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GEOTHERMAL HOT LINE

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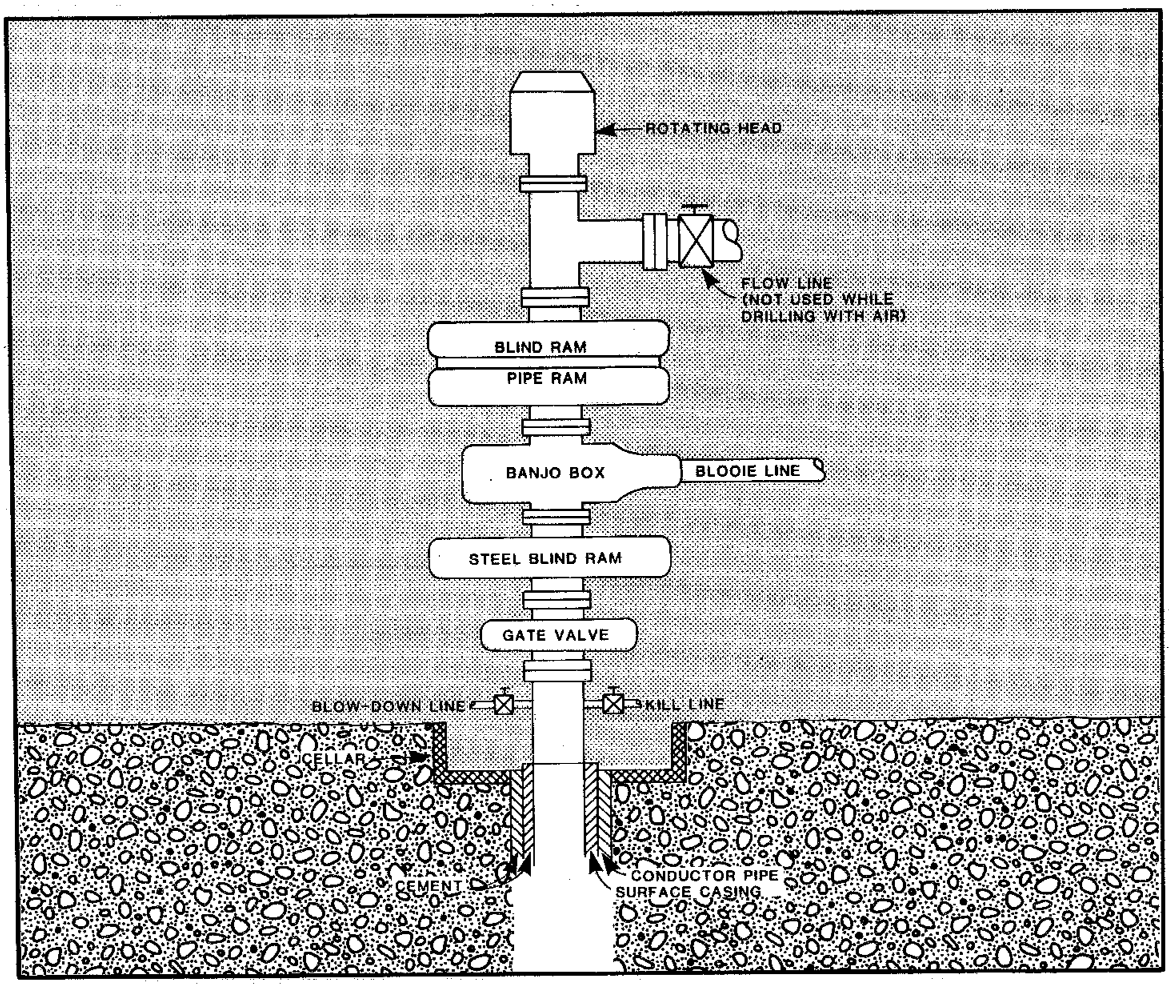

A typical, high-temperature, geothermal blowout prevention (air) stack. The drawing is reproduced from *Blowout Prevention in California*, a reference manual and guide published by the California Department of Conservation's Division of Oil and Gas. The new geothermal chapter of the manual is included in this *Hot Line* issue.

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IN THIS ISSUE

Blowout Prevention

Blowout Prevention for Geothermal Wells in California

by A. D. Stockton
Geothermal Officer
Division of Oil and Gas

Since 1965, the California Department of Conservation's Division of Oil and Gas has regulated the drilling, operation, maintenance, and abandonment of geothermal wells. The purpose of the regulation is to protect the surface and underground environment and to encourage the wise development of geothermal resources. Initially, laws and regulations for drilling geothermal wells were similar to those for oil and gas wells. However, as the geothermal industry has evolved, laws and regulations have been changed to take into account the inherent differences between oil and gas well operations and geothermal well operations.

For instance, laws and regulations have been adopted to specifically address measures to ensure geothermal wells do not have failures, such as blowouts. These measures that pertain to drilling operations are explained in the division publication, *Blowout Prevention in California*.

Very few geothermal wells drilled in California have failed. Blowouts have usually occurred from improper well siting; setting the surface casing at too shallow a depth; cementing surface casing in incompetent rock; or during workover operations on the well.

Most geothermal well blowouts do not occur during drilling operations. Those that do occur during drilling are often caused by an improperly planned or executed drilling fluid program. To prevent blowouts during drilling operations, blowout prevention equipment is installed on the well. In an emergency, the equipment is activated to keep the pressure in a well under control. The type of blowout prevention equipment used is regulated by the division, and a test of the equipment is witnessed by a division engineer.

A well-trained crew is a critical element in any blowout prevention program. If crew members cannot recognize the symptoms of a well blowout and how to properly react to them, the proper equipment, itself, is of no use.

A new geothermal chapter on blowout prevention, published in *Blowout Prevention in California*, is reproduced in this Hot Line issue. However, a geothermal operator will need the entire manual for reference.

Copies of the manual are available from the division, free of charge. The geothermal chapter follows.

GEOTHERMAL EQUIPMENT DESCRIPTIONS, OPERATING CHARACTERISTICS, AND REQUIREMENTS

4-1. HIGH-TEMPERATURE BOPE DESCRIPTION

The major BOPE components used while drilling in a high-temperature, water-dominated geothermal system are basically the same as those used on oil and gas wells and are described in the oil and gas sections of this manual. BOPE stacks used for controlling wells drilled with air in a vapor-dominant hydrothermal system contain additional devices not used in oilfield drilling, including a slab gate valve, banjo box, blooie line, muffler, and a rotating head as shown in Figure 24.

The slab gate valve serves as the base for the BOPE stack and is used for pressure control only in emergencies. The banjo box-blooie line-muffler assembly diverts air, steam, and drill cuttings away from the rig floor; the muffler is also used for noise control. The rotating head includes a stripper-packer attached to a ring that rotates on a bearing assembly. The entire rotating assembly turns with the kelly.

In normal air drilling, the packer does not act as a pressure seal because the banjo box-blooie line is open to atmospheric pressure. However, if the blooie line is closed, the rotating head becomes a blowout preventer. Normally, the rotating head must be cooled to protect the elastomer seals. Most high-temperature geothermal wells require the installation of a heat exchanger in the drilling-mud circulating system to keep the mud cool.

4-2. HIGH-TEMPERATURE BOPE REQUIREMENTS

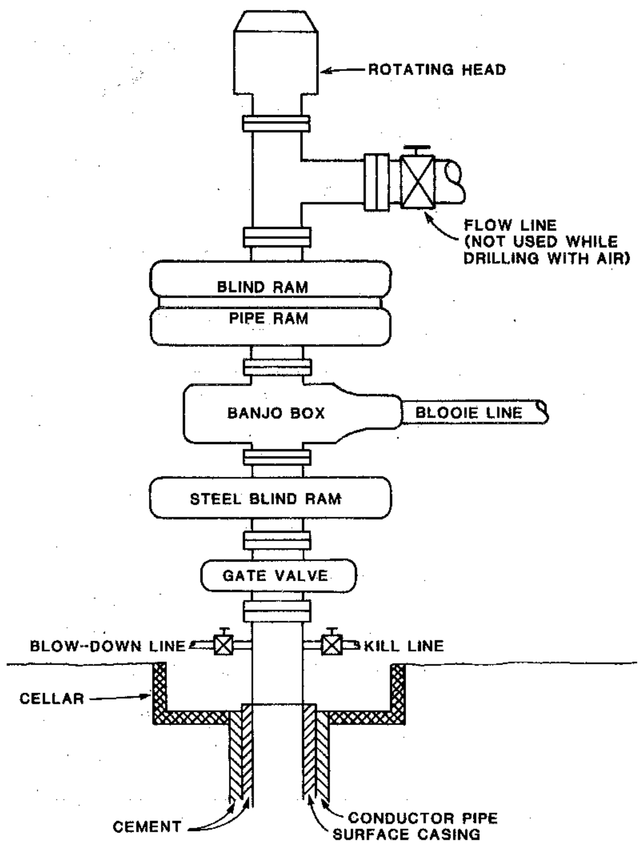
The following requirements are mandatory for most high-temperature wells. (Exceptions to the requirements of this section may be made by district engineers on a well-by-well basis, depending on geologic and well conditions.)

a. **Mud and Air Drilling**

Pressure - control equipment must be installed, pressure tested, and maintained in good operating condition during all drilling operations. Certain components, such as packing elements and ram seals, must be of high temperature-resistant material. All kill lines, blowdown lines, manifolds, and fittings should be made of steel or an acceptable substitute approved by the division, and should have a minimum working-pressure rating equivalent to the maximum anticipated wellhead surface pressure. Pressure-control equipment must conform to the provisions stated in Section 3 of this manual.

1. **Drilling Fluid** Sufficient drilling mud and materials to ensure well control should be maintained at the drill site and be readily accessible for use at all times.
2. **Related Well-Control Equipment** A full-opening drill string safety valve must be maintained in the drilling assembly or on the rig floor in the open position at all times while drilling operations are being conducted. A kelly cock may be installed between the kelly and the swivel.
3. **Testing and Maintenance** The annular and ram-type blowout preventers and auxiliary equipment must be tested in accordance with the provisions set forth in Section 5 of this manual.
4. **Conductor Pipe** Before drilling out the shoe of the conductor pipe, at least one remote-controlled, hydraulically operated, annular preventer, or an acceptable substitute (approved by the division), may be required. This installation must include a drilling spool with 2-inch side outlets. A kill line and blowdown line with appropriate fittings should be connected to the drilling spool. See Section 2 of this manual for the selection of equipment.
5. **Surface, Intermediate, and Production Casings** Before drilling out the shoe of the surface, intermediate, or production casing during mud or air drilling, installed blowout prevention equipment must include a minimum of:
   a) An annular preventer or a rotating head. The annual preventer shall be equipped with an actuating system that includes an accumulator.
   b) A manual and remote-controlled, hydraulically operated, double-ram blowout preventer or an acceptable substitute (approved by the division), with a minimum working-pressure rating exceeding the maximum anticipated surface pressure at the anticipated reservoir-fluid temperature.
   c) A drilling spool with side outlets or equivalent.
   d) A kill line equipped with a check valve or power-operated valve.
   e) A blowdown line equipped with at least one valve. The line should be securely anchored at all bends and at the end to prevent whipping or vibration damage during use (not required in vapor-dominated drilling).

   The following additional BOPE is required when drilling only with air or other gaseous fluid:
   f) At least one valve or slab gate between the banjo box and the wellhead.
   g) A blooie line.
6. **Air Drilling**
   Air or other gaseous-fluid drilling systems must have blowout prevention assemblies that include, from top to bottom, a rotating head, a double ram blowout preventer (pipe and blind) or equivalent, a banjo box or an approved substitute, and a blind-ram blowout preventer or gate valve (Fig. 24). Equivalent systems may be approved by the district engineer.



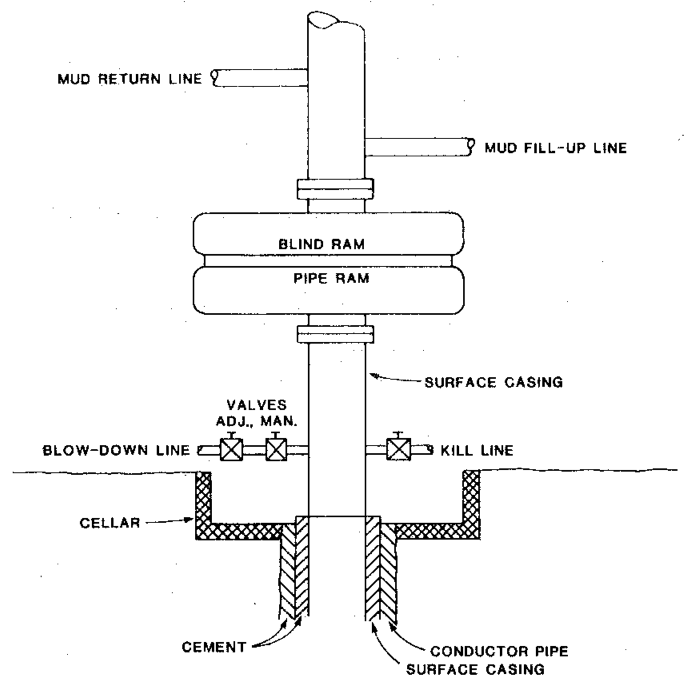
TYPICAL HIGH-TEMPERATURE GEOTHERMAL BOPE (AIR) STACK.

FIGURE 24

4-3. **LOW TEMPERATURE BOPE REQUIREMENTS**

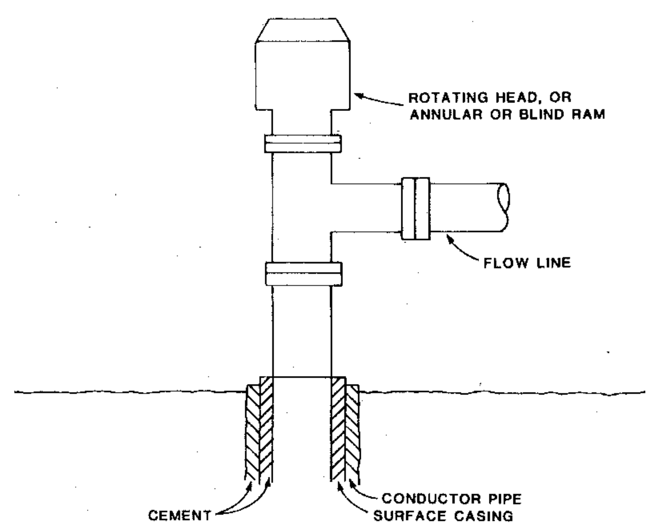
Low-temperature wells and temperature-observation wells drilled in high heat-flow areas not previously drilled, or in areas having a moderate- to high-potential for blowouts, require an annular and/or pipe and blind-ram preventer (Fig. 25). A kill line and a blow-down line should be installed below the preventer. In areas where geological conditions are known or where pressures are at or below hydrostatic pressure, the district engineer may approve the use of a single diverter stack. In the diverter stack (Fig. 26), a flow line is installed below a blowout preventer, gate valve, rotating head, or an approved equivalent device.

All required low-temperature BOPE equipment must be fully operational at all times. Pressure-control equipment must conform to provisions in Section 3 of this manual. All precautions should be taken to provide for the safety of the drilling crew and other personnel in case of a blowout or unexpected artesian flow.



TYPICAL LOW-TEMPERATURE GEOTHERMAL BOPE (AIR) STACK.

FIGURE 25



TYPICAL LOW-TEMPERATURE GEOTHERMAL BOPE DIVERTER STACK.

FIGURE 26

Statistics

Division CEQA Unit, 1984

The Division of Oil and Gas was designated by the California State Legislature as the lead agency under the California Environmental Quality Act (CEQA) for all geothermal exploratory drilling projects on private and state lands in California.

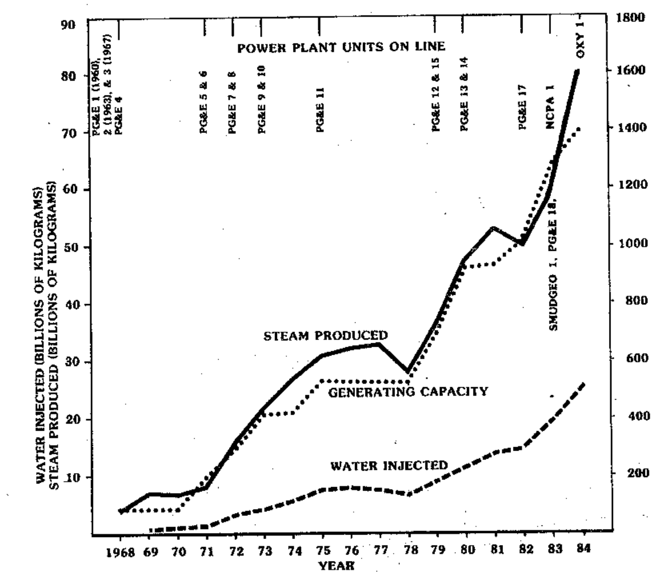
In 1984, 8 geothermal exploratory project applications were submitted to the CEQA Unit, compared with 11 in 1983. The applications were for 3 deep-test well projects and 5 observation well projects, compared with applications for 7 deep-test well projects and 4 observation well projects in 1983.

One Notice of Preparation was issued in 1984 by the CEQA Unit, compared with 4 in 1983; 7 Notices of Exemption compared with 6 in 1983; and 5 Notices of Determination compared with 2 in 1983. Five draft and 4 final environmental impact reports (DEIR's and FEIR's) were completed in 1984.

1984 Production and Injection Statistics, The Geysers Geothermal Field

"Steam production in The Geysers Geothermal field totaled 80.0 billion kilograms in 1984," said A. D. Stockton, Geothermal Officer for the Division of Oil and Gas. He said this was a 21.4 percent increase from 65.9 billion kilograms produced in 1983.

Injection of condensed steam and water from Big Sulphur Creek, which runs through the field, increased from 19.5 billion kilograms in 1983 to 24.6 billion kilograms in 1984, leaving a reservoir fluid deficit of 55.4 billion kilograms for 1984.



History of steam production, water injection, and power plant capacity at The Geysers Geothermal field.

Production Statistics, The Geysers Geothermal Field

YEAR	NET MWe GENERATING CAPACITY	PERCENT INCREASE	AVG. NO. PRODUCTION WELLS	PERCENT WELL INCREASE	GROSS STEAM PRODUCED 10^6 Kilograms	PERCENT STEAM INCR./DECR.
1968	78	---	16	---	3,515,849	---
1969	78	0	20	25.0	6,812,616	93.8
1970	78	0	20	0	6,425,402*	-5.7
1971	184	135.9	22	10.0	7,813,799	21.6
1972	290	57.6	37	68.2	15,777,373	101.9
1973	396	36.6	53	43.2	21,464,314	36.0
1974	396	0	65	22.6	26,329,259	22.7
1975	502	27.8	81	24.6	30,514,607	15.9
1976	502	0	91	12.3	31,995,187	4.8
1977	502	0	94	3.3	32,490,278+	1.5
1978	502	0	94	0	27,667,486	-14.8
1979	667	32.9	118	25.5	36,231,326+	31.0
1980	911	36.6	151	28.0	47,039,901+	29.8
1981	911	0	163	7.9	52,769,159	12.2
1982	1017	11.6	175	7.4	49,365,069	-6.4
1983	1309	28.7	224	28.0	65,884,117	33.5
1984	1441	10.1	252	12.5	80,049,895	21.5

* contains estimated data

\+ corrected

Geothermal Electrical Generation Up

In the fourth quarter of 1984, 2,163,924 megawatt-hours of electricity were generated from California geothermal resources. This figure represented a 20.6 percent increase over the same quarter in 1983. The figure represents 6.47 percent of electricity generated by utility companies in the state.

These figures were taken from Energy Watch, published by the California Energy Commission, May 1985.

Geothermal Electrical Generating Capacity Compared

Figures in the following table compare the growth of geothermal power plant electrical generating capacity in California and worldwide (including California).

The California figures were compiled by A. D. Stockton.

The worldwide figures were compiled by Ronald DiPippo and published by the Geothermal Resources Council in the International Volume of the 1985 International Symposium on Geothermal Energy.

Date	Worldwide Geothermal Power Plant Capacity (megawatts)	California Geothermal Power Plant Capacity (megawatts)	Percentage of Worldwide Geothermal Power Plant Capacity in California
Mid 1979	1,758.9	687	39.1
Mid 1980	2,110.536	933	44.2
Mid 1981	2,493.086	933	37.4
Mid 1982	2,558.886	1,060	41.4
Mid 1983	3,190.286	1,339	42.0
Mid 1984	3,769.686	1,426	37.8
End 1985	4,763.981	1,917	40.2

Imperial Valley

Imperial Valley Adjusted Releveling Data Available

by A. D. Stockton and the County of Imperial, Department of Public Works

The Imperial County Department of Public Works has received and distributed the adjusted level data for the 1980 Imperial County Subsidence Leveling Network. The data adjustment was undertaken by the National Geodetic Survey (NGS).

The data adjustment was necessary because certain leveling instruments were subject to magnetic influence. Thus, some of the primary level lines were influenced.

A spokesman for the NGS reported that most of the errors occurred in the 1974 and 1976 surveys. They found no error in the 1972 survey and very little error in the 1980 survey. The corrections for the 1974 and 1976 surveys will be released by the Imperial County Department of Public Works.

Imperial County is completing the fifth survey of the geothermal subsidence monitoring network. Unlike the four previous surveys, the fifth is a phased survey that is being performed over a period of several years. Following completion of the final phase of the survey, data will be compared with previous findings to identify the natural tectonic subsidence patterns in the area.

The county-wide survey network provides baseline information for comparison with site-specific surveys performed by geothermal developers. About 10 years of developers' surveys have been performed in the north Brawley, Heber, and Salton Sea areas.

In addition to surface monitoring, the Division of Oil and Gas monitors subsurface reservoirs to detect changes that may be indicative of future subsidence.

No localized subsidence has been detected near geothermal project sites to date. Periodic monitoring will continue to be necessary as development proceeds.

Update: Salton Sea Scientific Drilling Project

Drilling is scheduled to begin on October 23 at "State Well" 2-14, the Salton Sea Scientific Drilling Project. The 10,000 foot well will be drilled at a site in the Imperial Valley, close to Niland, California. Well temperatures are expected to reach 300°C at a depth between 3,000 to 6,000 feet. The brines are expected to have salinities of 250,000 to 300,000 milligrams per liter. Once completed, the well will be kept open for about a year for scientific experimentation.

The Division of Oil and Gas has issued a Report on Proposed Geothermal Operations (essentially, a drilling permit) to Kennecott Corporation for the well. The report includes stipulations for drilling the well. The stipulations follow.

1. Conductor pipe of adequate size and strength shall be cemented at a minimum depth of 45.7m (150').
2. Surface casing of adequate size and strength shall be cemented at a depth not less than 274.3m (900') nor deeper than 304.8m (1000').
3. This well shall be cased in such a manner as to protect or minimize damage to the environment, usable ground waters (if any), geothermal resources, life, health, and property.
4. An annular blowout preventer and a spool, fitted with a low-pressure pop-off and blow-down line, shall be installed on the conductor pipe (30") to ensure against possible gas blowouts during the drilling of the surface casing hole.
5. Division of Oil and Gas Class III A, 3M blowout-prevention equipment shall be installed on the 20" surface casing prior to drilling out the shoe of the surface casing, and be maintained ready for use at all times.
6. Division of Oil and Gas Class III B, 3M blowout-prevention equipment shall be installed on the 13-3/8" surface casing prior to drilling out the shoe of the surface casing, and be maintained ready for use at all times.
7. Division of Oil and Gas Class III B, 3M blowout-prevention equipment shall be installed on the 9-5/8" surface casing prior to drilling out the shoe of the surface casing, and be maintained ready for use at all times.
8. During the drilling of the surface casing (20") hole, the temperature of the return mud shall be monitored continuously. Either a continuous temperature-monitoring device shall be installed and maintained in working condition, or the temperature shall be read manually. In either case, return mud temperature shall be entered into the log book after each joint of pipe

has been drilled down (every 10 meters).

9. Drilling of the surface casing hole shall not proceed if the temperature of the return mud exceeds 60°C (140°F). If this temperature is reached, a supplemental drilling program must be approved by the division.

10. All well records listed in appropriate sections of the Public Resources Code and the California Administrative Code are submitted within 60 days after cessation of drilling operations. Subsequent records such as temperature surveys or required water analysis shall be submitted within 30 days after being run.

11. This division shall be notified:
    a. One day prior to the commencement of drilling.
    b. Before altering the proposed program or suspending operations. Additional requirements will be outlined at that time.
    c. To witness the placing and cementing of each casing string.
    d. To inspect the blowout prevention equipment prior to drilling out the shoe of the 30" conductor pipe.
    e. To witness a test of the blowout prevention equipment prior to drilling out the shoe of the 20" casing.
    f. To witness a test of the blowout prevention equipment prior to drilling out the shoe of the 13-3/8" casing.
    g. To witness a test of the blowout prevention equipment prior to drilling out the shoe of the 9-5/8" casing.
    h. To inspect any changes made to the blowout prevention equipment.

The Shallow Salton Sea Drilling Program

Adapted from a report prepared by Sandia National Laboratories.

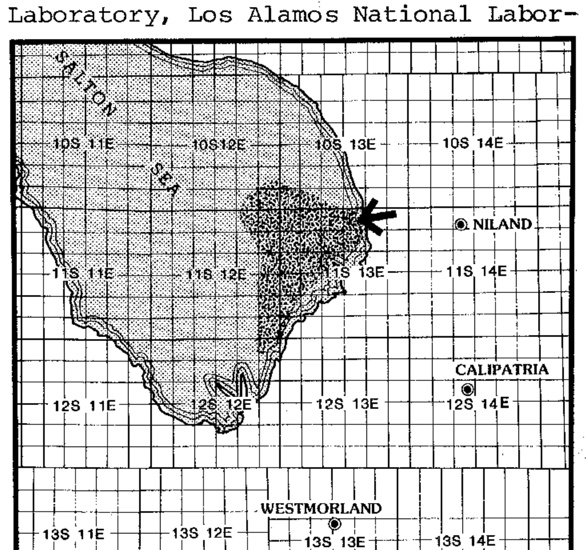
Introduction

The Continental Scientific Drilling Program is a national endeavor to explore, in a scientific sense, the third dimension of the earth's crust. The implementation of this program is carried out through an Interagency Accord on Continental Scientific Drilling between the National Science Foundation, the Department of Energy/Office of Energy Research, and the Department of Interior/USGS. This document was signed April 2, 1984, and it is the instrument by which the various agencies share resources and provide guidance to the overall program. The primary responsibility for Thermal Regimes drilling and a substantial portion of the related research is assigned to the U.S. Department of Energy.

To implement the field activities associated with Thermal Regimes, the Department of Energy/Office of Basic Energy Sciences established a Geoscience Research Drilling Office at Sandia National Laboratories. One of the responsibilities of this office is to interface with the scientific, drilling, and permitting communities so as to generate pertinent data in an economic and a physically and environmentally safe manner. These data come in the form of core and fluid specimens as well as the results of surface and subsurface geophysical experiments.

The Shallow Salton Sea Program

The Shallow Salton Sea Drilling Program is part of an initiative put forth by Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia. Previous drilling in this initiative occurred in the Valles Grande Caldera, New Mexico, and Long Valley Caldera, California.



A great deal of work has been done in the Salton Sea area by university, USGS, national laboratory, and industrial researchers. This interest stems from the fact that the Salton Sea Geothermal field lies within one of the largest and hottest hydrothermal areas in the world. Like other fields in the Salton Trough, this system is apparently related to the right lateral transform fault system on the western margin of North America. In that regime, wherever faults veer to the right, local zones of crustal extension allow magmatic intrusions to "leak" into the crust, providing heat sources to drive hydrothermal activity. Several small volcanic cones on the southeastern shore of the Salton Sea are direct evidence of the location of one of these "leaks".

The geothermal field southeast of the domes has been studied extensively by deep and shallow drilling as well as by several geophysical methods. The portion of the hydrothermal system to the northwest has not been explored as extensively, partly because the shallow sea makes exploration and resource utilization more difficult than it is in the landward part of the system. However, regional studies such as gravity, magnetics, and seismicity all indicate that the *pull-apart* zone extends under the Salton Sea and that the hydrothermal system probably does as well.

Recent efforts, based on the extensive data set for the southeastern part of the system, have resulted in a model that can be used to predict near-surface heat-flow contours from the unexplored part of the system.

Two features of the temperature field in the Salton Sea geothermal field put strong constraints on models of the hydrothermal system's development. First, uniform, steady-state heat-flow is observed in a 500 m thick thermal cap over an area of 30-40 km^2. This observation indicates that the rate of heat delivery to the thermal cap in this area has not changed for at least the time required for the cap to reach equilibrium, about 10,000 years. Secondly, the periphery of the high heat flow zone is abrupt, and the thermal gradient in the cap increases significantly with depth as the hydrothermal zone is approached. These observations suggest that heat has been delivered to the periphery for a much shorter time than is required for conduction in the cap to spread the boundary or to reach steady-state equilibrium.

A model of horizontal fluid flow outward from a heat source of hot fluids near the domes produces thermal fields that match these observations. The model is simple enough that analytical results can be evaluated for a broad range of parameters in order to place bounds on the nature of the hydrothermal system. This simple conceptual model for the fluid flow patterns has been used to estimate the age of the system and to evaluate quantitatively the limitations of our understanding of the heat source. More importantly, and in regard to heat flow conditions offshore, the model predicts that:

1. An area of high (4 to 5 times normal) and uniform heat flow will be found offshore to the northeast of the domes.

2. The area of uniform heat flow will be bounded by a narrow (1 km wide) zone of rapid transition to normal heat flow.

3. These regions can be detected and delineated by relatively shallow heat flow measurements.

4. If the location of the boundary region is determined, then quantitative estimates of the heat source location can be made.

A test of this model requires additional information from shallow offshore heat flow holes. Thus, the Shallow Salton Sea Drilling Program was designed.

The Shallow Salton Sea Drilling Program will consist of 20-30 temperature gradient holes drilled to a depth of 250 feet below the floor of the Salton Sea. Anticipated water depths are 2 to 30 feet. Temperature logs will be made immediately after drilling, and for about three months thereafter. Since the position of the horizontal temperatures is unknown, the early temperature logs will be used to site subsequent holes.

The drilling operation will be under the supervision of Ian Padden of IV Dimension Technologies, Ltd. Drilling will begin October 1985.

"We are looking forward to the project and are hoping it will answer many questions about the magnetic and gravity anomalies," said Dick Corbaley, Division of Oil and Gas Lead Engineer in El Centro.

For further information, contact Peter Lysne, Geoscience Research Drilling Office, Division 6240A, Sandia National Laboratories, Albuquerque, New Mexico 87185, Phone: (505) 846-6328.

Heber Power Plants On Line

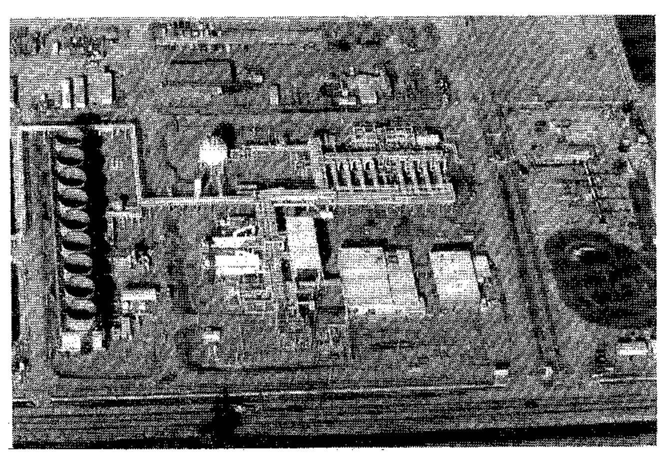
Two power plants in Heber Geothermal field have gone on line. One plant, a geothermal binary power plant, is the first of its size in the United States to use binary-cycle geothermal technology. The second plant is a dual-flash geothermal power plant.

The binary power plant went on line on September 11, 1985. It is currently (October 1) generating 11 megawatts net of electricity. One megawatt of the amount is being delivered to San Diego Gas and Electric Company. The 45 megawatt net plant is expected to be producing at full power on November 15, 1985.

Wells for the power plant were drilled by Chevron Geothermal Company of California. The plant was funded by the U.S. Department of Energy, the Electrical Power Research Institute, San Diego Gas and Electric Company, the Imperial Irrigation District, California Department of Water Resources, State of California, and Southern California Edison Company.

The dual-flash geothermal power plant at Heber Geothermal field has gone on line, as well. The 47 megawatt power plant, about 1 mile east of the binary plant, was started up on July 26, 1985. Currently (October 1), the plant is generating 37 megawatts net of electricity. Of this amount, 35 megawatts is being delivered to Southern California Edison. The plant is expected to be running at full power on November 15, 1985.

Partners in the dual flash project are Chevron Geothermal Company, operator of the Heber Geothermal Unit, a joint venture with Union Oil Company of California; and Heber Geothermal Company, operator of the power plant. Heber Geothermal is a joint venture of Dravo Corporation, and Centennial Geothermal Inc.



Aerial view of the binary power plant at Heber Geothermal field. Photo courtesy of R.F. Allen, San Diego Gas and Electric Company.

The Vulcan Power Plant

by Russ L. Tenney
Manager of Operations
The Magma Power Company

The Magma Power Company is constructing a dual-flash power plant near Calipatria, at the northern end of the Imperial Valley. The plant will be owned and operated by the Vulcan Power Company, a wholly owned Subsidiary of the Magma Power Company. The plant, named the Vulcan Power Plant, is designed to produce a nominal 36 megawatts gross and 32 megawatts net of electricity. The Vulcan project is financed by a loan from the Morgan Guaranty Trust Company and substantial cash equity from Magma Power. There are no public funds involved.

Engineering, procurement, and construction management were contracted to the Dow Engineering Company of Houston, Texas. Now, construction is about 99 percent completed, and all systems are scheduled to be released to operations by October 4, 1985. Startup and shakedown are scheduled for October and November, with commercial operation beginning December 2, 1985.

Magma will operate both the brine field and the generating station. Magma's patented crystallizer-clarifier process is being used to handle the high temperature, highly saline brine.

The brine to supply the plant is gathered from 12 production wells on four islands and transmitted to the plant via four brine headers. The 2-phase brine-system mixture is commingled at the plant and split into 2 trains. The brine then enters the high-pressure crystallizers. There, it is seeded to prevent silica scaling as the pressure is reduced to flash sufficient steam to drive the 29.4 megawatt Mitsubishi high-pressure turbine-generator. The unflashed brine, now heavily seeded, flows to the low-pressure (LP) crystallizers.

Here, the pressure is further reduced to generate sufficient steam to drive the 9.4 megawatt Mitsubishi low-pressure turbine.

The steam exhausted from both turbines is condensed in separate surface condensers and used as the cooling medium. A high efficiency Marley counterflow cooling tower is used to reject unusable heat to the atmosphere. Air and noncondensable gases are removed from the condensers with a hybrid system of air ejectors, inner and after condensers, and vacuum pumps. The noncondensables are then contacted with the brine to react the hydrogen sulfide with the heavy metals contained in the brine. The remaining gases, primarily carbon dioxide, are vented out of the LP crystallizers.

The unflashed brine flows to the reactor-clarifier. The fully developed crystals then begin to settle and are pushed to the center by a rake. Here, they agglomerate and thicken. Clarified brine then flows out the top of the clarifier and is filtered to remove any remaining suspended solids before being injected into some combination of the 6 injection wells. The solids are drawn off the bottom of the clarifier. They flow to a thickener, where they are further concentrated. Then, a portion of this sludge is used to seed the inlet brine. The remainder is disposed of.

This is really a very simple and straightforward process, with no batch operations and very little pumping. It uses existing technology, and has been successfully demonstrated. It poses acceptable commercial risk.

East Mesa "Ormesa" Power Plant

Adapted from the Imperial County Geothermal Development Status Report prepared by the County of Imperial, Department of Public Works.

Republic Geothermal, Inc. has transferred its East Mesa leases and wells to Ormat Systems, Inc. Ormat's subsidiary, Ormesa, is planning to develop a 30 megawatt gross, 20 megawatt net facility using 26 interconnected modular binary generating units, each with a gross rating of 1.25 megawatts. A Department of Energy Geothermal Loan Guarantee, previously approved for a Republic project, will be restructured for the revised project.

Ormesa has submitted development plans for approval by the Bureau of Land Management. Current schedules estimate start of construction in the summer of 1985 and completion in 1986.

The power will be purchased by Southern California Edison. The resource temperature is 160°C.

City of El Centro Well

Reprinted from the Imperial County Geothermal Development Status Report prepared by the County of Imperial, Department of Public Works.

The El Centro geothermal direct-use project was terminated, partly due to well problems. El Centro and the U.S. Department of Energy modified their contract to allow brief testing of the production well. Then, the production and injection wells were plugged and the project was abandoned. The abandonment was completed in August 1984.

Although the El Centro project was terminated, the project did result in the discovery of a potentially valuable low temperature resource (240°F) at a depth of 7,000 feet.

Northern California

Bottle Rock Power Plant On Line

The Bottle Rock geothermal power plant is a 55 megawatt plant owned, constructed, and operated by the California Department of Water Resources (DWR) in The Geysers Geothermal field. Testing began at the plant in January 1985, and full-capacity commercial generation began in March 1985.

Electrical power from the plant is being used in the State Water Project. Surplus power is sold by DWR to a number of utilities. The Department of Water Resources is the fifth largest utility in California.

Mammoth Lakes Geothermal Direct Heating Engineering and Feasibility Study
by Daniel L. Lyster, Director
Office of Energy Management
Mono County

On February 5, 1985, the Ben Holt Company entered into a contractual agreement with the County of Mono to provide the preliminary engineering and economic evaluation of a geothermal direct heating project at Mammoth Lakes, California. The primary funding of the project is from a California Energy Commission grant (No. 912-84-065) awarded to Mono County in the latter part of 1984.

The proposed direct heating system will use hot water from one of three possible geothermal resources in or near the mountain-resort town of Mammoth Lakes to heat fresh water in a closed-loop circulating system. The heated fresh water will be pumped through a distribution network for space heating, domestic water heating, and snow melting prior to its return to the geothermal well area where the water will be reheated with a heat exchanger.

Considering the relatively remote location of this mountain community, in which most of the heating needs are currently provided by electricity (with the remainder met by wood and liquefied petroleum gas), the need for a more economical and environmentally benign source of space heating is apparent. Additionally, the need for snow melting on roads, walkways, and parking lots provides further justification for such a project.

Of the three possible geothermal resources that may provide the hot brine to be used in the heat exchanger, only the resource currently fueling the Mammoth Pacific 7 megawatt power plant at Casa Diablo (about 5 miles from the proposed project area) is proven. The other two are believed to be within the federal geothermal leasehold recently acquired by the Union Oil Company of California (just outside the town limits) and within an unexplored area of the town.

To test the latter potential resource, a proposed scientific research well will be drilled on U.S. Forest Service land within the Mammoth Lakes town limits. The well will be funded primarily by the U.S. Department of Energy, with some contribution from the Mono County Geothermal Fund. The depth of the research well, which may be more accurately described as a monitoring piezometer, is proposed to be 1,500 feet.

Although the primary purpose of this relatively shallow well is to provide downhole temperature measurements, repeated fluid sampling, and to monitor changes in fluid pressure, the incidental well log data and information relating to local geology and stratigraphy will provide information necessary to assess the feasibility of drilling a production well closer to the point of use. Thus, if the drilling data appear encouraging, the Town of Mammoth Lakes may choose to solicit private funds for drilling the production well to provide geothermal brine to the direct heating project. If the drilling of the Department of Energy-County research well to a depth of 1,500 feet does not provide enough data to immediately justify the pursuit of a production well within the town limits, the town may approach the California Energy Commission for grant funds to deepen the well to a depth of 2,500 feet.

Oregon, Idaho, & Washington

Oregon Geothermal Development

by George R. Priest
Oregon Department of Geology and Mineral Industries

Reprinted from Oregon Geology, vol. 47, no. 6, June 1985.

In 1984, as in 1983, geothermal drilling in Oregon was at a very low level and was centered chiefly on Newberry Volcano. Drilling by California Energy in the Crater Lake area was delayed when the National Park Service (NPS) voiced concerns about possible negative environmental impacts. The total acreage of leased geothermal lands in Oregon decreased by 18 percent as developers winnowed out the less attractive prospects or left geothermal exploration in Oregon in response to unfavorable market and regulatory conditions.

Pump testing and monitoring of wells in Klamath Falls continued as the city finally began to utilize the geothermal district heating system constructed earlier by U.S. Department of Energy (USDOE) funds. The thermal aquifer at Klamath Falls seems to be little affected by the large-scale pumping.

Data from an 8,080-ft. (2463m) well drilled in 1981 near Breitenbush Hot Springs by Sunedco were put in the public domain. The well intercepted sheared tuffs carrying fluids with temperatures in excess of 136°C from 2,467 ft. (752m) to 2,566 ft. (782m). Temperature-gradient surveys in the area indicate that this aquifer may dip to the east where even higher temperature fluids probably occur. Temperatures were in excess of 141°C at 8,060 ft. (2457m), resulting in a probable conductive gradient in excess of 56° C/km. These data support the following hypotheses: (1) the High Cascade heat-flow anomaly inferred from shallow gradient data is representative of deep conductive heat flow, (2) the heat-flow anomaly affects a significant part of the Western Cascade Range, and (3) significant geothermal resources may exist in the Western Cascades far removed from the major High Cascade volcanoes.

BPA Studies Western Geothermal Sites

At least 13 geothermal sites in Oregon, Washington, Idaho, and Montana offer good potential for development, according to a study recently completed for the Bonneville Power Administration (BPA). Eight sites appear technically capable of generating a total of at least 1,000 megawatts of electricity. Geothermal energy in five other sites could be used directly for water or space heating to conserve electricity.

In December 1983, the BPA contracted with the four states to evaluate and rank geothermal resource sites throughout the region. The goal of the program was to consolidate and evaluate all geological, environmental, legal, and institutional information and apply a uniform methodology to the ranking of these sites. The information will be used as a data base and to forecast what geothermal energy might be available to the region over the next 20 years.

The study, coordinated by the Washington State Energy Office, was produced by the Oregon Department of Energy, the Oregon Department of Geology and Mineral Industries, the Idaho Department of Water Resources, and the Montana Department of Natural Resources and Conservation, in conjunction with a 25-member technical advisory group.

The team started out with 1,265 potential geothermal sites. Of these, 234 showed either development potential, cost effectiveness, or both.

The sites were ranked on: known geothermal potential, cost of further exploration, cost of the technology and equipment needed to use the resource, and legal, environmental and institutional barriers to developing the site.

Forty of the 234 sites have "superior" economic or developmental potential. Seventeen of these have electrical generation potential, and 23 could be used for water or space heating. The better sites tend to be concentrated in Oregon.

Thirteen sites ranked "high" in both developmental and economic potential. Of those, the eight areas with highest generation potential are:

Olene Gap, Oregon
Raft River, Idaho
Newberry Volcano, Oregon
Crane Creek, Idaho
Klamath Falls, Oregon
Glass Buttes, Oregon
Klamath Hills, Oregon
Big Creek, Idaho

The five areas that could be used best for water or space heating are:

Boise, Idaho
Yakima, Washington
Pullman, Washington
Pocatello, Idaho
Klamath Falls, Oregon

The report is titled Evaluation and Ranking of Geothermal Resources for Electrical Generation or Electrical Offset in Idaho, Montana, Oregon, and Washington. The principal investigator

is R. Gordon Bloomquist. For a free executive summary of the report or further information, contact John Geyer, BPA, Routing PQP, P.O. Box 3621, Portland, Oregon 97208. Phone (503) 230-5327.

Utah & Nevada

Geothermal Firms Get PSC Okay for Plant at Steamboat

The following article is reprinted, with permission, from the Bulletin, published by the Nevada Mining Association.

Geothermal Development Associates of Reno, Nevada, received a permit from the Nevada Public Service Commission to build a 5-megawatt geothermal power plant at Steamboat Springs, south of Reno.

According to G. Martin Booth III, president and a principal of Geothermal Development Associates (GDA), the company will be the operators of the joint venture power plant project. The project will cost about $10 million. Several production wells, two injection wells, and a few observation wells are planned for the project. The production wells will be shallow, between 500 and 1,000 feet, and the injection wells will be mainly below 1,000 feet.

David L. Mendive, vice president of engineering and a principal of GDA, said that the area shows good fracturing, porosity, and permeability. Short term testing of a shallow production well indicates excellent flow rates and temperatures higher than anticipated.

Pre-construction drilling has been completed. Geothermal Development Associates hopes to have the power plant constructed by the end of 1985. The steam-generated electricity will be sold to Sierra Pacific Power Company.

Biphase Systems in Utah and Nevada

"For 3½ years," said Walter Studhalter, Manager of Marketing for Biphase Energy Systems, "a 1.3 megawatt geothermal turbine generator wellhead unit has provided Utah Power and Light Company with its first geothermally produced electricity. The generator is installed next to a well at Roosevelt Hot Springs Geothermal field in SW Utah.

The electricity, first produced in October 1981, is generated from both the hot water and steam portions of the resource.

The generating unit includes a Biphase, rotary separator turbine that produces 20 percent more kilowatts per pound of geothermal fluid as compared with a geothermal system operating on steam alone.

"In commercial practice, the rotary separator turbine can be used either as a satellite wellhead separator to supply steam to a central plant and supplement the total electrical output, or as a wellhead generator in combination with a small steam turbine," noted Vasel Roberts, manager of the Electric Power Research Institute's Geothermal Power Systems Program.

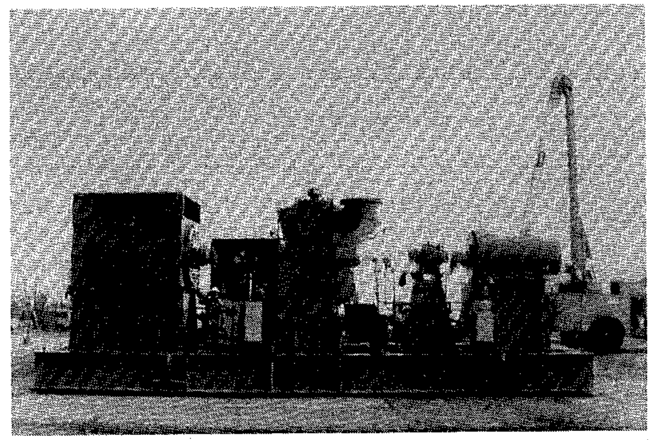
"As a wellhead unit," he added, "it can be used in the early stages of geothermal field development to provide information on the production characteristics of geothermal reservoirs. The information can also be used to compare the economics of the wellhead approach with that of alternative, centralized plants."

The mobile wellhead unit was developed by Biphase Energy Systems, a joint venture of Research-Cottrell and Transamerica Delaval. Additional development and fabrication funding was from the Electric Power Research Institute and the U.S. Department of Energy.

Steam for the Roosevelt Hot Springs project is provided by Phillips Petroleum Company. Utah Power and Light supplied materials and operating personnel.

"At the present time," said Studhalter, "Transamerica Delaval has contracted with Utah Power and Light to supply to the utility, seven, 14.5 megawatt units at times selected by the utility. Thus, the plants may be brought on line according to demand and well schedules."

"At Desert Peak, 65 miles northeast of Reno, Nevada," he continued, "Phillips Petroleum Company is engineering and building a 9 megawatt geothermal power plant. Included in the power plant is what we call the power skid, a biphase rotary separator turbine and a Delaval steam turbine, generator, and accessories."



Rotary separator turbine, installed at Roosevelt Hot Springs Geothermal field in SW Utah, near Milford. At the plant, 1.3 megawatts of electricity is generated.

Hawaii

The Hawaii Geothermal Project

This article is reprinted from a report distributed at the 1985 International Symposium on Geothermal Energy convened by the Geothermal Resources Council.

Drilling for geothermal energy in Hawaii started in the early 1960's on the Island of Hawaii. The first four wells were drilled in the Puna District to relatively shallow depths and did not penetrate a producing geothermal resource. A fifth well was drilled in 1973 near the Halemaumau Crater to a depth of 4,140 feet (1067 meters) where a temperature of 279°F (137°C) was reached.

With federal, state, county, and private funding, HGP-A was drilled near Kapoho in Puna from December 1975 to April 1976 when it was completed to a depth of 6,450 feet (1966 meters). With a bottom hole temperature of 676°F (358°C), HGP-A was one of the hottest geothermal wells in the world.

The production of steam is believed to come primarily from aquifers located at 4,500 feet (1372 meters), 5,800 feet (1768 meters), and bottom hole. The well produces 110,000 lbs./hr. (49,900 kg/hr.) of a mixed phase fluid (57 percent liquid and 43 percent steam) at a wellhead pressure of 175 psia (12.3 kg/cm^2) and 366°F (186°C).

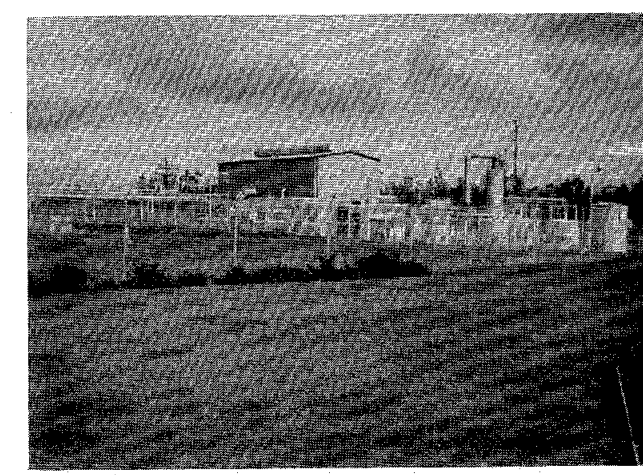
Construction of the power plant was undertaken with major support from the U.S. Dept. of Energy and a development group consisting of the State of Hawaii Department of Planning and Economic Development, the County

of Hawaii, and the University of Hawaii's College of Engineering. Rogers Engineering Company of San Francisco designed the power plant and provided construction management services. The plant was completed in mid-1981 at a cost of about $10 million. The plant design incorporates a single flash wellhead separator operated at a pressure of 175 psia, a 3 megawatt turbine generator set, and a shell and tube surface condenser. Noncondensable gases are removed from the condenser shell with a dual-stage steam ejector and are incinerated and scrubbed with a 10 percent solution in a packed tower. Off gases from the scrubber are vented to the cooling tower intake. Separated brine is discharged to the atmosphere in a muffler. It is allowed to percolate into the ground. Steam stacking conditions are handled using a caustic injection system to abate H_2S, and a rock muffler to control noise.

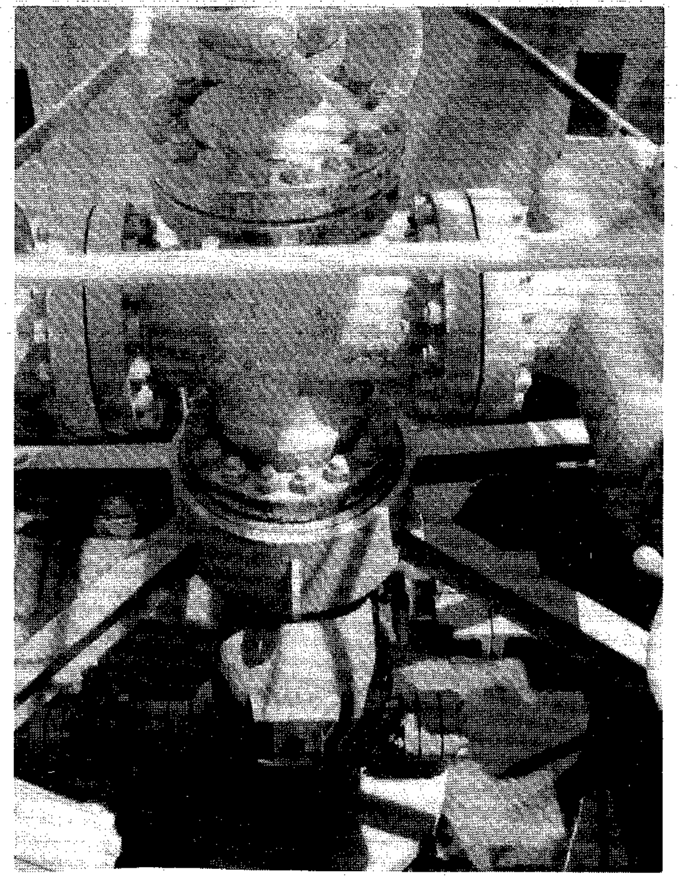
A number of mechanical problems were encountered with the major subsystems, including the turbine control valves and turbine vibration, which necessitated a suspension of operations about 90 days after start-up. After turbine repair and a subsystem recheck, start-up operations were resumed in December 1981 and commercial operation began in March 1982. Since commercial operation, the plant has had an availability factor exceeding 95 percent. Electrical output has been steadily increasing ... 19.3 x 10^6 kWh in 1983, 20.6 x 10^6 kWh in 1984, and a projected 24.7 x 10^6 kWh in 1985. Actual production has averaged about 2.6 megawatts gross/2.4 megawatts net.

Several changes in the chemical composition of the fluids produced by HGP-A brine have occurred during the nearly 4 years of continuous discharge from the well. Total dissolved solids concentrations have increased from 3500 mg/Kg to nearly 20,000 mg/Kg. Total noncondensable gas concentrations have declined by about 10 percent. The chemistry of the brine phase indicates that seawater is infiltrating into the part of the geothermal reservoir penetrated by HGP-A, possibly induced by fluid withdrawal. Disparities between the brine and steam chemistry and their calculated geothermeters also suggest that two or more aquifers are supplying fluids to the well: one producing dry steam and the remainder a saturated brine-steam mixture.

The major maintenance problems encountered in the generator plant have resulted from deposition of silica from the geothermal brine phase. Initial silica deposition rates were relatively slow, but, as salinities of the fluids increased, deposition rates in values and discharge lines also increased. Scale deposition in the steam supply system has been minimal and has consisted predominantly of iron sulfides and oxides. Exterior corrosion and maintenance of electrical equipment has also been aggravated by a combination of the very humid environment and the small amounts of H_2S discharged at the plant site.

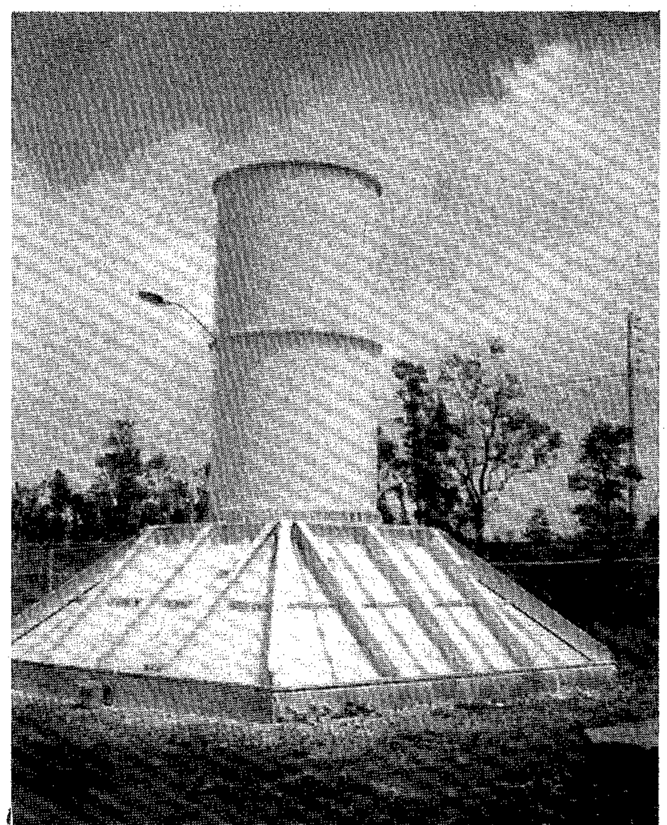


The Hawaii Geothermal Plant. The 3 megawatt plant is constructed at the well site. The turbine and generator are modular units that can be lifted with a bridge crane. Whenever volcanic eruptions threaten, these elements can be placed on a trailer and hauled away. Photos by Susan F. Hodgson.

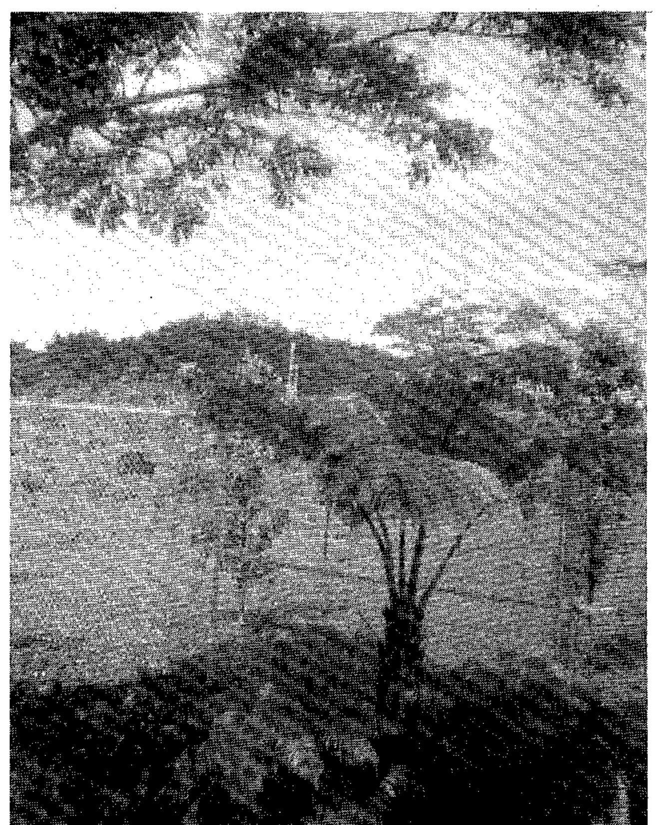


Well HGP-A, the first successful geothermal well in Hawaii. The well is 6,450 feet deep with a bottom hole temperature of 358°C. A concrete bunker is built around the wellhead to protect it from lava flows. If the well is threatened by a flow, it will be capped, and the bunker lid put into place.

Lid to the concrete bunker built around well HGP-A.



Rock muffler for well HGP-A.



Well KS-1A, as it was being drilled north of the Hawaii Geothermal Plant.

Development After HGP-A

This article is reprinted from a report distributed at the 1985 Symposium on Geothermal Energy convened by the Geothermal Resources Council.

Private interest in geothermal exploration and development in Hawaii increased substantially after the successful completion of well HGP-A. Privately financed exploration drilling was undertaken on the northwestern flanks of Hualalai volcano on the western side of the Big Island in the early part of 1978 by the Puu Waawaa Steam Company. Prior to drilling, several geophysical surveys were conducted around the Puu Waawaa cinder cone by a mainland-based exploration group; several geophysical anomalies were observed in this area; and two exploratory wells were drilled. Neither well encountered significantly elevated temperatures to depths of more than 2000 m, and both were abandoned shortly after completion.

In 1980, GEDCO, now a subsidiary of Barnwell Industries, drilled the Ashida-1 well at a site about 3 km WSW of the HGP-A well. This well has been reported to be deeper than 2000 m.

GEDCO also drilled Lanipuna 1 about 750 m south of the HGP-A well in 1981, and Lanipuna 6, about 1 km SE of the HGP-A well in 1984. No results of these wells have been publicly released.

Puna Geothermal Venture (PGV), consisting of Thermal Power Company as operator, Dillingham Geothermal, Inc. and Amfac Energy, Inc. has drilled two exploratory wells adjacent to the HGP-A property, as stepout wells to the HGP-A discovery. In August 1985, a third well was being drilled on the same drillsite as the first.

The PGV stepout wells, Kapoho State-1 (KS-1) and Kapoho State-2 (KS-2) were drilled in the rift near the trace of the 1955 fissure eruption. KS-1 was completed on November 12, 1981 to a total depth of 7,290 feet after 65 days of drilling. KS-2 was drilled almost immediately after KS-1, without any appreciable intervening flow tests. With only 56 days of drilling operations, KS-2 was completed at a total depth of 8,005 feet on April 2, 1982.

Puna Geothermal Research Center Dedicated

On August 24, 1985, the Puna Geothermal Research Center was dedicated. The laboratory is adjacent to well HGP-A and the 3.0 megawatt power plant facility in the Kilauea East Rift Zone, Island of Hawaii.

The $325,000 project was funded through the Hawaiian State Department of Planning and Economic Development. It will be managed by the Hawaii Natural Energy Institute of the University of Hawaii.

Research in the following areas will be emphasized:

- Well and reservoir analyses of the Kapoho geothermal reservoir;
- Silica inhibition, extraction, and use;
- Hydrogen sulfide removal and use;
- Use of geothermal heat and fluids for dehydration, food processing, cold storage, and icemaking;
- Monitoring and determining effects of geothermal liquids and gases on plants and animals;
- Producing liquid fuel from biomass through use of geothermal heat;
- Hydrogen production using geothermal heat; and
- Geothermal brine injection.

In addition to a basic research program with international participation, a Community Geothermal Technology Program will allow individual grants of up to $10,000 to individuals and firms to develop applications of geothermal energy.

Maui and Hawaii: Two Projects at the Permitting Stages
by Susan F. Hodgson

"People in Hawaii are generally supportive of geothermal development. They just want to make sure it's done right," said Rod Moss, Vice President of Mid-Pacific Geothermal, Inc. Moss was referring to geothermal projects planned for the Islands of Maui and Hawaii. Both projects are at the permitting stages but face different situations.

On Maui, the proposed area for development is a lease of about 4,000 acres owned by Ulupalakua Ranch, Inc. on the southwest rift zone of Haleakala volcano. The project will be a joint venture of True Geothermal Energy Company and Mid-Pacific Geothermal, Inc. True will be project operator once all the project permits are acquired.

The companies are awaiting publication of geothermal regulations by the County of Maui. Then, they will apply for drilling permits.

The county regulations will be based on recently enacted State of Hawaii laws governing county geothermal permitting procedures. The laws (Act 296, SLA 1983 and Act 151, SLA 1984) require the State Board of Land and Natural Resources to designate land areas, called Geothermal Resource Subzones, in which geothermal development activities will be permitted.

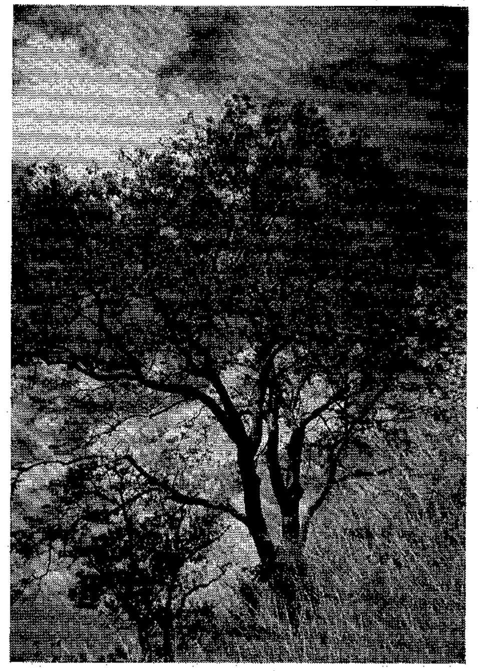
In the designated Geothermal Subzone on Maui is a 4,000 acre area of the southwest rift zone of Haleakala volcano. The True-Mid-Pacific project lease Moss described includes about 3,000 acres of this area. A year-long, baseline, air-quality survey of the area has been completed.

Moss said that perhaps up to 50 megawatts of electricity could be generated from the area. "There's been very limited geological work done in this subzone," he explained.

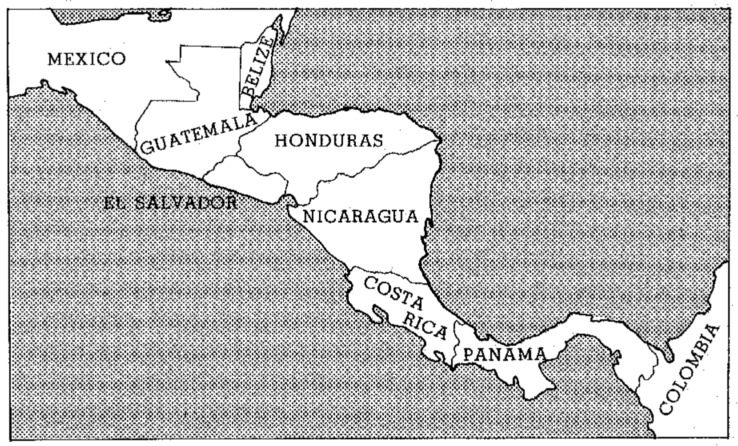
The electricity generated by the project will be purchased by Maui Electric Company, Ltd., in 12 to 15 megawatt increments.

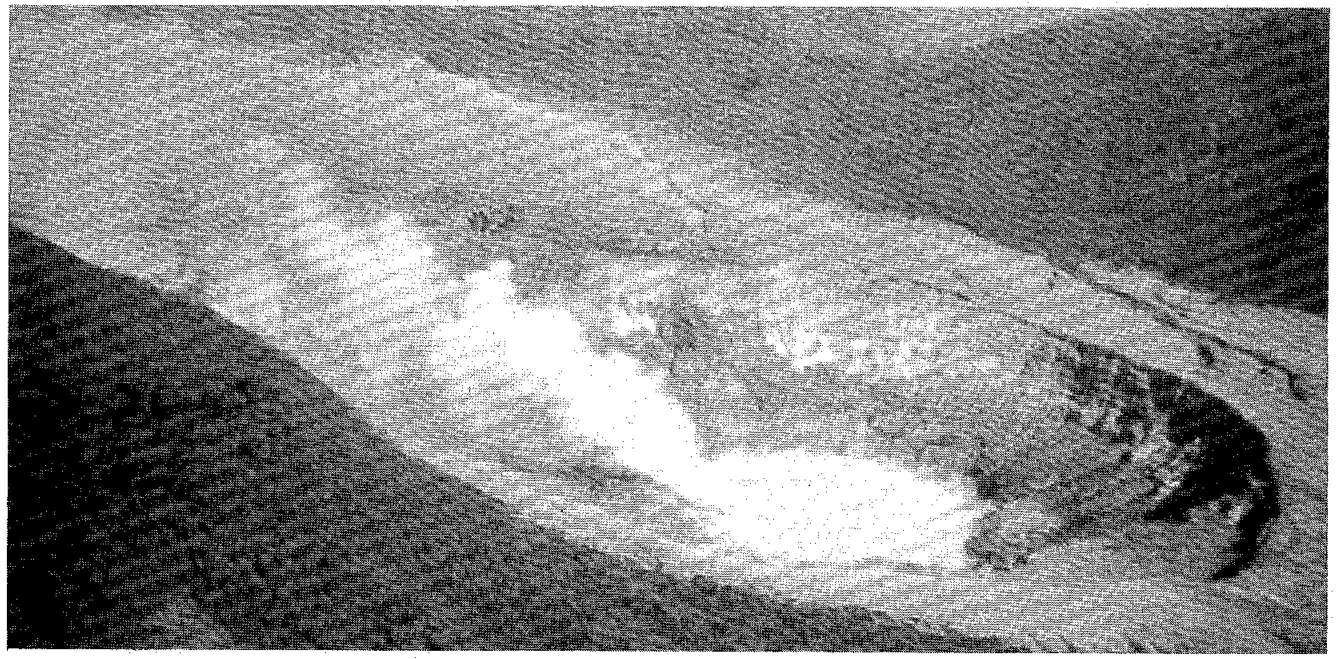
Mid-Pacific Geothermal, Inc. and True Geothermal Energy Company have signed a lease with the Estate of James Campbell for land on the flanks of Kilauea volcano on the Island of Hawaii, according to O. K. Stender, Chief Executive Officer of the Estate of James Campbell. The lease is on the Kahaualea parcel, on 25,000 acres of the estate on the east rift zone of Kilauea volcano. The site is about 15 miles up the rift zone from the Hawaii Geothermal Project, site of well HGP-A and the 3.0 megawatt power plant.

The geothermal lease, signed by a representative of the estate in 1981, is for land included in a State Conservation Zone. Thus, a state conservation district use permit is needed before the property can be developed. "Many hearings were held on the issue and environmental concerns expressed," said Stender. The situation has not been resolved.



CENTRAL AMERICA





View of Volcan Poas, Costa Rica. Photos by Ronald DiPippo.

Central American Energy Resources Project
by Susan F. Hodgson

"The geothermal resource potential of Central America appears to be outstanding," said Bob Hanold, a Program Manager for Los Alamos National Laboratory. "Through the Central American Energy Resources Project, begun in March 1985, we are working to help develop geothermal resources in Honduras, Costa Rica, El Salvador, and Guatemala. Geothermal development in these countries," Hanold continued, "should have a very positive impact on them, helping to relieve them from the purchase of imported oil. Geothermal development, of course, already is underway in most of these countries," he added. "We tailor our assistance to match the needs of each nation, individually."

"In every country," said Hanold, "we are assisted by counterpart scientists. Whenever appropriate, we offer these scientists training in recent geothermal technology as an additional facet of our project.

"Honduras has no geothermal projects underway. There, we will sponsor geologic, hydrogeochemical, and geophysical studies in areas of the country with surface geothermal features.

"We have sent high-temperature logging equipment and tools to Costa Rica. Right now, this September, the equipment is being used to log five wells at Miravalles Geothermal field in the northwestern area of the country (see Update: Miravalles Geothermal Field, this Hot Line issue). Reservoir pressure, temperature, and fluid flow are being measured; downhole brine samples are being collected; and inside diameters of wells calipered.

"Some reconnaissance studies of promising geothermal areas in the country will be made, similar to the studies in Honduras. However, present lower funding levels for this work in Costa Rica means fewer of these studies will be undertaken.

"The first geothermal power plant in Central America was put into service at Ahuachapan Geothermal field in El Salvador in June 1975. Today, three power plant units are operating in the field. However, production from the geothermal wells there has declined. This may be due both to mechanical problems in the wells and to the fact that no fluid is being injected in the field. Staff on the Central American Energy Resources Project will address these problems.

"Once the high-temperature logging equipment and tools are no longer needed in Costa Rica, they will be brought to Ahuachapan. Then, a battery of tests similar to those run in Costa Rica will be made.

"The results from these and additional tests will be used in an effort to help develop an injection program for the field. Project and El Salvadorean scientists will look for ways to regain field reservoir pressure.

"In Guatemala, the project has a different focus. Here, economic feasibility studies will be made for possible direct heat applications of low-temperature geothermal fluids in geothermal areas throughout the country. Emphasis will be placed on a geothermal area called Amatitlan, near Guatemala City.

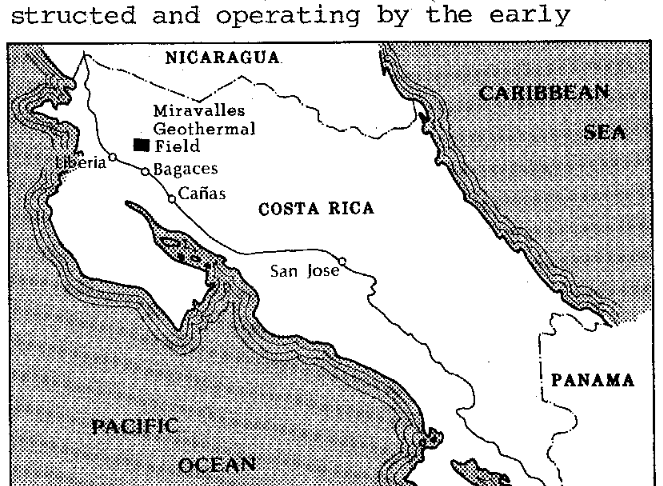
"Funds for the Central American Energy Resources Project," said Hanold, "are issued to Los Alamos National Laboratory by the United States Agency for International Development. Los Alamos is assisted in parts of the project by staff from the U.S. Geological Survey," he concluded.

For further information, contact Robert J. Hanold, Program Manager, Earth and Space Sciences Division, Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545. Phone (505) 667-1698.

Update: Miravalles Geothermal Field

by Susan F. Hodgson

"The power plant for Miravalles Geothermal field, a 55 megawatt single-flash unit, is scheduled to be constructed and operating by the early



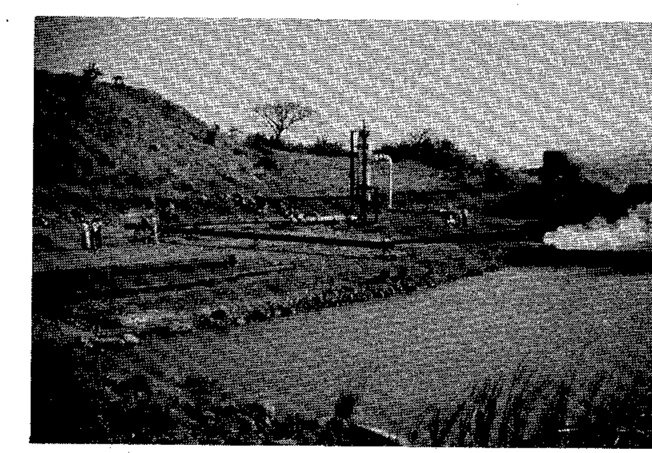
Road to Miravalles volcano. The geothermal field is to the left of the road at the foot of the volcano. Photos by Ronald DiPippo.

1990's," said Manuel Corrales, Chief of the Electric Planning Directorate of the Instituto Costarricense de Electricidad. "We are doing everything we can to ensure it will be an efficient plant," he added. "Geothermal energy is the best alternative Costa Rica has to oil-fired power plants."

Electricity generated at the power plant will be added to the Costa Rican electrical grid, to help meet the country's increasing demand for electricity. A second power plant is tentatively scheduled for 1994.

The Instituto Costarricense de Electricidad is looking for ways to finance its foreign currency expenses that occur from developing Miravalles field. Possible methods include a loan from the Interamerican Development Bank and/or a government-to-government loan.

In August 1985, well PGM 12 was completed at a total depth of 1580 meters.



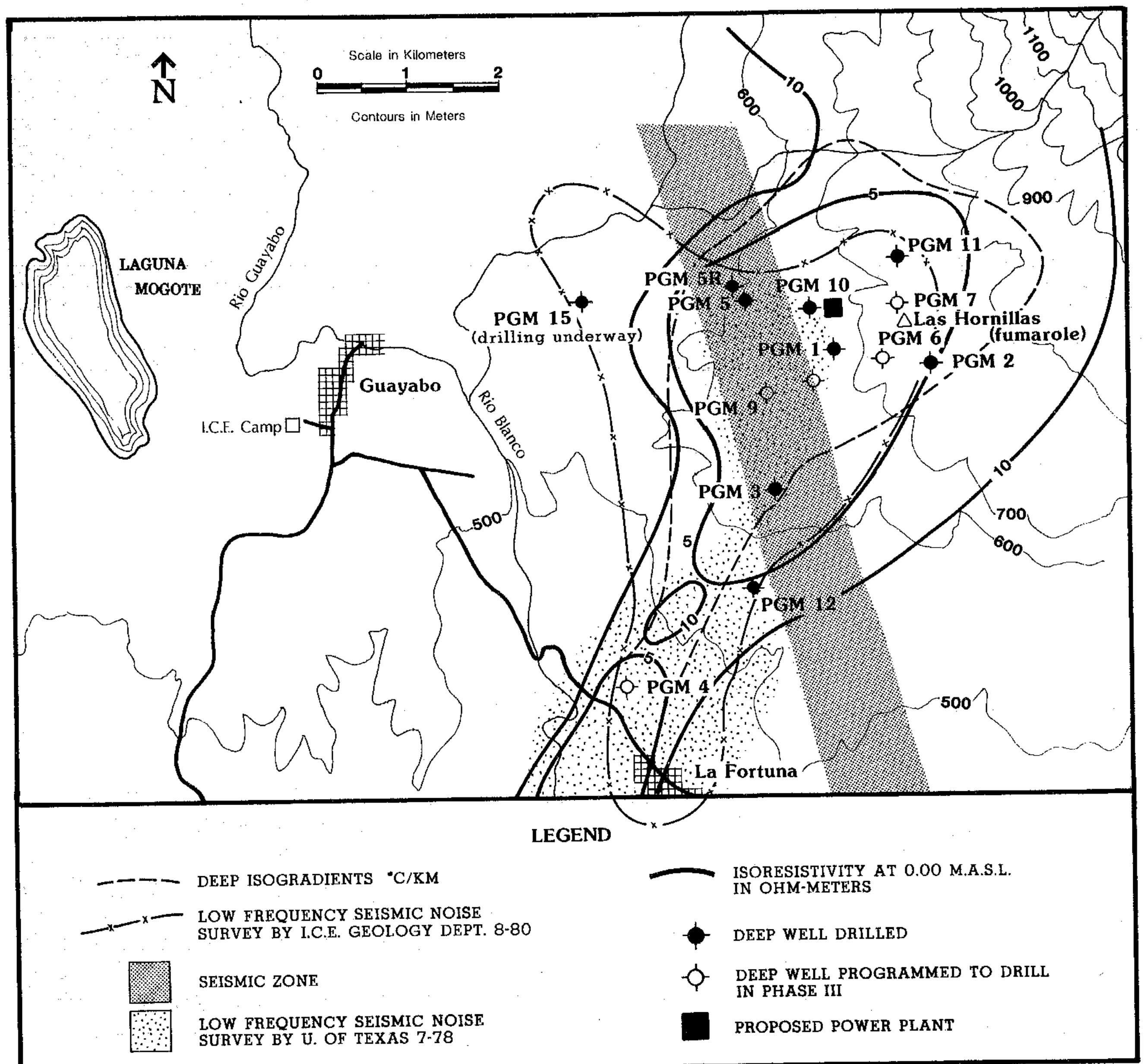
Testing well PGM 1, drilled in 1978, the first geothermal well drilled in Costa Rica.

It is a successful production well, bringing to 8 the number of production wells completed in the field. One hundred percent of the production wells drilled at Miravalles have been successful.

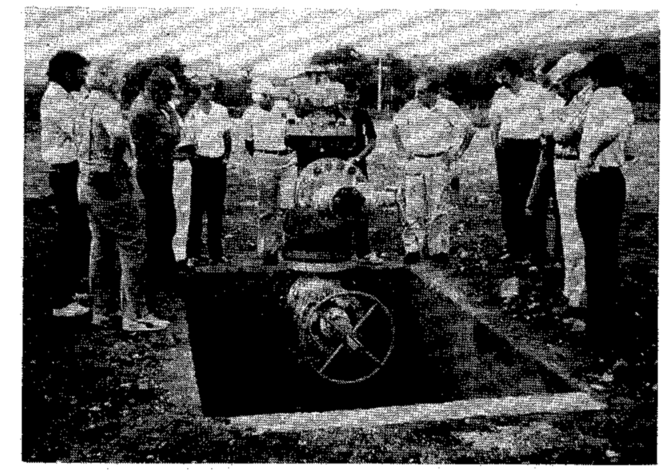
To operate the first power plant, 10 production wells are needed plus 2 standby production wells and 5 injection wells.

Now that well PGM 12 has been completed as a successful step-out well to the south, well PGM 15 is being drilled (in Sept. 1985) as a step-out well on the western edge of the field. If the well is not a successful production well, it will be used for injection. In any event, injection will occur at the field's western edge, to keep the injected waters as far as possible from the production area.

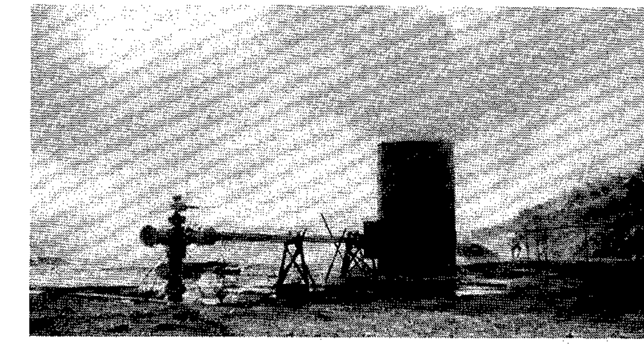
Concurrent with the drilling activity at PGM 15, many well and reservoir engineering tests are being made in the field. The tests are undertaken with geophysical and geochemical



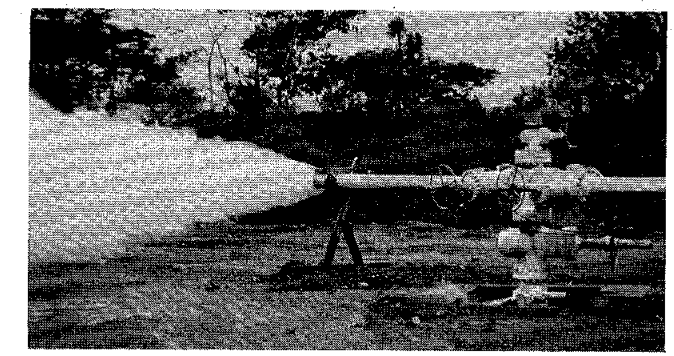
Miravalles Geothermal field anomalies, redrawn from a map by the Instituto Costarricense de Electricidad. The field temperature anomaly seems to run northeast-southwest.



Inspecting well PGM 5R, a shallow injection test well.



Well PGM 2.



Well PGM 5.

equipment brought to the field under the auspices of the Central American Energy Resources Project, managed by Los Alamos National Laboratory (see article, this Hot Line issue).

After the tests are run, preliminary power plant designs will be made.

Production data, Miravalles Geothermal Field, from figures by the Instituto Costarricense de Electricidad, published by the Geothermal Resources Council in the International Volume of the 1985 International Symposium on Geothermal Energy.

Production Data, Miravalles Geothermal Field+

Well No.	Date of Test	Production Diameter (in O.D.)	Well Head Pressure (kg/cm^2, abs.)	Lip Pressure (kg/cm^2, abs.)	Megawatts of Electricity**	Enthalpy (kJ/kg)	Total Flow (kg/s)
PGM-1	12/14/84	9 5/8	8.60	2.32	7.80	1057	76.4
PGM-2	10/16/80	4	6.40	1.89	1.30	990*	14.7
PGM-2-R	11/09/84	9 5/8	5.25	1.59	5.50	994*	53.8
PGM-3	7/04/81	9 5/8	8.44	2.44	7.90	1037	72.9
PGM-5	12/14/84	9 5/8	7.70	2.20	7.50	1039	71.0
PGM-10	12/16/84	7 5/8	6.20	1.80	3.90	1037	38.6

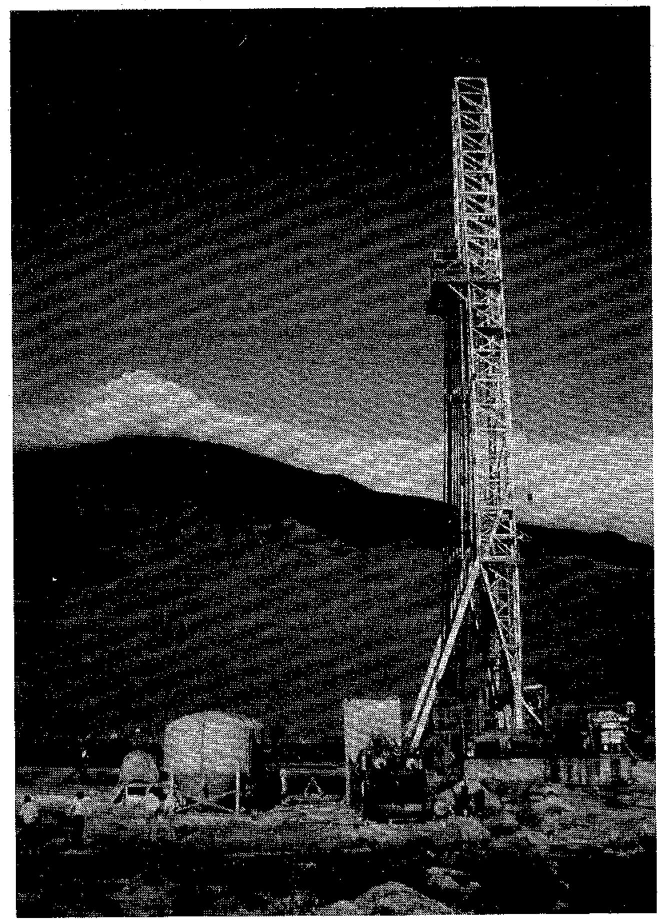
\+ The table has been reproduced from "Costa Rica: Country Update Report" by Manuel F. Corrales, printed in the International Volume of the 1985 International Symposium on Geothermal Energy.

* Estimated from the temperature measured in static conditions.

** Estimated from the Russell James' formula, assuming double flash and considering that all the steam separated at atmospheric pressure is used.

Then, locations will be picked for the remaining wells needed to support the power plant.

Engineers and geologists at the Instituto Costarricense de Electricidad have worked with consultants from several firms as development has progressed in the field. From 1974 to 1976, and 1978 to 1980, they worked with Rogers Engineering and GeothermEx, Inc. Presently, they work with Consultants from Electroconsult of Milan, Italy. Additional assistance is offered to the Instituto by a six-person technical advisory panel it established, called the Advisory Panel for the Miravalles Project. Panel members are F. Barberi, R. Christiansen, R. DiPippo, A. Duprat, R. Fournier, and R. Horne.



Drilling well PGM 11.

Low Temperature Development

<u>Developing Low-Temperature Geothermal Projects: Some Advice</u>

An interview with Gene Culver, Geo-Heat Center, Oregon Institute of Technology.

by Susan F. Hodgson

What factors should be considered in planning a low-temperature geothermal project? How should a project consultant be chosen? I asked Gene Culver of the Oregon Institute of Technology. His reply follows.

Low-temperature geothermal resources can be used in space-and domestic-hot water heating, agricultural, aquacultural, and industrial projects. Geothermal water quality, temperature, and quantity are unique for every project. Matching project needs to low-temperature resources is the primary step in project design.

How are geothermal projects and conventional projects similar? The principles of heat transfer, thermodynamics, and fluid dynamics are the same.

Geothermal projects differ from conventional projects in the ways the resource and project must be approached and how the project is constructed. Every site is different: different geologic conditions, well depth and size, water temperature, water pumping level, and water chemistry.

Water needs vary for all aquaculture, space-heating, and greenhouse projects, especially when the plants and animals come in contact with the water. Several multi-million dollar projects have failed due to failure to run complete water chemistry breakdowns at the parts per million and billion levels on geothermal water. Recently, one such project failed before it went on line.

The water analysis problem arises when water samples are taken to a laboratory geared to water potability analysis. After potability is determined, no further tests are made.

Water may be correctly judged potable and still be unfit for direct contact with heating equipment and some pipeline materials. Then, heat exchangers and other special arrangements are necessary.

To avoid this problem, a special chemical analysis of geothermal water must be requested from a laboratory. The pH should be measured at the site immediately after the fluid is produced. Constituents of special interest are chloride, sulfate, total alkalinity (mostly bicarbonate and carbonate), and total sulfide. The dissolved gases, ammonia, oxygen, and hydrogen sulfide require special sampling. Analysis should be accurate at the parts per billion level.

Boron, fluoride, and the heavy metal concentrations must be determined for surface disposal or because of plant and animal compatibility considerations.

Not only may these water constituents control whether or not a project is feasible, but they determine what type of system, including the disposal unit, must be constructed.

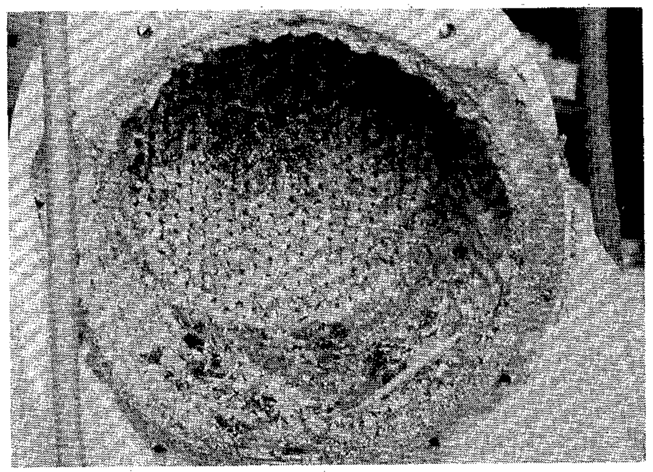
Geothermal energy isn't free. Low-temperature projects can require high up-front costs for wells, pumps, and special equipment. Pumping costs are usually relatively low, but can be significant in overall, life-of-the-project costs. For these reasons, it is important to use water efficiently. This requires considerations not important in conventional systems.

When hiring a consultant for a geothermal project, ask for references. Check past projects for satisfactory operation over a <u>long period</u>. Problems usually occur within 2 to 12 years.

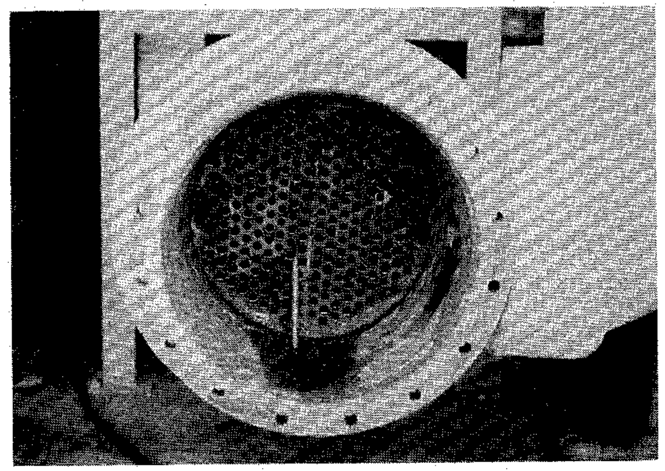
When a consultant's past projects have not been on line very long, ask how the most efficient use of resources and equipment was achieved. What was done about scaling and corrosion?

Low-and moderate-temperature geothermal resources have been used in this country well over 100 years. Is the consultant familiar with projects built in the past, the mistakes as well as the successes? A good consultant will have a thorough knowledge of such matters.

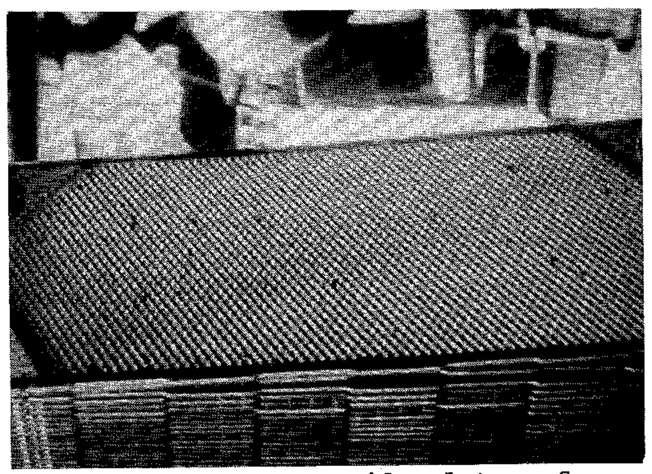
The Geo-Heat Center at the Oregon Institute of Technology offers advice on the construction of low-temperature geothermal projects. Such advice may be free-of-charge for applicants who apply through various state or federal programs. For further information, contact Gene Culver, Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, Oregon 97601, (503) 882-6321.



Shell and tube heat exchanger, in service for one year, showing scaling. Total dissolved solids, 1,200 ppm.

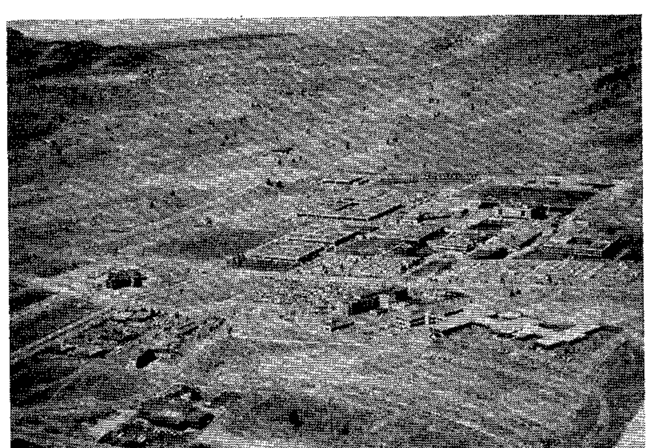


The same exchanger after cleaning.

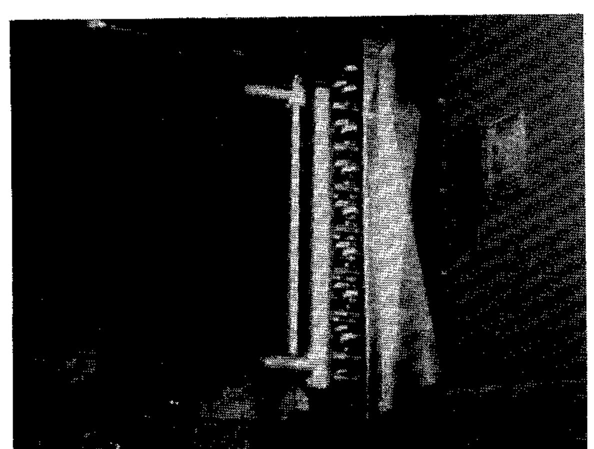


The geothermal-water side plates of a plate heat exchanger after two year's service. The exchanger was installed to replace the shell and tube exchanger shown in the first two photos.

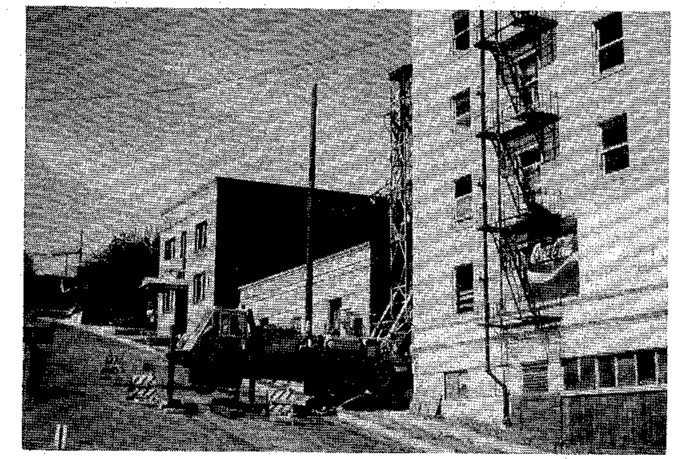
FRP (fiberglass reinforced plastic) insulated geothermal water distribution pipes, before installation in the Oregon Institute of Technology (OIT) system.



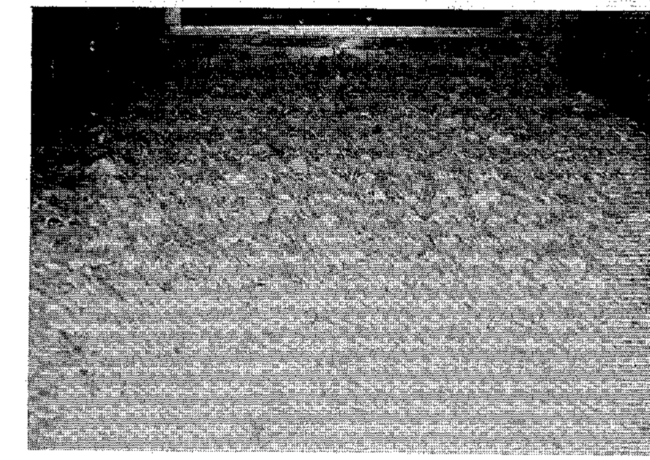
OIT and Merle West Hospital and nursing home.



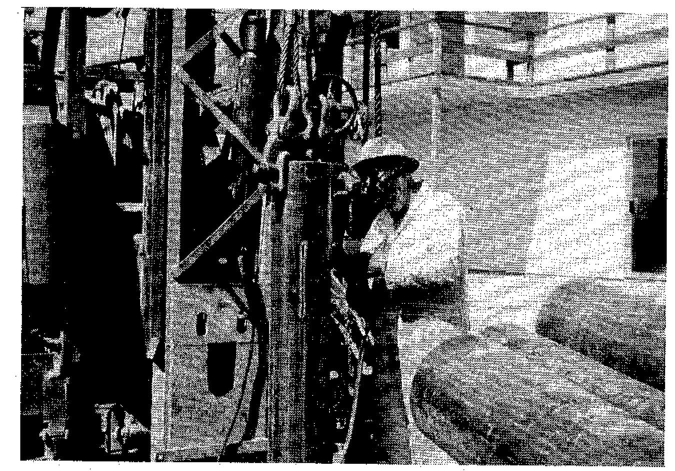
Retrofit hot water coil installed in forced-air duct in a residence, Klamath Falls, Oregon.



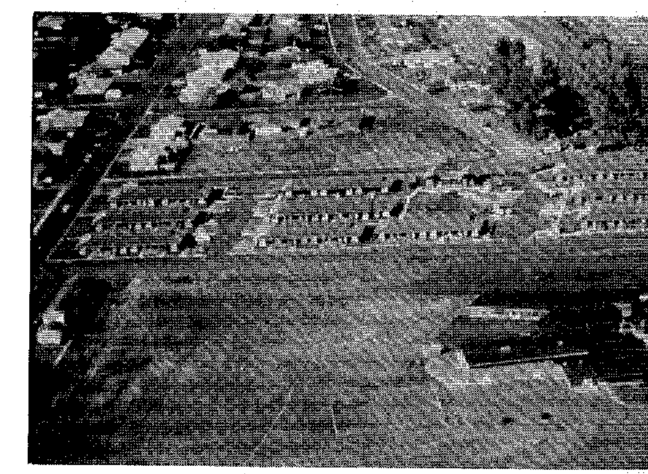
Drilling a shallow, geothermal well in an urban setting. Klamath Falls, Oregon.



Onions in a geothermal dehydration process at Brady Hot Springs, Nevada.

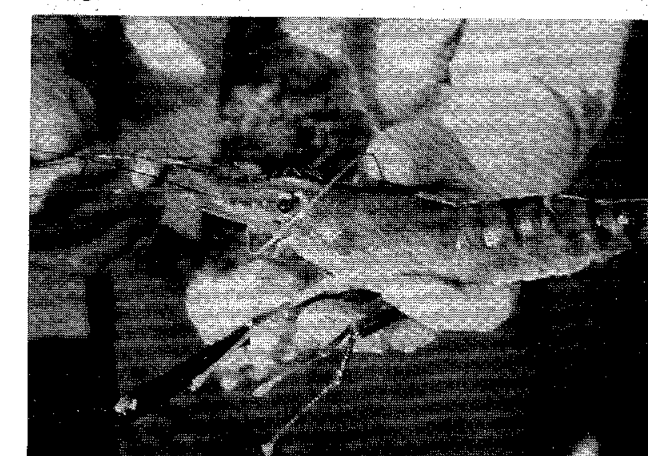


Slotting the casing for a downhole heat exchanger well at a private residence, Klamath Falls, Oregon.

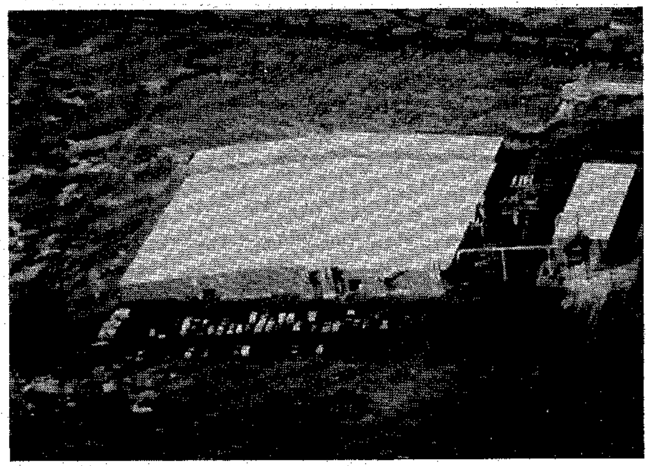


Kingswood Apartments and Lucille O'Neil School are both heated with geothermal energy. Kingswood uses 114°F water for space heating. Klamath Falls, Oregon.

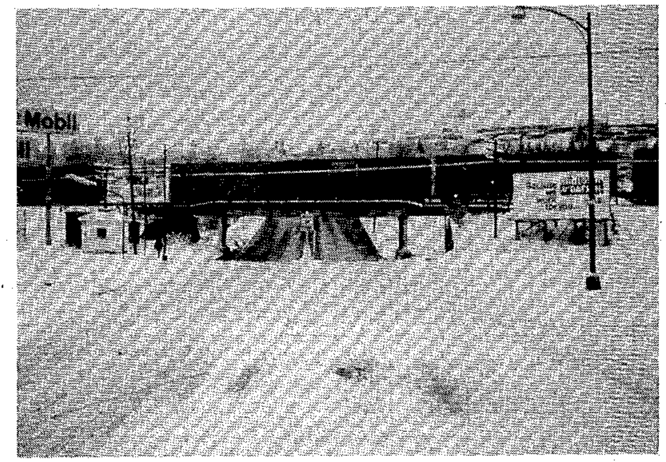
Trout being harvested from geothermal ponds. The ponds are fed with water that has passed through the OIT campus heating system.



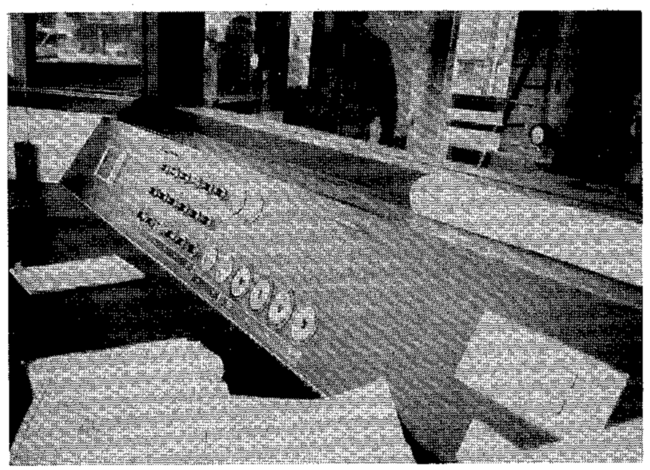
A male Macrobrachium Rosenbergii (fresh water prawn) grown in geothermal ponds at OIT.



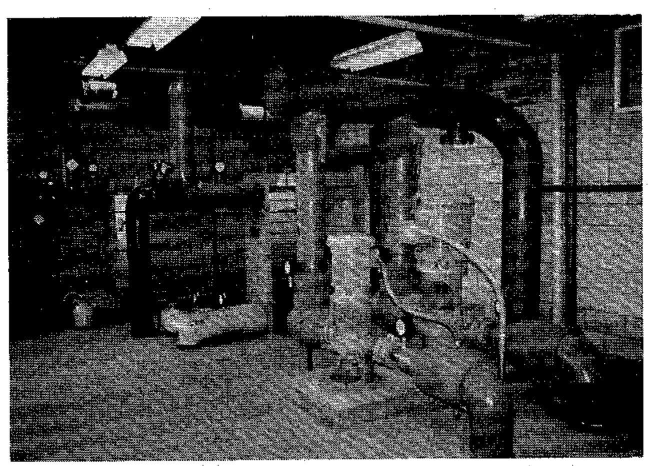
Maywood Industries wooden door and sash plant is heated with 115°F geothermal water. The plant uses almost 100 percent make-up air, due to sawdust collection. Winter temperatures of -5°F are not uncommon.



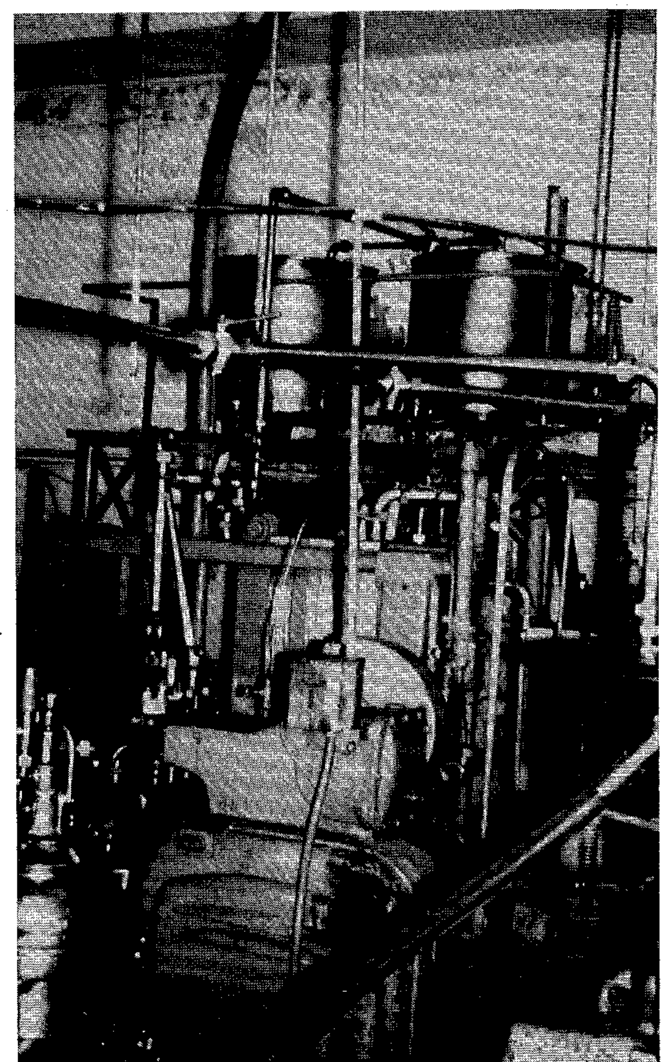
Snow melting in an underpass in Klamath Falls, Oregon, using a geothermal well.



The control console for the district heating system in downtown Klamath Falls, Oregon.



The plate heat exchangers and pumps for the district heating system in downtown Klamath Falls, Oregon.



A milk pasteurizer that uses geothermal heat, Klamath Falls, Oregon.

Technology

Bargain Days: Geothermal Equipment Available

The Tennessee Valley Authority (TVA) is selling \$1.4 billion of new equipment purchased for the construction of eight nuclear reactors. Because the nuclear projects were cancelled, the equipment is now for sale at discounts up to 80 percent. All the equipment was constructed and is being maintained to standards used for nuclear plants.

Ron Ogle, manager of the equipment sales, says he's sure that items such as heat exchangers, pumps and valves, and electrical equipment are suitable for use in geothermal projects. In addition, Ogle says that he has five, 7 megawatt steam turbines.

Ogle says geothermal developers should give him a call. One of his engineers will work with a developer's project engineer, finding ways to design the TVA equipment into a geothermal project. He says that besides the low price, an advantage of TVA equipment to a developer would be that no lead time is necessary for an order--all the equipment is in stock.

Ron Ogle may be contacted at TVA Investment Recovery Project, 400 W. Summit Hill Drive, Knoxville, TN 37902; phone (615) 632-7750 / Telex: En Des KXV 557-437 / Telecopy: 615-632-6290.

ITEMS AVAILABLE FROM THE TVA

- Accumulators (See pressure vessels)
- Air Cleanup Units
- Air Compressors
- Air Conditioning Units
- Air Ejectors
- Air Handling Units
- Air Separators
- Analog Computing Elements
  - Alarm Units
  - I/E, E/I Converters
  - Summing Root Converters
  - Square Root Converters
- Annunciators
- Arresters - Surge and Lighting
- Audiovisual Equipment
- Auxiliary Cabinet
- Batteries
- Battery Boards
- Battery Chargers
- Boilers - Auxiliary
- Bus Systems
  - Isolated Phase (24-kV)
  - Non-segregated Phase (6.9-kV)
- Cable, Connecting
- Cable, Insulating and Control
- Card Readers (Access Control)
- Cask Decontamination Package
- Chillers
- Circuit Breakers
  - Generator (24-kV)
  - Oil (161-kV)
  - Low Voltage (480-V and molded case) (See Switchgear Section)
  - Medium Voltage (6.9-kV) (See Switchgear Section)
  - Power (500-kV)
- Coding, Alarm, & Paging Equipment
- Coils - HVAC
- Compactors - Drywaste
- Computers and Peripheral Equipment
- Concrete Forms (Symons)
- Converters
  - AC-DC
  - DC-DC
  - I/P, P/I
- Cranes & Bridge
- Dampers
- Demineralizers
- Diesel Generators
  - 7-kW
- Disk, Hard and Floppy
- Display Generator
- Distribution Cabinets
  - 480-V AC
  - 120-V AC
  - 120-V AC/125-V DC/250-V DC
  - 125-V DC
  - 125-V DC/250-V DC
  - 28-V DC
  - Power Cab
  - Main Control/Relay Boards
  - Lighting Panel/Boards
- Electrical Metering Devices (Ammeter, Voltmeter, etc.)
- Elevators
- Evaporators
- Expansion Joints
- Fans
- Filters (NSSS)
- Heat Detector
- Heat Exchangers
- Heaters (Unit, Duct)
- Hoists
- Humidifiers
- Hydrogen Recombiner
- Intercom Equipment
- Inverters, Static
- Keyboard
- Load Centers
- Magnetic Tape
- Memory, Drum and Large Core
- Microwave Equipment
- Modem
- Motor Control Centers
- Motor Generator Sets
- Motors
- Motor Starters
- Multiplexer
- Neutral Grounding Resistors
- NSSS (Specialized Equipment)
- Panels, Instrument & Control
- Penetrations, Electrical
- Power Supplies
- Pressure Vessels
- Printed Circuit Board
- Printer, Line and Typer

- Processor
- Pumps
- Refrigeration Equipment (NSSS)
- Relays
  - Auxiliary
  - Protective
  - Pneumatic
- Scaffolding
- Screens - Traveling Water
- Seismic Monitoring
- Snubbers
- Strainers
- Switches,
  - Differential Pressure
  - Disconnect (500-kV, 161-kV)
  - Transfer
- Switchgear and Substations
- Switchyard Equipment
  - Insulators, Suspension
  - Insulators, Sta. Post
  - Corona Ring Assembly
  - Adapters
- Systems
  - A. Alum Sludge Dewatering System
  - B. Chiller Tube Cleaning System
  - C. 2-Ton Crane Electrification System
  - D. Nuclear Steam Supply System
  - E. Seismic Instrumentation System
  - F. Sodium Hypochlorite Generating System
  - G. Steam Turbogenerator System
- Tanks
- Test Panels, Electric/Pneumatic
- Telephone Equipment
- Transfer Switches and Cabinets
- Transformers
  - Instrument (PT, CT, etc.)
  - Lighting & Auxiliary (Dry Type)
  - Main & Station Service
  - Regulating & Isolating
  - Substation (Low & Medium Voltage)
- Trench - Precast Reinforced Concrete
- Turbines - Feed Pump
- Turbogenerators
- TV Systems
- Underwater Vacuum Cleaners
- UPS (Uninterruptible Power Supply)
- Vibration/Loose Parts Monitoring
- Video Copier
- Welding Rods

Lost Circulation Studied at Sandia

Recycled plastic scrap may be an ideal material to prevent the loss of drilling fluids during geothermal drilling operations. Two other possibilities are ground automobile battery cases obtained from salvage yards and volcanic glass. All are abundant, inexpensive, and capable of surviving the severe environments encountered in geothermal drilling operations.

Scientists at Sandia National Laboratories are experimenting with these materials. The results of these experiments, combined with information gathered by a special high-temperature geothermal well-logging tool (also developed at Sandia), are expected to make it possible to choose these lost circulation materials with confidence before geothermal drilling operations begin.

"Being able to do this would be an economic plus," said Dr. James Kelsey, supervisor of Sandia's Geothermal Technology Development Division. "Presently, choosing an effective lost circulation material can be hit-and-miss because there have been no major advancements in lost circulation material science for many years."

Sandia's Lost Circulation Test Facility was built at the suggestion of an industry technology review panel to support Sandia's geothermal research and development programs. At the facility, the performance of lost circulation materials is evaluated under a controlled environment that simulates downhole geothermal conditions.

The facility includes two test vessels that operate at temperatures up to 400°F and 1,000 psi. One vessel, 10 feet tall and 8 inches in diameter, simulates a length of well bore and provides a realistic annular flow of mud at rates up to 200 feet per minute. The other, 3 feet tall and 20 inches in diameter, can hold actual rock or soil that is formed into a simulated lost circulation zone.

During testing, mud and lost circulation material flow past slots that simulate different fracture widths or into actual rock or soil. The amount of material and particle size (sand to ¼ inch diameter) mixed with the mud vary with each test. A computer controls pressures, temperatures, flow rates, and records data.

To date, six commercially available lost circulation materials have been tested in the facility. At this time, only one appears to be suitable for geothermal applications -- ground battery casings.

"Next year we will begin testing other materials, for instance, high-temperature plastics that have been salvaged after their original use," said Glen Loeppke of Sandia's Geothermal Technology Development Division. "There are several criteria that a material must satisfy. Besides being able to survive high temperatures, it must be plentiful and inexpensive."

The test results will provide a data base that can be used with borehole logs to develop computer codes for predicting the best material for a given case.

These logs are made with a tool developed at Sandia. Called an acoustic borehole televiewer, it is based on a Mobil Research & Development Corporation design used originally to log oil and gas wells. Sandia adapted the tool to materials and electronics that survive harsh geothermal environments.

As the televiewer is pulled up the borehole, it emits bursts of acoustic energy from a rotating transducer. The energy travels through an acoustic window, hits the borehole wall, and is reflected back to the transducer.

The time required for pulses to return to the transducer and the amplitude of these reflections are recorded and processed with surface equipment to yield a black-and-white picture of the wall. Light areas represent smooth surfaces; dark zones represent rough surfaces or fractures.

Rigid Foam Appears To Be Good Lost Circulation Material

A rigid polyurethane foam, developed at Sandia National Laboratories as a temperature-tolerant packaging for electronics, may prove to be a very good material for preventing the leakage of drilling muds into surrounding rock formations.

The foam remains rigid even when heated to about 450°F. It was developed about 20 years ago for nuclear weapons use.

In the late 1970's, Sandia researchers who were working on techniques to improve the efficiency of geothermal drilling and well completions began to look at the foam in another light. Their idea was to have it plug fractures and voids in geothermal formations. "The most efficient way of accomplishing this appeared to be with a tool that could be lowered down the borehole," said Glen Loeppke of Sandia's Geothermal Technology Development Division. "Separate compartments in the tool could contain chemicals that, when mixed, generate foam that expands through openings in the tool's tip and into the cracks and voids."

Sandia completed a successful demonstration of a prototype tool last year. A new, slightly larger version will begin a long-term field test later this year. The test will be conducted by Poly Plug, Inc., Bedias, Tex.; NL Barnoid/NL Industries, Houston; and Union Geothermal, Los Angeles.

The aluminum alloy foam emplacement tool is 30 feet long and 8 inches in diameter. It attaches to the end of a drill string with standard threaded couplings. Once lowered into a lost circulation zone, chemicals from the tool's separate storage chambers are forced by mud pump pressure into a mixing chamber where they react to form foam that expands at a 7 to 1 ratio as it squirts out of holes at the bottom of the tool. Work is underway on development of a foam that will be able to form in deep boreholes where temperatures are between 600°F and 650°F.

Federal Programs

New DOE Core Repository

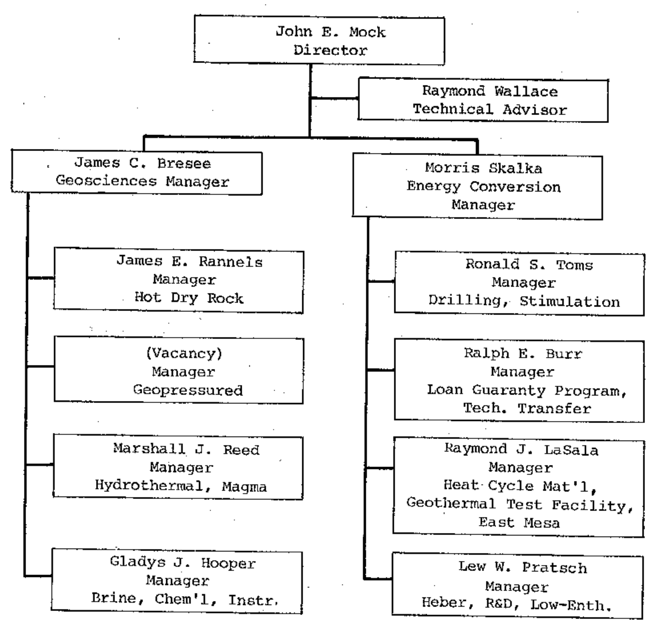
Grand Junction, Colorado, will be the site of a repository for cores, samples, and other materials obtained from the continental scientific drilling program. The repository will be established by the U.S. Department of Energy, and operated by the DOE, U.S. Geological Survey, and the National Science Foundation.

Samples and routine logging data gathered at drill sites will be protected and kept available for study.

Investigators who wish to obtain samples for study should apply to these persons: For Inyo Domes - J.C. Eichelberger, Geochemistry Division, Org. 1543, Sandia National Laboratories, Albuquerque, N.M. 87185, phone (505) 846-0398; for Valles Caldera - S.J. Goff, MS D462, Earth and Space Sciences Division, Los Alamos National Laboratory, Box 1663, Los Alamos, N.M. 87545, phone (505) 667-7200; for Salton Sea Scientific Drilling Project - W. Elders, Institute of Geophysics and Planetary Physics, University of California, Riverside 92521, phone (714) 787-3439.

Geothermal Technology Division Reorganized

The Geothermal Technology Division of the U.S. Department of Energy has been reorganized. The new address for the division is Geothermal Technology Division, U.S. Dept. of Energy, CE-342, Washington, D.C. 20585.



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(505) 844-2155

USGS Geothermal Research Program

In FY 1985, the United States Geological Survey continued a wide variety of studies conducted in the Cascade Range of Northern California, Oregon, and Washington. The goal of the effort is to understand the active volcanic, tectonic, and hydrothermal processes of the Cascades as a framework for characterizing and quantifying the region's geothermal resources.

The current trends for the Geothermal Research Program are increasing emphasis on understanding the interaction of magmatic heat sources and geothermal systems and assessing thermal energy in all types of geothermal energy sources associated with young igneous centers--magma, hot dry rock, and related hydrothermal systems. For example, the Questa caldera in northern New Mexico is being investigated to characterize magmatic/hydrothermal processes in the roots of an older, well-exposed igneous system. Advanced seismic techniques are being refined to identify and characterize subsurface magma bodies. Geophysical studies on the Big Island of Hawaii are delineating subsurface magmatic conduits of two active volcanoes, Kilauea and Mauna Loa; and geologic mapping is being compiled into a new geologic map of the entire island. Geologic mapping of young silicic volcanic centers is underway in Alaska.

An important component of the FY 1985 program continues to be research to understand the dynamics and evolution of hydrothermal systems. Isotopic and chemical studies are carried out, particularly at the Cerro Prieto field in Mexico, Larderello in Italy, The Geysers in California, and Yellowstone National Park to refine geothermometers, describe hydrothermal processes, and determine the origin of chemical constituents in geothermal fluids. Geoelectrical techniques are being developed and applied to determine the location and geometry of hydrothermal convection systems. Mineralogical studies are underway to characterize chemical interactions of geothermal fluids and the rocks through which they circulate, as exemplified by a study of hydrothermal alteration in core from a hole drilled in 1981 by the Geothermal Research Program at Newberry Volcano, Oregon.

The Geothermal Research Program also supports projects that evaluate selected geo-environmental concerns. Earthquake monitoring and analysis continue at The Geysers Geothermal field. Also, how thermal features in National Parks might be affected by nearby geothermal development is studied by numerical, seismic, and geochemical modeling techniques.

BLM

Bureau of Land Management Mineral Resources Policy

The following principles will guide the Bureau of Land Management (BLM) in managing mineral resources on public lands. They are part of the BLM Mineral Resources Policy signed by BLM Director Robert Burford on May 29, 1984.

1. Except for Congressional withdrawals, public lands shall remain open and available for mineral exploration and development unless withdrawal or other administrative action is clearly justified in the national interest.

2. BLM actively encourages and facilitates the development by private industry of public land mineral resources in a manner that satisfies national and local needs and provides for economically and environmentally sound exploration, extraction, and reclamation practices.

3. BLM will process mineral patent applications, permits, operating plans, mineral exchanges, leases, and other use authorizations for public lands in a timely and efficient manner.

4. BLM's land use plans and multiple-use management decisions will recognize that mineral exploration and development can occur concurrently or sequentially with other resource uses. The Bureau further recognizes that land use planning is a dynamic process and decisions will be updated as new data are evaluated.

5. Land use plans will reflect geological, energy and mineral values on public lands through more effective geology and energy and mineral resource data assessment.

6. BLM will monitor salable and leasable mineral operations to ensure proper resource recovery and evaluation, production verification, diligence and inspection and enforcement of the lease, sale or permit terms. BLM will ensure receipt of fair market value for mineral commodities unless otherwise provided for by statute.

7. The Bureau will maintain effective professional, technical, and managerial personnel knowledgeable in mineral exploration and development.

Proposal to Streamline BLM Bonding Requirements

To reduce public confusion and cut financial losses by the federal government, the 12 types of bonds currently required for oil, gas and geothermal activities on federal lands would be consolidated into only four and increased in dollar amount, under a proposal announced in May 1985 by the Department of the Interior's Bureau of Land Management (BLM).

BLM Director Robert F. Burford said the bonding requirements have been adjusted only once since 1929, and do not reflect current reclamation costs or royalty liabilities.

"The increases in bond coverage called for in this proposal would make the bonds commensurate with current restoration costs," Burford said.

Bonds protect the government from loss in the event of uncompleted reclamation work or nonpayment of required royalties. Under the proposal, bonds would be expanded to cover damages, both from leasing and exploration activities and from nonpayment of royalties. Also, the dollar amounts for nationwide, statewide and individual bonds would be increased.

Burford said the BLM is encountering an average of 10 cases each year where operators have left without properly plugging and abandoning wells, or properly reclaiming disturbed surface at the drilling site. Costs for carrying out this work can range from $25,000 to $100,000 per site, or a total of $250,000 to $1 million per year, of which the current bonds cover only a small portion.

Under the proposal announced today, current lessees holding nationwide, statewide and individual bonds covering geophysical exploration, geothermal resources and oil and gas leasing would be required to submit replacement bonds within one year after the new rules take effect.

A notice published in the May 1, 1985, Federal Register, invites public comment on the proposal by July 1, 1985. Comments should be sent to Director (140), Bureau of Land Management, Room 5555, 1800 C Street, NW, Washington, DC 20240.

Legislation

State Legislative Update

The following bills comprise the geothermal legislation considered by the California State Legislature for the 1985/86 session. The status of the bills is that of October 2, 1985.

Chaptered Legislation

AB 899, Hauser
Leases: reduced royalty

The bill authorizes the State Lands Commission to issue leases for direct heat application of geothermal resources for nonelectrical purposes for a royalty of less than 10 percent of gross revenue if it determines that such a royalty would be in the best interest of the state. (Chapter No. 434)

AB 1666, Hauser
Geothermal power plant development

The bill requires the State Energy Resources Conservation and Development Commission to include, in its written decision approving a geothermal site and related facility, findings on whether there are sufficient commercial quantities of geothermal resources to operate the proposed facility for its planned life. (Chapter No. 807)

AB 1960, Waters, N.
Geothermal revenues

The bill would authorize the revenues disbursed to counties of origin to also be expended for repair and maintenance of capital assets, as specified. (Chapter No. 800)

SB 593, Royce
Penalty established

The bill provides the Division of Oil and Gas the authority to establish by regulation the amount of penalty a geothermal well operator must pay for failure to pay annual well fees on specified geothermal wells. (Chapter No. 393)

SJR 13, Presley
Federal mineral leasing: revenue sharing

The measure urges the President and the Congress, the Secretary of the Interior, the Director of the United States Minerals Management Service, and the Director of the Office of Management and Budget to revise the Federal Government's mineral leasing royalty management system to ensure that states receive their full entitlement of revenue sharing funds and to refrain from implementing budgetary initiatives that would reduce those funds. (Chaptered by Sec. of State Resolution Ch. 81)

Federal Legislation

The status and content of federal legislation on geothermal energy from the 99th Congress follow. The information was current as of September 13, 1985.

H.R. 418

Sponsor: Quillen

Referred to:
House Energy and Commerce
House Interior and Insular Affairs

Short Title as Introduced:
Geothermal Energy Control Act of 1985

Latest Official Title:
Official Title as Introduced as of 02/07/85:
A bill to create a commission to grant exclusive franchises for the exploration for and the commercial development of geothermal energy and for the right to market any such energy in its natural state, and for other purposes.

Legislative Actions:
01/03/85 - Referred to House Committee on Energy and Commerce.
02/26/85 - Referred to Subcommittee on Energy Conservation and Power.
01/03/85 - Referred to House Committee on Interior and Insular Affairs.
02/12/85 - Referred to Subcommittee on Mining and Natural Resources.
03/12/85 - Executive Comment Requested from DOE.
04/25/85 - Executive Comment Requested from Interior.

Abstract:
Establishes the National Geothermal Energy Commission to grant exclusive licenses for the exploration for and commercial development of geothermal steam and resources and for the marketing of such energy in its natural state.

Digest:
Geothermal Energy Control Act of 1985 - Establishes the National Geothermal Energy Commission.

Requires the Commission to determine those areas in the United States that have a potential for the extraction of geothermal resources and to publish a list of such areas in the Federal Register.

Directs the Commission to grant exclusive 99-year licenses to persons capable of carrying out exploration and development of geothermal resources in such areas. Sets forth conditions for the granting of such licenses and for extensions of license terms. Authorizes the termination of a license for any violation of the terms of the license prescribed by the Commission.

Permits a licensee under this Act to apply for a license to market the geothermal resources from the licensee's area in their natural state. Requires the Commission to grant a marketing license for a geographic area that is the most reasonable area to market successfully the geothermal resources. Provides that there shall be only one marketing license per geographic area. Provides that a marketing license shall be valid for as long as the licensee holds the exploration and development license.

Permits the transfer of exploration and development licenses and marketing licenses with the Commission's approval.

Requires that a licensee under this Act be a U.S. citizen or a person owned or controlled by a U.S. citizen.

Restricts the sale of geothermal resources which have been converted to electrical or other energy forms to existing utility companies or other persons licensed to transmit such energy. Permits the sale of geothermal resources to such a company or person for conversion into other energy forms.

H.R. 843

Sponsor: Seiberling

Referred to:
House Ways and Means

Latest Official Title:
Official Title as Introduced as of 01/31/85:
A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes.

Legislative Actions:
01/30/85 - Referred to House Committee on Ways and Means.

Abstract:
Amends the Internal Revenue Code to revise the definition of geothermal energy for purposes of the residential energy income tax credit and the investment tax credit for energy property.

Digest:
Amends the Internal Revenue Code to define "Geothermal Energy" as the natural heat of the earth at any temperature. (Present regulations require that such heat exceed a specified temperature.)

Provides that an energy system that uses geothermal energy and a source of energy that does not qualify for investment and residential energy credits, shall qualify for the tax credits for energy property, if the geothermal energy provides more than 80 percent of the energy for the system.

Provides that an energy system that uses both geothermal energy and another energy source (such as biomass solar, wind, ocean thermal, or hydroelectric) qualifies for the investment tax credit for energy property, if the combination of such energy sources provides more than 80 percent of the energy for such system.

Provides that in the case of a taxpayer who claimed a geothermal credit on a return for any taxable year beginning before January 1, 1985, in reliance on the advice of an employee of the Internal Revenue Service that such credit would be allowable. The amendments made by this Act shall apply for purposes of determining whether such credit is allowable.

H.R. 1315

Sponsor: Latta

Referred to:
House Ways and Means

Latest Official Title:
Official Title as Introduced as of 02/28/85:
A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes.

Legislative Actions:
02/27/85 - Referred to House Committee on Ways and Means.

Abstract:

Amends the Internal Revenue Code to revise the definition of geothermal energy for purposes of the residential energy income tax credit and the investment tax credit for energy property.

Digest:

Amends the Internal Revenue Code to define "geothermal energy" as the natural heat of the earth at any temperature. (Present regulations require that such heat exceed a specified temperature.)

Provides that an energy system that uses geothermal energy and a source of energy that does not qualify for investment and residential energy tax credits shall qualify for the tax credits for energy property if geothermal energy provides more than 80 percent of the energy for such system.

Provides that energy systems that use both geothermal energy and another energy source (such as biomass, solar, wind, ocean thermal, or hydroelectric) qualify for the investment tax credit for energy property if the combination of such energy sources provides more than 80 percent of the energy for such system.

Finance

Geothermal Grant and Loan Program for Local Jurisdictions: Program Opportunity Notice

The California Energy Commission (CEC) is beginning the sixth funding cycle for the Geothermal Grant and Loan Program for Local Jurisdictions. Through this program, the CEC distributes funds received by the state from federal geothermal leases to local jurisdictions for projects relating to geothermal development.

The CEC has approximately $2.5 million available for this funding cycle.

The CEC will accept applications for any of the following types of projects:

1. planning projects for large- and small-scale power plants and direct-use development,

2. projects to assess and develop geothermal resources, and

3. projects to monitor or mitigate impacts of existing geothermal development.

With respect to such projects, the CEC encourages joint proposals by public and private entities and proposals for projects that will provide a direct economic stimulus to a community.

Beginning this funding cycle, the CEC will be requiring repayment of all funds awarded for resources development projects that produce revenue or energy savings. These loans will carry an interest rate of up to 8 percent, a maximum term of 6 years, and will not exceed 80 percent of the project cost. A feasibility study for these projects must be submitted with the final application.

The schedule for the sixth funding cycle is as follows:

Preapplication Deadline - 11/4/85
Results of Preapplication Evaluation - 12/13/85
Final Application Deadline - 1/31/86
Energy Commission Approval - 3/86
Legislative Approval - 7/86

If you are interested in applying for a grant or loan, send your name, address, and telephone number to the CEC. Important revisions have been made to both the application and the management manuals for this funding cycle. Please obtain new copies if you have not already done so. Also, all applicants will be required to submit a preapplication. Questions regarding this program should be directed to:

Michael Smith
California Energy Commission
1516 Ninth Street, MS 43
Sacramento, CA 95814
(916) 324-3502

Projects Receiving CEC Grants

The following California Energy Commission grant proposals have been approved by the Legislature for inclusion in the 1985-86 state budget. The grants became effective on July 1, 1985.

Heber Public Utility District, Imperial County ($44,605)

Complete engineering plans to extend water and sewer collection systems necessary to accomodate geothermal development in Heber.

City of Clearlake, Lake County ($81,520)

Conduct a temperature-gradient survey of local geothermal resources including five temperature gradient wells as part of a planned economic development program.

Lake County Planning Department ($100,000)

Prepare the geothermal resource and transmission element for inclusion in the Lake County General Plan.

Middletown Unified School District, Lake County ($73,653)

Purchase a bus to mitigate the impacts on school transportation services due to continuing development activities in the Geysers geothermal area.

Lake County Air Pollution Control District ($36,000)

Develop a more effective air quality impact assessment model for the Geysers geothermal area.

Pit Resources Conservation District, Lassen County ($91,300)

Conduct temperature gradient survey at two locations,which will aid in delineating the geothermal resources in Big Valley.

City of Susanville, Lassen County ($5,200)

Purchase the hardware and software for a computer-based monitoring and reporting system for the City's district heating project.

Mendocino County Air Pollution Control District ($32,376)

Conduct an air-quality baseline study and particulate-dispersion model for southeastern Mendocino County.

Surprise Valley Hospital District, Modoc County ($135,106)

Construct a geothermal space-heating and hot-water heating system for the hospital and medical clinic in Cedarville.

Mono County ($51,031)

Continue the Energy Management Department to coordinate geothermal development in Mono County.

Plumas Unified School District, Plumas County ($229,240)

Construct a geothermal space-heating system for the elementary and high schools in Greenville. Complete a feasibility study for a district-heating system in Greenville.

Indian Valley Hospital District, Plumas County ($19,000)

Complete modifications to the hospital's geothermal space-and water-heating system.

Sierra County ($431,000)

Drill a production and injection well on a 40-acre site in Sierra Valley for a horticultural commercial park as part of a county-sponsored economic development program.

Northern Sonoma County Air Pollution Control District ($6,200)

Purchase and test a microprocessor-based controller to upgrade the air emission particulate sampling system capability.

Sonoma County ($54,910)

Complete study to analyze the extent of chemical trace elements and parasites found in selected wildlife in the Geysers geothermal area.

Sonoma County ($23,987)

Construct a sediment control basin as part of the Healdsburg-Geysers Road project to protect fish spawning habitats in Little Sulphur Creek.

Sonoma County ($100,000)

Prepare the Geothermal Resources Management Plan for inclusion in the Sonoma County General Plan.

Assessing Geothermal Properties: An Interview with Harold Berthoff

by Susan F. Hodgson

"People think that what we do is to place a value on geothermal reserves. That's only a part. Our job is to determine the market values and taxable values of commercial geothermal properties," said Harold Bertholf, President of Harold W. Bertholf, Inc.

"Geothermal properties are subjected to the local property tax, local and state severence taxes, and income taxes at the state and federal levels," he continued. "Of those taxing vehicles, the largest tax burden in terms of dollars--other than income tax--usually is the local property tax, which is a function of the concept of market value. Our job is to do evaluations to estimate the market value. The vast majority of our company's geothermal work is in high-temperature geothermal resources, those used to generate electricity," Bertholf stated.

Finding the market value includes evaluating the reservoir. This means looking at the extent of a reservoir, the amount of steam or hot water in it, and at the rate at which these resources can be produced. This, along with future product prices and production costs, determines the size, shape, and duration of a property's future income stream. In addition, determining the market value also includes estimating the value for all site development items, such as wells, power plants, and electrical transmission lines. Factors such as contracts to sell the hot water, steam, and electricity and the economics of alternate fuel prices, including the world price of oil, are also important in the appraisal (see Table A).

Table A. Hypothetical Steam Property Cash Flow Analysis

Year	M.W.H. generated	Price $/mwh	Gross Income	Operating Costs	Net Income	Discounted Net Income
1	100,000	32.00	3,200,000	1,000,000	2,200,000	2,051,000
2	95,000	29.00	2,755,000	1,050,000	1,705,000	1,383,000
3	90,000	27.00	2,430,000	1,100,000	1,330,000	938,000
4	90,000	28.00	2,520,000	1,150,000	1,370,000	840,000
5	90,000	30.00	2,700,000	1,200,000	1,500,000	800,000
	465,000				$8,105,000	$6,012,000

Reserves (mwh) 465,000
Market Value $6,012,000
value attributed to wells and facilities $2,000,000
value attributed to steam rights $4,012,000

The market value of a property is the price the assessor concludes would be agreed upon by a willing buyer and seller, each trying to maximize their gains, and both having full knowledge of all the uses to which the property may be put. Whether or not the assessor personally believes the market value price to be high or low is not important. By state law, the assessor must follow and reflect current market conditions.

Geothermal properties are assessed each year. Like all other California property, the geothermal industry is protected by Proposition 13, the Jarvis-Gann Initiative.

During the construction phase of geothermal property, when wells are being drilled and other improvements installed (normally 6 to 8 years), the yearly assessments are a function of the market value of the property. However, in the year the operation goes into commercial production, a base-year value is established and Proposition 13 becomes effective for the property. This base value becomes the ceiling for future assessments, except for minor adjustments for inflation, new construction, or a sale. Assessments of the property base value can only be adjusted upward annually by 2 percent of the worth or by amounts to reflect the worth of new construction, new reserves, or a sale.

However, each year a new market value is estimated by the assessor. Any year this market value falls below the Proposition 13 base-year value, the taxpayer is assessed on the basis of the lower value. This constitutional provision was added for the benefit of all property owners, to take into account the possibilities of unforseen economic reversals.

The California State Board of Equalization strives to achieve uniformity in assessment practices among the various counties. Unfortunately, since the passage of Proposition 13, the concept of equity based upon the amount of taxes paid for similar properties has been somewhat lost, resulting in unequal tax burdens among property owners (see Table B). Nevertheless, since the passage of Proposition 13 in 1978, property tax increases have stabilized. "Undoubtably such taxes would be much higher today without the protection afforded by Proposition 13," Bertholf concluded.

*Table B. Tax Effects of Proposition 13 on Three Similar Properties**

Property	Market Value	Prop 13 Value	Tax	Tax w/o '13'
A	$6,012,000	$3,500,000	$35,000	$180,000
B	$6,012,000	$2,700,000	$27,000	$180,000
C	$6,012,000	$6,012,000	$60,012	$180,000

* Although all 3 of the above properties are identical, their property liability is different. Property B was developed at a different time than property A, when steam prices were "lower", resulting in a lower "base value". Property C had sold just before tax time, requiring the assessor to apply market value as the new "base value".

What Do Geothermal Projects Cost?

by A. D. Stockton
Geothermal Officer
Division of Oil and Gas

What do geothermal projects cost in 1985 dollars? Excluding steam costs, expenses for a 110 megawatt power plant with a lifetime of 30 years designed for the vapor-dominated reservoir at The Geysers Geothermal field are estimated at $1.48 billion. With steam costs included, the estimate rises to $3.18 billion.

The cost of a 50 megawatt geothermal power plant, with a lifetime of 30 years, designed for a hot water reservoir of over 100°C is estimated at $1.47 billion. With hot water costs included, the estimate rises to $1.9 billion.

These cost estimates, and all other estimates on the accompanying chart, were provided by industry representatives. In general, the estimated costs are maximum amounts, although some cost ranges are included.

Geothermal Project Costs (in 1985 Dollars)

(In general, the estimated costs are maximum amounts, although some cost ranges are included. All estimates were received from industry representatives.)

Operator		Management Interest in Resource	Regional Investigation, Exploration	Leasing	CEQA Requirements for Exploratory Projects: EIR, Negative Declaration (up to 6 wells)	Intensive Exploration	Well-Pad Siting, Roads (1 exploratory well and / or several TG holes)	Drilling & Completion, Reservoir Assessment (3 wells)	CEQA Requirements for Development Projects	Drilling Confirmation Wells (3 - 5) Reservoir Assessment	Resource Marketing			Field Development (Includes Replacement Wells, Pipelines, Roads)	Field Production (Royalties, Injection Wells, and Injection Plants)	Field Maintenance	Totals
Vapor	Time & Cost		1 to 2 years $6,000 to $20,000	1 to 6 years $10 to $50/acre Bonus ($40,000)	Up to 1 year $2,000 to $50,000	2 to 10 years $35 to $125/acre (up to $200,000)	Up to 3 months $650,000 up to $1,300,000	1½ to 3 months $1,300,000 to $3,000,000	Up to 1½ years $200,000 to $700,000	1 to 5 + years $6,000,000 to $15,000,000	1 year $40 to $50,000			30 + years $45,000,000	30 + years $325,000,000	30 + years $150,000,000	$540,460,000
Hot Water > 100°C	Time & Cost		1 to 2 years $4,000 to $20,000	1 to 10 years $1 to $30/acre Bonus ($200,000)	Up to 1 year $2,000 to $20,000	2 to 3 years $10 to $100/acre (up to $40,000)	Up to 3 months up to $200,000	1 to 3 months $300,000 to $3,000,000	Up to 1½ years $100,000 to $165,000	1 to 10 years $1,000,000 to $25,000,000	2 years $100,000			30 + years $75,000,000	30 + years $135,000,000	30 + years $180,000,000	$418,845,000
Hot Water < 100°C	Time & Cost		1 to 2 years $5,000 to $10,000	1 + years $1 to $5/acre Bonus (up to $40,000)	Up to 6 months $100 to $10,000	2 + years $10/acre (up to $20,000)	0 to a few weeks $0 to $10,000	1 to 4 weeks $3,000 to $100,000	Up to 1½ years $0 to $10,000	Depends on type $100,000±	0 to 1 year 0 to $100,000			30 + years $500,000	30 + years 0 to $750,000	30 + years $300,000	$ 1,975,000
Utility, Supplier											Management Interest	Resource Confirmation Consultants	CEQA, Plant Notice of Intent, and / or Application for Certification	Plant Construction: Vapor (110 megawatts) Hot Water > 100°C (50 megawatts) Hot Water < 100°C (direct use)	Plant Production	Plant Maintenance	
Vapor	Time & Cost											Up to 1 year $70,000	1 to 4 years $400,000 to $1,400,000	2 years $200,000,000	30 + years $ 600,000,000 $1,700,000,000*	30 + years $135,000,000	$ 936,470,000
Hot Water > 100°C	Time & Cost											Up to 1 year $70,000	1 to 4 years $700,000	2 to 3 years $150,000,000	30 + years $600,000,000 $450,000,000*	30 + years $300,000,000	$1,050,770,000
Hot Water < 100°C	Time & Cost											Up to 1 year up to $20,000	1 year ± $1,000 to $10,000	1 week to 1 yr. $1,000 to $2,000,000	30 + years $0 to $50,000	30 + years $0 to $30,000	$ 2,110,000
Cumulative Total Costs (Maximum)		Vapor Hot Water > 100°C Hot Water < 100°C	$20,000 $20,000 $10,000	$160,000 $320,000 $ 75,000	$210,000 $340,000 $ 85,000	$410,000 $380,000 $105,000	$1,710,000 $ 580,000 $ 115,000	$4,710,000 $3,580,000 $ 215,000	$5,410,000 $3,745,000 $ 225,000	$20,410,000 $28,745,000 $ 325,000	$20,460,000 $28,845,000 $ 425,000	$20,530,000 $28,915,000 $ 445,000	$21,930,000 $29,615,000 $ 455,000	$266,930,000 $254,615,000 $ 2,955,000	$1,191,930,000 $2,891,930,000* $ 989,615,000 $1,439,615,000* $ 3,755,000	$1,476,930,000 $3,176,930,000* $1,469,615,000 $1,919,615,000* $ 4,085,000	$1,476,930,000 $3,176,930,000* Vapor $1,469,615,000 $1,919,615,000* >100°C Hot Water $ 4,085,000 <100°C
Time		Up to 1 year	1 to 2 years	1 to 6 years	135 days to 1 year	2 to 3 years	3 months	4 months	Up to 1 year	1 to 5 years	1 year	Up to 1 year	Up to 1 year	30 years	30 years	30 years	
Cumulative Total Years (Minimum)		1	2	3	4	6	6 +	6 +	7+	10 +	11+	12+	14+	44+	44+	44+	*Fuel costs included (vapor or hot water)

US AGENCIES PROVIDING ASSISTANCE TO FOREIGN BUSINESS OPPORTUNITIES

US AGENCY FOR INTERNATIONAL DEVELOPMENT

- The mission of USAID is to conduct assistance programs directed toward satisfying basic needs and improving economic growth in developing countries.

- Over the past five year period, AID has spent approximately 22% of its $1 billion budget on renewable energy activities.

- Contact:

  Dr. Alan Jacobs
  Director, Office of Energy
  Bureau for Science and Technology
  Room 508 SA-18
  Agency for International Development
  Washington, D.C. 20523
  (703) 235-8902

DEPARTMENT OF COMMERCE

- The mandate of the Department of Commerce (DOC) is to promote and develop the foreign and domestic commerce of the United States. Within DOC, programs involving international trade and export are primarily the responsibility of the International Trade Administration (ITA). ITA determines policy, directs programs, and coordinates all issues concerning trade administration, trade development, and trade/investment policy.

- Since 1981, the Trade Development Program within ITA has maintained a full-time renewable energy industrial specialist who has conducted trade promotion activities both within the United States and abroad.

- Contact:

  Les Garden
  Renewable Energy Specialist
  Office of International Major Projects
  International Trade Administration
  Room 2811
  U.S. Department of Commerce
  Washington, D.C. 20230
  (202) 377-0556

EXPORT IMPORT BANK

- The mission of the Export Import Bank (EXIMBANK) of the United States is to aid in the financing and facilitation of U.S. exports.

- In 1982 and 1983 EXIMBANK provided financial assistance amounting to $648 million for renewable energy projects.

- Contact:

  James Crist
  Vice President, Exporter Credits and Guarantees
  811 Vermont Ave, N.W.
  Export Import Bank
  Washington, D.C. 20571
  (202) 566-8819

OFFICE OF THE UNITED STATES TRADE REPRESENTATIVE

- The mission of the U.S. Trade Representative (USTR) is to serve as the President's chief advisor on foreign trade policy. It has primary responsibility for developing international trade policy and coordinating its implementation.

- USTR is available to assist U.S. renewable energy companies in mitigating trade barriers established by foreign countries relating to the importation of U.S. equipment and technology.

- Contact:

  Director, Private Sector Liaison Division
  600 17th Street, N.W.
  Office of the U.S. Trade Representative
  Washington, D.C. 20506
  (202) 395-6120

OVERSEAS PRIVATE INVESTMENT CORPORATION

- Mission of OPIC is to serve as the key federal agency for promoting mutually beneficial American business investment in the developing world.

- In 1983, OPIC supported the provision of insurance to Union Geothermal of Indonesia, Ltd., for geothermal exploration and development in Indonesia.

- Contact:

  R. Douglas Greco
  Manager, Natural Resources
  1129 20th St., N.W.
  Overseas Private Investment Corporation
  Washington, D.C. 20527
  (202) 653-2956

SMALL BUSINESS ADMINISTRATION

- The mission of SBA is to assist and counsel small businesses.

- Special business loan program for the startup, continuation, or expansion of small business that is developing, manufacturing, selling, installing, or servicing specific energy conservation or solar energy equipment.

- Contact:

  Office of Public Information
  Central Office
  U.S. Small Business Administration
  1441 L Street, N.W., Room 100
  Washington, D.C. 20416
  (202) 653-6365

MULTILATERAL LENDING INSTITUTIONS

AFRICAN DEVELOPMENT BANK (AFDB)

- The African Development Bank promotes the economic and social progress of regional member countries - individually and jointly.

- In 1984, AFDB provided $2.2 million for the financing of a geothermal project in Djibouti.

- Contact:

  African Development Bank Group
  B.P. No 1387
  Abidjan, Ivory Coast

ASIAN DEVELOPMENT BANK (ADB)

- The Asian Development Bank is dedicated to the task of assisting the economic development of its developing member countires (DMC's) and of fostering economic growth and cooperation in the region of Asia and the Far East, including the South Pacific.

- As of the end of 1983, ADB lending for energy amounted to $3.4 billion for 133 loans in 19 DMC's, representing 25.5% of the total assistance to all DMC's. During the same period, the ADB provided technical assistance grants for the energy sector amounting to $19.6 million.

- Contact:

  Office of the U.S. Director
  Asian Development Bank
  P.O. Box 789
  Manila 2800
  Republic of the Philippines

CARIBBEAN DEVELOPMENT BANK (CDB)

- Caribbean Development Bank is a regional financial institution established for the purpose of "contributing to the harmonious economic growth and development of the member countires in the Caribbean and promoting economic cooperation and integration among them, having special and urgent regard to the needs of the less developed countires (LCD's) of the Region."

- CDB finances the Caribbean Alternative Technology and Energy Program.

  - The Alternative Technology and Energy Program funded $126,000 in projects in 1983, $451,000 in 1982, and $749,000 in 1981.

- Contact:

  The Bank Secretary
  Caribbean Development Bank
  P.O. Box 408
  Wildey
  St. Michael
  Barbados
  (809) 426-1152
  Telex: WB 2287

INTER-AMERICAN DEVELOPMENT BANK (IDB)

- Inter-American Development Bank is an international financial institution created to help accelerate the economic and social development of its member countries.

- From 1961-1984, 27% of the Bank's lending has gone to energy projects.

- IDB has provided financing for geothermal projects in Panama, Guatemala, and Costa Rica.

- Contact:

  Office of the U.S. Executive Director
  Inter-American Development Bank
  Room 1032
  808 17th Street, NW
  Washington, D.C. 20577
  (202) 634-8044

UNITED NATIONS (UN)

- The United Nations is an international organization formed to international peace, security, and cooperation.

  - United Nations Development Programme's (UNDP) central energy activity is the UNDP/World Bank Energy Sector Assessment Program (ESAP) and the accompanying Energy Sector Mangement Assistance Program (ESMAP). Both programs are directed toward energy sector planning and include new and renewable energy resource options in developing country energy planning.

- United Nations Department of Technical Cooperation carries out fieldwork in natural resources and energy and in economic and social infrastructure development.

- Contact:

  Dereck Lovejoy
  Technical Advisor, Renewable Energy
  Division of Natural Resources and Energy
  U.N. Department of Technical Cooperation for Development
  United Nations
  New York, New York 10017
  (212) 754-8597

WORLD BANK GROUP

- International Bank for Reconstruction and Development (IBRD)

  - Mission is to promote the economic development of member countires primarily by extending loans on conventional terms for specific high-priority projects.

- International Development Association (IDA)

  - Mission is to promote the economic development of less-developed member countries by making credits on concessionary terms, thereby reducing the burden on the recipient countries' balance-of-payment positions.

- International Finance Corporation (IFC)

  - Encourages growth of productive private enterprise in developing countries by extending loans and non-controlling equity capital, providing underwriting and stand-by commitments, and attracting and acting as catalyst for outside financing.

- For renewable energy technology projects financed by the World Bank, emphasis has been placed on large hydro-electric, geothermal power grid extension projects, or biomass resouce development (reforestation).

- The World Bank has financed $34.5 million of the geothermal project in Kenya, and has given it a $240 million line of credit over the next 50 years.

- The World Bank also is the executive agency for the joint UNDP/World Bank Energy Assessment Program (ESAP) and the accompanying Energy Sector Management Assistance Program (ESMAP).

- Contacts:

  Richard Dosik
  World Bank
  Energy Department
  1818 H Street, N.W.
  Washington, D.C. 20433
  (202) 477-6894

Leases

BLM Lease Sale Information

On September 24, 1985, the Bureau of Land Management (BLM) had no tentative or scheduled geothermal lease sale dates for land in KGRA's.

As of October 1, 1985, a centralized source will no longer exist where geothermal lease sale schedules can be obtained for land in KGRA's. To collect such information, contact the Adjudication Department of each state BLM office.

Negotiated Geothermal Lease Issued

by Don Hoagland
State Lands Commission

In May 1985, the California State Lands Commission (SLC) issued a negotiated geothermal lease to Union Oil Company. The lease was for about 3,681 acres in the Truckhaven area on the west side of the Salton Sea, Imperial County. It is the first negotiated geothermal lease to be issued by the state.

Terms of the lease provide for a 5 year primary term and a 5 year drilling term; royalties of 12.5 percent of gross revenue from the sale of steam and 10 percent of gross revenue from the sale of minerals or chemical compounds recovered from the brines; an annual rent of $25 per acre; and a minimum royalty of $2 per acre.

Union, Phillips Petroleum, and Southern Pacific Land Company had formed a federal geothermal unit in the Truckhaven area, and had placed all of the federal and private lands within the unit under lease. They wished to lease the state lands, as well, if a longer length of time were available before drilling must

begin. The companies were willing to pay a larger rental fee in exchange for this longer exploration time.

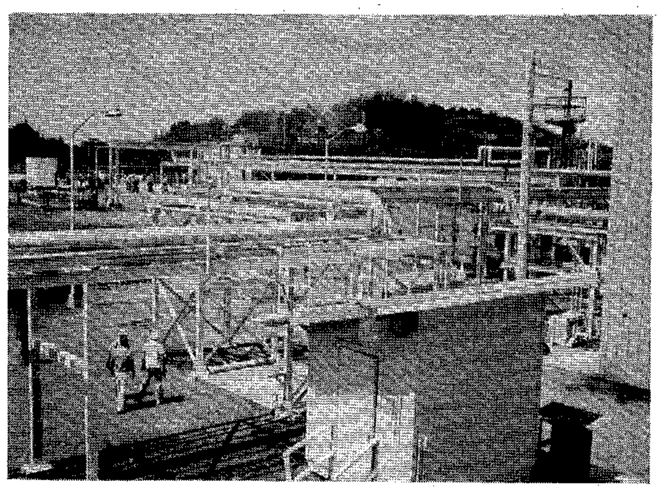
Because only the state lands within the unit were not under lease, the SLC agreed to the conditions and offered the companies the negotiated lease. The SLC was able to do so under a law passed in 1983 allowing negotiated leases in specified circumstances.

Normally, the SLC issues a 2 year geothermal prospecting permit in unproven areas. A prospecting permit may be extended an additional 2 years, but that requires further SLC action. An extension may only be granted if the permittee is drilling or has applied for the necessary permits to drill.

Seminars and Conferences

A Talk With Dave Anderson
by Susan F. Hodgson

"I feel the international geothermal community has accepted the Geothermal Resources Council as a focal point for professional interaction--as a source of geothermal information and a way to connect with people and organizations involved in geothermal energy," said Dave Anderson, Executive Director of the Geothermal Resources Council.



Symposium tour of the geothermal power plant on the Island of Hawaii.

"We had 630 registered attendees at the 1985 International Symposium on Geothermal Energy in Hawaii this August. About 200 were from countries other than the United States. It was an exciting chance for everybody to meet and discuss projects throughout the world. A more intensive interaction of the geothermal community will result from the discussions," Dave added.

"The August symposium was our ninth," he said. "People have told me some of the highlights were the poster sessions, the overall international nature of the conference, and the high quality of the technical papers.

"In addition, the three GRC publications have been well received. These would be the two volumes of transactions (available for $80.00 from the GRC) and the International Volume (presently free of charge). The International Volume soon will go into its second printing, and a price will be set once the book is reprinted.

"If you would like information on the GRC, write me at P. O. Box 1350, Davis, CA 95617-1350," Dave said.

Stanford Seminar Schedule

The Stanford Geothermal Program (SGP) seminar schedule for Autumn Quarter 1985 is as follows. The seminars are held on the Stanford University campus, Room 124, Noble Building, on Thursday afternoons from 1:15 to 2:30 p.m. There is no charge.

October 3, "Tracer Dispersion Experiments," Roland N. Horne, SGP.

October 10, "Linear Boundary Detection in a Single Interference Test," Jonathan Leaver and Avrami Sageev, SGP.

October 17, "Application of the 1-D Linear Heat Sweep Model," Paul Kruger, SGP.

October 24, "Reservoir Testing," Henry J. Ramey, Jr., SGP.

November 7, "Hydrothermal Alterations in Geothermal Systems," Dennis Bird, Geology.

November 14, "Geological and Mineralogical Evaluation of Surface Geothermal Manifestations," Y. Yamaguchi and Ronald Lyon, AES.

November 21, "Study of Natural Fractured Systems with Digital Borehole Televiewer Analysis," Mark Zoback, Geophysics.

III South American Symposium of Cogeodata, Lima, Peru, November 26-29, 1985, in the auditorium of PETROPERU S.A., Av. Paseo de la Republica No. 3361, San Isidro.

The purpose of the symposium is to exchange experiences in using computers in the search for energy resources. Among the topics covered will be the evaluation of sedimentary basins, remote sensing, geochemistry, geothermics and geohydrology, and marine geology.

There will be simultaneous translations of the proceedings in English and Spanish.

The cost, until September 30, 1985, is $212.50 for Peruvians and $255.00 for others; after this date, the cost will be $250.00 for Peruvians and $300.00 for others.

The symposium is arranged by the committee on Storage, Automatic Processing and Retrieval of Geological Data of the International Union of Geological Sciences. For further information, write PETROPERU S.A., CENCAP, Apartado Postal 1081, Lima 27, Peru. Telephone: 41-1919, extension 4850, 4855, or 4858.

Annual Meeting of the Geothermal Research Society of Japan, Kyushu University, Fukuoka, Japan, December 4-6, 1985. Free.

Authors are invited to present original papers at the oral and poster sessions. On December 7, a one-day bus tour will be undertaken to the geothermal power plants at Hatchobaru and Suginoi.

For further information, write the Geothermal Research Society of Japan, c/o Geological Survey of Japan, 1-1-3 Higashi, Yatabe, Tsukuba, Ibaraki, 305 Japan.

Eleventh Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, January 21-23, 1986.

The workshop, sponsored by the Stanford Geothermal Program, is designed to bring together researchers, engineers, and managers involved in geothermal reservoir studies and developments to discuss their progress and exchange ideas.

Second Annual V.E. McKelvey Forum on Mineral and Energy Resources, Denver, Colorado, February 5-6, 1986.

Current USGS research activities in geothermal energy in the Cascade Range and Salton Sea are included among the 75 oral and poster presentations planned for the forum.

For further information, write the Training and Research Assistance Corporation, P.O. Box 6100, Denver, Colorado 80206; phone (303) 393-7061.

Fifth International Symposium on Water-Rock Interaction, Reykjavik, Iceland, August 8-17, 1986.

The symposium is sponsored by the International Association of Geochemistry and Cosmochemistry. For further information, contact Halldor Armannsson, Orkustofnun-The National Energy Authority, Grensasvegur 9, 108 Reykjavik, Iceland.

Geothermal Resources Council 1986 Annual Meeting, September 29-October 1, 1986, Americana Canyon Hotel, Palm Springs, California.

The meeting will include a technical program, special sessions, exhibits, a photo contest, field trips, and special events.

Contact the GRC for further information at P.O. Box 1350, Davis, California 95617.

Videotapes

Before the Drilling Begins

The environmental documentation process and well pad engineering practices used at The Geysers Geothermal field are the topics of a new videotape available from the Division of Oil and Gas. The videotape is about 13 minutes long and was taped on location at The Geysers Geothermal field.

The videotape, titled "Before the Drilling Begins," may be purchased for $150 in ½" (VHS or Beta) or 3/4" formats. It may be rented for $25 plus a $25 deposit refundable upon return of the tape.

Contact Susan Hodgson for further details (916) 323-2731.

The Geysers - One of Nature's Miracles

A new, 15 minute videotape surveys development of geothermal energy at The Geysers Geothermal field. The videotape was prepared for the Geysers Geothermal Association.

The videotape (or a 16 mm film of the production) may be rented, free of charge, with a $25.00 deposit refundable upon return of the tape. Videotaped copies may be purchased, as well. Fees are $25.00 for a ½" VHS videotape or $50.00 for a ½" Beta or 3/4" videotape.

For further information, contact Judy Evans, ThermaSource Inc., P.O. Box 1236, Santa Rosa, California 95402; telephone (707) 523-2960.

Maps

Geodynamic map of the Circum-Pacific Region. The map consists of 5, full-color, adjacent, equal-area sheets at a scale of 1 to 10 million, and a summary Pacific Basin sheet at a scale of 1 to 17 million. Individual sheets are $15 each, and the set of 6 sheets is $46.00. They are available from the AAPG Bookstore, P.O. Box 979, Tulsa, Oklahoma 74101.

The Geodynamic Maps focus on present geologic processes. They complement other Circum-Pacific map series depicting the geology, energy resources, and mineral resources.

The Geodynamic Maps contain information on the current movements of the earth's outer layers and on mass differences and stresses within the earth that will tend to cause future movement. Estimates of plate motion derived from magnetic lineations and hotspot traces, earthquake epicenters and focal mechanisms, historic faulting, and active volcanoes illustrate processes that are taking place now. Gravity anomalies, seismic measurements of crustal thickness, and the state of stress within rocks illustrate static inhomogeneities related to the motion within the earth's crust and mantle.

Geologic map of Wyoming. By J.D. Love and A.C. Christiansen. 1985. Three sheets, 1:500,000 scale. $7.50. Available from the Western Distribution Branch, USGS, Box 25286, Federal Center, Denver, Colorado 80225.

The map is the first to show subdivisions of Wyoming's Precambrian rocks. The map locates kimberlite pipes and intrusives in diatremes, a subsurface impact structure, and subsurface thrust faults that are based on new seismic and drill-hole data.

State maps on file. A service offered by Facts on File Publications, 460 Park Avenue South, New York, New York 10016. Phone (212) 683-2244.

Geographical, historical, demographical, economic, and natural history maps. The maps are free of copyright restrictions.

Publications

70th Annual Report of the State Oil and Gas Supervisor. 1985. Free. Published by and available from the California Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, California 95814.

Statistical and verbal summaries of 1984 California geothermal activities.

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New Division of Oil and Gas Open File Report

Reconnaissance study of thermal springs and wells and the deposits of recently extinct thermal springs in the Peninsula Ranges, Province of Southern and Baja California is the title of a new Open File Report available from the Division of Oil and Gas. The report may be copied in the headquarters, Long Beach, El Centro, and Santa Rosa offices. It was written by R. Gordon Gastil and Kathe K. Bertine of the Department of Geological Science, San Diego State University. The abstract of the report follows.

The thermal and thermal-related waters of Southern and Baja California can be subdivided into seven provinces, each with a distinctive geochemical identity. Of these, only the Salton Basin-Colorado Delta Province is clearly related to volcanic activity (small spreading centers along the plate boundary). The thermal water in the remaining provinces appears to be derived from the circulation of surface waters to depth in areas of both high and moderately low geothermal gradient, along open fractures extending a number of kilometers in depth (a reservoir temperature of 200°C would require a depth of 9 km at normal gradient).

The boundaries of these provinces are not clearly related to geologic subprovinces defined by surficial rocks and structures, and are probably determined by regional variations in the thermal gradient.

Analyses for hydrogen, sulfur, strontium, and carbon isotopes indicate that the majority of the thermal waters, particularly those rising from the crystalline rocks, are essentially undiluted by surface water, have been out of contact with the surface for more than 50 years, and have undergone minimum exchange with near-surface rocks.

Silica and tritium data on cold springs and wells, as well as thermal waters, suggest that a large proportion of the subsurface water has participated in deep circulation. Thus, a significant proportion of the heat transfer from depth may be convective rather than conductive.

A comparison of the distribution of thermal water localities with the map of seismic epicenters, shows a positive correlation between the concentration of thermal water localities, and the frequency of seismic events. If thermal water abundance is a measure of elevated geothermal gradient at depth, it may be the elevated gradient that limits the ability of the upper crustal rocks to accumulate strain. Thus, areas of little thermal water along major plate boundaries may be areas capable of accumulating large strain, and thus are potentially hazardous.

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State energy overview, 1983. DOE/EIA-0354(83). $16.00. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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List of publications. 1985. Free. Published by and available from the Colorado Geological Survey, Publications Dept., 1313 Sherman Street, Room 715, Denver, Colorado 80203.

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Cenozoic evolution of the Northwestern Honey Lake Basin, Lassen County, California. By Colleen T. Roberts. Comprises Vol. 80, No. 1, January 1985 edition of the Colorado School of Mines Quarterly. $14.00. Available from the Colorado School of Mines Press, Golden, Colorado 80401.

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State energy data report, 1960-1983. DOE/EIA-0214(83). By the Energy Information Administration. 1985. $22.00. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20585. Phone (202) 783-3238.

Estimates of annual energy consumption at the state and national levels are presented, computed by major economic sector and by principal energy type for 1960-1983.

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Geology and geothermal energy of the Salton Trough, a field guide. Compiled by Lawrence J. Heber, 1985. $7.00 (send payment with order; include tax and postage). Published by and available from the Historian, Far Western Section, National Assoc. of Geology Teachers, Dept. of Geological Sciences, Univ. of California, Santa Barbara, CA 93106.

The guide to the geothermal areas of the Salton Trough and to Cerro Prieto includes a road log and 16 articles.

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California Geology. $5.00 a year for 12 issues. Send check or money order to California Geology, P.O. Box 2980, Sacramento, CA 95812.

Each issue features articles on California's geological environment, such as hot springs, geothermal development, minerals, and gems.

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Sonoma Valley Reports

Three open-file geothermal reports of the Sonoma Valley in Northern California are available from the California Department of Conservation's Division of Mines and Geology. The reports are available for reference in the Sacramento, San Francisco, and Los Angeles district offices. Copies may be purchased from the Sacramento District Office only. Mail orders to DMG, P.O. Box 2980, Sacramento, CA 95812.

The reports are:

OFR-83-13SAC, "Investigations of low-temperature geothermal resources in the Sonoma Valley area, California", by L.G. Youngs, R.H. Chapman, G.W. Chase, S.P. Bezore, and H.H. Majmundar, 1982. 103 pages; $10.00.

OFR-83-27SAC, "Geothermal resources of the Northern Sonoma Valley Area, California", by L.G. Youngs, L.F. Campion, R.H. Chapman, C.T. Higgins, E.M. Leivas, G.W. Chase, and S.P. Bezore, 1983. 106 pages; $18.00.

OFR-84-29SAC, "Geothermal resources investigations of the Sonoma Valley area, Sonoma and Napa Counties, California", by Linda F. Campion, C. Forrest Bacon, Rodger H. Chapman, Gordon W. Chase and Leslie G. Youngs. 137 pages; $18.00.

In addition, the November 1985 issue of California Geology will include an article about aspects of the reports.

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Evaluation and ranking of geothermal resources for electrical generation or electrical offset in Idaho, Montana, Oregon, and Washington. DOE/BP-13609-3. Principal investigator R. Gordon Bloomquist. 1985. The Executive Summary (23 p.) is free. Available from John Geyer, BPA, Routing PQP, P.O. Box 3621, Portland, Oregon 97208. Phone (503) 230-5327.

The study is described in an article in this Hot Line issue.

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Catalogue sciences de la terre. 1985. Published by and available from the Bureau de Recherches Geologiques et Minieres, B.P. 6009-45060 Orleans Cedex - France.

Many geological publications and posters are available on the geology of France.

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Proceedings of "Geothermal Reservoir Engineering Workshop"; set of 6 hardbound volumes. $100.00 per set, United States; $110.00 per set, foreign orders. Presently, volumes are not sold individually. Payment must accompany order. Published by and available from the Stanford Geothermal Program, Dept. of Petroleum Engineering, Stanford University, Stanford, California 94305.

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Hydrothermal injection research program, annual progress report FY-1984. By Univ. of Utah Research Institute Earth Science Laboratory and EG&G Idaho, Inc., Earth and Life Sciences, and Energy Programs Branch. 1984. Microfiche $4.50, paper $13.00.

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Fracture detection and mapping for geothermal reservoir definition: an assessment of current technology, research, and research needs. LBL-18146. By Norman E. Goldstein. 1984. Paper $10.00.

To purchase, write Ms. Imgard Baune, Earth Sciences Division, Lawrence Berkeley Laboratory, Building 50E, Berkeley, California 94720.

Experience at several geothermal fields has shown that reservoir fluids are produced in important volumes only where a well has intersected narrow and infrequent zones containing fractures that are both open and well-connected hydraulically. The location and characterization of open fractures within specific geothermal wells is also vitally important to engineers for interpreting wellhead pressure and flow test data and for designing a proper reinjection scheme to avoid premature thermal breakthrough of injected fluids into production wells.

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Commercial status of electrical generator technologies. No. P300-85-003. By the California Energy Commission staff. 1985. $6.55. Published by and available from the CEC, Accounting Office, 1516 Ninth Street, MS-2, Sacramento, CA 95814.

The commercial availability status and deployment issues of 48 electrical generation and associated fuel technologies are identified. Twenty-one of these technologies are found commercially available based on the following three criteria: demonstrated feasibility, existence of suppliers, and reasonable electrical generation costs. For the other technologies, an earliest date of commercial availability is estimated, when possible.

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PURPA Lines, Alternative Energy Business News. Charter subscriptions are $250 a year for issues every other week. Order from Hydro Consultants Inc., PURPA Lines, 755 Boylston St., Suite 707, Boston, MA 02116.

According to the brochure, PURPA Lines was created to cite where the most and least attractive rates exist; details of current contracts under PURPA; the latest information on wheeling; the location of potential markets for power sales; the best places for project development; the lease and regulatory decisions that could impact power sales; and other matters relating to PURPA.

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LBL geothermal program, list of publications on geothermal energy. Free. Published by and available from the Earth Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720.

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International journal of energy research. Published quarterly and available from the Subscriptions Department, John Wiley & Sons Limited, Baffins Lane Chichester, Sussex PO19 1UD, England. Vol. 9, No. 3, July - September 1985 is a special issue on Geothermal Energy; guest editor P. Ungemach. Subscription prices: U.K. £99.00; elsewhere U.S. $210.00.

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Hot springs and hot pools of the Southwest. By Jayson Loam and Gary Sohler. 1985. $13.95, paper cover. Published by and available from the Wilderness Press, 2440 Bancroft Way, Berkeley, CA 94704.

The locations are given for hot springs and hot pools in California, Nevada, Arizona, New Mexico, and West Texas.

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Recovering zinc-lead sulfide from a geothermal brine. RI8922, Bureau of Mines Report of Investigations. By L. Schultz and D. Bauer. 1985. Available from Larry Schultz at the U.S. Bureau of Mines, 1605 Evans Avenue, Reno Nevada 89512. Phone (general number) (702) 784-5391; (Larry Schultz) (702) 784-5378.

The Bureau of Mines devised a technique to recover a Zn-Pb concentrate from a geothermal brine. More than 99 percent of the Zn and Pb was precipitated by treating the brine with H_2S and controlling the pH with lime. Recycle of the sulfide precipitates increased crystal size and resulted in easily filterable products. A typical sulfide precipitate contained 53 percent ZnS, 8 percent PbS, 24 percent MnS, and 15 percent FeS. Addition to sulfide as FeS or CaS was not effective in precipitating Zn and Pb, but Zn in the brine was selectively removed with a strongly basic ion-exchange resin. A proposed flowsheet for metals recovery is discussed.

Tectonostratigraphic terranes of the Circum-Pacific Region. Earth Science Series, Number 1. Compiled by D.G. Howell, et al. $32.00. Includes a copy of the new AAPG map, "Preliminary Tectonostratigraphic Terrane Map of the Circum-Pacific Region" (The map is $15.00 when sold separately). Published by and available from the AAPG, P.O. Box 979, Tulsa, Oklahoma 74101. Phone (918) 584-2555.

The publication includes 42 papers on principles and applications of terrane analysis, and on tectonostratigraphic terranes in the circum-pacific region.

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The following NTIS Reports are available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

Program Review

Proceedings of the geothermal program review III. CONF-8410179. Sponsored by the U.S.-DOE. 1984. Microfiche $4.50, paper $28.00.

Models

Update and assessment of geothermal economic models, geothermal fluid flow and heat distribution models, and geothermal data bases. DOE/CE/30784-2. Edited by D. Kenkeremath. 1985. Microfiche $4.50, paper $13.00.

State Projects

Geothermal resources of the Bighorn Basin, Wyoming. DOE/ID/12026-T8. By H. Heasler and B. Hinckley. 1985. $8.50, microfiche $4.50.

A geological, geochemical, and geophysical survey of the geothermal resources at Hot Springs Bay Valley, Akutan Island, Alaska. DOE/ET/27105-T1. By R.J. Motyka et al. Paper $17.50, microfiche $4.50.

A detailed microearthquake survey of Long Valley, California, KGRA, July - September 1981. DOE/ID/12144-T1. By C. Cramer, D. Stierman, and T. Lee. 1983. Microfiche $4.50, paper $16.00.

Magma

Selection of promising sites for magma energy experiments. SAND84-2171. By C. Carson. 1985. Microfiche $4.50, paper $7.00.

Hot Dry Rock

Hot dry rock geothermal energy development program, Annual Report, FY 1983. LA-10347-HDR. Compiled by and edited by M.C. Smith, G.J. Nunz, and M.G. Wilson. 1985. Microfiche $4.50, paper $11.50. (The four most recent reports in this series, unclassified, are LA-8280-HDR; LA-8855-HDR; LA-9287-HDR; and LA-9780-HDR.

Geopressured

Technical support for geopressured-geothermal activities in Louisiana. DOE/NV/10174-3. By R. Pilger. 1982. Microfiche $4.50, paper $34.00.

Geochemistry

Geochemical engineering reference manual. DOE/SF/11520-T1. By L. Owen and D. Michels. 1984. Microfiche $4.50, paper $40.00.

The well-organized publication reviews geochemical literature, the majority of which was compiled from an extensive, computer-aided search. The search included data from the COMPENDEX online data services provided by Engineering Information, Inc., 345 East 47th Street, New York, New York 10017; a tabulation of USGS Geothermal Research Program publications available from the USGS, Menlo Park, California 94025 and the USGS database called GEOTHERM (call (415) 323-8111, ext. 2906); the Lawrence Berkeley National Laboratory on-line remote access database, called GRAD; Geothermal Resources Council publications; geothermal files of the U.S. Dept. of Energy, San Francisco office; and annual bibliographies published by the Electric Power Research Council (EPR), 3412 Hillview Avenue, Palo Alto, California 94304.

Technology

Test and demonstration of a 1-MW wellhead generator: helical screw expander power plant, model 76-1. Final report to the International Energy Agency. DOE/CE-0129. U.S. Dept. of Energy, 1985. $20.50, microfiche $4.50.

East Mesa Geothermal Pump Test Facility. DOE/SF/11556-T1. By R. Olander and G. Roberts. 1984. $8.50, microfiche $4.50.

Lost circulation technology workshop. SAND85-0109. By B. Caskey. 1985. Microfiche $4.50, paper $10.00.

Geothermal elastomeric materials technology application (GEM-TA) program. DOE/SF/11537-1. By A. Hirasuna, D. Davis, G. Friese, and J. Trailer. 1984. Microfiche $4.50, paper $14.50.

Direct Use

Resource assessment for geothermal direct use applications. DOE/ET/12099-3. By C. Beer, W. Hederman, M. Dolenc, and D. Allman. 1984. $8.50, microfiche $4.50.

The geothermal potential for commercial and industrial direct heat applications Salida, Colorado. DOE/ID/12192-1. By B. Coe, J. Dick, M. Galloway, J. Gross, R. Meyer, R. Raskin, and J. Zocholl. 1982. Microfiche $4.50, paper $22.00.

Optimization of design and control strategies for geothermal heating systems. DOE/ID/12167-T2. By J. Batdorf and G. Simmons. 1984. Microfiche $4.50, paper $11.50.

Resource development; system design, construction, and operation for geothermal direct use applications. DOE/ET/12099-4. By C. Beer, W. Hederman, Jr., D. Allman, M. Dolenc, and F. Childs. 1984. Microfiche $4.50, paper $17.50.

Direct utilization of geothermal heat in cascade application to aquaculture and greenhouse systems at Navarro College. DOE/ET/27058-1. By K. Smith. 1984. Microfiche $4.50, paper $17.50.

Direct use of low temperature geothermal water by Aquafarms International, Inc. for freshwater aquaculture (prawns and associated species). DOE/ET/27047-2. By R. Broughton, M. Price, V. Price, and Dov Grajcer. 1984. $20.50, microfiche $4.50.

Geothermal heating project at St. Mary's Hospital, Pierre, South Dakota. DOE/ET/28441-7. By St. Mary's Hospital. 1984. $26.50, microfiche $4.50.

The City of El Centro geothermal energy utility core field experiment. DOE/ET/27045-2. By S.G. Province and P.B. Sherwood. 1984. $31.00, microfiche $4.50.

Use of geothermal energy for sugar refining in Imperial County. Pilot plant implementation. DOE/SF/10814-T1. By Holly Sugar Corporation. 1984. $10.00, microfiche $4.50.

California Wells

Division Well Data Available

A computer-generated file of geothermal production and injection statistics for wells and records open to public inspection is available from the Division of Oil and Gas. All data are in metric units. The file may be purchased for $50.00 from the Division of Oil and Gas in Sacramento.

Drilling Permits for Geothermal Wells Approved Jan.-July 1985 by the Division of Oil and Gas

DISTRICT G1

Date Notice Received	Operator & Well No.	API No.	Sec. T. R.	Location & Elevation
	LASSEN COUNTY			
6/5/85	Tsuji Nursery, Inc. "TNI" 2	025-90073	5 29N 12E	Fr. SW cor. 83m N, 120m E. 1280m GR.
	MODOC COUNTY			
7/8/85	Eliot Allen and Associates "Canby School" 1	049-90016	36 42N 9E	Fr. NE cor. 120m S, 230m W. 1310m GR.
7/8/85	Eliot Allen and Associates "Alturas Airport" 1	049-90017	14 42N 12E	Fr. NW cor. 700m S, 245m E, 1335m GR.
7/8/85	Eliot Allen and Associates "Adin School" 1	049-90015	28 39N 9E	Fr. SE cor. 775m N, 650m W. 1286m GR.
	MONO COUNTY			
3/22/85	Wood & Associates "Chance" 2	051-90044	35 3S 28E	Fr. NW cor. 514m S, 114m E. 2158m KB.
3/22/85	Wood & Associates "Chance" 3	051-90045	35 3S 28E	Fr. NW cor. 569m S, 365m E. 2155m KB.
	SIERRA COUNTY			
6/14/85	County of Sierra "SV" 5	091-90007	4 21N 15E	Fr. NE cor. 32m S, 1174m W. 1490m GR.

DISTRICT G2

Date Notice Received	Operator & Well No.	API No.	Sec. T. R.	Location & Elevation
	IMPERIAL COUNTY			
8/2/85	Kennecott Corporation "State" 2-14	025-90632	14 11S 13E	Fr. SE cor. 313.94m N, 76.2m W. Ele. -74.07m
	RIVERSIDE COUNTY			
2/22/85	City of Lake Elsinore "GW" 1	065-90008	7 6S 4W	Fr. NE cor. 45.7m S, 33.5m W. Ele. 385m
2/22/85	City of Lake Elsinore "GW" 2	065-90009	7 6S 4W	Fr. NE cor. 76m S, 50m W. Ele. 383m
6/26/85	Harding Lawson Associates DHS-1	065-90010	32 2S 5E	Fr. SE cor. 380m N, 640m W. Ele. 314 m
6/26/85	Harding Lawson Associates DHS-2	065-90011	33 2S 5E	Fr. SE cor. 130m N, 390m W. Ele. 1378m
6/26/85	Harding Lawson Associates DHS-3	065-90012	29 2S 5E	Fr. SW cor. 205m N, 75m E. Ele. 361m
6/26/85	Harding Lawson Associates DHS-4	065-90013	30 2S 5E	Fr. NW cor. 230m S, 730m E. Ele. 392m
6/26/85	Harding Lawson Associates DHS-5	065-90014	30 2S 5E	Fr. NW cor. 640m S, 770m E. Ele. 378m

DISTRICT G3

Date Notice Received	Operator & Well No.	API No.	Sec. T. R.	Location & Elevation
	LAKE COUNTY			
1/9/85	Geysers Geothermal Co. "McKinley" 12	033-90503	35 11N 8W	Fr. NW cor. 279.3m S, 472m E. 732m GR.
7/1/85	Geysers Geothermal Co. "D & V" A-4	033-90509	34 11N 8W	Fr. NE cor. 238m S, 610m W. 1031m KB.
7/17/85	MCR Geothermal Corp. "Francisco" 4-5	033-90512	5 11N 8W	Fr. NE cor. 350.4m S, 1188.1m W. 785.5m GR.
	MENDOCINO COUNTY			
3/8/85	GEO Operator Corporation "TV" 4	045-90053	19 12N 9W	Fr. NW cor. 442.1m S, 609.7m E. 732m GR.

Date Notice Received	Operator & Well No.	API No.	Sec. T. R.	Location & Elevation
	SONOMA COUNTY			
12/28/84	Union Oil Co. of Calif. "DX State 4596" 73	097-90640	7 11N 8W	Fr. NW cor. 636m S, 1485m E. 1022m KB.
2/8/85	Union Oil Co. of Calif. "Curry" 3	097-90644	13 11N 9W	Fr. SE cor. 474m N, 158.2m W. 587.6m KB.
2/8/85	Union Oil Co. of Calif. "DX State 4596" 62	097-90643	7 11N 8W	Fr. NW cor. 715.3m S, 999.4m E. 861m KB.
2/21/85	Union Oil Co. of Calif. "LF State 4597" 27	097-90645	20 11N 8W	Fr. NE cor. 213.4m S, 731.5m W. 964.6m KB.
2/21/85	Union Oil Co. of Calif. "Ottoboni St 4596" 26	097-90647	12 11N 9W	Fr. NW cor. 201.9m S, 518m E. 946.9m KB.
3/8/85	GEO Operator Corporation "WS" 6	097-90648	31 11N 9W	Fr. NE cor. 396.3m S, 518.2m W. 670m GR.
4/5/85	Union Oil Co. of Calif. "D & V" 17	097-90652	33 11N 8W	Fr. NE cor. 917.45m S, 374.9m W. 803.14m KB.
4/29/85	Union Oil Co. of Calif. "Ottoboni St 4596" 27	097-90653	1 11N 9W	Fr. SE cor. 504m N, 40m W. 717m KB.
5/28/85	Union Oil Co. of Calif. "Ottoboni St 4596" 28	097-90654	1 11N 9W	Fr. SE cor. 511m N, 46m W. 717m KB.
5/23/85	GEO Operator Corporation "Rorabaugh" A-26	097-90656	14 11N 9W	Fr. NW cor. 1219m S, 231m E. 758m KB.
6/11/85	GEO Operator Corporation "TG" 66	097-90657	14 11N 9W	Fr. SE cor. 30.5m N, 701.2m W. 755m GR.
6/11/85	GEO Operator Corporation "TG" 67	097-90658	23 11N 9W	Fr. NE cor. 564m S, 487.8m W. 682.8m GR.
6/11/85	GEO Operator Corporation "TG" 68	097-90659	24 11N 9W	Fr. NW cor. 259.1m S, 213.4m E. 878m GR.
6/17/85	Union Oil Co. of Calif. "DX State 4596" 71	097-90661	6 11N 8W	Fr. NE cor. 259m S, 46m W. 916.14m KB.
7/5/85	Union Oil Co. of Calif. "Geyser Gun Club" 8	097-90662	11 11N 9W	Fr. NE cor. 349.95m S, 694.94m W. 883.51m KB.
7/19/85	GEO Operator Corporation "Rorabaugh" A-27	097-90664	14 11N 9W	Fr. NW cor. 582m S, 616m E. 541m KB.
7/23/85	Union Oil Co. of Calif. "Ottoboni St 4596" 29	097-90665	1 11N 9W	Fr. SE cor. 518m N, 61m W. 717m KB.

Date Notice Received	Operator & Well No.	API No.	Sec. T. R.	Location & Elevation
	SONOMA COUNTY			
7/23/85	Union Oil Co. of Calif. "Geyser Gun Club" 9	097-90666	11 11N 9W	Fr. NE cor. 356.62m S, 685.8m W. 873.51m KB.
7/23/85	Union Oil Co. of Calif. "GD Horner State" 6	097-90668	5 11N 8W	Fr. SW cor. 167.6m N, 182.9m E. 952.54m KB.
7/23/85	Union Oil Co. of Calif. "DX State 4596" 80	097-90667	6 11N 8W	Fr. SW cor. 167.6m N, 1066m E. 975m KB.
7/23/85	Union Oil Co. of Calif. "DX State 4596" 81	097-90669	6 11N 8W	Fr. SW cor. 184m N, 1088m E. 995m KB.
7/23/85	Union Oil Co. of Calif. "DX State 4596" 86	097-90670	6 11N 8W	Fr. SW cor. 180m N, 1094m E. 995m KB.
7/30/85	Union Oil Co. of Calif. "D & V" 6	097-90671	33 11N 8W	Fr. NE cor. 613.2m S, 663.6m W. 815.9m KB.
7/31/85	Union Oil Co. of Calif. "LF State 4597" 38	097-90672	20 11N 8W	Fr. NE cor. 213.4m S, 731.5m W. 984.5m KB.

TR02(10-85-DWRR-16C)

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