

GEOHERMAL RESERVOIR RESEARCH FUNDED BY THE U.S. DEPARTMENT OF ENERGY

Marshall J. Reed, Ph.D., Program Manager

U.S. Department of Energy
Washington, DC 20585
e-mail: Marshall.Reed@ee.doe.gov

The Department of Energy (DOE) and its predecessor agencies (AEC, NSF, and ERDA) have funded research related to geothermal reservoirs since 1972. Much of the early geothermal work was based on the accumulated knowledge of petroleum reservoirs and hydrologic systems. In the intervening years, geothermal research has revealed much about the physics and chemistry that distinguishes geothermal reservoirs from accumulations of other natural fluids. Continued research in geothermal energy will provide a better understanding of reservoirs and more useful tools to manage the extraction of thermal energy.

The DOE geothermal reservoir research exists in the context of the larger Geothermal Research and Technology Development Program. The Geothermal Exploration program develops technology to better locate and characterize geothermal systems, and the Geothermal Drilling and Instrumentation program generates technology advances in drilling and logging geothermal wells. The outcome of these programs is used by the Geothermal Conversion, Operation, and Maintenance program to improve the utilization of energy from geothermal fluids and to reduce the cost of operations and materials. The Geothermal Direct Use program develops new technology and provides assistance in non-electric utilization of the thermal energy, and the Geothermal Heat Pump program provides technology advances and technology dissemination for heating and cooling applications. All of these DOE programs are involved in the education of new scientists and engineers to support the use of geothermal energy, and each program has the goal of providing environmental benefits from the expansion of geothermal development.

Since 1975, the Stanford Workshop on Geothermal Reservoir Engineering has provided an important forum for presenting the progress in characterizing geothermal systems and for discussing the remaining needs in reservoir research!. The success of the Workshop is due primarily to the active participation of the geothermal industry. Without the perspective of operations experience, the research would lack direction. The Geothermal Research Program of

DOE relies on industry input to select the most important research topics and to set funding priorities. I encourage comments and suggestions from anyone who is interested in improving the DOE Geothermal Research Program.

Geothermal Reservoir Technology Research funded by DOE combines theoretical, laboratory, and field studies in the development of tools and methods to explore for hydrothermal systems, to better characterize known fields, to determine the physical and chemical properties of reservoir rocks and fluids, to describe and evaluate reservoir processes, and to investigate the effects of production and injection operations in order to optimize reservoir management plans and extend the commercial lifetime of producing fields. DOE carries out this geothermal research in cooperation with industry by providing funding to DOE National Laboratories, universities, commercial research organizations, and other U.S. government agencies. This research and development program has two goals: (a) to assist U.S. industry in solving near-term problems that are hindering a larger development of geothermal energy worldwide, and (b) to carry out fundamental and long-term research that might result in significant commercial returns in the future.

The geothermal industry has requested a test and evaluation of the three-dimensional seismic technology that is used successfully in the petroleum industry to locate reservoirs. Geothermal reservoirs differ in several important respects from petroleum reservoirs, and these variations in seismic response will be the focus of the research. The identification of high-angle fractures is of high priority because they may control fluid flow in many geothermal systems. There is a strong interest in the development of an electromagnetic system that will detect permeable fractures in the rock around a geothermal exploration well. Along with these studies, research will be conducted to develop methods to improve the interpretation of seismic responses from geothermal systems and to resolve electromagnetic responses from fractures.

Geothermal companies have a continuing interest in the improvement of reservoir simulation. The TOUGH2 reservoir simulator is being revised and expanded to increase its capabilities. There is strong interest in inverse modeling and the associated development of the ITOUGH code. Work is underway to couple a wellbore simulator to the reservoir simulator so that measurements at the surface can be easily converted to reservoir conditions. Longer term research is being conducted to incorporate mineral solution and precipitation in reservoir simulation to predict changes in permeability. Another research effort is directed at improving the characterization of fractures as discrete, high-transmissivity, fluid conduits within geothermal reservoirs. Additional research will utilize the results of tracer injection tests to quantify the diffusion and dispersion of chemical fronts within the reservoir.

Industry reviewers have recommended and DOE has funded the cost-shared investigation of 1 km of core from the Unocal reservoir in the Salak geothermal area of Java. This investigation follows the successful characterization of permeability and other rock properties from The Geysers core hole. This new investigation will provide information on the formation of permeability and other characteristics of geothermal reservoirs in andesitic and granodioritic rocks. Research of this type supports the long-term goal of developing physical and chemical measurements of reservoir conditions that can eventually be used to develop models for reservoir simulation.