral Resources.

Geothermal Application Feasibility Study for the New Mexico State University Campus

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A geothermal area adjacent to the New Mexico State University campus has demonstrated water temperatures in the range of approximately 100 to 200°C. As some of these temperatures are above the minimum considered necessary for economic development, the area may potentially provide enough energy to at least partially meet the heating, cooling and electrical power needs of the campus.

The primary objective of this project is to determine whether geothermal development of the area is practical. In order to accomplish this, the investigators are:

1. Identifying the hardware needed for extracting the geothermal energy and converting it to more usable forms;
2. Determining whether existing systems could be used to deliver the energy produced or whether new ones would have to be developed;
3. Investigating the economics of the proposed system and the feasibility of its construction;
4. Developing environmental impact information; and
5. Outlining any regulatory or institutional impediments to the system's construction and operation.

PRINCIPAL INVESTIGATORS: Dr. Narendra N. Gunaji, Department of Civil Engineering, Dr. A. G. Walvekar, Department of Industrial Engineering, Dr. Leo LaFrance, Department of Mechanical Engineering, Dr. E. Thode, Department of Marketing and Management, Dr. L. Chaturvedi, Departments of Earth Sciences and Civil Engineering, and Dr. Chandler Swanberg, Departments of Earth Sciences and Physics, New Mexico State University.

Deep Terrestrial Heat Flow Measurements in New Mexico and Neighboring Geologic Areas

Terrestrial heat flow measurements have important applications both to evaluation of regional geothermal potential and to better understanding of hydrocarbon pool formation. The most significant problem in measuring these geothermal gradients, however, is abstraction of heat by groundwater movement. This project is seeking to accurately measure geothermal gradients in New Mexico and neighboring geologic areas by deep temperature logging of a dozen or more wells of about 5,000 feet and deeper. These wells should be below zones of

groundwater movement and are being made available for use by various industrial organizations.

PRINCIPAL INVESTIGATOR: Dr. Marshall Reiter, New Mexico Bureau of Mines and Mineral Resources and Department of Geophysics, New Mexico Institute of Mining and Technology.

Feasibility Study of Geothermal Energy for Heating Greenhouses

Presently, the majority of commercial greenhouses in New Mexico use either natural gas of propane for heating in winter. This project is studying the technical and economic feasibility of using low temperature geothermal sources to heat these facilities instead. The geothermal heating system is being compared to that of existing gas-fired heating systems in terms of initial capital investment and projected operating and maintenance costs. Geothermal sources suitable for heating applications, either with existing greenhouses or with possible future facilities, are being identified.

PRINCIPAL INVESTIGATOR: Dr. Leo J. LaFrance, Department of Mechanical Engineering, New Mexico State University.

Geothermal Resources of New Mexico: A Survey of Work to Date

A comprehensive survey of geothermal research and development work accomplished to date in New Mexico is needed before significant further development can take place. Under this project, such a survey is being developed. The location and natural setting of target areas are being summarized, as well as the status of research, exploration, leasing and drilling. The completed report will draw together the various published data relating to the state's potential resource areas, summarize development efforts to date, give the names and locations of persons presently engaged in research on geothermal resources and briefly state their areas of interest.

PRINCIPAL INVESTIGATOR: Dr. William J. Stone, New Mexico Bureau of Mines and Mineral Resources.

Geothermal Application Feasibility Study for the New Mexico Institute of Mining and Technology Campus

A geothermal source located within about two miles of the New Mexico Institute of Mining and Technology on land owned by the Institute is believed to have a thermal gradient approximately seven times that normally found in the area. The purpose of this project is to determine the economic, technical and environmental feasibility of providing the space heating, water heating, cooling and electrical power needs of the Institute by harnessing this energy source. For the purposes of this study, the geothermal source is assumed to have ideal resource characteristics, such as quality, quantity and heat content. The primary question being addressed is whether harnessing and delivering this energy to the campus, and perhaps the community as well, would be economical compared to present energy costs.

PRINCIPAL INVESTIGATOR: Dr. Alan R. Miller, Department of Metallurgy, New Mexico Institute of Mining and Technology.

Use of Geothermal Energy for Desalination in New Mexico - A Feasibility Study

Studies are now being conducted to document the geothermal resources of New Mexico, with some areas demonstrating sufficient potential to warrant consideration for economic development. Another potential economic resource in the state is saline water, which is not currently being used despite the large quantities available and increasing competition for fresh water rights. This project is examining the possibility of using energy from the state's geothermal resources to desalinate otherwise unusable water for industry, agriculture and municipalities. Specifically, the project is identifying the need for and possible uses of desalinated water, investigating the presence of geothermal areas which might be economically used for desalination purposes, gathering information about desalination techniques and how these can be integrated with geothermal energy sources and studying the economics of applying these proposed methods and techniques.

PRINCIPAL INVESTIGATORS: Dr. Lokesh N. Chaturvedi, Departments of Earth Sciences and Civil Engineering, Dr. Conrad Keyes, Jr., Department of Civil Engineering, Dr. Yash Gupta, Department of Chemical Engineering, and Dr. Chandler A. Swanberg, Departments of Physics and Earth Sciences, New Mexico State University.

Completed Projects

"Geothermal Potential of Rio Grande Rift," Dr. Douglas G. Brookins, Dr. Jonathan F. Callender, Dr. George R. Jiracek, Dr. Albert M. Kudo, Dr. Gary P. Landis and Dr. Lee A. Woodward, Department of Geology, University of New Mexico.

"Oxygen Isotope Geochemistry and Geothermal Energy Potential in New Mexico," Dr. Gary P. Landis, Department of Geology, University of New Mexico.

"Geothermal Gradient Measurements," Dr. Marshall Reiter, New Mexico Bureau of Mines and Mineral Resources and Department of Geoscience, New Mexico Institute of Mining and Technology.

"Investigation of Thermal Regime of Rio Grande Rift and Neighboring Provinces by Employing Very Deep Heat Flow Measurements and Establishing a Crustal Radiant Heat Generation," Dr. Marshall Reiter, New Mexico Bureau of Mines and Mineral Resources and Department of Geoscience, New Mexico Institute of Mining and Technology.

"Seismic Investigation of Magma Layer in Crust Beneath Rio Grande Rift near Socorro, New Mexico, (and Relative to Geothermal Energy Potential of Region)," Dr. Allan R. Sanford, Department of Geoscience, New Mexico Institute of Mining and Technology.

"Geothermal Equipment," Dr. Chandler Swanberg, Departments of Earth Sciences and Physics, New Mexico State University.

"Geothermal Investigations in Southwest New Mexico," Dr. Chandler Swanberg, Departments of Earth Sciences and Physics, New Mexico State University.