



Geothermal Drilling Organization

The Geothermal Drilling Organization (GDO), founded in 1982 as a joint Department of Energy (DOE)-Industry organization, develops and funds near-term technology development projects for reducing geothermal drilling costs. Sandia National Laboratories administers DOE funds to assist industry critical cost-shared projects and provides development support for each project. GDO assistance to industry is vital in developing products and procedures to lower drilling costs, in part, because the geothermal industry is small and represents a limited market.

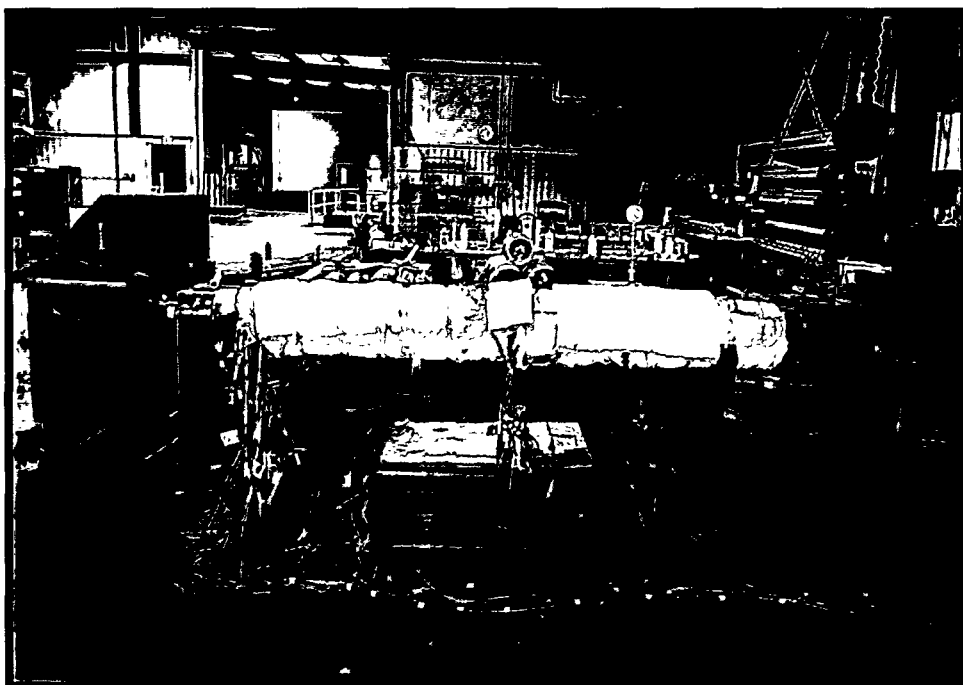
Approach

The GDO encourages commercializing of emerging cost-reducing technologies and fosters a spirit of cooperation among the various segments of the geothermal industry. For Sandia, the GDO also serves as a mechanism for learning the industry's drilling problems and for transferring technology.

The GDO is composed primarily of geothermal operators and service companies. The objective of the GDO is to reduce geothermal drilling costs by developing and commercializing new tools, materials, and techniques in cost-shared projects with industry. Industry shares at least 50% of the cost of a project (in reality, often much more).

Geothermal Drilling Organization Membership

- APS Technology, Hellertown, PA
- Baker Hughes Inteq, Santa Rosa, CA
- Ballew Tool Co., Cobb, CA
- Boart Longyear Co., Salt Lake City, UT
- CalEnergy, Ridgecrest, CA
- Calpine Corp., Santa Rosa, CA
- Drill Cool Systems, Bakersfield, CA
- Geo Hills Associates, Reno, NV
- Halliburton Energy Services, Bakersfield, CA
- Layne Christensen Corp., Salt Lake City, UT
- Los Alamos National Laboratory, Los Alamos, NM
- M-I Drilling Fluids Co., Bakersfield, CA
- Nabors Drilling USA, Inc., Bakersfield, CA
- Novatek, Provo, UT
- Pajarito Enterprises, Los Alamos, NM
- Resource Group, Palm Desert, CA
- Sandia National Laboratories, Albuquerque, NM
- Smith Drilling & Completion, Healdsburg, CA
- Thermasource, Santa Rosa, CA
- Tonto Drilling Services, Inc., Salt Lake City, UT
- Unocal Geothermal, Santa Rosa, CA
- EVI Weatherford, Rio Vista, CA
- EVI McAllister, Palm Springs, CA



Thermal test of stator section for high-temperature positive displacement air motor. (See project description under New Projects.)

Projects

Several GDO projects have been completed successfully, including development of a high-temperature borehole televiwer, high-temperature rotating head rubbers, and a retrievable whipstock. New projects are continually being proposed. Completed, ongoing, and new projects are described on the next three pages.

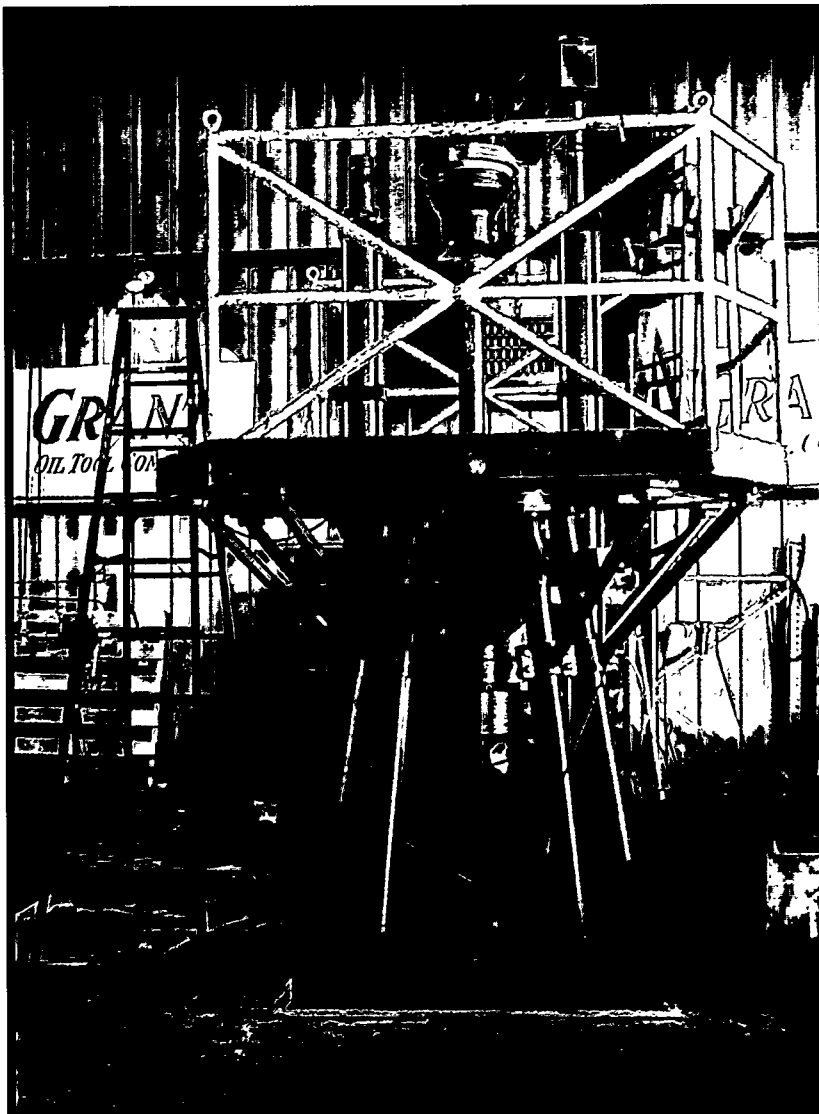
Completed Projects

Retrievable Whipstock for Geothermal Wells

A reliable and retrievable whipstock was needed to provide a means for sidetracking geothermal wells. AZ Grant International (now a part of Smith International) developed and successfully field tested a 13 3/8-inch combination anchor and whipstock. Such assemblies are now commercialized, have had a very good track record, and are described in the Smith International Catalogue. *(Smith International, Calpine, and Sandia)*

Rotating Head and Stripper Rubbers

The high temperatures and pressures of a geothermal well will degrade the rotating head rubber reducing its lifetime. AZ Grant International (now a part of Smith International) optimized a butyl elastomer suitable for geothermal use. As a spin-off of this program, nitrile and other elastomers were optimized for use in hydrocarbon extraction. These items are commercially available and described in the Smith International Catalogue. *(Smith International, Calpine, and Sandia)*



Fixture to test rotating head/stripper rubbers.



Detail of rotating head rubber.

Retrievable whipstock (left). Reproduced from the Smith International Catalogue.

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Ongoing Projects

Positive Displacement Motor for High Temperatures

A high-temperature air motor is needed to kick off geothermal wells at various azimuths. Baker Hughes Inteq has developed and fabricated two 8-inch air motor assemblies for high-temperature drilling. These two assemblies were fabricated after laboratory tests at Celle, Germany and Houston, TX. A preliminary field test was conducted in The Geysers. The other air motor is awaiting a suitable test bed for a full field test. (*Baker Hughes INTEQ, Calpine, and Sandia*)

Insulated Drill Pipe

Insulated Drill Pipe will deliver cooler fluid to the bottom of wells, thereby improving tool life, preserving drilling fluid properties, and enabling the use of downhole electronics when drilling in high-temperature formations. Drill Cool, with Sandia assistance, conducted thermal and mechanical tests on the drill pipe. The thermal conductivity is an order of magnitude less than that of conventional drill pipe. Drill Cool is now fabricating a string of insulated drill pipe for a test in a CalEnergy well in the Imperial Valley. Afterwards, strings of insulated drill pipe will become commercially available. (*Drill Cool, CalEnergy, and Sandia*)

Percussive Mud Hammer for Geothermal Drilling

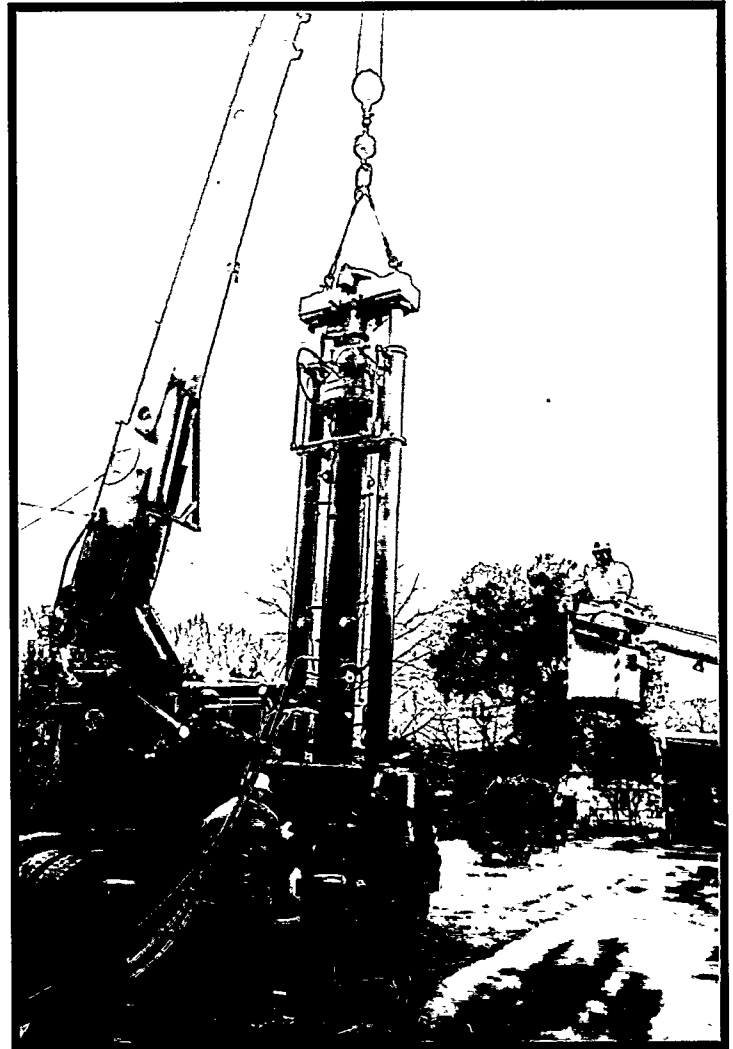
Percussive drilling is often faster in certain rock types than conventional rotary drilling, but an effective percussive hammer for use with liquid drilling fluids is not yet available. Novatek is developing a 7 1/2-inch mud hammer for hydrocarbon extraction. At the conclusion of a number of field trials, Novatek will embark on the design of a mud hammer for geothermal drilling. (*Novatek, Amoco, Unocal, CalEnergy, and Sandia*)

Expert System to Detect Lost Circulation

To assist the driller and drilling engineer in interpreting hydraulic drilling data, expert system software can monitor inflow and outflow rates and other rig parameters and interpret data to identify anomalies that may occur during drilling. Decision making at any hour of the day or night would be aided by a logical analysis of the situation. Tracor is developing such an expert system. (*Tracor, CalEnergy, and Sandia*)

Foam Cements to Remedy Lost Circulation

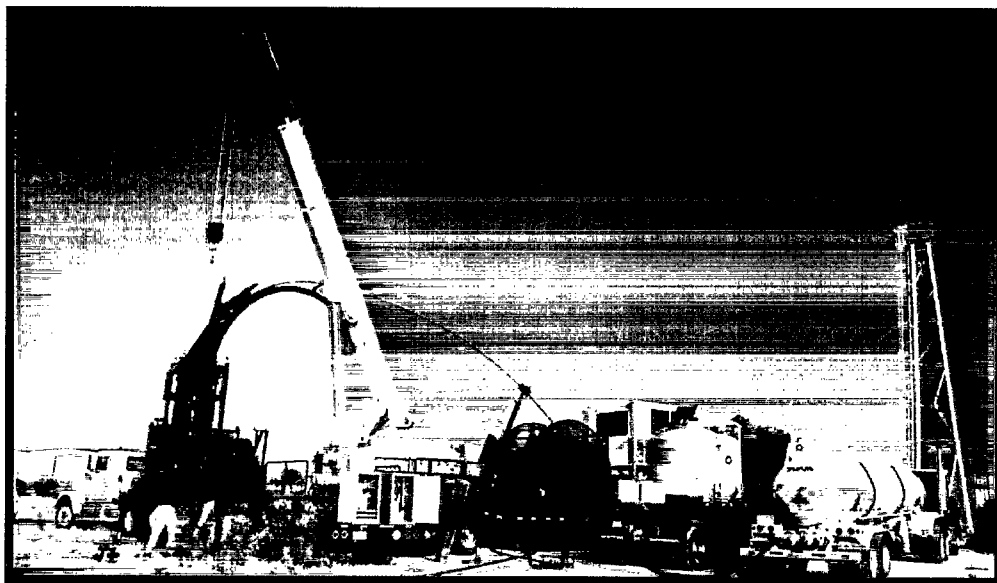
Lost circulation remains a persistent geothermal drilling problem, if not the most persistent drilling problem. Nitrogen foam cement has had a good track record for stemming lost circulation where conventional methods have failed, but often the foam cement operation was plagued with problems. This project should provide improved hardware and make the application of nitrogen foam cement more systematic. The new direction will include working with service companies and consultants to devise proper procedures and hardware for the foam cement operation. (*CalEnergy, Halliburton, EVI McAllister, Resource Group, and Sandia*)



Running tool assembly of valve changing tool.

High-Pressure, High-Temperature Valve Changing Tool Assembly

A need for a high-pressure, high-temperature valve (wellhead) changing assembly has been identified. A new tool rated at 635° F and 2000 psi (vs 400° F and 1000 psi heretofore available) has been developed, field tested, and successfully applied for an operator in Hawaii. At present, the milling capability of this tool assembly is being improved. (*Smith International, Puna Geothermal Venture, and Sandia*)



Full test of pedal basket bridge plug for Geysers Deformed Casing Remediation project.

New Projects

High Temperature Stator for Drilling Applications

The elastomer in the stator unit of an air-drilling assembly can degrade or catch fire if the temperatures are too hot during the drilling operation. APS Technology is developing a stator unit that should have a significantly smaller temperature rise for a given load. Life tests on a prototype stator are planned. *(APS Technology and Sandia)*

Low Emissions Atmospheric Metering Separator

The present blowers used in geothermal (and hydrocarbon) operations are inefficient and have the potential for creating operational, safety, and environmental problems. Two-Phase Engineering is designing a Low-Emission, Atmospheric-Metering Separator (LEAMS) as a replacement for this inefficient blower muffler. It should reduce site cleanup costs. Drill Cool will fabricate and field test a prototype separator. CalEnergy will provide field-testing opportunities. *(Two Phase Engineering, Drill Cool, CalEnergy, and Sandia)*

Geysers Deformed Casing Remediation

A large number of deformed production casings have been identified in The Geysers and other geothermal fields. This can impair production and render proper plugging and abandonment extremely difficult. Preparations are being made to undertake a deformed casing remediation operation by setting a pedal basket bridge plug above the production zone, milling out the deformity in the casing, and setting a casing patch. *(Unocal and Sandia)*

Evaluation and Interpretation of Foam Cement Integrity Logs

Evaluation of the integrity of nitrogen foam cement continues to present a serious problem for geothermal operators. Problems are due to large casing sizes, lack of experience of service companies and operators, and a lack of consistent procedures to run these logs. CalEnergy, GWB Consultants, Sandia, and other geothermal operators will develop a series of procedures to attain a consistent interpretation of foam cement integrity logs. *(CalEnergy, GWB Consultants, Geo Hills Associates, and Sandia)*

Laboratory Testing of a Novel Lost Circulation Product

There is always a need for commercial products that could stem lost circulation. A quantity of a lost circulation product successfully used in Indonesia has been brought to the USA for laboratory testing. The Resource Group and Sandia will embark on laboratory tests of this product. It is possible that one or more of the major drilling fluid companies will join in characterizing this material. *(Resource Group and Sandia)*

Summary

The Geothermal Drilling Organization is more active than ever with the geothermal industry. New proposals are continually being considered. Interested parties may get in touch with the GDO contacts listed above. Quarterly meetings will be announced in the GRC Bulletin.

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