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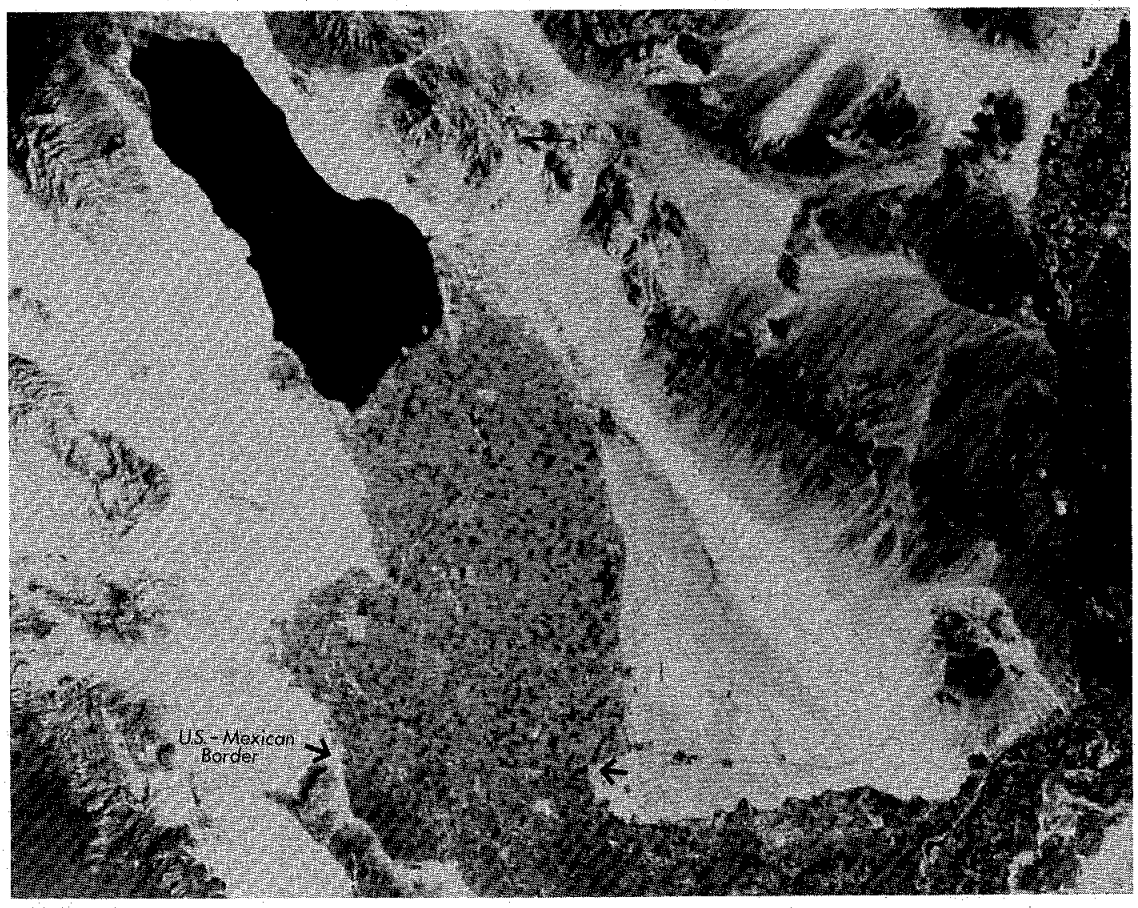

The Imperial Valley, California, photographed on the Apollo 9 Earth-orbital mission in 1969 at an altitude of 120 miles. Apollo photographs predated Landsat images, and were the beginning of repetitive photographic coverage of the earth from space.

Freshwater lakes intermittently occupied the Salton Trough from the Pleistocene Epoch to a few hundred years ago, according to Gordon Oakeshott in *California's Changing Landscapes.* The largest of the Ice-Age lakes, whose level was slightly above present-day sea level, was Lake Coahuila. Shorelines of this lake are readily apparent along the eastern side of the sea.

In 1901, an irrigation canal was dug from the Colorado River to the Imperial Valley. During the flood season in 1905, the canal was breached near its mouth at the Colorado River. The water eventually spilled northward through two dry washes into the Salton sink, forming the Salton Sea, photo upper left. The deltas of both flood courses form the concave area curving into the Salton Sea on the southeastern shoreline. Today, the shore of the Salton Sea is about 200 feet below sea level.

The checked patterns around the sea represent irrigated agricultural fields. Irrigation water is supplied by the All American Canal, the long narrow line intersecting the Colorado River, bottom photo right.

Because of different land-use practices, the U.S.-Mexican border is defined in the photo. Information on current Imperial Valley geothermal activity is in this *Hot Line* issue.

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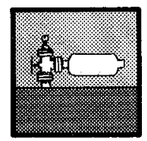

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Southern California

Geothermal Development in Imperial County

"We're very pleased that geothermal development is finally underway here in the valley," said Dick Mitchell, Planning Director for Imperial County.

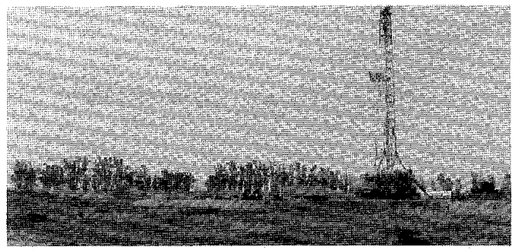
"Most environmentalists aren't opposed to geothermal development here. They see it for the economic boost it is," added Philip Shafer, Imperial County Planner.

These statements summarize the optimistic approach Imperial County takes to geothermal development.

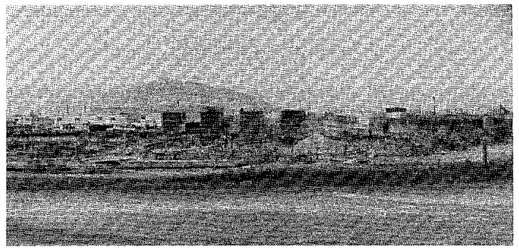
Shafer temporizes his views, however, by mentioning a possible "industrial feeling" resulting from power plant facilities. This could bring a certain loss of the agricultural and desert ambiance - which he terms "...an important consideration...."

Mitchell said that the Geothermal Element of the Imperial County Plan will be rewritten, and that the 18-month project will begin in January 1984. The county received a grant from the California Energy Commission to undertake the work, which includes rewriting the transmission and water regulation (injection) elements, as well.

Heber Power Plant Projects Underway



Drilling rig on the site of the dual-flash, 49 megawatt net power plant at Heber Geothermal field, in the Imperial Valley. Partners in the 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 planned power plant. Heber Geothermal is a joint venture of Dravo Energy Inc., a subsidiary of Dravo Corporation, and Centennial Geothermal Inc. Photos by Susan F. Hodgson.



Chevron U.S.A. Inc.-San Diego Gas and Electric Company 45 megawatt net binary geothermal power plant under construction at Heber. The site is just west of the dual-flash plant.

Contractor Awarded Binary Power Plant Project

A $4.2 million contract has been awarded to R. G. Fisher Constructors, Fresno, for foundation and structural work on the San Diego Gas & Electric Company Heber binary geothermal power plant in the Imperial Valley.

The Fisher company will install foundations for all the equipment required for the 45-megawatt plant. In addition, the contract is for the installation of large concrete pipe supports and structural steel supports and the underground electrical work, to be encased in concrete.

The contract also calls for Fisher to build steel platforms near certain plant facilities.

Dravo Constructors Inc. is the construction manager for the Heber project and will administer the R. G. Fisher contract.

Rate Increase for S.D.G.&E. for Heber Binary Plant

The California Public Utilities Commission has granted San Diego Gas & Electric Company (S.D.G.&E.) authority to increase electricity rates one-half of one percent (or $2,572,000 a year), to pay for its portion of 1983 projected expenditures at the geothermal binary power plant project at Heber.

The Heber plant is a demonstration project that will be the nation's first plant of its size to use binary-cycle geothermal technology. Because of the importance of the project nationwide, the United States Department of Energy is contributing to the cost, along with the Electric Power Research Institute, Southern California Edison, the State of California, the Imperial Irrigation District, and the California Department of Water Resources. Although its share of the cost is 50 percent, S.D.G.&E. will own 83.2 percent of the facility.

Heber Geothermal field is about 7 miles south of El Centro. The geothermal brine will be extracted from strata at depths of between 2,000 and 10,000 feet.

Sites exist to drill 50-to 60-wells for the two power plants. Initially, 9 production wells and 8 injection wells are proposed for the dual-flash plant and 13 production wells and 9 injection wells for the binary plant.

Both projects have a production island area and an injection island area. Three wells were drilled by Chevron between July and November 1982 for the dual-flash plant. Drilling should resume by the end of December 1983. Chevron began drilling wells for the binary plant on December 1, 1983.

Both projects are scheduled to be completed by mid-1985. At that time, the binary plant will undergo a 2-year demonstration period. Then, long-term operating plans for the plant will be made. The dual-flash plant will be considered a commercial producer once it begins operation, and will have no demonstration period.

Geology and Mineral Resources of Imperial County, California, (County Report 7, 1977), describes the Salton Trough geology. The publication is available for $8.50 from the California Division of Mines and Geology, P.O. Box 2980, Sacramento, California 95812.

Developing High-Temperature Geothermal Energy

"Anyone who wants to be in the geothermal business has to learn the utility business," said Al Cooper, Vice President of Chevron Geothermal Company of California. Cooper, addressing a gathering at the Ninth Workshop on Geothermal Reservoir Engineering sponsored by the Stanford Geothermal Program, spoke on constraints facing developers of high-temperature geothermal resources.

"Some constraints are technical," he said. These include learning how to manage fracture-controlled reservoirs, gathering resource assessment data, and understanding brine characteristics.

Some constraints are economic. As energy prices fall in general, so do the prices of geothermal energy. "Under present economic conditions," said Cooper, "the utilities don't need many more power plants and their customers continue to conserve energy."

"If utilities feel geothermal energy can't compete with other energy sources, we won't be able to develop it," he added.

"Any contracts negotiated to sell geothermal energy must include an adequate return for the utility and the producer. In California, the Public Utilities Commission (PUC) looks at these contracts and acts as an advocate for the rate payers," Cooper continued.

"We have to interface more with the PUC. We need its help. We need a more certain market to move this thing forward. We'll have to learn to work with the utility people, as well, so geothermal energy will be ready when the market is," he concluded.

Resurveying Project Underway

A new releveling of the Imperial Valley Geothermal Subsidence Detection Network is underway. The level net, consisting of about 200 miles of first order level lines and 270 miles of second order level lines, was last surveyed in 1980-81. This net was first run in 1971 and 1973, and extended in a 1975-1976 resurvey. In 1978, a releveling program by the National Geodetic Survey was tied to the survey net.

Due to the high cost of completing a total resurvey in one winter, Imperial County is using a four-phased approach. According to Bob Estes, Assistant County Surveyor, the north-south axis of the first order lines was run in 1982-83, and the east-west axis of these lines will be run in 1983-84. (Both are financed by the California Energy Commission grant and by Imperial County.) The next priority of the county will be to resurvey some of the second order lines, which extend to the borders of the cultivated areas.

The purpose of the network and periodic resurveys is to collect baseline data on the pattern of natural vertical changes, so that any impacts of geothermal production on surface elevation can be quickly noted and addressed.

During 1984 and 1985, the National Geodetic Survey will adjust and analyze data and prepare a report on the findings.

Concerning the network, Estes said, "I feel comfortable with our data. We have technically qualified people making the survey and adjusting the data. We have a firm network upon which we can depend."

Calipatria Industrial Parks

"We're making progress," said William Sorensen, City Planner for the City of Calipatria. "Things can go very rapidly once we know the magnitude

of the resource we have."

Sorensen was describing Calipatria's projected establishment of two geothermally heated industrial parks. The first would be built within a 100-square-mile area encompassing the city's school district.

Both parks will be established as public utilities, under state charter. The city will maintain shares in the ventures, which will be handled as common stock operations. Heat extracted from the binary system will be passed through a heat exchanger and sold to private enterprise. "We hope the users will become investors and thus care for the system," said Sorensen.

Many local industries are interested in the project, which will provide energy contractable over time for stable rates. Potential users include greenhouse operators and algae growers.

To date, a temperature probe hole has been drilled north of the city's airport. One will be drilled a few miles northwest of the airport, as well. The temperature probe holes are funded by grants from the Department of Housing and Urban Development ($25,000) and the California Energy Commission and the City of Calipatria ($104,000).

The city is looking for investors to fund the geothermal wells. The wells will not extend below 2,000 feet and the temperatures are not expected to be above 300°F. The optimum wellhead temperature for the project is between 175° to 230°F.

"The industrial parks will produce growth, job opportunities, and economic stability," said Sorensen. "We need an alternate economic base. Many other areas can do the same thing."

For further information, write Mr. Sorensen at 131 West Main Street, Calipatria, California 92233.

Geothermal Aquiculture in Coachella Valley

"We established Aquafarms International in the Coachella Valley," said Dov Grajcer, project manager, "because it offered the best chances for success on the hardest terms. Some difficulties come from desert conditions" Grajcer continued. "Little is known of how water and deserts interact. A 60° temperature differential can occur in a day. Also, the water here is high in calcium. However, we live near a market, labor is available, and land was relatively cheap. But, geothermal water is a key factor in our success, giving us great energy savings."

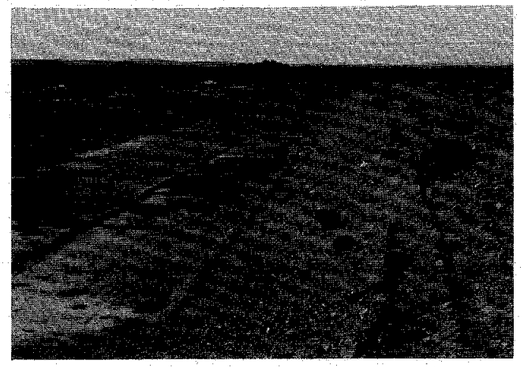
Malaysian prawns, bass, catfish, Japanese koi, and grass-eating carp are raised in the ponds at Aquafarms. Water from 3 geothermal wells and 5 irrigation wells is mixed in the firm's 61 ponds, with a combined water surface of 50 acres. Pond sizes vary from 1/10 acre to 2 acres. The water flows first to the prawn ponds, then cascades through irrigation pipes to ponds with the other fish.

The warmest geothermal well produces water at a temperature of 106°F with a TDS of 1,100 ppm. The second-warmest geothermal well -- perforated in a nongeothermal zone and a deeper, geothermal zone -- has geothermal water with a temperature of 93°F. The third has a temperature of 86°F. All 8 wells have a combined flow of 2,500 gallons per minute.

Aquafarms raises the prawns and fish to various stages of maturity depending on a customer's order. Most mature prawns are sold to gourmet restaurants in Los Angeles and Palm Springs. The company eventually hopes to supply young prawns and fish to other hatcheries.

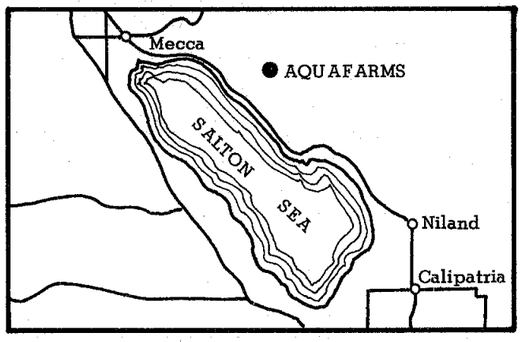
Aquafarms was established in 1975. In 1979, it received a U.S. Department of Energy (DOE) grant to demonstrate the feasibility of using geothermal water for raising prawns.

Eventually, the DOE will print a manual on the topic, written by Aquafarms.



A pond at Aquafarms, before and after it is filled with water.

Male Malaysian prawn at Aquafarms International. Photo by Susan Hodgson.



"The days of expansion for commercial fisheries are over," said Becky Broughton, Aquafarms Deputy Manager. "Our product has the advantage of year-round availability. Also, our prawns do not contain iodine, as they are raised in fresh water."

For further information, contact Dov Grajcer at (619) 393-3036, or write Aquafarms International, P.O. Box 157, Mecca, California 92254.

District Heating Project for San Bernardino

The City of San Bernardino, California, received a $2,750,000 grant from the California Energy Commission to finance a geothermal district heating system. Six city and county buildings will be heated with the geothermal water. Nine public buildings and complexes along with 18 private facilities are potential users of geothermal heat.

The granted amount converts to a loan in 1985, with a 10.8 percent interest charge. The loan is to be repaid to the state over a 10-year period.

Naval Geothermal Studies Undertaken

The geothermal potential of land beneath several Southern California U.S. Naval facilities is being evaluated by geologists from the California Division of Mines and Geology.

Under an $80,000 grant from the U.S. Department of Energy, on behalf of the Navy, the geologists are measuring temperatures of hot oilfield brines beneath the Long Beach Naval Shipyard and the Seal Beach Naval Weapons Station. A brief reconnaissance of geothermal potential beneath Naval facilities in the San Diego area is also being undertaken.

The Navy wishes to learn what the direct heat potential is beneath its properties. Once this is determined, decisions for utilizing the energy will be made.

For further information, contact Chris Higgins at (916) 322-9997.

Northern California

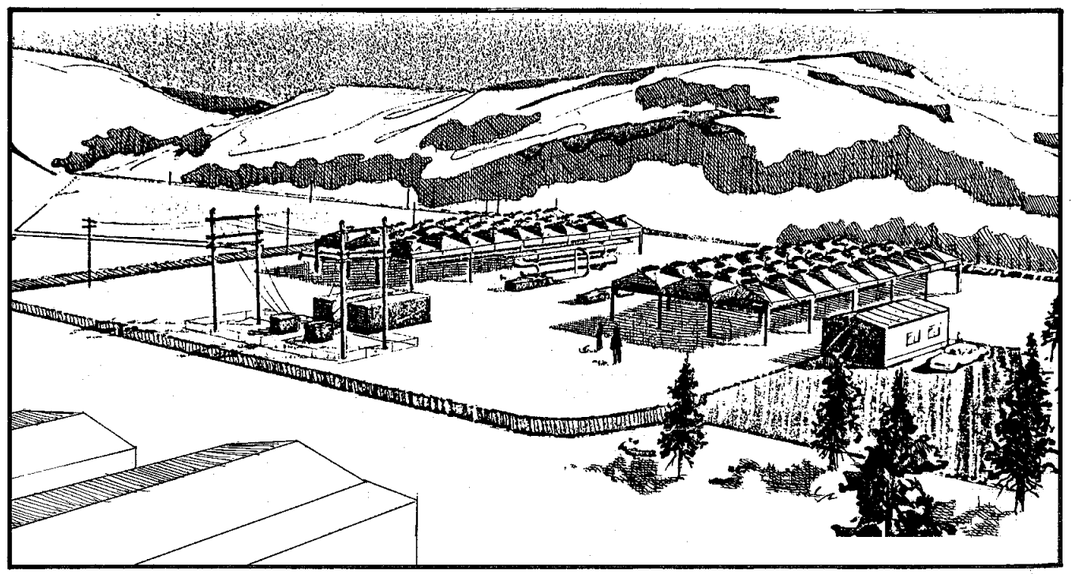
Binary Project at Mammoth Lakes

A 7 megawatt geothermal power plant is under construction near Mammoth Lakes, California, at Casa Diablo Hot Springs by the Ben Holt Company, on property owned by Magma Energy, Inc. Construction is by Kennebec Construction Company, a Holt subsidiary.

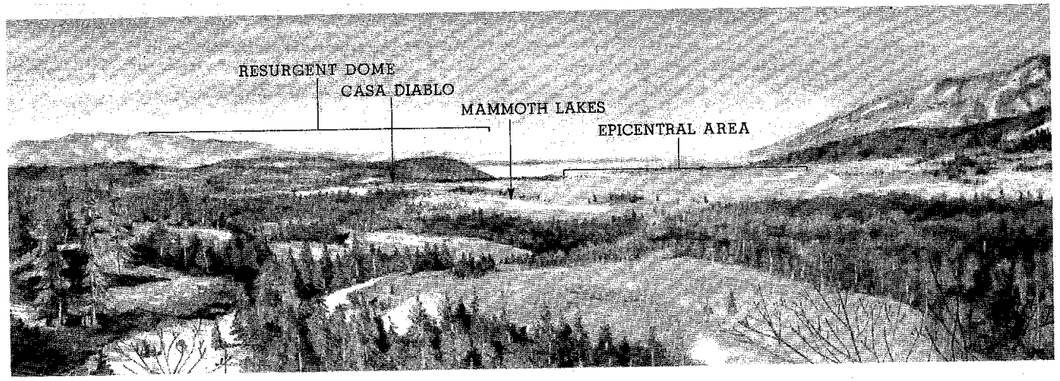
The facilities are owned by Mammoth-Pacific, a joint venture of Pacific Energy Resources Company and Mammoth Binary Power Company. Pacific Energy Resources Company is a subsidiary of Pacific Lighting Corporation. The general partner of Mammoth Binary Power Company is Holt Geothermal Co., an affiliate of The Ben Holt Co. Mammoth Binary Power Company is managing the project.

The design of the plant is based on Magma's patented Magmamax process, which has been demonstrated at Magma's 10 megawatt plant in the Imperial Valley. Under the Magmamax process, isobutane is heated under pressure by hot water in a tubular heat exchanger. The vapors are expanded in a turbine, condensed by cooling with air, and pumped back to the heat exchangers in a closed circuit.

Site preparation and grading began in August 1983 and the project is scheduled for completion in August 1984. The electricity produced at the power plant will be sold to Southern California Edison Company. The electricity generated at the plant will supply about one-third of the summer load of the Mammoth Lakes area and one-sixth of the winter load. The geothermal hot water used in the process will be supplied from wells drilled by Mammoth-Pacific.



The proposed binary geothermal power plant near Mammoth Lakes, California.



The U.S. Geological Survey placed the Mammoth Lakes region, which is within the Long Valley caldera, under formal warning of potential volcanic hazard in early 1982. This means "the outbreak of volcanic activity is a possibility but by no means a certainty."

Casa Diablo Hot Springs, near Mammoth Lakes, is the site of a geothermal binary power plant project, now underway.

Scientists have new evidence that magma from an 8-kilometer-deep chamber is forcing itself into rock as shallow as 3 kilometers. The activity is causing earthquakes and swelling the earth's crust. According to an article in the 7/10/83 issue of Science by Richard Kerr, researchers accept the expansion of the magma chamber as indisputable and view shallow magma intrusion as plausible, even probable.

Illustration from left to right: the resurgent dome overlying the magma chamber and the center of the current uplift; Casa Diablo Hot Springs, site of the geothermal power plant; Mammoth Lakes; and the epicentral area of the 1980-1982 earthquake swarms.

Five wells have been drilled at the site: 4 production wells and 1 injection well. A second injection well may be drilled in 1984.

Features of the power plant include:

Geothermal fluid produced as a liquid with 100 percent injected back into the reservoir. No steam is produced.

Isobutane in a closed circuit never exposed to the atmosphere.

Atmospheric air, not water, used for cooling. The process uses no water and expels no vapors to the atmosphere from a cooling tower.

The plant will occupy fewer than 3 acres of ground and will have a maximum height above grade of about 25 feet.

The cost of the project is estimated at $12,500,000.

"The Mammoth project is an excellent example of meeting expanding power needs of a community by generating that power from local geothermal resources," said Ben Holt. "This project is a world's first in its use of modular construction on a significant scale. The essentially emission-free design will harmonize with the surrounding terrain," he added.

Further Sonoma Valley Studies

The geothermal potential of the Sonoma Valley continues to be studied by geologists from the California Division of Mines and Geology (see July 1982 Hot Line).

Presently, 7 grid patterns of 4-to 5-foot temperature-probe holes are being drilled in the valley by CDMG geologists. The 7 gridded areas contain either known warm-water wells, hot springs, or faults tentatively located by geophysical methods.

The downhole temperatures of the holes are measured. The results will be plotted to see if a pattern of relatively high temperatures emerges.

For further information, contact Forrest Bacon at (916) 322-9918.

Susanville Project Dedicated

On October 14, 1983, about 2 years after the groundbreaking ceremony for geothermal production well "Johnston" 1, State Senator Ray Johnson dedicated the new geothermal space heating, laundry, and hot water system at the California Correctional Center-Susanville. Payback for the system is estimated at 4-to-5 years, with initial costs of the geothermal energy at about two-thirds the cost of oil, decreasing to one-half the cost in 9 years.

Eventually the 180°F geothermal water piped through the correctional facility will be cascaded at 150°F into a Park of Commerce.

Very Productive Well Drilled at The Geysers

The most productive well in The Geysers Geothermal field is a new well just completed by Aminoil USA, Inc. Well "MLM" 4 was completed in Sec. 35, T. 11N., R. 8W. The well tested at about 460,000 pounds of steam per hour. The productive interval was between 3,567 feet and 5,892 feet in the 5,892 foot-deep well.

New Power Plant On Line

In late November 1983, power plant SMUD Geo #1 began operations at The Geysers Geothermal field. Operated by the Sacramento Municipal Utility District, the plant has a gross electrical generating capacity of 72 megawatts and a net capacity of 65 megawatts. The plant's operation raises the field cumulative net total capacity to 1,302 megawatts of electricity.

The plant is rated at a steam delivery of 1 million pounds per hour. The plant is powered by steam extracted from 11 Aminoil USA, Inc. wells, which are connected by about 12,000 feet of flow lines.

The power plant includes a Stretford H_2S abatement system. A secondary treatment system using hydrogen peroxide is used to remove hydrogen sulfide from the condensate.

According to Energy Watch, published by the California Energy Commission, 3.7 percent of the electricity (1,157,745 megawatt-hours) sold by California Public Utilities for the months of April, May, and June 1983 was generated from geothermal resources.

Most of this electricity was generated in The Geysers Geothermal field.

Reservoir Definition Study of The Geysers

"With this project, the northern, northwestern, and southeastern limits of the field may be defined," said Dick Thomas, California Division of Oil and Gas (CDOG) engineer. "The other boundaries are known with more certainty," he added.

Thomas referred to a CDOG heat-flow and reservoir definition study of The Geysers Geothermal field.

"A heat-flow map may be used as a planning tool in deciding where geothermal wells can be drilled, power plants sited, and power lines located," Thomas added.

One part of the study will be to correct well temperature data for topographical conditions. Measured temperature gradients for wells

drilled near mountain tops or valley bottoms cannot be correctly extrapolated to the depth of the reservoir, since the well temperatures show the effects of heat losses or gains due to the uneven topography. Heat originating at great depths preferentially flows through the valley bottoms rather than at the mountain tops.

Also, thermal conductivity values for 180 well cutting samples from The Geysers will be determined in the study.

The CDOG study is partially funded with a $14,000 grant from the U.S. Department of Energy.

Nevada

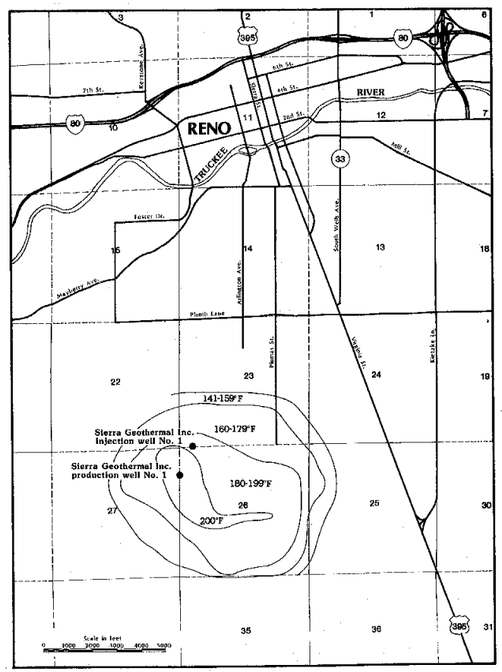
Reno Subdivision Geothermally Heated

by David Carlson
William E. Nork, Inc.

Two wells were drilled and completed in southwestern Reno, Nevada, near Warren Estates, another geothermally heated subdivision (see July 1982 Hot Line). The wells are part of a system that will supply geothermal water to as many as 400 homes in that area. Pipes to distribute geothermal water will be laid throughout the subdivision. Homeowners may choose to retrofit home heating systems with heat exchangers to take advantage of the geothermal energy. A production well and an injection well have been drilled. As need arises, additional production and injection wells will be drilled and tied into the system.

Both wells are owned by Sierra Geothermal Inc. They were designed by William E. Nork, Inc. and drilled within the Moana KGRA. The 653-foot deep production well had a bottom hole temperature of 207.8°F when it was drilled in November 1980. During a pumping test undertaken in September 1983, the well yielded over 150 gal./min. of 215°F water.

In September 1983, the injection well was drilled and completed about 1,000 feet northeast of the production well to a depth of 895 feet. During the pumping test, the well yielded 200 gal./min. of 178°F water. Calculations show that this well can accept at least 120 gal./min. of spent geothermal fluid.



Isotherm map of the Moana Geothermal Resource Area, south of Reno, Nevada. The western portion of the isothermally delineated area is the site of a subdivision to be heated with geothermal energy. The central portion of the area is the site of Warren Estates, another geothermally-heated subdivision.

The temperature gradients were calculated by David E. Carlson of William E. Nork, Inc.

Nevada Geothermal Industry Can Export Electricity

The 1983 session of the Nevada Legislature passed legislation allowing geothermal developers to export larger amounts of electrical energy from Nevada.

In the past, producers of electricity from geothermal resources were required to make:

-- 50 percent of their production capacity available to utilities located within the area and within the state; or

-- Permit those Nevada utilities to recapture up to 50 percent of production from out-of-state utilities that had contracted to purchase the electricity from the geothermal producers.

Geothermal developers and the Nevada Mining Association members testified the restriction has discouraged investment towards the huge capital outlays needed to establish a geothermal-electrical utility in Nevada. They said Nevada-based utilities may not be able to purchase their half of the shares. Moreover, prospective out-of-state purchasers of geothermally generated electricity may find it uneconomical to contract for the energy if they are not guaranteed 100 percent of production.

The legislation, A.B. 592, now reads:

> "In case of geothermal projects, the construction permit (from the state) may be conditioned only on a prior offering of the capacity of the project to the public utility in this state which primarily serves retail customers in the service area nearest to the proposed project; and if the offer is declined, the applicant is free to export the capacity of the project without any obligation to re-offer that capacity to any public utility in this state."

The legislation was opposed by representatives of Nevada electrical utilities.

Utah

Utah Well a Surprise

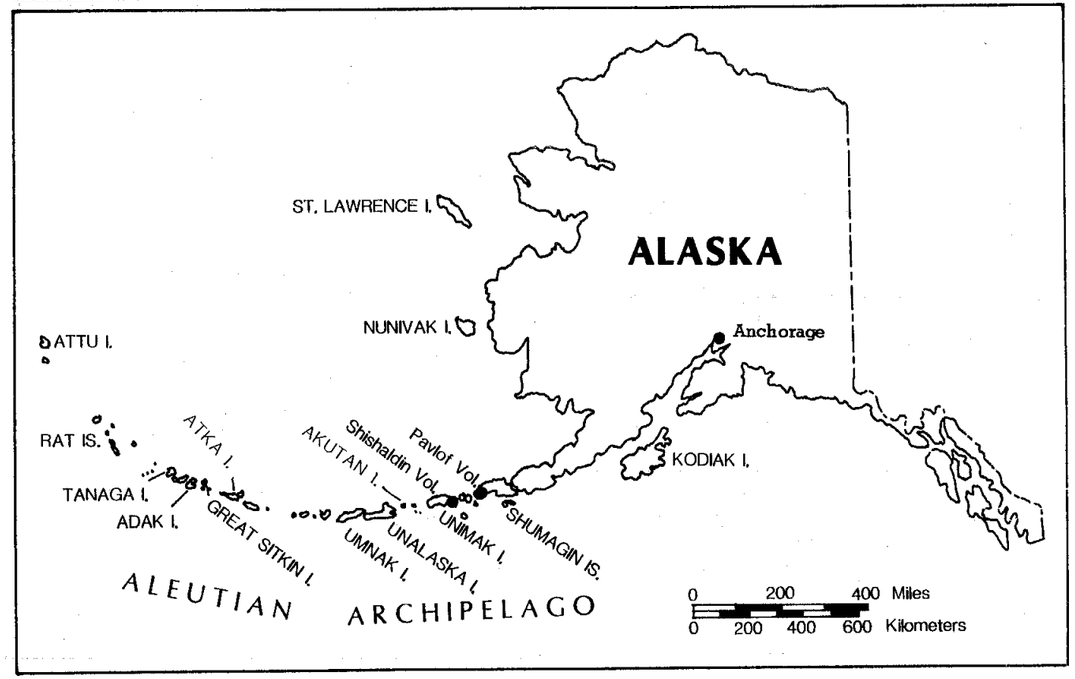
A geothermal well drilled 20 miles north of Beaver, Utah, unexpectedly penetrated a steam pocket at a depth of less than 1,200 feet. Steam temperatures in the well were above 400°F. The discovery was quite unexpected, as the well was drilled less than 1,400 feet from 1 of 4 wells drilled by Union Oil Company, none of which penetrated steam reserves with temperatures above 350°F.

The well, which blew out on October 24, 1983, was drilled by Mother Earth Industries, a small, family-owned company. Wayne Portanova, company president, said that the volume of steam and its shallow depth were two surprises. He said steam from the well could produce 5 to 10 megawatts of electricity from a flash system or 15 to 20 megawatts from a binary system. The original plan of the company was to install a 1.8 megawatt generator on a well to supply electricity to the City of Provo.

Until the Mother Earth well was drilled, the City of Provo was considering purchase of the 160-acre Ribgy coal property in Emery County, according to an article in The Oil Daily. The coal was to be used to fire a new, proposed city power plant. The geothermal energy was to be a supplementary power source. Now, says Provo Mayor Jim Ferguson, the geothermal well will take care of the city's power needs well past 1990.

The well was capped in November 1983, and a new well planned for a location 250 feet east to determine the extent of the reservoir. Ray Gould, a drilling engineer at the well site, said a power plant could be in operation by August 1984.

Alaska



Aleutian Archipelago, Alaska.

Unalaska Island Well Completed
(Adapted from Alaska Mines and Geology)

The first Alaskan geothermal well to successfully produce steam was recently completed at the Makushin Geothermal field on Unalaska Island, 900 miles west of Anchorage.

The Makushin field, 12 miles west of Unalaska Village on Unalaska Island in the Aleutian Island chain, was studied by the Alaska Division of Geological and Geophysical Surveys (DGGS) in 1980 and 1981.

The number and distribution of thermal areas east of Makushin volcano and the chemistry of thermal waters and gases emanating from the thermal field indicate that a significant and widespread geothermal resource may exist at Makushin. Subsequent studies show that temperatures in the geothermal reservoir exceed 375°F, and could reach 572°F.

On the basis of highly promising DGGS findings at the Makushin Geothermal field, the state funded a major geothermal drilling program in 1981. The program purpose is to confirm the existence of a geothermal resource suitable to produce electrical energy needed by the island, and to drill a production well.

The program is administered by the Alaska Power Authority. In consultation with DGGS, the Power Authority selected Republic Geothermal, Inc. (RGI) of Santa Fe Springs, California to drill and test the wells.

A preliminary model of the geothermal resource area developed by DGGS and RGI was used to help site three thermal-gradient holes that were drilled in 1982. One of these holes, drilled to a depth of 1,500 ft., confirmed that resource temperatures exceeded 385°F.

Funding limitations precluded drilling a major production well, but a 3-in. diameter exploratory well was drilled to confirm reservoir fluid productivity. Drilling began on the well in June 1983 near the head of Makushin Valley, at an elevation of 1,200 ft. The well site was chosen on the basis of exploratory work by DGGS and RGI, and on the accessibility of the site to Unalaska Village.

Artesian well

In late August 1983, the well penetrated a fracture in the plutonic reservoir rock at a depth of 1,950 ft. (nearly 750 ft. below sea level). The fracture contained 375°F hot water.

Water and steam flowed from the well at a rate of 50,000 lb/hr. The temperature and flow from the 3-in. diameter pipe are estimated to be sufficient to produce 0.5 megawatts of electricity. Two standard production wells of 9⅝ in. diameter could generate up to 10 megawatts of electrical power, enough to meet the needs of the Unalaska community. Hot water from the well could also be used for direct-heating applications.

DGGS geologist Roman Motyka believes much hotter temperatures are likely to be found deeper in the system. He said hotter temperatures would make the generation of electricity more efficient if fluid productivity from a deeper reservoir equals that from the 1,950-ft. zone.

Preliminary analysis indicates the thermal water contains high concentrations of alkali-chlorides and has a salinity about one-fourth that of ocean water. Such concentrations are typical of hot-water geothermal systems. Rock cores from the well will also be examined, but this will take longer, said Motyka. The two studies will provide better data on deep reservoir temperatures and conditions, information necessary if and when the geothermal field is put into production.

In addition to Unalaska, DGGS has identified other locations in the Aleutian Islands with highly promising-to outstanding-geothermal resource potential. These include Akutan Island, northeast Atka Island, and Umnak Island.

Bonneville Power Administration

BPA-WSEO Agreement Signed

On September 23, 1983, John Spellman, Governor of the State of Washington, and Peter Johnson, Administrator for the Bonneville Power Administration (BPA), announced signing a $500,000 agreement for the Washington State Energy Office (WSEO) to lead a study aimed at the identification and analysis of the region's geothermal energy potential.

WSEO will provide the technical and administrative coordination of the 18-month project, which will be conducted cooperatively with the other states in the BPA area. Agreements will be completed with Oregon, Idaho, and Montana to carry out much of the work.

According to Richard Watson, Director of WSEO, "This is the first in-depth analysis of the region's geothermal energy resources. It is important not only to the long range planning efforts of BPA, but also to the implementation of the Northwest Regional Power Plan." (See Hot Line, July 1983.)

The program will provide information on the availability, timing, and costs of geothermal energy for electrical generation, and identify how much future electrical generation may be offset through direct utilization of the region's geothermal resources. BPA will also be provided with information on institutional factors and legal restrictions that may affect the development of the resources.

For more information, contact Dr. R. Gordon Bloomquist, Program Coordinator, WSEO, 400 East Union, Olympia, Washington 98504, (206) 754-0774.

Federal Programs

DOE's Current Geothermal Reservoir Programs and Comments on International Cooperation in Hydrothermal Research

Ronald S. H. Toms

United States Department of Energy (DOE)
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Presented on December 13, 1983 at the Ninth Workshop on Geothermal Reservoir Engineering, at Stanford University.

ABSTRACT

DOE's geothermal program continues to emphasize a range of reservoir-related programs in reservoir definition, brine injection, stimulation, hot dry rock, geopressured resources and, now, magma resources. These programs are described briefly. Programs in international cooperation between the U.S. and 23 other countries on hydrothermal research have produced important gains in knowledge over the past ten years. Although the activity has diminished, a resurgence is anticipated.

CURRENT RESERVOIR-RELATED PROGRAMS

DOE's interest in geopressured resources is to determine the economics and to provide a technology base that industry will exploit. The three existing deep wells that were drilled in the Gulf Coast geopressured reservoirs will be continuously flow-tested this year to determine the drawdown and changes in fluid composition and gas content. EPRI is planning a total energy extraction experiment that will give further impetus to industry involvement.

In hot dry rock we plan this year to complete the Phase II thermal loop at Fenton Hill, New Mexico, to the originally planned size, and to begin extended operation of the loop to assess reservoir longevity, operating performance and environmental effects. We also plan to model the reservoir that we will have created.

Our experimental work in well stimulation was completed last year, and this year we will study the lessons learned and perform additional analyses of new techniques before embarking on more experimental work. However, through our hard rock penetration research studies we have identified the use of a tailored-pulse loading, by a slow-burning propellant, as a promising technique, and work on this will proceed.

Brine injection technology has become an important program in hydrothermal research. We will continue to develop tracer, geophysical and modeling techniques to monitor and predict migration of spent brines injected into reservoirs. We will also continue the development of chemical conditioning methods to prevent unwanted chemical reactions in the well and in the adjacent injected zone. We plan to develop well completion technology to enhance the acceptance of injected brines by the well and thus extend its useful life.

Our efforts on reservoir definition will continue on many fronts. We will continue the development and validation of reservoir models capable of predicting productivity and depletion rates. We will evaluate surface and subsurface geophysical techniques capable of mapping natural fracture systems within reservoirs. Specific study areas will include Cerro Prieto and Los Azufres, Klamath Falls, the Newberry Caldera and others to be determined.

Under our State assistance programs we will continue programs in resource assessment,

resource development, technical assistance and technology transfer. There will be an emphasis on high temperature resources, especially the Cascades and other prospects associated with shallow magma bodies.

In conjunction with reservoir productivity we are continuing the work in two-phase flow in the well-bore. This includes studies into the fundamental phenomena in facilities using freon and air-in-water to simulate well-bore conditions.

As part of our effort in hard rock penetration research we are developing techniques for precise borehole mapping. We have already adapted an inertial navigation system to map a relatively cold well-bore, and temperature hardening is the next step.

The proposal last year to provide a hole-of-opportunity in the Salton Sea for scientific research, under the Continental Scientific Drilling Program, has resulted in funding that will be used for a competitive solicitation for deepening or drilling a well to 18,000 feet in the Salton Sea KGRA. It is anticipated that this effort will provide valuable geothermal research into the understanding of the formation of the Salton Sea geothermal anomaly, the nature of any underlying reservoirs, and new estimates of geothermal potential, as well as a variety of important answers in the earth sciences.

Finally, we are this year taking an engineering look at the potential for magma energy extraction. The scientific feasibility for this was established by the "magma tap" experiments at Kilauea Iki in Hawaii. We will review the candidate shallow magma bodies in the continental U.S. to evaluate their characteristics and location. We will estimate the cost of drilling and extracting energy from selected prospects, and consider their potential economics with regard to potential users and transmission lines. If the estimates are sufficiently promising we will then plan a definitive experiment for the future.

INTERNATIONAL COOPERATION

In view of the international theme of this meeting and the presence of so many distinguished geothermal experts from around the world, I will now give a short review of DOE's cooperation in international research. A meeting such as this one is an ideal forum for experts to exchange information. The world's geothermal community has a good record of informally sharing its research results, but as you know there are other, more formal ties between nations through which even closer interactions among researchers are fostered. Specifically it is DOE's cooperative agreements in geothermal energy and the outlook for the future that I will now discuss.

Since the days of its predecessor agencies, the Atomic Energy Commission and the Energy Research and Development Administration, DOE has actively pursued international cooperation in geothermal research. Ten years ago, in 1973, we joined with Iceland in a program of information exchange on direct heat applications and advanced energy conversion systems. Also in that year the United States was a party, along with fourteen other countries, in a geothermal pilot study sponsored by NATO's Committee on the Challenges of Modern Society (CCMS). This study examined a broad spectrum of geothermal topics including reservoir assessment, direct heat applications, small power plants, and hot dry rock.

The NATO-CCMS pilot study was a benchmark for future international cooperation in geothermal research. During the past decade nearly every international agreement concerning geothermal energy came about, either directly or indirectly, as a result of this pioneering effort. Not only was international cooperation stimulated, but the study spawned a renewed awareness in many countries of geothermal energy's potential. While perhaps not contributing directly to power on line, the NATO-CCMS work highlighted the many benefits of joint research among nations while also promoting geothermal energy as a real alternative in a petroleum-based world economy.

DOE perceives at least four principal values or benefits from its international cooperative agreements. First of all, such agreements enhance our domestic research programs by bringing a larger pool of talent and data to bear on technical problems. For instance, the knowledge we have gained about production from a liquid-dominated field through our bilateral agreement with Mexico will serve as a model for production in the Imperial Valley.

Secondly, we realize substantial cost savings through task sharing. The outstanding example of this benefit is our IEA Cooperative Agreement with Germany and Japan in hot dry rock technology. Under that agreement Germany and Japan each contribute up to 25 percent of the budget to operate the Fenton Hill Project in New Mexico. In return, both countries receive all project findings and may assign scientific and technical personnel to work with LANL Fenton Hill for extended periods.

The remaining benefits of our cooperative agreements are less tangible but no less important. We believe that cooperative R&D in alternative energy sources will encourage and accelerate a transition from dependency on imported oil and gas, thereby increasing this nation's and other nations' energy security. Lastly, but an important benefit, we regard our cooperative projects as a most positive step to improved relations between the U.S. and other nations.

Since the NATO-CCMS study, DOE has participated in ten other international cooperative arrangements. Of these, six were direct, bilateral agreements; the remainder were agreements involving three or more countries conducted under the auspices of an umbrella organization such as the IEA. The eleven agreements involved a total of 23 other countries. Italy has participated with us in four

of those agreements, while Mexico, Japan, and Germany each have been party to three.

Whereas the legacy of international cooperation over the past decade has been rich, we have apparently reached a low point in that cooperation. Of the eleven agreements mentioned before, only two are actually active at present: (i) the IEA Agreement on Hot Dry Rock Technology and (ii) the bilateral arrangement between DOE and ENEL (Italy). Even the DOE-ENEL agreement, probably the one having the most interest to reservoir engineers, has been largely inactive of late while new tasks are being negotiated.

A number of reasons can be cited for the slackened interest in cooperation on geothermal research. The recent worldwide oil surplus coupled with a pervasive recession caused many nations to reevaluate their energy research programs. With fewer incentives and less funds for research, many countries chose to deemphasize their international programs; greater emphasis was placed on purely domestic R&D activities. During this period DOE strived to fulfill its international commitments. The Department was reluctant, for budgetary reasons, to assume new obligations.

Although, today, budget constraints are still very much present, DOE understands the usefulness and importance of cooperative research and development. Some of geothermal's remaining problems can best be solved through the combined efforts of experts from many countries. Accordingly, we are negotiating a new U.S.-Mexico Agreement covering both the Cerro Prieto and Los Azufres fields.

We particularly endorse arrangements which maximize information exchange among countries working on similar technical problems. In this regard DOE has begun negotiations with the United Kingdom's Department of Energy on a comprehensive program of information exchange in hot dry rock technology.

The benefits of international cooperation and technology exchange among nations are again being evaluated. We predict that the next decade will witness a revitalization of many past ties in cooperative research and the forging of new ones. Certainly experience has taught that no single country can solve all technical problems confronting us, and that by working together we will reach solutions a great deal faster.

BLM Geothermal Activities

In Executive Order 3087, the Minerals Management Service (MMS) was combined with the Bureau of Land Management (BLM) for onshore mineral production management. Three BLM offices address the exploration and development of geothermal steam in California. The offices are in Sacramento, Riverside, and El Centro.

Some of the activities are identical to the activities of the old Minerals Management Service. The Office of the Associate State Director of Minerals, Fluid Minerals Branch, will handle geothermal resources. The California Desert District at Riverside will have an Assistant District Manager of Mineral Resources to handle all of the actions formerly done by MMS within the Southern California Region. The Resource Area Office in El Centro will have a geologist and a staff to process any actions that are proposed in the field with reference to prelease and post-lease activities. The merger was completed by June 8, 1983, with the geothermal staff essentially the same staff once with MMS.

The BLM has worked towards making Imperial County federal land resources available for leasing. BLM lands include the Glamis and Dunes KGRA's, most offshore resources in the Salton Sea KGRA, some scattered tracts within the Brawley KGRA, a few acres in the Heber area, and a significant block of lands in the East Mesa KGRA. There are some noncompetitive areas in addition to the KGRA's. The Desert Plan is the master plan for resource allocation and leasing of geothermal steam. Many of the noncompetitive areas are in the Yuha area, near Kane Springs, and in the Chocolate Mountains area according to Roger Zortman, BLM, who presented these data at the Imperial County Geothermal Development meeting in May 1983.

BLM geothermal regulatory operations in Imperial County are headed by Peter Ertman. Ertman, Branch Chief for Resource Program Operations, says his office regulates geothermal preleasing, drilling, production, abandonment, and power plant activities on federal lands in the valley.

To date, about 20 geothermal wells

(not all active and some abandoned) fall under BLM purview in the valley.

Ertman says there are two types of geothermal leases managed by his office. Leases in KGRA's are issued through a competitive bidding process. The fee is $2.00 a year per acre, plus a royalty percentage, plus a bonus bid. Noncompetitive leases are issued for lands outside of KGRA's. Applications for noncompetitive leases are submitted over-the-counter, and a BLM decision on the proposals is released in 90 days. The leasing fee is $1.00 per acre per year.

According to Bruce Hellier, BLM Fluids Branch Chief, Minerals Resources Division, the BLM receives more revenue from California geothermal leases than from onshore oil and gas leases in the state. About $6 million is expected by the BLM in 1984 in royalty income from California geothermal leases.

BLM Areas of Mineral Potential

The U.S. Bureau of Land Management (BLM) is inviting recommendations from both the public and industry nominating "Areas of Critical Mineral Potential" (ACMP). Geothermal resources are considered "minerals."

The move stems from President Reagan's April 5, 1982, report to the Congress on his National Materials and Minerals Management Program Plan calling for an invitation to the public to nominate areas of high mineral interest. Nominations will be used to identify areas of critical mineral potential for priority withdrawal review. There is no time limit for such recommendations.

Robert F. Burford, director of the BLM, said that information gathered in the process will help to stimulate review of areas presently withdrawn or "off-limits" to energy and mineral entry or development. The nominations will also provide a basis for negotiating access to minerals on public lands withdrawn by other agencies.

Withdrawn areas in Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming can be nominated, except for Indian reservations and other Indian holdings; lands in the National Wildlife Refuge System; and other lands administered by the U.S. Fish and Wildlife Service, National Park System, Wild and Scenic Rivers System, National System of Trails, and designated wilderness areas. Areas within BLM or Forest Service Wilderness Study Areas may be nominated and will be treated as part of the wilderness study program.

Nominations should be in the form of a letter written as specifically as possible and including the following information:

1. Minerals of interest.
2. A map or land description showing the area nominated.
3. A brief statement of the rationale for the nomination, i.e., mineral occurrence or exploration potential.
4. A brief description of the nature and the effect of the withdrawal or segregation, if known.
5. The name, address, and telephone number of a person who may be contacted by BLM to review the nomination.

Geologic maps, cross-sections, and sample analyses may be included. Published literature and reports may be cited in support of the nominations. Any data considered confidential should be appropriately marked. Nominations should be limited to no more than three typewritten pages excluding any maps or bibliographic materials. Send nomination to: Director (690), Bureau of Land Management, 1800 C Street, N.W., Washington, D.C. 20240.

After Washington Office review, nominations will be sent to BLM State and District offices for processing. Each party making a nomination will be notified of the action BLM plans to take regarding the nominated area.

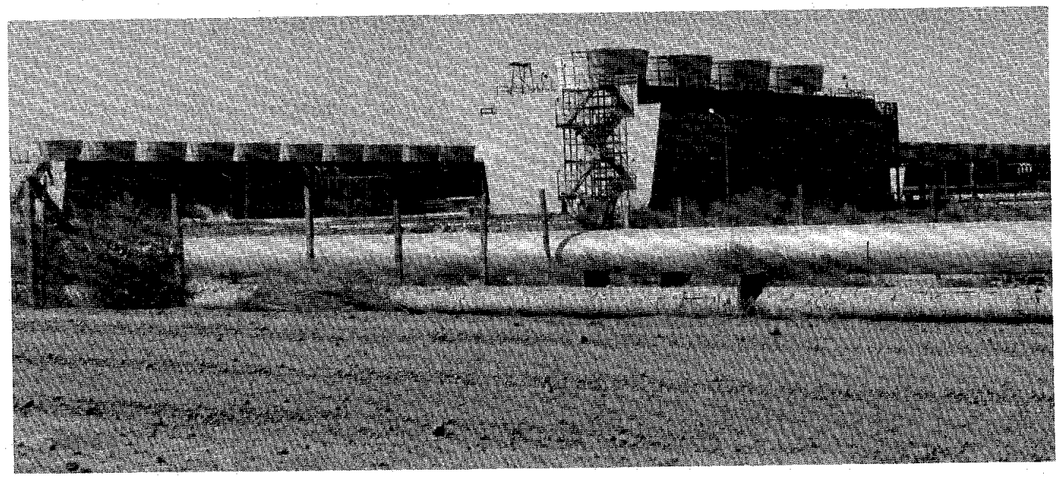
Cerro Prieto

Cerro Prieto Geothermal Field
by Susan F. Hodgson

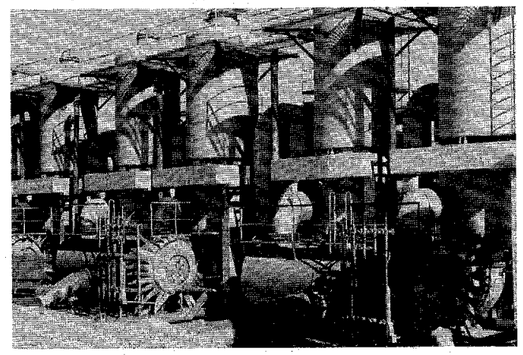
Cerro Prieto Geothermal field is in a flat, poorly drained area of the Mexicali Valley, about 35 km south of Mexicali, Baja California.

The photo was taken in the southern end of the field where there are mud volcanoes and hot springs.

There are over 110 wells in the field, which is being expanded to the east.

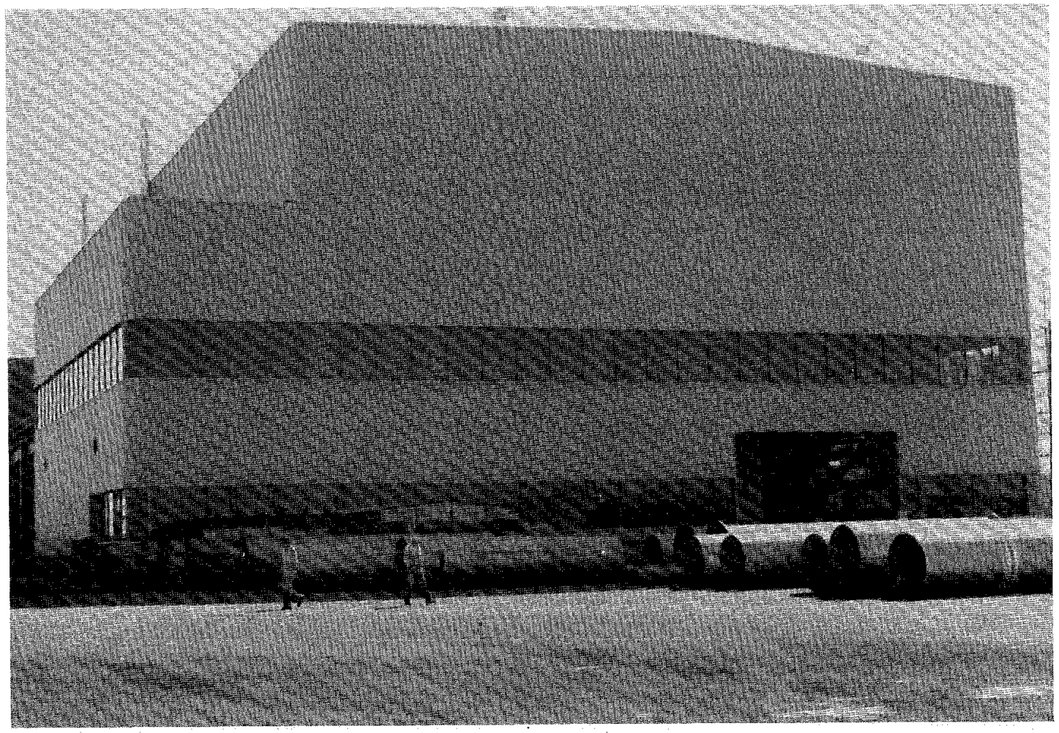


Cerro Prieto 1 is a 180 megawatt geothermal power plant. The two larger plant units produce 150 megawatts of electricity. They are operated with high-pressured steam, flashed at the wellhead and piped directly to them.

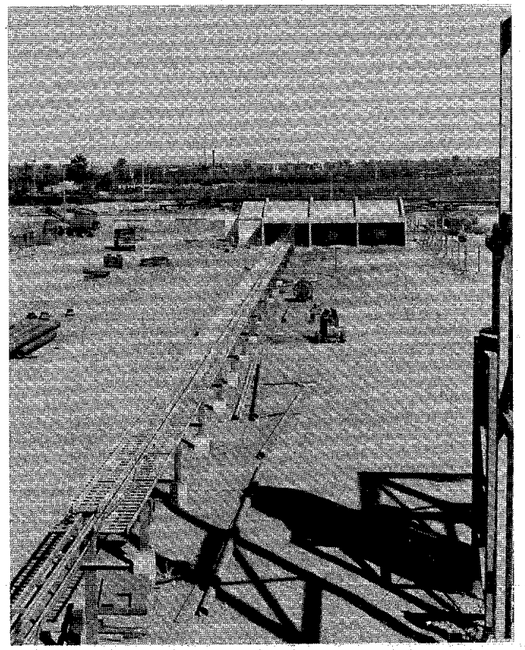


The smaller, 30 megawatt unit is operated with medium-and low-pressured steam. This steam is flashed from hot water collected from the wells and brought to this gathering station.

The remaining brine is pumped from the gathering station into the large holding pond.



Cerro Prieto power plant Unit 2, under construction. The plant, with two - 110 megawatt units, will cost about $118 million dollars. Toshiba turbines will be used.



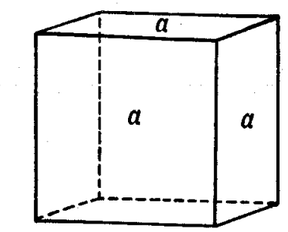
The pathway along which steam from 25 wells will be piped into Cerro Prieto 2. The plant is scheduled for completion in February 1984.

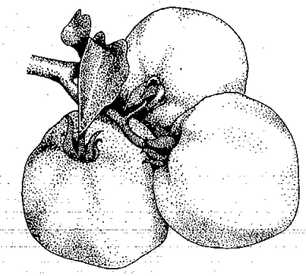
Cerro Prieto 3, an identical plant, will be built a few miles north of Cerro Prieto 2, and slightly northeast of Cerro Prieto 1. Cerro Prieto 3 is scheduled for completion in 1985, and will bring the field to a total generating capacity of 620 megawatts.

Little injection has occurred in the field. However, once Cerro Prieto 2 and 3 go on line, injection programs will begin. This is necessary because the power plants are next to farming areas.

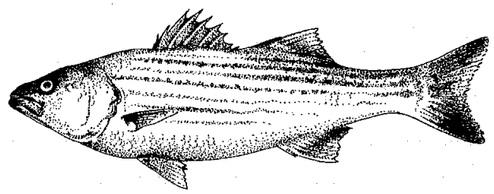
The total dissolved solids in brines from the field are between 4,000 to 4,500 ppm.

Projects underway at Cerro Prieto to use the by-products of field geothermal activities include the extraction of potassium chloride from geothermal brines. In 1984, the government plans to begin full-scale operations to extract about 100,000 tons per year of KCl from the brines -- about the total Mexican demand for the product. The KCl will be sent to fertilizer plants throughout the country.





In a hydroponics project at the field, squash, tomatoes, and other vegetables are grown in greenhouses that use geothermal water piped in from the cooling towers.



Also at the field, prawns, striped bass, and other fish are raised in a series of demonstration ponds. The pond water is heated by pipes filled with hot geothermal brine.

Canada

Canadian Geothermal Exploration Rights Awarded

A Canadian company, O'Brien Energy and Mines Limited, received the first geothermal exploration rights to be awarded in Canada.

The geothermal permit, advertised as Parcel No. G3 with 8286 hectares of Crown rights in the Mt. Cayley area, is about 100 kilometers north of Vancouver. The award was based on what was considered to be the best proposed geological or geophysical exploration and exploratory drilling program.

O'Brien will undertake yearly commitments over a five-year program that, if successfully completed, will require expenditures up to a maximum of $4,249,720.00. In the event that the company does not meet each of the yearly commitments, the geothermal permit will be cancelled.

O'Brien Energy and Mines Limited has extensive experience in geothermal operations, and, at present, is part of a group developing geothermal properties for power generation in the Roosevelt area near Milford, Utah.

At the end of each year, O'Brien has the option of continuing with the program for the subsequent year or surrendering the permit. At the end of the fifth year, no further commitments are required. For subsequent years until the permit is surrendered or converted to a geothermal lease, the statutory obligations of the Geothermal Resources Administrative Regulations will apply.

New Zealand

Ngawha Geothermal Field Update

(Reprinted from Geothermal News, August 1983 edition, published by The Geothermal Coordinator, DSIR, Head Office, Private Bag, Wellington, New Zealand.)

The 1982 Energy Plan indicated that though Ngawha Geothermal field was scheduled for development primarily for electricity production, the "timing and mode of operation" had yet to be finalized. It was possible that commissioning could be deferred to beyond the end of the planning period (i.e. by 15 years). This hedge was a consequence of the uncertainty in the construction of the Aramoana Aluminium Smelter.

When the smelter development fell through, the forecasted electricity demand took a nose dive. Hence, the large scale (100 MW-size) Ngawha development was deferred until at least 1997. However, as also stated in the Energy Plan, the possibility of installing smaller scale, noncondensing sets was acknowledged. Presently, MOE, NZE and MWD are investigating the utilization of small (2-15MW) backpressure sets at Ngawha and at other fields.

Along with the Ngawha deferral, the need for drilling exploration wells was reassessed, reducing a two-rig operation to a one-rig operation. Because existing operations at Wairakei and Kawerau must be maintained and development at Broadlands is proceeding, the exploration drilling program had to be curtailed. Since there should be "plenty of time in the future" for pursuing exploration drilling at Ngawha, upon completion of NG 13, the GC - 350 rig was shifted to Mokai in the search for higher enthalpy fluid.

The G.C. 350 rig was set up at Ngawha well NG 13 on December 20, 1982.

Drilling began on January 23 and was completed during May after many difficulties. Maximum drilled depth was 2337.7m. During the completion tests, the maximum temperature was 287°C at 2300m (the highest temperature yet encountered at Ngawha). Overall permeability is excellent, and the well should prove to be the largest producer at Ngawha.

China

Chinese Looking at Geothermal Technology

The People's Republic of China wishes to establish contact with Western firms active in alternative energy fields, including the development of geothermal energy.

Western companies are being asked to show such products at a series of exhibitions scheduled for early 1984.

Other activities are planned, as well, to acquaint Chinese officials with the Western technology. For further information, contact David Phillips, China Industrial Development, Inc., 447 W. Garvey Avenue, Suite 130, Monterey Park, California 91754, phone (213) 571-6401.

High-Temperature Reservoirs

High-Temperature Geothermal Reservoirs

"After the successful development of the vapor-dominated geothermal reservoir at Larderello, geologists and geochemists searched for other dry-steam systems," said Don White.

"Eventually many geothermal systems were found, but only about 5 percent are vapor-dominated," he added.

White has spent many years studying the evolution and nature of geothermal reservoirs. He feels all geothermal reservoirs pass through natural life cycles, and all begin as hot water systems. Only by changing in a special manner will a hot-water system ever become a vapor-dominated system.

White has published information on this topic. Abstracts follow from two of his papers: *Vapor-Dominated Hydrothermal Systems Compared with Hot-Water Systems* and *Production of Superheated Steam from Vapor-Dominated Geothermal Reservoirs*. Abstracts from two other papers will appear in the next issue of the Geothermal Hot Line. These are: *Active Geothermal Systems and Hydrothermal Ore Deposits* and *Geochemistry Applied to the Discovery, Evaluation, and Exploitation of Geothermal Resources*.

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Abstract from *Vapor-Dominated Hydrothermal Systems Compared with Hot-Water Systems* by D.E. White, L.J.P. Muffler, and A.H. Truesdell, published in Economic Geology, vol. 66, No. 1, Jan.-Feb. 1971.

Vapor-dominated ("dry-steam") geothermal systems are uncommon and poorly understood compared with hot-water systems. Critical physical data on both types were obtained from U.S. Geological Survey research in Yellowstone Park. Vapor-dominated systems require relatively potent heat supplies and low initial permeability. After an early hot-water stage, a system becomes vapor-dominated when net discharge as steam starts to exceed water recharge. Steam then boils from a declining water table; some steam escapes to the atmosphere, but most condenses below the surface, where its heat of vaporization can be conducted upward. The main vapor-dominated reservoir actually is a two-phase heat-transfer system. Vapor boiled from the deep (brine?) water table flows upward; most liquid condensate on the reservoir borders flows down to the water table, but some may be swept out with steam in channels of principal upflow. Liquid water favors small pores and channels because of its high surface tension relative to that of steam. Steam is largely excluded from smaller spaces but greatly dominates the larger channels and discharge from wells. With time, permeability of water-recharge channels, initially low, becomes still lower because of deposition of carbonates and $CaSO_4$, which decrease in solubility with temperature. The "lid" on the system consists in part of argillized rocks and CO_2-saturated condensate.

Our model of vapor-dominated systems and the thermodynamic properties of steam provide the keys for understanding why the major reservoirs of The Geysers, California, and Larderello, Italy, initially have rather uniform reservoir temperatures near 240°C and pressures near 34 kg/cm^2 (absolute; gases other than H_2O increase the pressures). Local supply of pore liquid and great stored heat of solid phases account for the physical characteristics and the high productivity of steam wells.

We suggest that vapor-dominated systems provide a good mechanism for separating volatile mercury from all other metals of lower volatility. Mercury is likely to be enriched in the vapor of these systems; the zone of condensation that surrounds the uniform reservoir is attractive for precipitating HgS.

A more speculative suggestion is that porphyry copper deposits form below the deep water tables hypothesized for the vapor-dominated systems. Some enigmatic characteristics of these copper deposits are consistent with such a relationship, and warrant consideration and testing.

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Abstract from *Production of Superheated Steam from Vapor-Dominated Geothermal Reservoirs* by A.H. Truesdell and D.E. White, published in Geothermics, vol. 2, Nos. 3-4, 1973.

Vapor-dominated geothermal systems such as Larderello, Italy, The Geysers, California, and Matsukawa, Japan yield dry or superheated steam when exploited. Models for these systems are examined along with production data and the thermodynamic properties of water, steam and rock. It is concluded that these systems initially consist of a water and steam filled reservoir, a water-saturated cap rock, and a water or brine-rich deep reservoir below a water table. Most liquid water in all parts of the vapor-dominated part of the system is relatively immobilized in small pores and crevices; steam dominates the large fractures and voids of the reservoir and is the continuous, pressure-controlling phase. With production, the pressure is lowered and the liquid water boils, causing massive transfer of heat from the rock as it cools and eventually dries. Passage of steam through already dried rock produces superheating as pressure decreases toward a producing well. After an initial vaporization of liquid water in the reservoir, the decrease in pressure produces increased boiling below the deep water table. With heavy exploitation, boiling extends deeper into hotter rock and the temperature of the steam increases. This model explains most features of the published production behavior of these systems and can be used to guide exploitation policies.

Legislation

California Legislative Update
by Cheryl Menezes

The following is an update on the geothermal bills introduced in the State Legislature. All four bills will be effective on January 1, 1984. For a full description of the bills, see the July 1983 issue of the Hot Line.

AB 886 State Lands' issuance of exploratory permits or leases.
Chaptered. Chapter 617, Statutes of 1983.

AB 988 Abolition of the Geothermal Resources Board.
Chaptered. Chapter 369, Statutes of 1983.

AB 1466 Fees for CDOG Geothermal Regulatory Program.
Chaptered. Chapter 375, Statutes of 1983. *(See below)*

AB 1780 CEC Geothermal Grants.
Chaptered. Chapter 837, Statutes of 1983.

Geothermal Well Fees in California

To pay for the California Division of Oil and Gas (CDOG) geothermal regulatory program, present law allows the CDOG to collect a one-time well-drilling fee when an operator submits an application to drill a geothermal well; however, these fees provide only 12 percent of the necessary funding. The remaining 88 percent comes from an assessment placed on each barrel of oil and 10,000 cubic feet of gas produced by California oil and gas operators.

The passage of AB 1466 in 1983 has removed this present funding inequity by authorizing the CDOG to retain the well-drilling fee and to impose an annual fee upon each producing, idle, and service geothermal resource well. This will result in the geothermal industry paying for 100 percent of the CDOG's geothermal regulatory cost rather than just 12 percent. AB 1466 contains most of the details regarding the new funding method; however, the bill states that a system for determining the fee and administering the fee collection shall be adopted by regulation. It is also necessary to define certain terms to ensure that wells are properly classified, because the law provides exemptions from the assessment for certain types of wells.

The following is a list of the sections of Subchapter 4, Chapter 4, Division 2, Title 14, of the California Administrative Code that are being amended or adopted.

Section 1933.1 adopts a procedure, the use of which is necessary for determining the amount of assessment applicable to each operator. It further adopts a process that is necessary to determine the well owners of record on December 31 who will be responsible for paying the fees.

Section 1933.2 is adopted to require that, on or before June 15, the Director of the Department of Conservation is to notify each operator of that operator's assessment. The establishment of a date is necessary to ensure that operators are informed of applicable charges in a timely manner. The section is also necessary to detail the procedure to be followed if an operator believes an assessment error has been made.

Section 1933.3 is adopted to require the director to create the annual assessment roll and forward the roll to the State Controller prior to July 1. This is necessary to ensure that all assessments are accounted for.

Section 1933.4 is adopted to establish July 1 as the date that the charges are due and payable. Also, the section adopts the penalty for failure to pay. The section is necessary to establish a deadline for payment.

A public hearing on the adoption of these proposed regulations was held on January 27, 1984. The text of any modified regulation will be made available to the public at least 15 days before the regulation is adopted.

Federal Legislative Update

Status of federal legislation affecting geothermal energy, as of December 1, 1983.

1. H.R.21 : SPON=Kastenmeier; STTL=Energy Competition Act LATEST ACTION=Feb 4, 83 Referred to Subcommittee on Monopolies and Commercial Law.

2. H.R.278 : SPON=Quillen; STTL=Geothermal Energy Control Act of 1983 LATEST ACTION=Feb 16, 83 Executive Comment Requested from Interior.

3. H.R.576 : SPON=Fish; STTL=Business Energy Tax Credit Act of 1982 LATEST ACTION=Jan 6, 83 Referred to House Committee on Ways and Means.

4. H.R.1341 : SPON=Lehman, of CA, et. al; LATEST TITLE=A bill to establish the Mono Lake National Monument in the State of California, and for other purposes. LATEST ACTION=Jul 22, 83 Referred to the Committee on Energy and Natural Resources.

5. H.R.1568 : SPON=Cheney; STTL=Wyoming Wilderness Act of 1983 LATEST ACTION=May 4, 83 Executive Comment Requested from USDA.

6. H.R.1596 : SPON=Bedell, et. al; STTL=Renewable Energy Small Business Development Act of 1983 LATEST ACTION=Feb 23, 83 Referred to House Committee on Ways and Means.

7. H.R.1775 : SPON=Fuqua, et. al; STTL=Renewable Energy Tax Credit Act of 1983 LATEST ACTION=Mar 2, 83 Referred to House Committee on Ways and Means.

8. H.R.1884 : SPON=Fuqua, et. al; STTL=Renewable Energy Tax Credit Act of 1983 LATEST ACTION=Mar 3, 83 Referred to House Committee on Ways and Means.

9. H.R.1966 : SPON=Frank; LATEST TITLE=A bill to amend the Internal Revenue Code of 1954 to repeal the option to expense intangible drilling and development costs in the case of oil, gas, and geothermal wells, to repeal percentage depletion in the case of such wells, and to repeal certain benefits enacted by the Economic Recovery Tax Act of 1981 with respect to the windfall profit tax on domestic crude oil. LATEST ACTION=Mar 8, 83 Referred to House Committee on Ways and Means.

10. H.R.2058 : SPON=Marriott; STTL=Geothermal Steam Act of 1983 LATEST ACTION=Apr 7, 83 Executive Comment Requested from Interior.

11. H.R.2520 : SPON=Panetta, et. al; STTL=Income Tax Simplification Act of 1983 LATEST ACTION=Apr 13, 83 Referred to House Committee on Ways and Means.

12. H.R.2587 : SPON=Fuqua; STTL=Department of Energy Civilian Research and Development Authorization Act for ;Fiscal Year 1984 LATEST ACTION=May 16, 83 Received in the Senate and read twice and referred to the Committee on Energy and Natural Resources.

13. H.R.2927 : SPON=Hall, of CH, et. al; LATEST TITLE=A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes. LATEST ACTION=May 5, 83 Referred to House Committee on Ways and Means.

14. H.R.3072 : SPON=Heftel, et. al; STTL=Renewable Energy Incentive Act of 1983 LATEST ACTION=May 19, 83 Referred to House Committee on Ways and Means.

15. H.R.3132 : SPON=Bevill; STTL=Energy and Water Development Appropriation Act, 1984 LATEST ACTION=Jul 14, 83 Became Public Law No: 98-50.

16. H.R.3153 : SPON=Chappie; LATEST TITLE=A bill to amend section 35 of the Mineral Lands Leasing Act to provide for the disposition of certain revenues under the Geothermal Steam Act of 1970. LATEST ACTION=Jun 10, 83 Executive Comment Requested from Interior.

17. H.R.3168 : SPON=Heftel, et. al; LATEST TITLE=A bill to amend the Internal Revenue Code of 1954 to provide that the energy investment tax credit shall be allowed for certain U.S.-produced energy property used predominantly in any beneficiary developing country. LATEST ACTION=May 26, 83 Referred to House Committee on Ways and Means.

18. H.R.3271 : SPON=Gephardt, et. al; STTL=Fair Tax Act of 1983 LATEST ACTION= Jun 9, 83 Referred to House Committee on Ways and Means.

19. H.R.3356 : SPON=Seiberling, et. al; LATEST TITLE=A bill to establish the Mono Basin National Forest Scenic Area in the State of California, and for other purposes. LATEST ACTION=Jun 16, 83 Referred to House Committee on Interior and Insular Affairs.

20. H.R.3358 : SPON=Shannon, et. al; STTL=Energy Security Tax Incentives Act of 1983 LATEST ACTION=Jun 16, 83 Referred to House Committee on Ways and Means.

21. H.R.3363 : SPON=Yates; LATEST TITLE=A bill making appropriations for the Department of the Interior and related agencies for the fiscal year ending September 30, 1984, and for other purposes. LATEST ACTION=Nov 4, 83 Became Public Law No: 98-146.

22. H.R.3585 : SPON=Downey; STTL=Tax Equity Act of 1983 LATEST ACTION=Jul 18, 83 Referred to House Committee on Ways and Means.

23. H.R.3766 : SPON=Richardson; STTL=San Juan Basin Wilderness Protection Act of 1983 LATEST ACTION=Sep 1, 83 Executive Comment Requested from Interior.

24. S.96 : SPON=Melcher; STTL=Lee Metcalf Wilderness and Management Act of 1983 LATEST ACTION=Oct 31, 83 Became Public Law No: 98-140.

25. S.543 : SPON=Wallop, et. al; STTL=Wyoming Wilderness Act of 1983 LATEST ACTION=May 4, 83 Executive Comment Requested from USDA.

26. S.558 : SPON=Jackson; STTL=Geothermal Steam Act Amendments of 1983 LATEST ACTION=Jun 8, 83 Committee on Energy and Natural Resources received executive comment from Agriculture Department. Favorable.

27. S.616 : SPON=Durenberger, et. al; STTL=Renewable Energy Small Business Development Act of 1983 LATEST ACTION=Mar 7, 83 Committee on Finance requested executive comment from OMB, Treasury Department, Energy Department.

28. S.883 : SPON=McClure, et. al; STTL=Geothermal Steam Act Amendments of 1983 LATEST ACTION=Jun 8, 83 Committee on Energy and Natural Resources received executive comment from Agriculture Department. Favorable.

29. S.1237 : SPON=Symms, et. al; LATEST TITLE=A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes. LATEST ACTION=May 11, 83 Committee on Finance requested executive comment from OMB, Treasury Department, Energy Department.

30. S.1305 : SPON=Packwood, et. al; STTL=Renewable Energy Tax Incentive Act of 1983 LATEST ACTION=Jul 18, 83 Subcommittee on Energy and Agricultural Taxation. Hearings held.

31. S.1331 : SPON=Cranston; LATEST TITLE=A bill to establish the Mono Lake National Monument in the State of California, and for other purposes. LATEST ACTION=May 19, 83 Read twice and referred to the Committee on Energy and Natural Resources.

32. S.1369 : SPON=Durenberger, et. al; LATEST TITLE=A bill to amend section 170 of the Internal Revenue Code of 1954 to increase the amounts that may be deducted for maintaining exchange students as members of the taxpayer's household. LATEST ACTION=May 31, 83 Committee on Finance requested executive comment from OMB, Treasury Department.

33. S.1396 : SPON=Domenici, et. al; STTL=Energy Security Tax Incentives Act of 1983 LATEST ACTION=Jun 1, 83 Committee on Finance requested executive comment from OMB, Treasury Department, Energy Department.

34. S.1421 : SPON=Bradley, et. al; STTL=Fair Tax Act of 1983 LATEST ACTION=Jun 23, 83 Committee on Finance requested executive comment from OMB, Treasury Department.

35. S.1740 : SPON=Bingaman; STTL=San Juan Basin Wilderness Protection Act of 1983 LATEST ACTION=Aug 3, 83 Read twice and referred to the Committee on Energy and Natural Resources.

36. S.1767 : SPON=Mitchell; STTL=Personal Income Tax Reform Act of 1983 LATEST ACTION=Aug 20, 83 Committee on Finance requested executive comment from OMB, Treasury Department.

Grants

CEC Geothermal Grant Program for Local Governments

by Nancy Libonati

The California Energy Commission (CEC) will award about $2.8 million in geothermal grants in its fourth funding round. Workshops to explain the CEC grant program were held in October 1983. Local jurisdictions submitted 46 preliminary applications requesting a total of $6,738,024 by November 25. Final applications are due February 3, 1984. Final grant agreements will be approved by the legislature in July 1984 as a part of the 1984/85 fiscal year state budget.

The grant proposals sought include studies of problems related to geothermal resource areas; development of new geothermal resource areas; and mitigation measures in areas of existing geothermal development. Also sought are joint public-private geothermal development projects that will directly stimulate community economics. A private entity developing a geothermal resources project may participate in the grant program if an eligible local jurisdiction is either a partner in the project or receives project benefits.

The following fourth round preliminary applications were received.

NOTE: S = grant monies requested
M = matched contributions

1. Riverside Planning Dept.
Geothermal Energy Element
$150,000(S) $50,000(M)

2. City of Desert Hot Springs;
Resource Assessment Well Drilling
$182,000(S) $6,500(M)

3. Kelseyville Unified School District
Purchase of a School Bus
$71,998(S) $1,112(M)

4. Siskiyou County
Groundwater Heat Pump for Co. Courthouse and Jail
$289,000(S) $739,444(M)

5. M-S-R Public Power Agency
Feasibility/Financial Study
Elec. Generation
$65,000(S) $70,200(M)

6. Surprise Valley Unified School District; Retrofit Elementary/High Schools
$197,365(S) $20,861(M)

7. Modoc County
Resources Assessment and
Revolving Loan Program
$244,000(S) $206,398(M)

8. City of Calipatria
Resource Assessment Well
Drilling
$393,000(S) $412,980(M)

9. Bridgeport Public Utility
District; Drill and Test
Production Well
$1,052,583(S) $1,940,622(M)

10. Mono Co. Economic Development
Corp; Feasibility Study
Mammoth Lakes
$145,500(S) $12,700(M)

11. Indian Springs School
Geothermal Space and
Water Heating
$153,786(S) $25,775(M)

12. City of Santa Clara
Resource Assessment
Including TG Holes
$159,000(S) $18,000(M)

13. City of San Diego
Geothermal Aquaculture of
Stripped Bass and Catfish
$127,515(S) $70,625(M)

14. County of Inyo
Reconstruction of Coso
Hot Springs Road
$110,000(S) $0(M)

15. City of Rohnert Park
Resource Assessment and
Drill 2000' TG Hole
$154,859(S) $0(M)

16. Sonoma County
Survey and Aerial Mapping
of Cloverdale-Geysers Road
$85,000(S) $2,576(M)

17. Sonoma County
Revegetation of Healds-
burg-Geysers Road
$28,399(S) $0(M)

18. City of San Bernardino
Geothermal Retrofit of
City Hall
$12,050(S) $13,000(M)

19. City of San Bernardino
Geothermal Retrofit of
Community Center
$10,850(S) $4,500(M)

20. City of San Bernardino
Geothermal Retrofit of
Senior Citizens Center
$20,700(S) $6,000(M)

21. City of San Bernardino
Geothermal Retrofit
Support Program
$625,000(S) $775,000(M)

22. City of Paso Robles
Geothermal Pool Heating
$101,900(S) $37,000(M)

23. 29 Palms Water District
Resource Assessment for
Space Heating
$74,000(S) $0(M)

24. Lake Co.-Mendocino/Lake
Community Col.; Demo and
Educational Greenhouse
$375,600(S) $178,549(M)

25. Sierra County
Resource Confirmation in
Sierra Valley
$207,054(S) $7,750(M)

26. City of Susanville
Computer Monitoring of
District Heating System
$26,712(S) $12,439(M)

27. City of Susanville
Pipeline Extension
$143,437(S) $9,346(M)

28. City of Susanville
Installation of Variable
Speed Pump
$43,238(S) $5,072(M)

29. Konocti School District
Purchase of School Bus
$65,000(S) $923(M)

30. County of Lake
Land Use Mapping in The
Geysers
$21,277(S) $5,424(M)

31. County of Riverside
Geothermal Energy in
Riverside County
$33,300(S) $18,000(M)

32. City of Lake Elsinore
Geothermal Development
Program
$163,928(S) $55,200(M)

33. County of San Bernardino
Design and Retrofit of GSA
$25,740(S) $5,680(M)

34. County of San Bernardino
Design and Retrofit of
the Sheriff's Office
$15,000(S) $14,910(M)

35. County of San Bernardino
Design and Retrofit of EPWA
$50,540(S) $25,160(M)

36. County of San Bernardino
Design and Retrofit of
the Central Jail
$45,000(S) $27,260(M)

37. County of San Bernardino
Design and Retrofit of
County Center
$596,000(S) $35,750(M)

38. Surprise Valley Hospital
Space Heating for the Hospital
$180,000(S) $18,000(M)

39. Mendocino County RCD
Baseline Data Collection
for Pieta Creek
$33,930(S) $9,718(M)

40. County of San Bernardino
Resource Assessment in
29 Palms
$75,000(S) $3,717(M)

41. City of Lakeport
Analysis of Municipal
Small Scale Electric
$22,500(S) $7,000(M)

42. Lake County APCD
Continuous H_2S Monitoring
and Process Control
$30,000(S) $7,150(M)

43. Calif. Pines Com. Service
Dist.; Geothermal Pool
and Space Heating
-(S) -(M)

44. County of Lassen
Feasibility Study of Geo-
thermal Space Heating
$35,000(S) $3,772(M)

45. Fort Bidwell Indian Comm-
unity; Slim Bore Exploratory
Well
$19,800(S) $12,430(M)

46. Kern Council of Governments
High Temperature Exploration
Program
$61,309(S) $6,309(M)

Seminars, Tours, and Conferences

Stanford Geothermal Program Seminars

Under the aegis of the Stanford Geothermal Program, the following seminars are scheduled. All will be held in Room B67, Mitchell Building, Stanford University, from 1:15 to 2:30 p.m. The seminars are open to the public and are free of charge.

For further information, contact Jon S. Gudmundsson, Petroleum Engineering Department, Stanford University, at (415) 497-1218.

DATE	TITLE	SPEAKER
January 19, 1984	"How Big The Geysers?"	Bob Greider, Geothermal Resources International, Inc.
January 26, 1984	"Geothermal Resources for Direct Use in Lake County"	Gerald Niimi, ThermaSource Inc.
February 2, 1984	"Localization and Evolution Through Tertiary Time of High Temperature Geothermal Systems"	Don White, U.S.G.S.
February 9, 1984	"Magma's Activities in East Mesa and Niland"	Tom Hinrichs, Magma Power Company
February 16, 1984	"Tracking Injected Fluids with Geophysical Methods"	Paul Kassameyer, Lawrence Livermore Laboratory
February 23, 1984	"Temperature Logging--Anomalous Fluid Motions and Instabilities"	Tom Urban, U.S.G.S.
March 1, 1984	"Aminoil's Operations at The Geysers"	John Counsil, Aminoil USA, Inc.
March 8, 1984	"Salton Sea 10 Megawatt Plant - Performance Review"	Philip Messer, Union Oil Company

Pumping Geothermal Brine, Los Angeles, March 21-23, 1984.

The topics of Downhole Pumps and Corrosion and Surface Brine Pumps will be covered in this course.

For further information, contact the Geothermal Resources Council Meetings Group, P.O. Box 1350, Davis, California 95617. Phone (916) 758-2360.

Industrial Study Mission to Japan on Geothermal Energy Development. March 24 to April 2, 1984. Sponsored by the Technology Transfer Institute, a Tokyo-based management consulting firm. Team Director: Dr. Paul Kruger, Professor, Civil Engineering, Stanford University. Cost: $3,650.00.

Tour activities include a seminar on binary cycle development; visits to binary cycle hardware companies such as Toshiba and Mitsubishi Metal; and tours of steam and hot water geothermal fields.

Individual consultations and tours can be arranged.

For further information, contact Kazuo Moro, Director, Technology Transfer Institute, 624 S. Grand Avenue, Suite 2407, Los Angeles, California 90017. Phone (213) 628-9381.

54th Annual California Regional Meeting, Society of Petroleum Engineers, Long Beach, California, April 11-13, 1984.

The theme of the meeting is Western Energy Frontiers. Two areas of special interest for the meeting are "Geothermal Engineering" and "Environmental Problems and Energy Conservation including Power Co-Generation."

For further information, contact the SPE, 6200 North Central Expressway, Dallas, Texas 75206.

59th Annual Meeting, AAPG-SEPM-SEG, Pacific Section, Sheraton Harbor Island East Hotel, San Diego, California, April 18-21, 1984.

The program will emphasize overviews, including an opening talk on Standard's Point Arguello offshore activity. One SEPM symposium will feature The Imperial basin--tectonics and sedimentation, stratigraphy, petroleum potential, and geothermal potential.

For further information, contact the Program Chairman, Rick Belyea (714-546-2219), c/o John Minch, Saddleback College, Mission Viejo, California 92692.

Geothermal Resources Council 1984 Annual Meeting, MGM Grand Hotel, Reno, Nevada, August 27-29, 1984.

The meeting will include three days of technical sessions, a poster session, and special sessions, among other activities. For further information, contact the GRC Meetings Group, P. O. Box 1350, Davis, California 95617.

Geothermal Resources Council 1985 Annual Meeting, Kona Surf Hotel, Kailua Kona, Hawaii, late August 1985.

The international meeting will be an expansion to 4 days of the 1985 GRC annual meeting. Special international update sessions along with worldwide geothermal development will be discussed. Field trips, special courses, and seminars may be included.

For further information, contact the GRC Meetings Group, P.O. Box 1350, Davis, California 95617.

Maps

Geological world atlas. $190.00 plus $15.00 shipping and handling in North America and $35.00 elsewhere. The atlas, started in 1911, is co-published by the Commission for the Geologic Map of the World and UNESCO. The American Association of Petroleum Geologists is the North American distributor. Available from the AAPG Bookstore, P.O. Box 979, Tulsa, Oklahoma 74101.

The atlas contains valuable geologic data compiled by geologists and geophysicists around the world.

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Maps in earth science publications, 1980. (Maps published in 1981-82 will be cited in a volume now under preparation.) $7.00; prepayment required for orders below $20.00. Payable to the I. D. Weeks Library, University of South Dakota, Vermillion, South Dakota 57069.

In the publication, over 900 maps published in 1980 (and their sources) are identified. Map titles are arranged under geographic headings.

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Geologic map index of California, 1982. By W.L. McIntosh and M.F. Eister. Free. Published by and available from the U.S.G.S., Distribution Branch, Box 25286, Federal Center, Denver, Colorado 80225.

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Geologic map of the Santa Rosa Quadrangle, 1982, by D.L. Wagner and E.J. Bortugno. $15.00. Published by and available from the California Division of Mines and Geology, P.O. Box 2980, Sacramento, California 95814.

The map includes 5 sheets drawn at a scale of 1:250,000 and a list of thermal springs and wells, and the radiometric ages of rocks in the Santa Rosa Quadrangle.

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Preliminary geologic map of the Kyle Hot Springs 7.5-minute quadrangle, Pershing County, Nevada. OF 83-0393. By D.H. Whitebread and M.L. Sorenson. 1 over-sized sheet, scale 1:24,000. $2.50; microfiche $1.00. Available from the OFSS, Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, Colorado 80225.

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Geothermal Resources of Texas, 1982. Scale 1:1,000,000. Free. Available from the Bureau of Economic Geology, The University of Texas at Austin, University Station, Box X, Austin, Texas 78712.

The map includes a table with data on selected thermal wells and springs of Texas and a generalized map with Texas regional structural-tectonic features.

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Geologic map of Oregon west of the 121st Meridian (the western half of the state). Miscellaneous Geologic Investigations Map I-325, U.S.G.S. $5.00. Scale 1:500,000.

Order from the Oregon Dept. of Geology and Mineral Industries, 1005 State Office Building, Portland, Oregon 97201.

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Mapa geológico de Costa Rica (preliminary edition). 1982. 1:200,000. 9 sheets. Color. Price unknown. Available from the Ministerio de Economía e Industria, Apartado 10216, San José, Costa Rica.

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Preliminary geologic map of Furnas Volcano, Sao Miguel, Azores. OF 83-0395. By R.B. Moore. 1 over-sized sheet. $3.75, microfiche $1.00. Available from the OFSS, Western Distribution Branch, USGS, Box 25425, Federal Center, Denver, Colorado 80225.

Publications

Assessment of low-temperature geothermal resources of the United States - 1982. USGS Circular 892. Edited by Marshall J. Reed. Free. Available from the USGS, Branch of Distribution, 604 South Pickett Street, Alexandria, Virginia 22304.

The report provides the first quantitative estimation of the thermal energy recoverable from low-temperature (below 194°F or 90°C) geothermal systems in the United States. The assessment includes estimates of accessible resource base (geothermal energy in the ground), the resource that might be recoverable at the surface, and the heat that might be usable in a specific application.

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Selected data for low-temperature (less than 90°C) geothermal systems in the United States: reference data for USGS Circular 892 (see above). Open-File Report 83-0311. By M.J. Reed, R.H. Mariner, C.A. Brook, and M.L. Sorey. $17.00; microfiche $3.50. Published by and available from OFSS, Western Distribution Branch, USGS, Box 25425, Federal Center, Denver, Colorado 80225.

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Basic data for thermal springs and wells as recorded in GEOTHERM (for Arizona data, order publication OF 83-0427, $27.00 paper and $3.50 microfiche; for Colorado data, order publication OF 83-0429, $23.00 paper and $3.50 microfiche.) Both are by J.D. Bliss.

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1983 State energy overview. DOE/EIA-0354. GPO Stock No. 061-003-00338-9. $9.00; foreign $11.25. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The publication contains an overview of energy data for the United States, by state.

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EIA publications directory, the Energy information directory, and the directory of energy data collection forms. Free. Published by and available from the National Energy Information Center, DOE, 1000 Independence Avenue, S.W., Washington, D.C. 20585.

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68th Annual Report of the State Oil and Gas Supervisor. 1982. 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 1982 California geothermal activities.

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Lassen Volcanic National Park

The following publications are available from the OFSS, Western Distribution Branch, USGS, Box 25425, Federal Center, Denver, Colorado 80225.

Precision gravity network for monitoring the Lassen geothermal system, Northern California. OF 83-0193. By R.C. Jachens and R.W. Saltus. 1 over-sized sheet. $5.00, microfiche $4.00.

Principal facts for 382 gravity stations in Lassen Volcanic National Park and vicinity. OF 83-0584. By R.C. Jachens, D.R. Spydell, and R.W. Saltus. $2.00, microfiche $3.50.

Chemical analyses of thermal and non-thermal springs in Lassen Volcanic National Park and vicinity. Open File Report 83-0311. $3.50; microfiche $3.50.

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Cogeneration in California. 1983. $48.00. Available from Government Institutes, Inc., P.O. Box 1096, Dept. FK, Rockville, Maryland 20850.

A workbook developed in conjunction with a course presented in June 1983. Contributing authors are from the California Energy Commission, the Public Utilities Commission, San Diego Gas and Electric Company, and other companies involved in cogeneration projects at California industrial, commercial, and institutional sites.

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California Energy Commission Publications

The following publications are published by and available from the California Energy Commission, Publication Unit, 1516 Ninth Street, MS #13, Sacramento, California 95814.

Project Status Report No. 5. $14.00. Identifies and describes over 1,800 potential future electric generation projects in which California investor-owned utilities, municipal utilities, local irrigation districts, and the California Department of Water Resources have an ownership interest or from which they expect to receive energy.

Securing California's energy future: 1983 biennial report. $10.00

In the report, emerging energy supply and demand trends are identified. The level of statewide and service area electrical energy demand for each year in the forthcoming 5, 12, and 20-year periods is included.

Cumulative impact study of The Geysers KGRA: public service impacts of geothermal development. Publication number P700-83-004. First copy free; additional copies $6.85.

In the report, existing public services and fiscal resources in Sonoma, Lake, Mendocino, and Napa Counties (counties included in The Geysers KGRA) are described. Public services impacts

and fiscal impacts of two geothermal development plans are analysed. A method is outlined for calculating mitigation fees for geothermally-related impacts on local schools and roads.

Small-scale systems using geothermal energy: a guide to development. Publication number P500-83-011. $2.20.

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An overview of small-scale (100 kilowatts to 10 megawatts) electrical systems that could be developed with geothermal hot water as the energy source. Resource considerations, small-scale technologies, and financial incentives are discussed.

Feasibility of geothermal direct use applications in San Bernardino, California. Publication number P500-83-013. $3.15.

A proposed geothermal district heating system is described in the report. An analysis of project and user costs and paybacks is included.

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UPDATE of An Annotated Bibliography, Geothermal Publications of the California Division of Mines and Geology

by Leslie G. Youngs

(Publications for the years 1960 through 1981 are in the July 1981 issue of the Geothermal Hot Line. The Bibliography is reprinted, with permission, from the November 1983 edition of California Geology.)

1982

Boylan, R.T., 1982, Mammoth Lakes/Long Valley microearthquake project: CALIFORNIA GEOLOGY, v. 35, no. 9, p. 187-190.

The article describes the initiation of a CDMG microearthquake monitoring program at Long Valley, Mono County, California to determine the effectiveness of the technique as a tool for geothermal resource exploration and to determine the relationship of microseismicity to hydrothermal activity in the area.

Chapman, R.H., and Chase, G.W., 1982, Geophysical study of the Rohnert Park geothermal prospect, Sonoma County, California: California Division of Mines and Geology, Report for the California Energy Commission, Interagency Contract No. 500-80-102, 29 p., 4 plates ($4.00).

The results of magnetic, gravity, and electrical resistivity surveys conducted in the Rohnert Park area, Sonoma County, are presented in this report. Subsurface volcanic rocks which possibly contain warm water aquifers were mapped.

Chapman, R.H., and Chase, G.W., 1982, Geophysical study of the Sonoma State Hospital area geothermal prospect, Sonoma County, California: California Division of Mines and Geology, Report for the California Energy Commission, Interagency Contract No. 500-80-102, 36 p., 2 plates ($4.00).

The results of magnetic, gravity, and electrical resistivity surveys conducted in the central portion of the Sonoma Valley near Sonoma, Sonoma County, are presented in this report. A subsurface fault was delineated which appears to be asssociated with a known alignment of warm water wells and springs in the area.

Chapman, R.H., Youngs, L.G., and Chase, G.W., 1982, Gravity, structure, and geothermal resources of the Calistoga area, Napa and Sonoma Counties: CALIFORNIA GEOLOGY, v. 35, no. 8, p. 175-183.

The article contains a newly compiled gravity map of the Calistoga and St. Helena, California, U.S. Geological Survey 15-minute quadrangles. An interpretive model is presented showing the relationship of selected gravity anomalies to the geology and geothermal resources of the area.

Leivas, E. and Bacon, C.F., 1982, Reconnaissance geothermal resource assessment of another 40 sites in California—Part of the fourth year report, 1981-82, of the U.S. Department of Energy—California State-Coupled Program for reservoir assessment and confirmation: California Division of Mines and Geology, Open-File Report 83-12 SAC, Report for U.S. Department of Energy, Contract No. DE-FG03-81SF10855, 218 p. ($15.00).

The report presents geological, geochemical, and historical data for another 40 low-temperature geothermal sites located throughout California.

A brief summary of OFR 82-4 SAC appears with the announcement of availability in CALIFORNIA GEOLOGY (June 1983), v. 36, no. 6, p. 135-136.

Macleod, N.S., and Sammel, E.A., 1982, Newberry Volcano, Oregon—A Cascade Range geothermal prospect: CALIFORNIA GEOLOGY, v. 35, no. 11, p. 235-244.

The article presents the results and conclusions of a U.S. Geological Survey geothermal and geologic investigation of the Newberry Volcano area of the Cascade Range in central Oregon. Included are geologic and temperature data from two exploratory holes drilled near the caldera.

1983

Campion, L.F., Chapman, R.H., Chase, G.W., and Youngs, L.G., 1983, Resource investigation of low- and moderate-temperature geothermal areas in Paso Robles, California—Part of the fourth year report, 1981-1982, of the U.S. Department of Energy—California State-Coupled Program for reservoir assessment and confirmation: California Division of Mines and Geology, Open-File Report 83-11 SAC, Report for U.S. Department of Energy, Contract No. DE-FG03-81SF10855, 53 p., 8 plates ($9.00).

The report presents the data and results of a detailed scientific geothermal resource investigation of the Paso Robles area, San Luis Obispo County. The history of geothermal development, geology, geochemistry, hydrology, geophysical surveys, temperature measurements, and geothermal reservoir characteristics are described in the report.

A brief summary of OFR 83-11 SAC appears with the announcement of availability in CALIFORNIA GEOLOGY (October 1983), v. 36, no. 10, p. 229.

Chapman, R.H., Chase, G.W., and Youngs, L.G., 1983, Geophysical study of the Santa Rosa geothermal area, Sonoma County, California: California Division of Mines and Geology, Open-File Report 83-9 SAC, 36 p., 1 plate ($4.00).

The results of magnetic, gravity, and electrical resistivity surveys conducted near the city of Santa Rosa, Sonoma County, are presented in the report. Interpretation of data suggests that the known low-temperature geothermal resources in the area are within a dense mass of volcanic rocks underlying the eastern part of Santa Rosa and Bennett Valley.

A brief summary of OFR 83-9 SAC appears with the announcement of availability in CALIFORNIA GEOLOGY (May 1983), v. 36, no. 5, p. 116.

Hammond, P.E., 1983, Volcanic formations along the Klamath River near Copco Lake, Siskiyou County: CALIFORNIA GEOLOGY, v. 36, no. 5, p. 109.

A section of this article describes the nature and potential of interstratified zones within volcanic rocks as geothermal reservoirs in an area near Copco Lake, Siskiyou County, California.

Higgins, C.T., Chapman, R.H., and Chase, G.W., 1983, Geothermal resources of the Bridgeport-Bodie Hills region, California—Part of the fourth year report, 1981-82, of the U.S. Department of Energy—California State-Coupled Program for reservoir assessment and confirmation: California Division of Mines and Geology, Open-File Report 83-14 SAC, Report for U.S. Department of Energy, Contract No. DE-FG03-81SF10855, 105 p., 5 plates ($8.00).

The report describes detailed geological, geochemical, and geophysical investigations of the area immediately southeast of Bridgeport, Mono County, as well as a regional geothermal evaluation of the Bodie Hills. The results of the investigations are used to speculate on the source of the thermal water and the nature of the area's source of heat.

A brief summary of OFR-14 SAC appears with the announcement of availability in CALIFORNIA GEOLOGY (September 1983), v. 36, no. 9, p. 194.

Majmundar, H.H., 1983 (in press), Technical Map of the Geothermal Resources of California: California Division of Mines and Geology, Geologic Data Map Series, Map no. 5, scale 1:750,000.

A 4½ by 5 foot, 7-color map of California with more than 600 geothermal wells and springs annotated. In addition to temperature data, the map presents information on water chemistry including some mineral concentrations and water chemical type. An accompanying explanatory text contains tables and maps.

Youngs, L.G., Campion, L.F., Chapman, R.H., Higgins, C.T., Leivas, E., Chase, G.W., and Bezore, S.P., 1983, Geothermal resources of the Northern Sonoma Valley area, California: California Division of Mines and Geology, Open-File Report 83-27 SAC, 106 p., 6 plates ($18.00).

The report presents the data and results of a scientific geothermal resources investigation of the northern Sonoma Valley area, Sonoma County. History of known warm water springs in the area, geology, geophysical investigations, seismicity, shallow and moderately deep hole temperature surveys, hydrology, geochemistry, and general geothermal assessment are addressed in the report. Also included is an overall comparison of the geothermal resources of the northern Sonoma Valley area to the central and southern portions of the valley.

A brief summary of OFR 83-27 SAC appears with the announcement of availability in this issue of CALIFORNIA GEOLOGY, p. 251.

Youngs, L.G., Chapman, R.H., Chase, G.W., Bezore, S.P., and Majmundar, H.H., 1983, Investigation of low-temperature geothermal resources in the Sonoma Valley area, California — Part of the fourth year report, 1981-82, of the U.S. Department of Energy—California State-Coupled Program for reservoir assessment and confirmation: California Division of Mines and Geology, Open-File Report 83-13 SAC, Report for U.S. Department of Energy, Contract No. DE-FG03-81SF10855, 103 p., 9 plates ($10.00).

This report presents the data and results of a detailed scientific geothermal reservoir investigation of the Sonoma Valley area, Sonoma County. Historical geothermal development, geology, geochemistry, geophysical surveys, temperature surveys, hydrology, and geothermal reservoir characteristics are discussed in the report.

A brief summary of OFR 83-13 SAC appears with announcement of availability in CALIFORNIA GEOLOGY (June 1983), v. 36, no. 6, p. 134.

Youngs, L.G., Kishi, E.H., and Campion, L.F., 1983, Preliminary report on the low-temperature geothermal resources of the Big Valley area, Lake County, California: California Division of Mines and Geology, Open-File Report 83-30 SAC, 74 p., 6 plates.

The report is a compilation of existing scientific data and newly acquired downhole temperature data, interpreted to evaluate the low-temperature geothermal resources of Big Valley, Lake County, California. History of the known warm springs in the area, geology, hydrology, downhole temperature measurements, geothermometry results, and geophysical data are discussed in the report.

Publications may be ordered from the California Division of Mines and Geology, P.O. Box 2980, Sacramento, California 95812.

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NBMG Publications

The following publications are published by and available from the Nevada Bureau of Mines and Geology, University of Nevada, Reno, Reno, Nevada 89557-0088.

The Nevada mineral industry, 1982. $5.50 by mail. Geothermal drilling and utilization are among the topics discussed in this overview of 1982 mineral industry activity.

A mineral inventory of the Elko Resource Area, Open-file report 83-9. $32.00.

Results of geochemical sampling within the Elko Resource Area, Elko, Eureka, and Lander Counties, Nevada, Open-file report 83-10. $13.00.

A mineral inventory of the Esmeralda-Stateline Resources Area, Las Vegas District, Nevada, Open-file report 83-12. $26.00.

Results of geochemical sampling within Esmeralda-Stateline Resource Area, Open-file report 83-11. $14.50.

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Oregon Geothermal energy publications. Free. Published by and available from the Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, Oregon 97201.

A wide variety of geothermal publications is available from the Oregon Department of Geology and Mineral Industries. A monthly publication, Oregon Geology, also published by this department, often contains geothermal information. Oregon Geology, published monthly, is available for $6.00 a year or $15.00 for 3 years.

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Thermal springs in the Boise River basin, south central Idaho. WRI82-4006. By R.E. Lewis and H.W. Young. $3.50; microfiche $3.50. Published by and available from the Open-File Services Section, Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, Colorado 80225.

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List of publications, Colorado Geological Survey. Free. Available from CGS Publication Department, 1313 Sherman Street, Room 715, Denver, Colorado 80203.

The list includes many geothermal publications, along with 10 new publications. Most of the new publications are assessments of geothermal areas in Colorado. One, on another topic, is titled Industrial Market Opportunities for Geothermal Energy in Colorado, and is available for $1.00 by mail.

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Energy alternatives in Latin America. Edited by Francisco Szekely. $25.00 paper, $50.00 cloth. Available from UNIPUB, 1180 Avenue of the Americas, New York, N.Y. 10036.

In the United Nations publication, the potentials of new and renewable energy sources in Latin America are assessed.

•

Advances in European geothermal research. Proceedings of the Second International Seminar on the results of EC geothermal energy research, Strasbourg, 4-6 March, 1980. Edited by A.S. Strub and P. Ungemach. $59.00. Available from Kluwer Boston Inc., 190 Old Derby Street, Hingham, MA 02043.

Includes over 70 research and project assessment papers presented in technical sessions that include regional exploration and reservoir assessment and local exploration and drilling.

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Geologic assessment of the fossil energy and geothermal potential of the Sudan. OF 83-0356. By L.W. Setlow. $7.75; microfiche $3.50. Published by and available from the OFSS, Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, Colorado 80225.

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Geothermal resources: energy on tap, Transactions, Volume 7, for the 1983 Annual Meeting of the Geothermal Resources Council. $33.00. Compiled by and available from the GRC, P.O. Box 1350, Davis, California 95617.

The volume includes a special section on the Cascades and Unalaska Island, one of the Fox Islands in the central portion of the Aleutian Islands arc.

A list of the many GRC publications can be ordered from the address.

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The application of nuclear techniques in geothermal investigations. Proceedings of the consultants' meeting organized by the International Atomic Energy Agency, Vienna, Austria, 1981. Edited by E. Barbier and W. F. Giggenbach. $55.00. Available from the

Pergamon Press, Fairview Park, Elmsford, New York 10523.

The book contains recent advances in the application of isotopic and chemical techniques and recommendations to the IAEA on future activities and developments.

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"Rates of hydrothermal reactions." By Bernard J. Wood and John V. Walther, Department of Geological Sciences, Northwestern University, Evanston, Illinois 60201. Published in the October 28, 1983, issue of Science, vol. 222, p. 413-415.

The authors state that an understanding of rate relations of hydrothermal reactions would allow predictions to be made for reactions in geothermal and metamorphic systems. After undertaking a literature review, they discovered a general Arrhenius relation between reaction rate and temperature that appears to hold over temperatures from 25° to 710°C. It also holds for a large number of different silicate and related mineral species.

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Earth sciences division annual report 1982, Lawrence Berkeley Laboratory. LBL-15500UC-13. $21.50. Available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

Compendium of projects with many papers on aspects of geothermal energy. General topics include Geophysics; Geomechanics; Geochemistry; Reservoir Engineering and Hydrogeology; and Mexican-American Cooperative Program, Cerro Prieto.

California Wells

CDOG Collects Geothermal Well Data

Every month, the California Division of Oil and Gas collects geothermal production and injection data from the state's geothermal operators.

A computer-generated file of these geothermal production and injection statistics for wells with records open to public inspection is available from the division for $50.00.

Also available is an instruction booklet for operators submitting these data. The booklet is called Manually Prepared Geothermal Steam Production, Water Production, and Injection Reports.

Drilling Permits for Geothermal Wells Approved June 1983 Through December 1983 by the California Division of Oil and Gas

Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
		LAKE COUNTY				
5/24/83	Union Oil Co. of Calif. "DX State 4596" 53	033-90465	8	11N	8W	Fr. SE cor. 732m N, 853m W. 1026.5m KB.
6/20/83	Union Oil Co. of Calif. "High Valley St" 39A-30	033-90460	30	12N	8W	Fr. SW cor. 17m N, 409m E. 889.7m KB.

Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
9/2/83	Grace Geothermal Corp. "PR" 1	033-90470	27	14N	8W	Fr. NE cor. 579m S, 305m W. 699m RT.
9/2/83	Grace Geothermal Corp. "PR" 2	033-90471	22	14N	8W	Fr. SW cor. 61m N, 396m E. 714m RT.
9/2/83	Grace Geothermal Corp. "PR" 3	033-90472	22	14N	8W	Fr. SW cor. 244m E, 701m N. 701m RT.
9/2/83	Grace Geothermal Corp. "PR" 4	033-90473	21	14N	8W	Fr. SW cor. 305m E, 701m N. 427m RT.
10/12/83	Aminoil USA, Inc. "MLM" 4	033-90476	35	11N	8W	Fr. NW cor. 535m S, 767m E. 772m GR.
10/25/83	Union Oil Co. of Calif. "DX State 4596" 54	033-90477	8	11N	8W	Fr. SW cor. 761m N, 659m E. 1028.5m KB.
12/8/83	Union Oil Co. of Calif. "L'Esperance" 1	033-90479	6	11N	8W	Fr. NE cor. 259m S, 762m W. 862.1m KB.
	MENDOCINO COUNTY					
7/27/83	GRI Operator Corp. "NWW" 1	045-90049	26	12N	9W	Fr. SE cor. 457m N, 152.4m W. 689m GR.
8/16/83	GRI Operator Corp. "NWW" 5	045-90050	27	12N	9W	Fr. NW cor. 259.2m S, 213.5m E. 1097m GR.
	NAPA COUNTY					
9/20/83	Max Quast "Roman Spa" 1	055-90081	36	9N	7W	Fr. SE cor. 100m N, 310m W. 183m RT.
	SONOMA COUNTY					
7/8/83	Union Oil Co. of Calif. "DX State 4596" 67	097-90591	7	11N	8W	Fr. NE cor. 579m S, 945m W. 1029.5m KB.
7/25/83	Union Oil Co. of Calif. "Thermal" 15	097-90600	13	11N	9W	Fr. NE cor. 529m S, 144m W. 518.7m KB.
8/2/83	GRI Operator Corp. "Prati" 9	097-90526	35	12N	9W	Fr. SE cor. 46m N, 381m W. 671m KB.
8/10/83	GRI Operator Corp. "Prati State" 10	097-90597	1	11N	9W	Fr. NW cor. 283m S, 497m E. 744m GR.
9/7/83	GRI Operator Corp. "Rorabaugh" 22	097-90598	14	11N	9W	Fr. SW cor. 160m N, 483m E. 771m KB.

Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
9/7/83	GRI Operator Corp. "Prati State" 31	097-90599	35	12N	9W	Fr. SW cor. 427m N, 307m E. 643.7m KB.
10/13/83	Union Oil Co. of Calif. "Ottoboni St. 4596" 87A-2	097-90602	2	11N	9W	Fr. SE cor. 286.2m N, 66.8m W. 809.2m KB.
10/25/83	Union Oil Co. of Calif. "DX State 4596" 74	097-90601	7	11N	9W	Fr. NE cor. 579m S, 259m W. 1030.8m GR.
10/28/83	Union Oil Co. of Calif. "DX State 4596" 75	097-90603	7	11N	9W	Fr. NE cor. 580m S, 257m W. 1030.8m GR.
12/1/83	GRI Operator Corp. "Prati" 30	097-90605	34	12N	9W	Fr. NE cor. 387m S, 457m W. 710m KB.
	LASSEN COUNTY					
12/27/83	Carson Develop. Co., Inc. "Wineagle" 1	035-90069	23	29N	15E	Fr. SW cor. 983m N, 641m E.
	MONO COUNTY					
9/8/83	Mammoth-Pacific "MBP" 1	051-90035	32	3S	28E	Fr. ctr., 351m Nly, 586m Wly. 2238m GR.
9/8/83	Mammoth-Pacific "MBP" 2	051-90037	32	3S	28E	Fr. ctr., 229m Nly, 449m Wly. 2226m GR.
9/8/83	Mammoth-Pacific "MBP" 4	051-90036	32	3S	28E	Fr. ctr., 47m Nly, 585m Wly. 2235m GR.
9/8/83	Mammoth-Pacific "MBP" 5	051-90038	32	3S	28E	Fr. ctr., 127m Nly, 669m Wly. 2245m GR.
11/22/83	Mammoth-Pacific "IW" 2	051-90040	32	3S	28E	Fr. ctr., 298m Nly, 99m Ely. 2223m GR.
11/22/83	Mammoth-Pacific "IW" 1	051-90039	32	3S	28E	Fr. ctr., 333m Nly, 38m Ely. 2224m GR.
	IMPERIAL COUNTY					
10/11/83	Grace Geothermal Corp. "Brawley" 1	025-90560	17	13S	14E	Fr. SE cor. 182.9m N, 609.6m W. -41.4m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 2	025-90561	20	13S	14E	Fr. NE cor. 548.6m S, 487.7m W. -39.3m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 3	025-90562	28	13S	14E	Fr. NW cor. 426.7m S, 0.0m E. -38.1m GR.

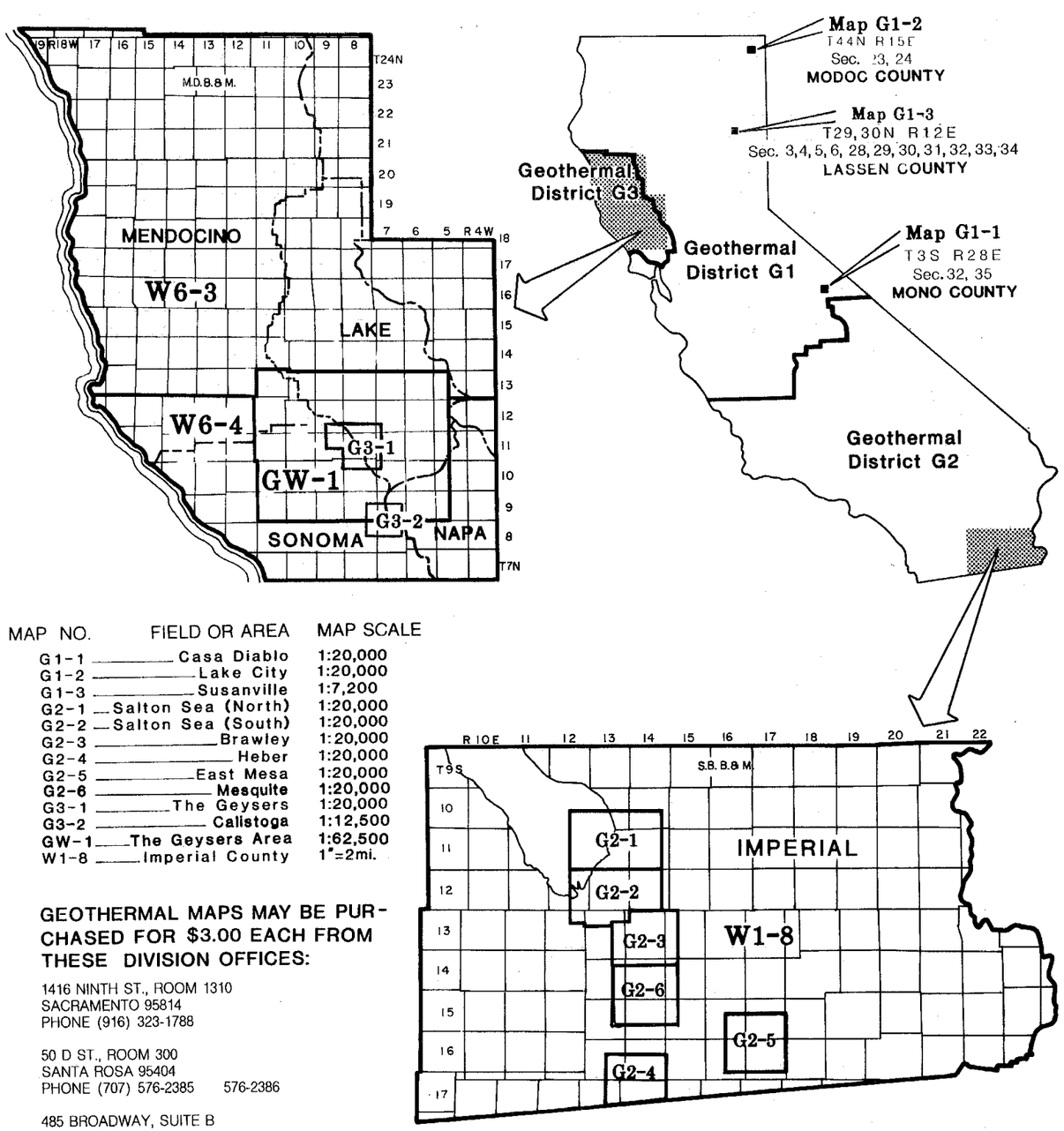
Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
10/11/83	Grace Geothermal Corp. "Brawley" 4	025-90563	20	13S	14E	Fr. SE cor. 91.4m N, 213.4m W. -39.0m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 5	025-90564	21	13S	14E	Fr. SW cor. 335.3m N, 381m E. -45.7m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 6	025-90565	21	13S	14E	Fr. SE cor. 518.2m N, 304.8m W. -45.7m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 7	025-90566	21	13S	14E	Fr. NE cor. 243.8m S, 152.4m W. -53.3m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 8	025-90567	15	13S	14E	Fr. SW cor. 182.9m N, 243.8m E. -47.7m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 9	025-90568	15	13S	14E	Fr. SE cor. 137.2m N, 396.2m W. -43.5m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 10	025-90569	22	13S	14E	Fr. SE cor. 640.1m N, 381m W. -42.7m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 11	025-90570	23	13S	14E	Fr. SW cor. 61m N, 213.4m E. -41.1m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 12	025-90571	27	13S	14E	Fr. NE cor. 213.4m S, 365.8m W. -42.0m GR.
10/11/83	Grace Geothermal Corp. "Brawley" 13	025-90572	22	13S	14E	Fr. SW cor. 426.7m N, 365.8m E. -41.1m GR.
10/28/83	Redbird Oil Company "Redbird Arizona State" 1-12	025-90573	12 GSR	8S B&M	23W	Fr. NE cor. 673.6m S, 99.6m W. 41.1m GR.
11/21/83	Chevron Geothermal Co. of California "HGU" 9	025-90574	34	16S	14E	Fr. NW cor. 1039.1m S, 22.0m E. -1.0m GR.
11/21/83	Chevron Geothermal Co. of California "HGU" 107	025-90575	33	16S	14E	Fr. SW cor. 384.7m N, 258.8m E. -2.0m GR.

SAN BERNARDINO COUNTY

Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
10/26/83	Board of Water Commissioners, Municipal Water Dept., City of San Bernardino TG-6	071-90038	15	1S	4W	Fr. centerline of intersection, Mill St. and Arrowhead Ave., 790m N, 1230m W. 307.9m GR.

Date Notice Received	Operator & Well No.	API No.	Sec.	T.	R.	Location & Elevation
12/14/83	Board of Water Commissioners, Municipal Water Dept., City of San Bernardino TG-7	071-90039	15	1S	4W	Fr. centerline of intersection, Mill St., and Arrowhead Ave., 63m N, 236m W. 305m GR.
12/14/83	Board of Water Commissioners, Municipal Water Dept., City of San Bernardino TG-8	071-90040	15	1S	4W	Fr. centerline of intersection, Mill St. and Arrowhead Ave., 751m S, 91m W. 302m GR.
12/14/83	Board of Water Commissioners, Municipal Water Dept., City of San Bernardino TG-9	071-90041	15	1S	4W	Fr. centerline of intersection, Mill St. and Arrowhead Ave., 2890m S, 1260m E. 308m GR.
12/14/83	Board of Water Commissioners, Municipal Water Dept., City of San Bernardino TG-10	071-90042	15	1S	4W	Fr. centerline of intersection, Mill St. and Arrowhead Ave., 3750m S, 1615m E. 313m GR.

California Division of Oil and Gas
GEOTHERMAL MAPS



MAP NO.	FIELD OR AREA	MAP SCALE
G1-1	Casa Diablo	1:20,000
G1-2	Lake City	1:20,000
G1-3	Susanville	1:7,200
G2-1	Salton Sea (North)	1:20,000
G2-2	Salton Sea (South)	1:20,000
G2-3	Brawley	1:20,000
G2-4	Heber	1:20,000
G2-5	East Mesa	1:20,000
G2-6	Mesquite	1:20,000
G3-1	The Geysers	1:20,000
G3-2	Calistoga	1:12,500
GW-1	The Geysers Area	1:62,500
W1-8	Imperial County	1"=2mi.

GEOTHERMAL MAPS MAY BE PURCHASED FOR $3.00 EACH FROM THESE DIVISION OFFICES:

1416 NINTH ST., ROOM 1310
SACRAMENTO 95814
PHONE (916) 323-1788

50 D ST., ROOM 300
SANTA ROSA 95404
PHONE (707) 576-2385 576-2386

485 BROADWAY, SUITE B
EL CENTRO 92243
PHONE (619) 353-9900

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CALIFORNIA DIVISION OF OIL & GAS
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11626
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