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RENEWAL ISSUE

GEOTHERMAL HOT LINE

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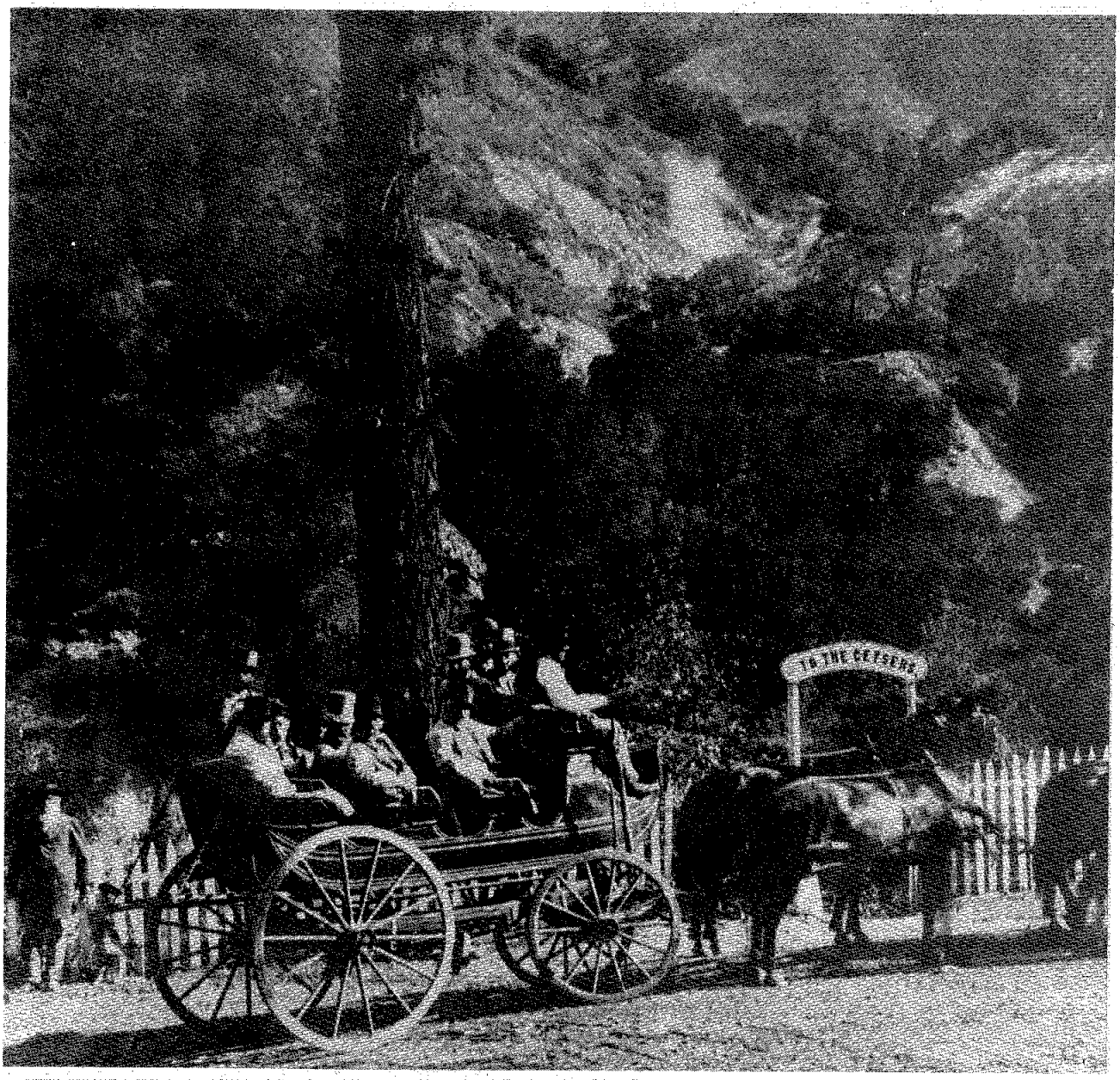
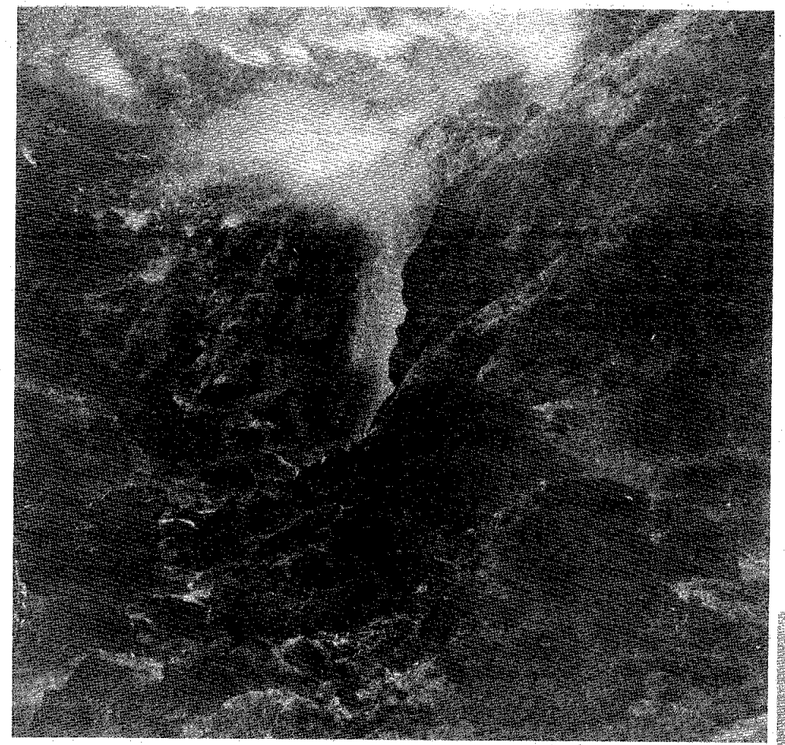
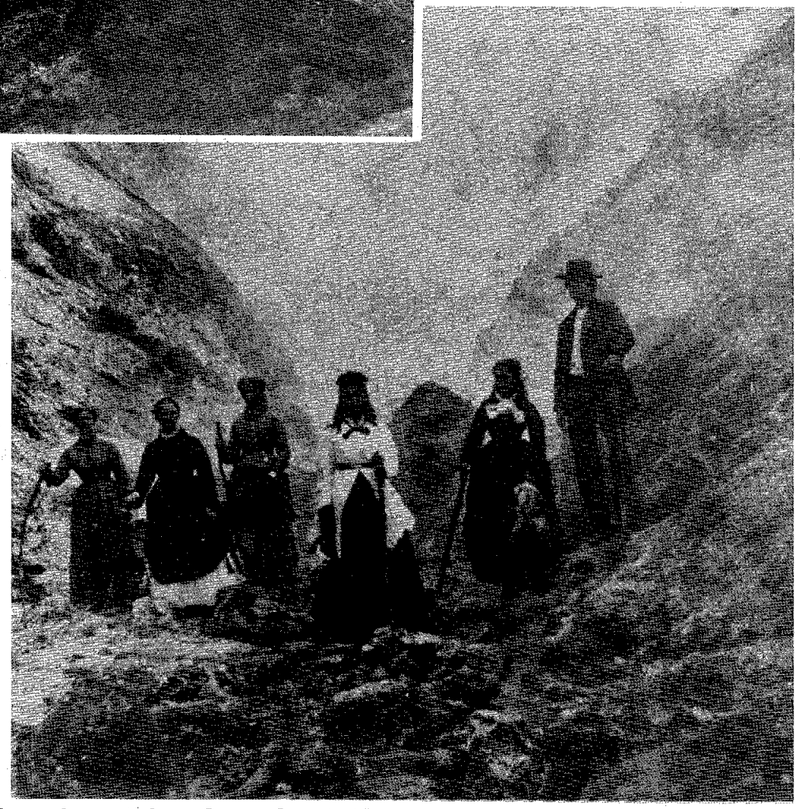


A wagonload of visitors arriving at The Geysers, probably around the turn of the century. The exact date is unknown. The "Calistoga" painted on the wagon, beneath the driver's elbow, suggests the visitors may be arriving from that city. The idea seems to be confirmed by Robert Louis Stevenson, who wrote in 1883 in The Silverado Squatters, that the railroad ended at Calistoga and "...the traveller who intends faring farther, to the Geysers or to the springs in Lake County, must cross the spurs of the mountain by stage." Photo from a stereograph by Andrew Price, courtesy of the Library of Congress.



Steam vents at The Geysers, probably around the turn of the century. Exact date unknown. Note pathway, photo right. Photo from a stereograph by Andrew Price. One side of the stereograph reads "Great Geyser Springs." Photo courtesy of the Library of Congress.



Early visitors at The Geysers exploring the steam vent areas, probably around the turn of the century. Exact date unknown. Photo from a stereograph by Andrew Price, inscribed "Witches Cauldron and Devil's Pulpit," Geyser Springs, Sonoma County, California. Photo courtesy of the Library of Congress.

These two pictures may have been taken from almost the same spot, as the scarps, outlined in front of the steam on the right-hand sides of the photos, are quite similar.

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RENEWAL ISSUE

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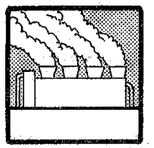

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Development

The Geysers, A Perspective

One day in 1847, William Bell Elliott was tracking a grizzly bear northeast of Healdsburg. Following the bear into The Geysers Geothermal field, he was startled by hissing sounds and by wafts of steam venting from canyon fissures. Later, with his friends, he said "I thought I had come upon the gates of hell itself."

As time passed, more and more people visited The Geysers. By the end of the 1800's, the area was nationally known as a health spa.

A 3-day journey to The Geysers began for one spa visitor on a foggy San Francisco morning aboard the steamboat Rambler. Two paddlewheels moved the little boat out of San Francisco Bay, through San Pedro Bay, and up the twisting passage of Petaluma Creek. In Petaluma, the traveller caught a stagecoach headed for Healdsburg, arriving after dark. He spent the night in a Healdsburg inn and, the following morning, rented a horse to ride through the mountains on the final lap of the journey.

The traveller came to The Geysers at last and set out to explore the famous area. He saw the steam vents that had impressed Elliott, "...issuing from the earth in a hundred different places." He climbed down into Big Sulphur Creek to explore the channel of hot and cold mineral springs, "...white, red, and black sulphur springs; iron soda; and boiling alum springs." He tasted powdered mineral residue on rock ledges as he walked along, his tongue and lips puckering from the chemicals.

Today, visitors drive to The Geysers on narrow-but-adequate roads. They find the grizzly bears are gone; Big Sulphur Creek is still mineralized; and steam rises in graceful puffs from geothermal wells and power plants as well as from narrow fissures: the gates of hell enclose one of the world's few dry-steam geothermal fields.

Nine hundred seven Megawatts of electricity are produced there, enough to meet the electrical needs of San Francisco, the city steamboats slowly left behind, perhaps 100 years ago.

Historical Records Help to Assess Geothermal Resources

"The whole neighbourhood of Mount Saint Helena is full of sulphur and of boiling springs. The Geysers are famous; they were the great health resort of the Indians before the coming of the whites. Lake County is dotted with spas; Hot Springs and White Sulphur Springs are the names of two stations on the Napa Valley railroad; and Calistoga itself seems to repose on a mere film above a boiling, subterranean lake. At one end of the hotel enclosure are the springs from which it takes its name, hot enough to scald a child seriously while I was there. At the other end, the tenant of a cottage sank a well, and there also the water came up boiling. It keeps this end of the valley as warm as a toast."

Reprinted by permission of the publishers From Scotland to Silverado by Robert Louis Stevenson, edited by James D. Hart, Cambridge, Mass.: The Belknap Press of Harvard University Press, Copyright 1966 by the President and Fellows of Harvard College.

If your work includes assessments of geothermal resources, researching the historical record of a geothermal area is probably the least expensive and most easily performed resource evaluation technique. Data such as the number and locations of wells, flow rates, temperatures, geothermal surface features, depth to geothermal zones, historical depletion of resource, areal extent of resource, and uses made of the resource for the past one hundred years or so can be extremely useful. All of these are part of the historical record, and readily available in local libraries or archives of local and state historical societies. Oral accounts from long-time community members can provide the information as well.

Les Youngs of the California Division of Mines and Geology has successfully used the historical record as one of the first steps toward assessing the geothermal resources of the City of Calistoga and the City of San Bernardino. With accounts like Stevenson's and others more specific, he has traced changes in water temperatures, volumes, flow rates, and mineral content for surface features and "hot water" wells. From historical accounts, he learned when and where wells were drilled, well depths, and other well data.

For the San Bernardino project, Youngs looked through old water supply papers written around the turn of the century. The papers had "hot water" well sections with location and temperature data. Not only were the same wells mentioned through the years, providing well histories, but the locations of many "forgotten" wells were uncovered.

When Youngs plotted the wells, he found they were all on the NE side of the San Jacinto fault. He suggests that the fault may act as both a barrier and a heat conduit for the geothermal reservoir.

While exploring the historical records, Youngs was also able to trace the rise and fall of businesses that used geothermal resources. For example, today in Calistoga, the Napa Valley Springs Mineral Water Company commercially bottles mineral water collected from a "hot water" well on its property. This property once belonged to a winery, owned by Ephriam Light, who used the hot water to clean wine barrels and tanks. Mr. Light purchased the winery property from Sam Brannan - when it was the stable area of his famous spa, opened in 1862.

Youngs says that the historical records of an area should be examined before any geothermal exploration or resource evaluation program is planned. Such an investigation may pinpoint areas of exploration or eliminate certain scientific techniques from an evaluation program, thus saving time and money. Also, research into the historical literature or oral records is free and open to the general public or small business operators who may wish to investigate the feasibility of using geothermal resources in their areas.

In early 1981, Youngs' Calistoga historical findings will be published in two formats by the California Division of Mines and Geology: once as part of an open file report titled Resource Assessment of Low-and Moderate-Temperature Geothermal Waters in Calistoga, Napa County; and once in an issue of California Geology.

Variety Typifies the CDMG Geothermal Program

Statewide mapping projects, a computerized data storage program, and local resource assessment studies--all

are part of the California Division of Mines and Geology (CDMG) contribution to the Department of Energy, State Coupled Geothermal Program. The purposes of the federal program are to identify and assist in developing areas of low- and moderate-temperature geothermal resources throughout the United States.

One CDMG project, developed under the program, is a 1:750,000 scale map of California's geothermal resources on which low-and moderate-temperature resource areas are emphasized. Information displayed includes thermal springs and wells, Known Geothermal Resources Areas, areas of known or suspected thermal waters suitable for direct uses, points of measured heat flow, and land jurisdiction. The map is available, free of charge, from the California Division of Mines and Geology, 2815 "O" Street, Sacramento, California 95816.

In 1982, a second, more detailed map will be published with additional geological and geochemical data.

Besides their inclusion on maps, data for all known and newly discovered thermal springs and wells in California are being entered in computerized data storage banks. The banks are stored in the U.S. Geological Survey Office of Resource Analysis at Menlo Park, California, in GEOTHERM, a computer program used to file, process, and retrieve the data.

GEOTHERM data may be obtained directly from the General Electric computer network. Persons with no access to the GE network may obtain GEOTHERM data (for a fee, unless they have contributed data to GEOTHERM) by contacting James Bliss, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

As part of the resource assessment phase, the CDMG is studying the geothermal resources in Calistoga, in the northern Napa Valley, to learn the extent and source of the Calistoga hot water reservoir. Of the many geophysical surveys performed at Calistoga, electrical resistivity appears to be the most useful for delimiting the resource. A survey of over 200 water wells in the area has also provided data on temperatures and chemistry of the groundwater at various depths. Several shallow-and moderate-depth exploratory holes are being drilled to determine the local stratigraphy and reservoir properties. An open file report titled Resource Assessment of Low-and Moderate-Temperature Geothermal Waters in Calistoga, Napa County, will be available about March 1 from the CDMG "O" Street address.

Preliminary work similar to the Calistoga study is underway in the Paso Robles area, San Luis Obispo County, and in areas near San Bernardino. The Paso Robles area is underlain by an extensive hot water aquifer with temperatures of at least 47°C (117°F). Similar temperatures have been measured in water wells south and northeast of downtown San Bernardino. The extent, quality, and sources of the hot water will be determined during these two studies.

In addition, a reconnaissance study of the geothermal resources of Los Angeles County is underway. Because surface evidence of geothermal resources in the county is sparse, the study focuses on data from water, oil, and gas wells. Water samples will be analysed to determine how they will react with metals used in direct-use geothermal projects. Eventually, a detailed geothermal gradient map will be drawn.

On a smaller scale, studies have been conducted at Kelly Hot Springs, the Bridgeport-Bodie Hills region, Mono Basin, and the area south of San Diego Bay. The Kelly Hot Springs geophysical study is available as an open file report from the CDMG "O" Street office. For general information on the Bridgeport study, contact Forrest Bacon (916) 322-9918; for geophysical data, call Rodger Chapman (916) 322-9305. Both are at the "O" Street address.

The CDMG and the California Division of Oil and Gas can answer public inquiries about low-and moderate-temperature geothermal resources in California. The CDMG also assists participants in other U.S. Department of Energy geothermal programs.

Much material for this article has been excerpted, with permission, from "The Search for Hot Water in California" by Chris T. Higgins, published in the December 1980 issue of California Geology.

U.S. and Canadian Cascades Studied

The Cascade Regional Assessment by the U.S. Geological Survey is well underway. Many reports are being compiled, for later publication.

Canadian geologists are studying the northern tip of the Cascade Range, including the Meager Creek and Meager Mountain areas, 150 kilometers north of Vancouver, B.C. There, the geologists are exploring an area of volcanic activity 15 kilometers in diameter. The volcanic activity occurred from 1.9 million to 2.4 million years ago, and hot springs with temperatures measuring 60°C (140°F) have been located north and south of Meager Mountain.

Since the late 1970's, the British Columbian provincial government has spent $4 million for geothermal exploratory activity in the Meager Mountain area. Fourteen core holes have been drilled south of Meager Mountain and 8 core holes north of Meager Mountain. The holes are up to 365 meters deep with temperatures as high as 202°C (396°F).

The provincial government is looking for geothermal resources with temperatures above 200°C (392°F) to use in electrical generation projects.

Legal

Title VI, Geothermal Energy

The following summary of Title VI of the Energy Security Act of 1980 is repeated from the Department of Energy "Energy Insider."

1. Loans are authorized through FY 1986 for geothermal reservoir confirmation drilling projects, with funding limited to $5 million for FY 1981; $20 million for each of the next four fiscal years.

2. This title provides $5 million for loans to support feasibility studies in FY 1981 for nonelectrical geothermal projects, such loans to cover up to 90 percent of the cost.

3. Consideration must be given to geothermal energy use in all new federal facilities.

What do you Think about Geothermal Regulations?

Do you have any comments or suggestions on California Division of Oil and Gas (CDOG) regulations? If you will write them down, the division would like to hear from you.

Your ideas will be part of a statewide review mandated by Assembly Bill 1111. The purpose of the review is to simplify and improve the quality of state regulations and to remove any unnecessary or unauthorized regulations.

Your suggestions will be used to help the division determine whether or not its regulations are:

1. Necessary to implement, interpret, or make specific a law or court decision;

2. Adopted by agencies authorized to do so;

3. Clearly written so that persons affected by them can easily understand them;

4. Consistent with existing laws; and

5. Referenced to a specific statute or court decision.

Comments on the disclosure and inspection of public records are due prior to 2/23/81 (but receipt at a later date is acceptable); comments on geothermal regulations are due prior to 5/1/81; comments on environmental protection are due prior to 7/1/81; and comments on the implementation of the California Environmental Quality Act (CEQA) are due prior to 11/31/81.

Comments on oil and gas regulations may also be submitted. Those concerning offshore well regulations are due prior to 9/1/81; those concerning onshore well regulations are due prior to 11/31/81.

Inquiries or comments should be addressed to Robert Reid, California Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, California 95814 (Telephone: (916) 445-9686).

Copies of the current regulations are found under Title 14, Division 2 of the Public Resources Code, available from the State of California, Documents Section, P.O. Box 1015, North Highlands, California 95660. The cost is $6.04.

California to Receive Geothermal Royalties

The State of California will receive $20 million immediately and could receive $31.6 million a year by 1990 because of court decisions dealing with its right to geothermal energy royalties, according to Ken Cory, State Controller.

The decision (Pariani v. State of California, 105, Cal. Ap. 3d, 923, May 20, 1980) found that mineral rights held by the state for certain sites in Lake and Sonoma Counties covered geothermal wells on the properties.

Cory said the state now receives $5 million a year from geothermal wells on 6,300 acres, but has mineral rights on 500,000 acres that have geothermal energy potential.

1916 Homestead Act Lands Uses Clarified

An informational memo from federal officials favors surface landowners in geothermal resource areas, but still allows limited use of their property, according to Lakeport, California attorney Peter Windrem. Windrem said the federal opinion "definitely" restricts the use of 1916 Homestead Act surface lands as power plant sites. Utility companies wishing to build power plants on 1916 Homestead Act surface lands will have to negotiate with landowners for their consent to do so.

However, landowner permission is probably not necessary for constructing roads, drilling pads, well sumps, or pipelines needed to transport the geothermal steam.

The Geysers

Two Studies of The Geysers Near Completion

Two major studies of The Geysers Geothermal field are slated for 1981 publication. One, a reservoir study of the field, will be published first by the California Division of Oil and Gas (CDOG) in limited edition, and then by the U.S. Department of Energy.

Titled A Reservoir Assessment of The Geysers Geothermal field, the study has three sections and co-authors: the geological section is by Dick Thomas of the California Division of Oil and Gas; the geophysical section is by Rodger Chapman of the California Division of Mines and Geology; and the reservoir section is by Herman Dykstra, a private consultant.

The publication schedule is:

Spring 1981 - Text, as an open file report, may be read at CDOG offices.

About July 1, 1981 - 1,200 copies may be purchased from the CDOG.

Late 1981 or 1982 - Copies may be purchased from the DOE.

The second study is titled Research in The Geysers - Clear Lake area, California, U.S.G.S. Professional Paper 1141. Edited by R. J. McLaughlin and J. M. Donnelly-Nolan, it will be published in the spring of 1981. The price is unknown.

The publication will contain an introduction by the editors and 23 research papers written on studies undertaken in The Geysers - Clear Lake area.

Power Plant Unit 14 Begins Operation

On September 25, 1980, power plant Unit 14 began commercial operation at The Geysers Geothermal field. Producing 110 Megawatts of electricity, Unit 14 raises the total field output to 907 Megawatts of electricity.

The day Unit 14 began production nearly coincided, by chance, with the 20th anniversary of the day electrical power generation began at The Geysers. That event occurred with the inauguration of Pacific Gas and Electric Company's (PG&E) power plant Unit 1, an 11,000 kilowatt installation.

In 1973, according to "P.G. and E. Progress," when the utility added its ninth and tenth units, The Geysers became the world's largest geothermal electrical generating facility.

Total cost of Unit 14, including electrical switchyard costs, is about $59 million. The unit has a primary and secondary abatement system designed to remove hydrogen sulfide, which is present in geothermal steam.

Presently, P.G. & E. has 15 power plant units operating at The Geysers. (Unit 15 began operation in 1979.) Two more units are under construction and expected to begin operation in 1982.

U.S. Backs NCPA Power Plant at The Geysers

A group of small Northern California public power agencies received a $45 million loan guaranty from the U.S. Department of Energy (DOE) to build a 110 megawatt geothermal electrical generating plant at The Geysers Geothermal field. The power plant is the first to be built and owned by the group called the Northern California Power Agency (NCPA), which includes nine small cities and a rural cooperative.

The plant is scheduled for completion in 1982. Steam for the plant will be purchased from Shell Oil Company

In August 1980, Ruth M. Davis, assistant secretary of the Department of Energy (DOE) for resource applications, signed the loan guaranty on behalf of her agency at ceremonies in San Francisco. Dr. Priscilla Grew, Director of the California Department of Conservation, attended the ceremonies.

The guaranty means the federal government will back repayment of the 30-year loan, obtained by the NCPA from the California subsidiary of the Bank of Montreal. The loan is for 75 percent of the power plant construction costs. The other funds will be raised through nonguaranteed debt revenues.

Under the DOE Geothermal Loan Guaranty Program (GLGP), the federal government pledges to guarantee the repayment of the principal and interest on loans made to businesses whose planned use of geothermal energy will advance the development of geothermal resources.

The GLGP program includes a broad range of projects involved with:

1. Determining and evaluating the commercial potential of geothermal resources
2. Researching and developing geothermal extraction and utilization technologies
3. Obtaining rights to geothermal resources
4. Developing, constructing, and operating facilities for the demonstration or commercial production of electrical energy from geothermal resources

5. Developing, constructing, and operating equipment or facilities for nonelectric application of geothermal resources.

Any organization, public or private, may be granted a geothermal loan guaranty. Loan guaranties of up to 75 percent of the estimated aggregate cost of a project are granted up to 30 years. At least 25 percent of the cost must be provided by the borrower. The maximum loan guaranty for a single project is $100 million, with allowances for larger amounts for projects considered to be in the national interest.

For more information on the GLGP, contact the Geothermal Loan Guaranty Office, DOE-San Francisco Operations Office, 1333 Broadway, Oakland, California 94612 (Telephone: (415) 273-7151).

Erosion Study at NCPA Power Plant Site

An erosion study is underway at the Northern California Power Agency (NCPA) power plant site in The Geysers Geothermal field. Undertaken by David Schwartz of the Department of Conservation and co-funded by the department and the California Energy Commission, study goals include:

1. Visual estimates of sheet and rill erosion on disturbed and undisturbed slopes;

2. Measurement of rainfall and rainfall intensity;

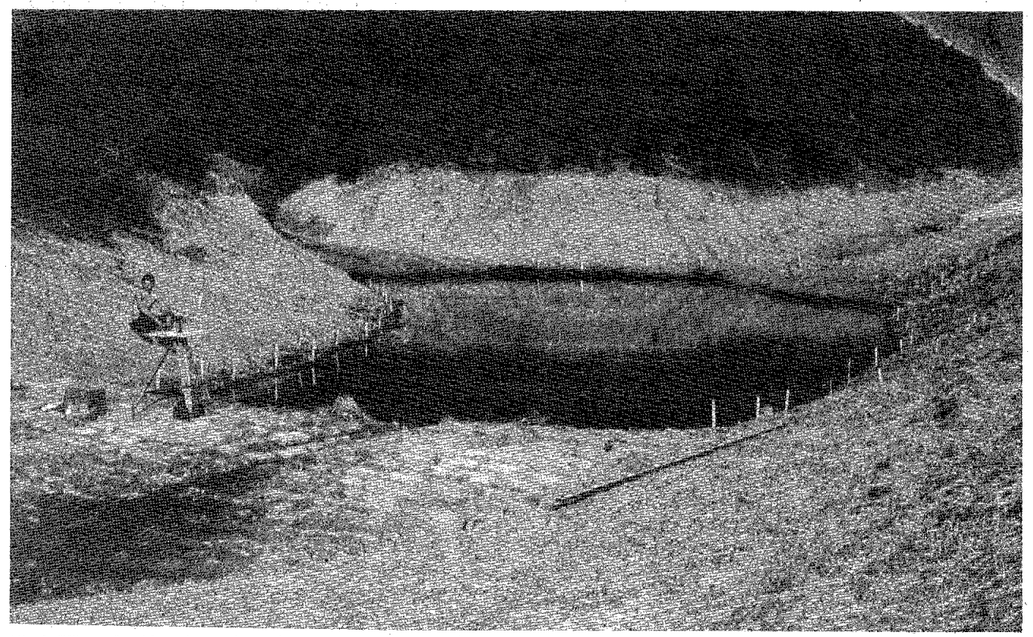
3. Measurement of suspended sediment and discharge and the establishment of sediment rating curves for each stream; and

4. Review and assessment of sediment volume data from the sediment basin at the NCPA site.

The final report is scheduled for completion in June 1982.

DWR Power Plant Approved

The California Department of Water Resources (DWR) has received approval for its final plan to build a 55 Megawatt geothermal power plant in The Geysers Geothermal field.



Sediment basin at the foot of the NCPA power plant site. Most water from the site drains into the pond. Erosion from the site will be measured by comparing surveys of pond bed topography. Photo by David Schwartz.

In November 1980, the California Energy Commission approved the $70 million Bottle Rock plant, to be built in the Lake County portion of the field.

DWR has agreed to spend $1.7 million to rebuild Bottle Rock Road and $250 thousand to install a flashboard dam on Kelsey Creek. Compensation will be made for loss of wildlife habitat.

Advanced pollution control technology built in the plant will include a scrubber system and a secondary system to reduce the hydrogen sulfide emissions in the plumes of steam. Site development is scheduled to begin in March 1981. The plant is to be in full operation by June 1984.

SMUD Power Plant Up for Approval

On March 25, the California Energy Commission (CEC) will hold a hearing on the Sacramento Municipal Utility District (SMUD) - proposed $45 million geothermal power plant to be built in The Geysers Geothermal field.

Don Martin, SMUD project manager, said that the Environmental Protection Agency (EPA) has expedited its review of SMUD's Prevention of Significant Deterioration Permit (PSD), and the PSD review should be finished in time for the hearing.

If the proposal for the 55 Megawatt project is approved, construction could begin in the spring.

Air Pollution Model Under Development

Scientists from 18 laboratories and institutions, working through the Lawrence Livermore National Laboratory Atmospheric Sciences Division, are designing a computerized air pollution model allowing them to simulate pollutant flow and assess air quality in hilly regions. Three studies at The Geysers Geothermal field--one in July 1979; one at Anderson Creek Valley in September 1980; and one planned for Big Sulphur Creek in August 1981--have been designed to provide data for the model.

The Anderson Creek Valley project considered the basic physics of transport.

The Big Sulphur Creek study is planned to determine whether or not the Anderson Creek data can be generalized to other areas, and to study the relationship of geothermal cooling tower emissions to nocturnal drainage flows. During the study period, tracers of several chemicals will be added to steam plumes emitted from geothermal plant cooling towers. The chemical concentrations will then be measured in the Big Sulphur Creek area.

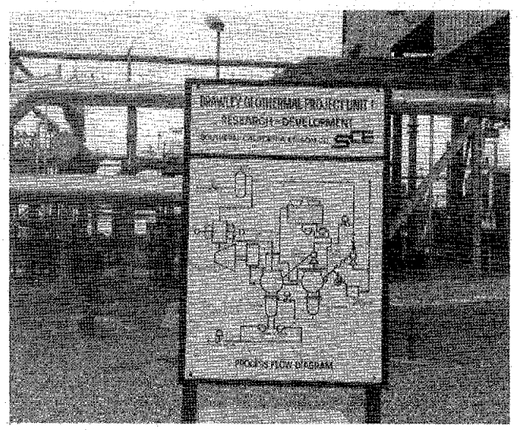
Imperial Valley

Niland Power Plant Contract Awarded

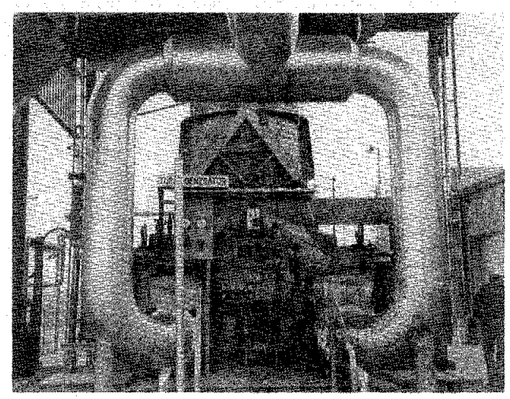
Southern California Edison has awarded a contract to Fluor Power Services Inc., a wholly owned subsidiary of Fluor Corporation, to design and engineer a pilot 10 Megawatt geothermal power plant at the Salton Sea Geothermal field near Niland, in the Imperial Valley.

The contract, estimated at $1 million, is for a power plant with a single-flash, geothermal generating unit. Plant completion is scheduled for spring 1982.

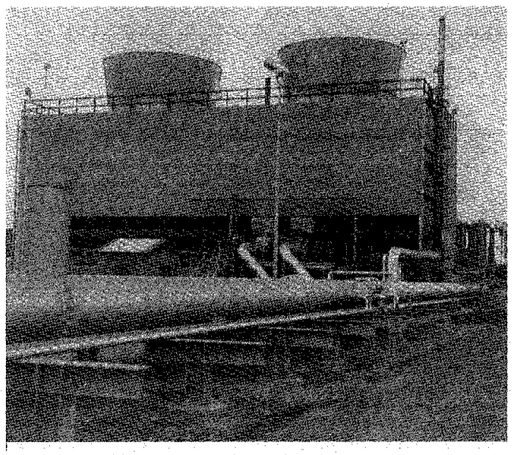
Flashed steam for the plant will be provided by Union Oil Company of California, which has drilled four wells capable of production.



Process flow diagram, Brawley geothermal project. Capital cost of the plant is about $11 million. Photos by Doug Stockton.



Turbine generator, Brawley geothermal project. The Brawley facility uses a flashed steam system to furnish geothermal steam to the turbine. The turbine is a single unit with five impulse stages.



Cooling tower, Brawley geothermal project. A conventional two cell, induced draft, counterflow, wet cooling tower with a rated heat load of 200 MM Btu/hr. provides 0.908 m^3/sec (14,400 gpm) cooling water with a 5.5°C (10°F) approach to wet bulb temperature.

Brawley Power Plant Dedicated

The Brawley Geothermal Electric Project, the first commercial Imperial Valley geothermal power plant, was dedicated on October 15, 1980. Southern California Edison Company, the plant owner, operates the 10 Megawatt electrical generating plant with geothermal energy extracted from the Brawley reservoir through wells owned by Union Oil Company of California. The local electrical utility, the Imperial Irrigation District, purchases the power from Southern California Edison.

Edison is conducting performance and reliability studies on all phases of power plant operations. The company wishes to assess the technical feasibility of generating electricity with high salinity geothermal brines. Total dissolved solids of the brines in the Brawley reservoir is about 100,000 mg/l.

Direct Heat

Direct Heat Data and Workshop

A Blueprint for Financing Geothermal District Heating in California, a study prepared for the California Department of Conservation by Derek Hansen & Associates, has recently been released by the department.

Written to encourage the development of direct heat geothermal systems, the study analyzes the financial and institutional context within which direct heat use is being developed. The paper sets forth a plan for utilizing public and private financing for direct heat projects, and recommends changes in current law and regulations that would improve the investment climate.

A workshop on the report, involving representatives from industry and various sectors of the financial community, is planned for the spring.

To receive a copy of the report and workshop information, write or call Michael Gersick, Deputy Director, Department of Conservation, 1416 Ninth Street, Room 1320, Sacramento, CA 95814 (Telephone (916) 322-1080).

Alfalfa - Drying Plant Planned for El Centro

A project to build a geothermal alfalfa-drying plant in El Centro, California is underway. WESTEC Services, Inc., San Diego, has signed a contract with Handlers, Inc. in conjunction with the California Energy Commission to create a preliminary design and an economic assessment of the project.

The project will be the first commercial application of geothermal power to the alfalfa-drying process in the United States. The world's only other such alfalfa-processing plant is currently operating in New Zealand.

At the plant, the alfalfa will be dried before it is compressed into pellets for sale as livestock feed.

Hot Dry Rock

Hot Dry Rock Producing Electricity at LASL

Part of the electricity needed at the Department of Energy Hot Dry Rock Geothermal Energy Progam research site at Fenton Hill in New Mexico now comes from turbines run by heat from hot granite located two miles underneath the site.

It is the first time electricity has been produced from hot dry rock. The experiment, which produced 60 kilowatts of electricity, is scheduled to operate from mid-1980 to early 1981.

"The fact that we are able to generate electricity demonstrates that the program is now out of the research stage and has entered the engineering development phase," says Gregory Nunz of the Los Alamos Scientific Laboratory, manager of the program. He emphasizes that the electricity generated represents only a small fraction of the potential of the resource at the site.

New Hampshire Hot Dry Rock Project

A plan for the world's first full-scale commercial hot dry rock geothermal project for the generation of electricity has been submitted by HDR Energy Development Corporation to the Department of Energy (DOE). The project will be developed within the Conway-Osceola granite of New Hampshire where the White Mountain magma series is massive enough, hot enough, and close enough to the surface to be reached with current drilling technology. HDR plans to use turbo-and hammer drilling with air as a circulating fluid. Complex fracturing techniques will be used in the granite to form the vast amount of heat-transfer surface necessary for the project.

The proposed $80 million joint venture with the DOE is based, in part, upon government-sponsored research at the Los Alamos Scientific Laboratory. However, the size of the fracture complex has been increased from that used at Los Alamos, and the resistance to flow decreased between the injection and extraction sides of the high-temperature earth loop.

Utah

Power Plant at Roosevelt Hot Springs

A 20 Megawatt geothermal power plant will be built by Utah Power and Light Company at Roosevelt Hot Springs, Utah, about 200 miles south of Salt Lake City. Electricity will be generated at the plant with steam purchased from Phillips Petroleum Company. Power plant completion is scheduled for 1983. At that time, other power plants may be built, raising field energy production to around 120 Megawatts.

The plant may become the first geothermal power plant in the United States outside the State of California.

Utah State Prison to be Heated Geothermally

In Crystal Hot Springs, Utah, a direct-heat geothermal project is underway to provide space heating for the Utah State Prison. Two exploratory wells have been drilled for the project. One well, deepened from 280 feet to 505 feet, produced an artesian flow of about 300 gpm at 60°C (180°F). A second well, drilled to about 1,005 feet, is being tested. The project is partially funded by the U.S. Department of Energy under a cost-sharing program.

Cerro Prieto

SDG&E Buys Geothermal Power from Mexico

An agreement for the first international sale of geothermal power in North America was signed on November 12, 1980 by San Diego Gas and Electric Company (SDG&E), Southern California Edison, and the Comision Federal de Electricidad of Mexico.

Under the agreement, SDG&E will purchase 150 Megawatts of electricity over a 10-year period from Mexico's Cerro Prieto Geothermal field, and Southern California Edison will purchase 70 Megawatts of electricity from the field. Later, the two companies may be able to purchase additional geothermally-generated electricity from Mexico, possibly as much as 300 Megawatts each, if Mexican geothermal reserves are adequate. Negotiations for the additional purchases are underway.

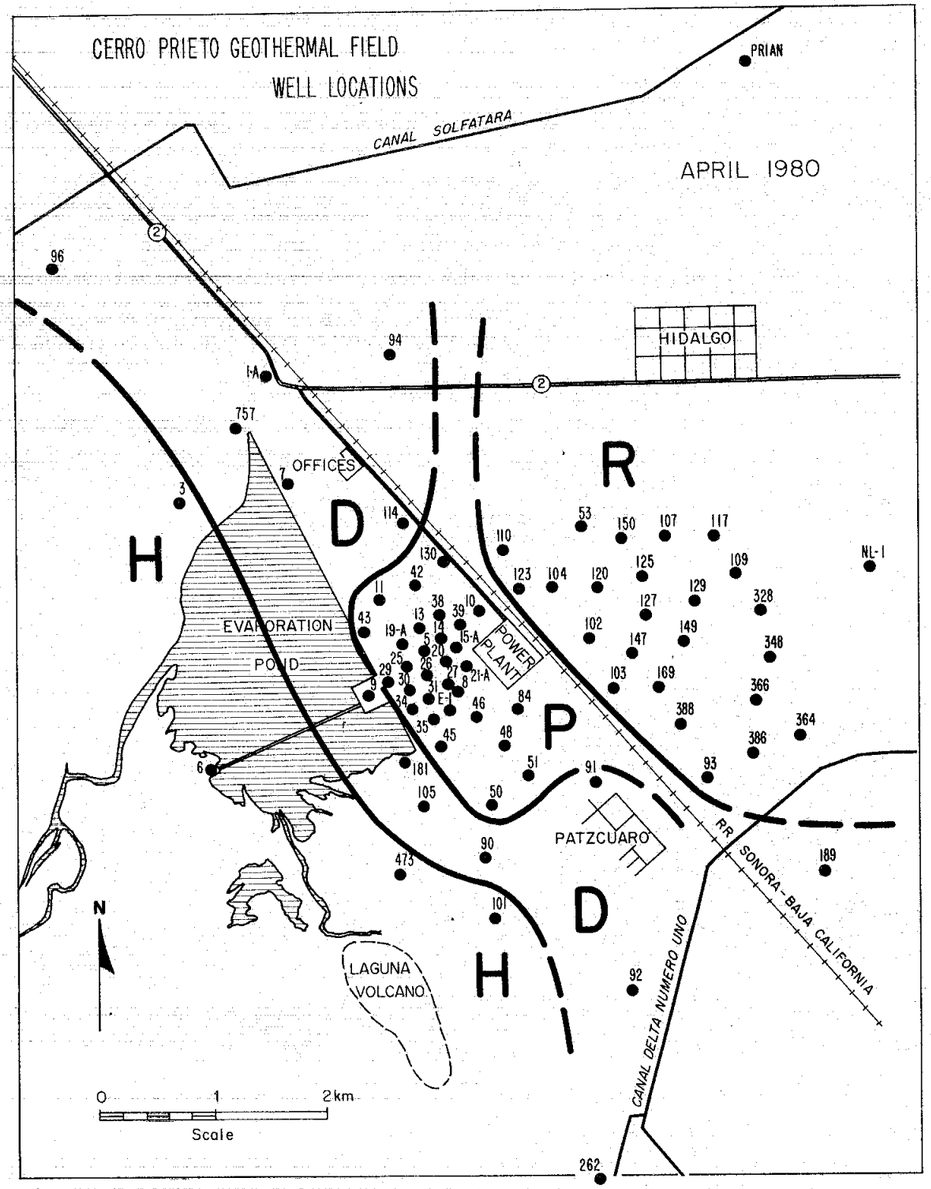
The Mexican electricity will not reach San Diego customers until 1984, when two new power stations will be operating at Cerro Prieto Geothermal field. Presently, two power stations are operating, producing 150 Megawatts of electricity that is used in Mexico.

Cerro Prieto Reservoir Studied

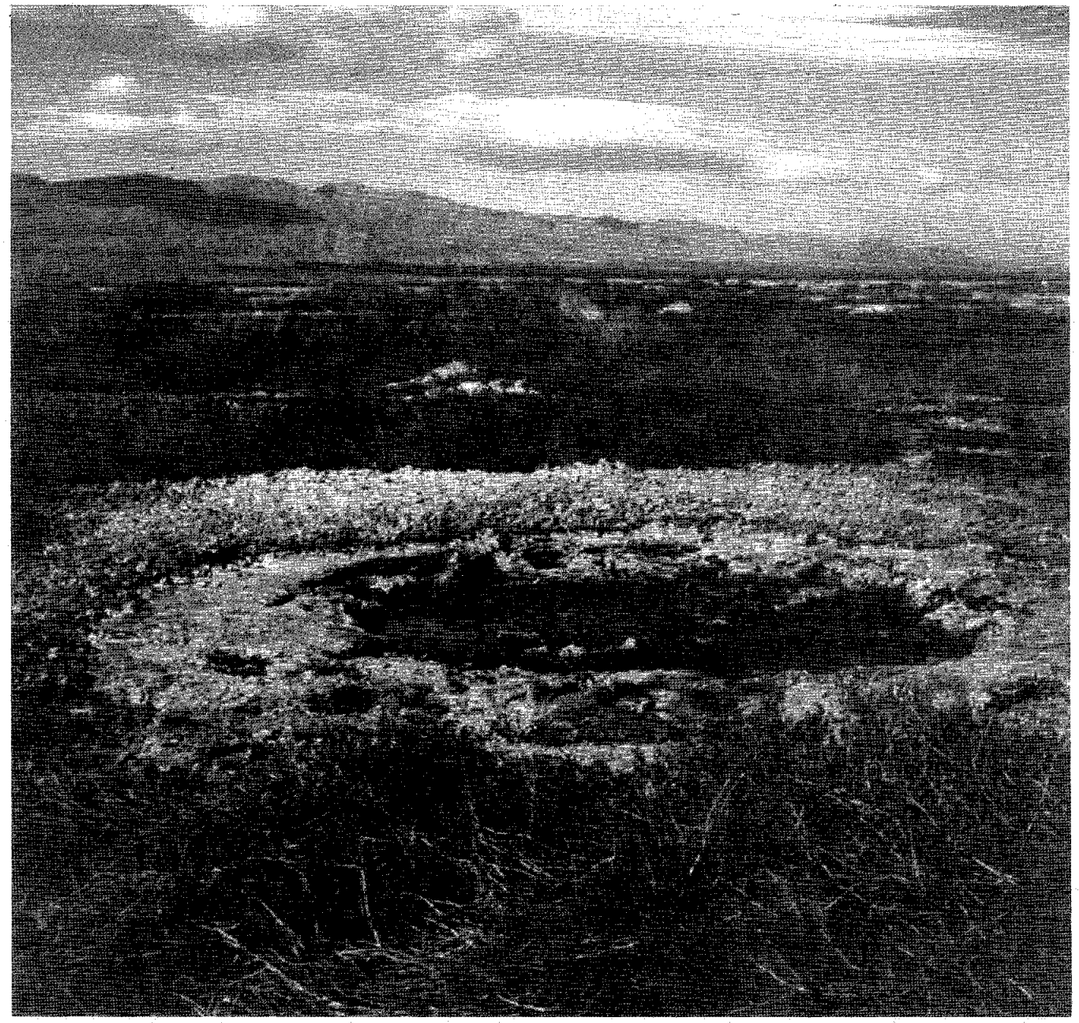
Dr. Wilfred Elders is the principal investigator in a study designed to analyze reservoir heating at the Cerro Prieto Geothermal field through isotope geochemistry, geothermometry, and an evaluation of thermal mineral variations in well cores and cuttings.

The latest results of hydrothermal alteration studies at the Cerro Prieto Geothermal field reveal the shape of the reservoir. These data record patterns of hydrothermal circulation prior to production. As shown in the figure, four regions have been defined. It is inferred that a thermal plume, elongated in a NW-SE direction, dips at approximately 45° to the northeast. This plume is recharged at depth from the northeast and discharges to the southwest. Some of the surface discharge is in the Laguna Volcano mud pot and thermal springs region (see photos).

Contour maps of the field based on $\delta^{18}C$ in calcite from sandstones provide 200°C and 300°C isotherms. The hottest mineral zone yet drilled, the biotite-



Proposed division of the geothermal field at Cerro Prieto into regions of characteristic flow regime. These are: R - Recharge Zone, P - Thermal Plume Zone, D - Discharge Zone, and H - Horizontal Flow Zone.

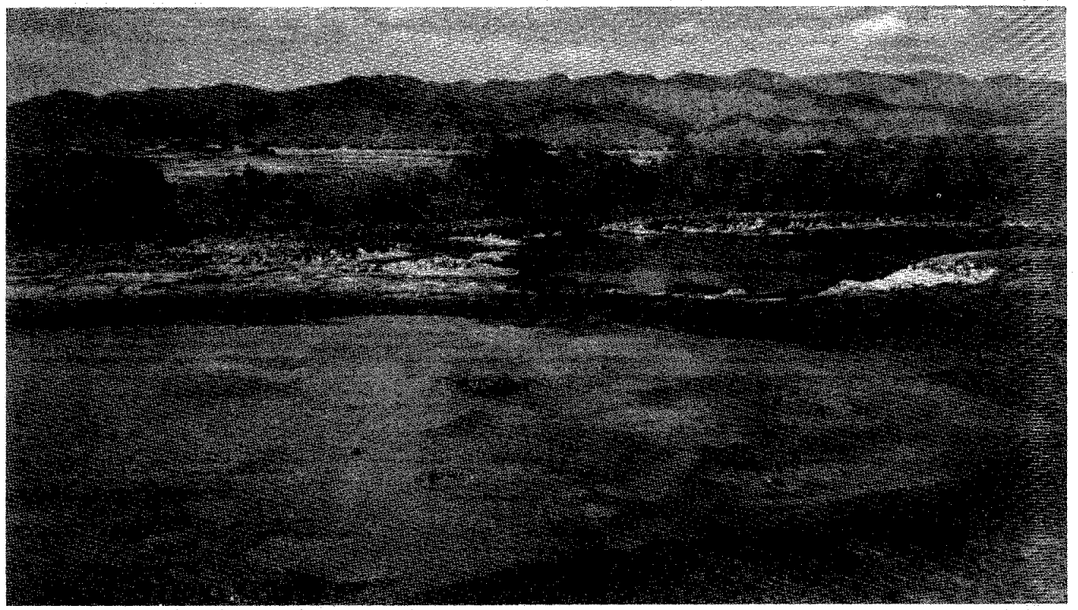


Hot spring at Cerro Prieto Geothermal field. According to J. N. Valette, the field's surface emissions may be divided into four groups: hot and warm springs; boiling mud lakes and mud pots; cold pools; and fumaroles of diverse temperatures. Photo by Susan Hodgson.

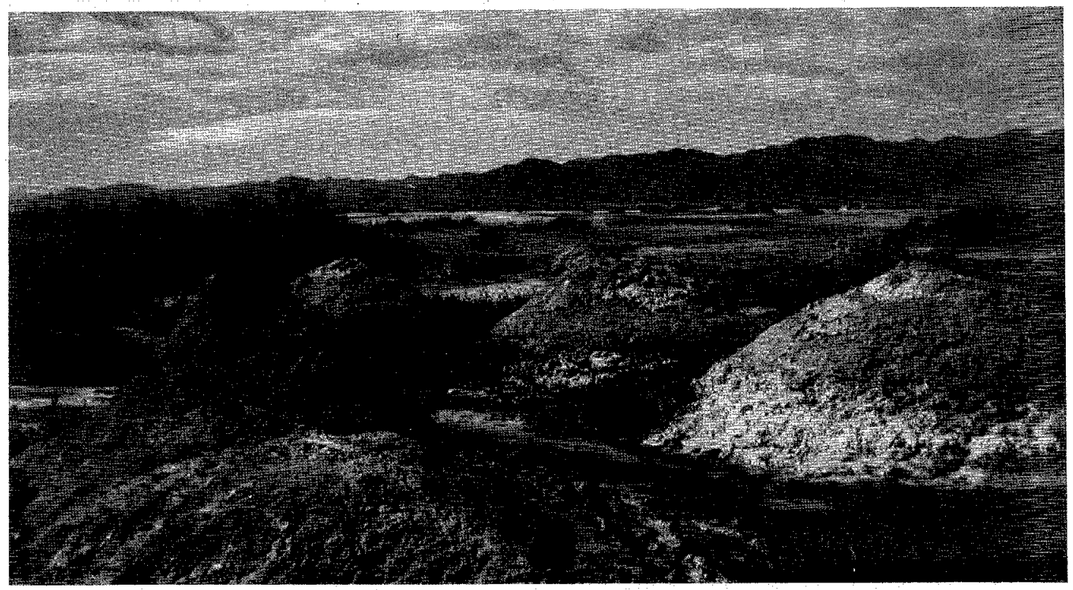
stilpnomelane zone of ~325°C, is displaced deeper towards the east and northeast relative to the ~225°C epidote zone above it.

Examination of the spacing of mineral zones with depth in individual boreholes permits division into four classes: (1) prograde; (2) telescoping (or compressed); (3) extended (or elongate); and (4) reversed.

Preliminary studies of the annealing of fission tracks in apatite suggest that heating in the area of well T-366 at Cerro Prieto has lasted only tens of thousands of years.



Bubbling mud pots at Cerro Prieto Geothermal field. Mud pot water temperatures have registered at 100°C (212°F) with a pH between 6 and 7. Researchers found large concentrations of condensate water in the field's mud springs and geysers. They noted good correlations between fluid emitted in pools and geysers and fluid produced by wells. Photo by Susan Hodgson.



Mud volcanoes at Cerro Prieto Geothermal field. Wafts of steam were venting from several cones as the picture was taken.The mud volcanoes are about 3 feet high.Sierra de las Cucapa is in the background. Photo by Susan Hodgson.

Costa Rica and Peru

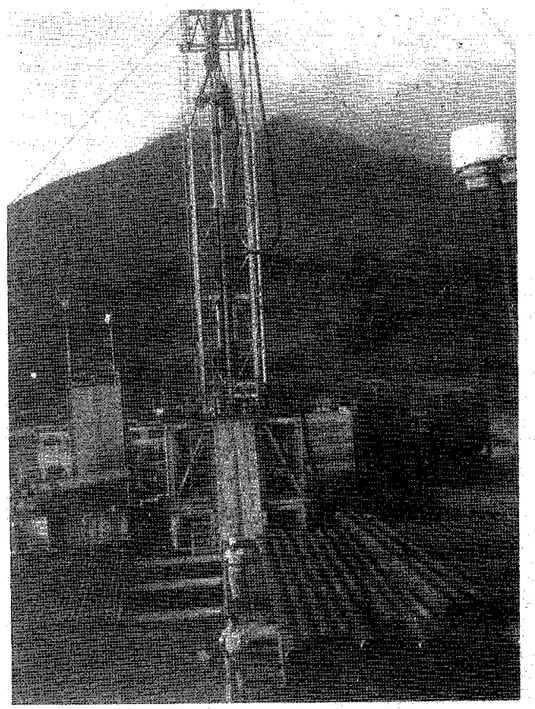
Costa Rican Development at Miravalles

Part II

The following information was provided by the Instituto Costarricense de Electricidad.

Costa Rica's geothermal development program is directed by the Instituto Costarricense de Electricidad. Geothermal exploration has been concentrated in the northwestern region of the country, in Guanacaste Province along the flank of a chain of active volcanoes. Particular attention has focused on an area called Las Hornillas de Miravalles.

The first well drilled at Las Hornillas de Miravalles was well "PGM-1", completed in July 1979. The productive reservoir is in a zone of fractured and permeable crystalized, lithic tuff, capped by a stratum of altered tuff. In February 1980, the bottom hole temperature was 241°C (446°F) and the pressure measured substantially over 178 psi. It is estimated that between 7 and 9 MWe can be produced from the well.

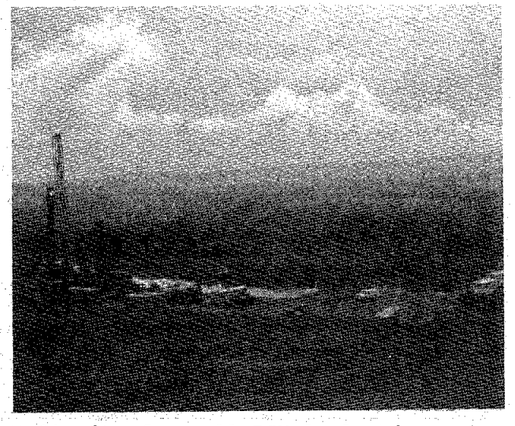


Well PGM-1, while drilling. Miravalles volcano is in the background. Photos courtesy of the Instituto Costarricense de Electricidad.

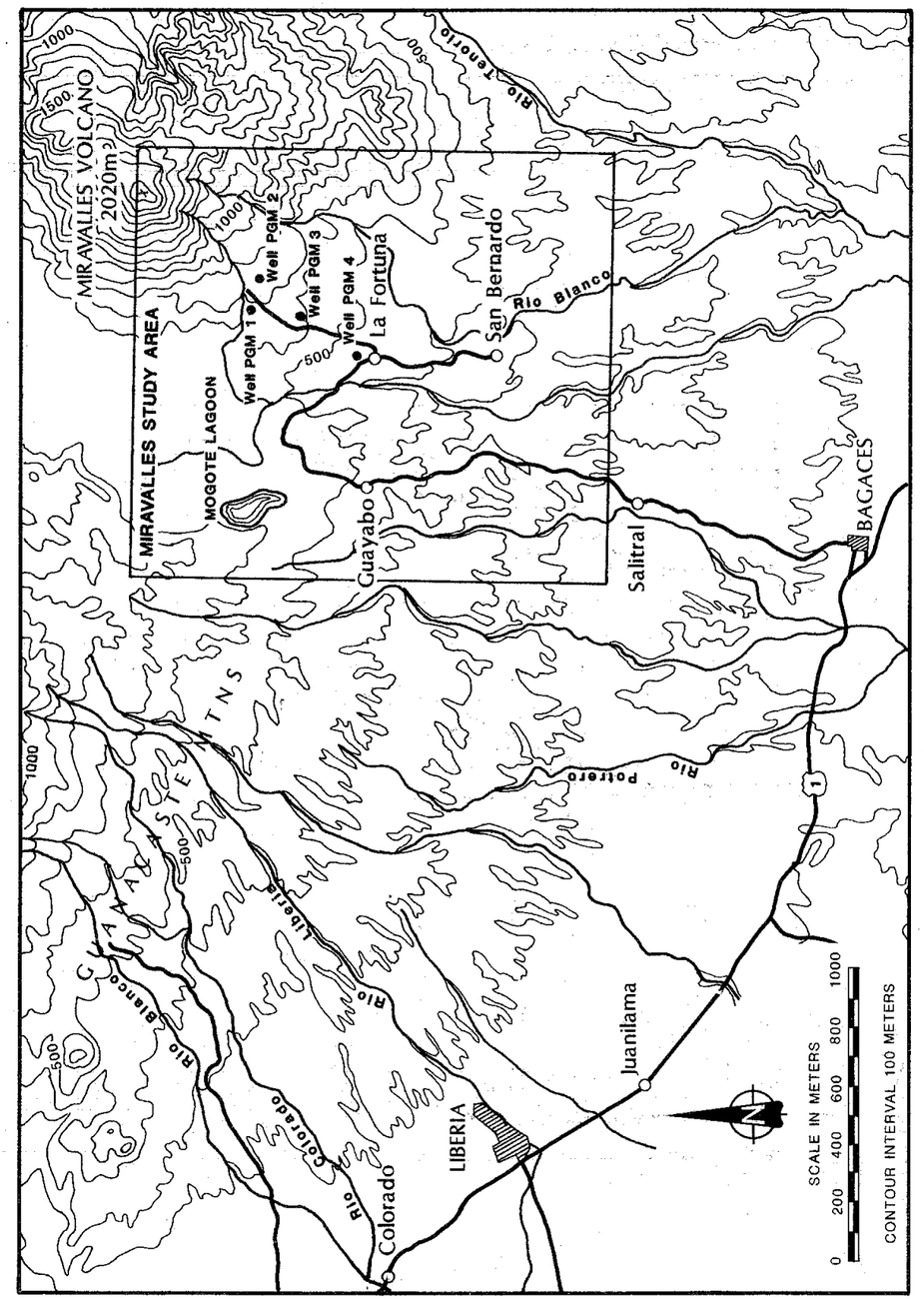
Well "PGM-2" was completed in January 1980. Strata penetrated by the well was lithologically similar to that penetrated by "PGM-1", although a different degree of hydrothermal alteration was discovered. The production zone of well "PGM-2" is in fractured tuff. In February 1980, the bottom hole temperature of the well was 210°C (410°F).

A field reservoir evaluation is underway. Results of the study will determine the size of the first generating unit and the number of wells to be drilled in the next few years.

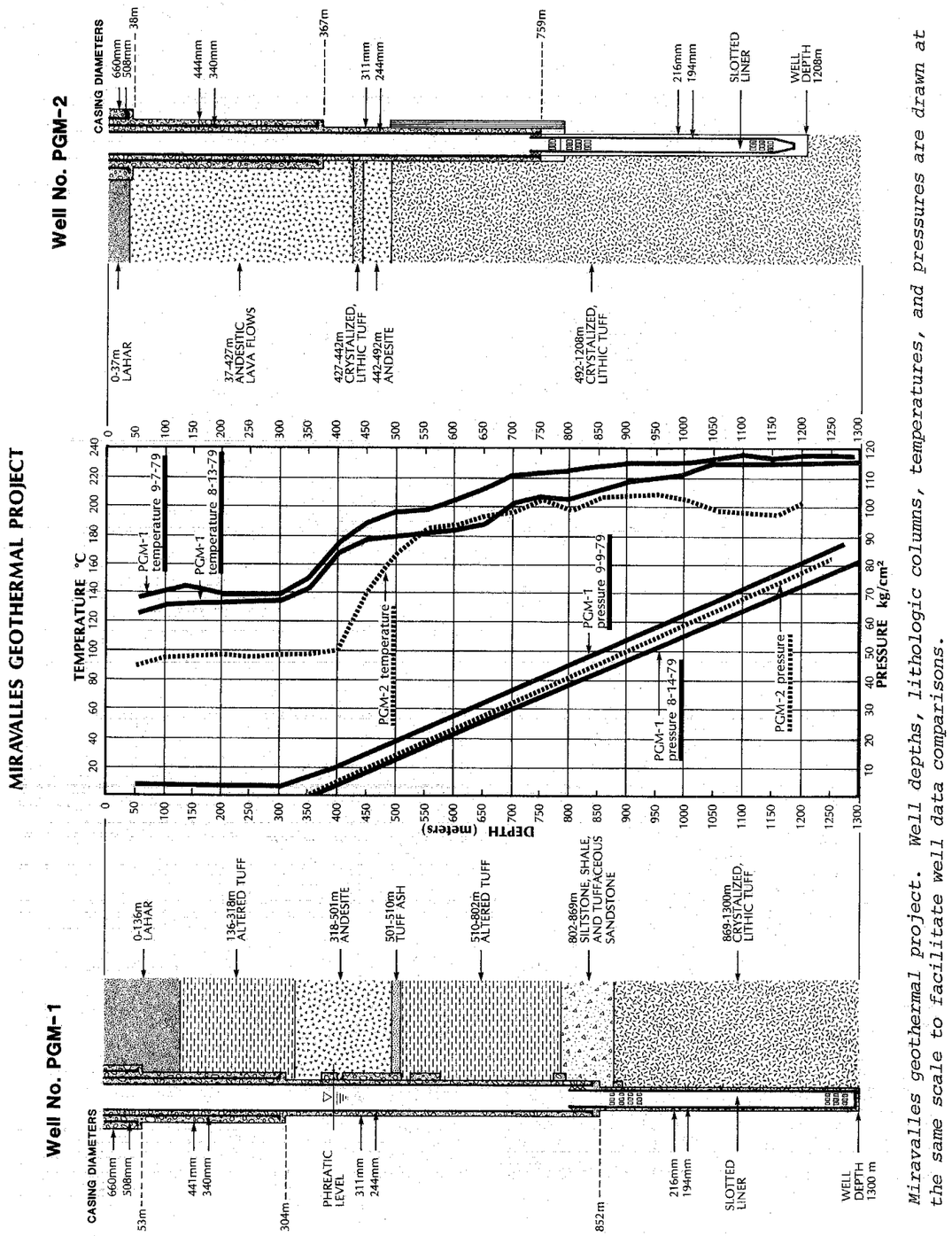
Salinity was low in water samples collected from well "PGM-1", and no problems from scaling or corrosion are expected to occur in well or power plant machinery. TDS of the samples ranged from 6,000 to 7,000 ppm.



Well site for well PGM-1, looking towards the Guanacaste plains. Miravalles volcano is behind the photographer.



Miravalles study area, Guanacaste, Costa Rica.



Miravalles geothermal project. Well depths, lithologic columns, temperatures, and pressures are drawn at the same scale to facilitate well data comparisons.

Peruvian Geothermal Energy

Peru may have one of the world's largest reservoirs of geothermal energy, according to "El Comercio," a Lima newspaper.

The article states that Japanese technicians are studying methods of tapping the natural underground steam around the city of Cajamarca and of converting the oil-fired electrical plants in the area to accomodate this form of power.

Cajamarca would be the second city in the region to use geothermal energy. Other volcanic zones are being investigated, as well, for their geothermal potential.

The Philippines

Philippines Geothermal Development

Geothermal development is well underway in the Philippines. Geothermal energy presently supplies this nation with 500 Megawatts of electricity, or 4.2 percent of its energy needs. The country hopes that by 1985 this number will rise to 12.2 percent.

Further exploration and development activities are underway. The Philippine National Oil Company is developing geothermal fields in Leyte, Northern and Southern Negros, Davao, and Albay. One field recently discovered is the Daklan field in Benguet. Exploration is also underway in Mount Pinatubo, Zambales.

Leases

Lease Sale Schedule as of 1/26/81

Lease sale dates are provided by the state directors of the U.S. Bureau of Land Management (BLM). Lease sale dates are tentative until public notice is issued 30 days prior to sale.Lease sale notices may be obtained by contacting the appropriate BLM office. Two sales, previously scheduled, have been cancelled: 1) Island Park, Idaho and Montana; and 2) Corwin Springs, Montana.

Location of KGRA	Latest Sale Date Scheduled	Original Sale Date
Mono-Long Valley/East Mesa (BLM-FS) CA	05/12/81	02/? /79
Baca Location One/Lightning Dock/San Ysidro/ Socorro Peak (BLM-FS) NM	05/19/81	04/15/81
The Geysers (MRL)/Coso Hot Springs (BLM) CA	05/21/81	05/? /79
Gillard Hot Springs and Clifton (BLM) AZ	06/09/81	08/? /79
Lassen Hot Springs (USFS) CA	06/16/81	06/? /79
Belknap-Foley HS/McCredie/Newberry Caldera (USFS) OR	06/25/81	07/06/78
Indian Heaven (USFS) WA	06/25/81	03/19/79
Beckwourth Peak (BLM) CA	09/15/81	06/? /79

Conferences and Courses

Community Geothermal Meeting Organized

Geothermal potential and state regulatory procedures are the topics to be discussed before the Calistoga Planning Commission at a meeting scheduled for March 3, 1981. Participating in the discussion will be representatives from the California Division of Oil and Gas, California Division of Mines and Geology, State Water Quality Control Board, State Lands Commission, and the Department of Health Services, Food and Drug Administration.

The meeting will be held at 7:00 p.m. in the Calistoga Community Center.

United Nations Sponsors Geothermal Training

Presently, the United Nations and its agencies sponsor geothermal training programs in four countries: Iceland, Italy, Japan, and New Zealand. There are three types of programs: a diploma course at the University of Auckland, New Zealand, sponsored by UNDP; comprehensive, group oriented courses at Kyushu University, Fukuoka, Japan and at the International Institute for Geothermal Research, Pisa, Italy, both sponsored by UNESCP; and practical training courses in specialities developed for individuals at the National Energy Authority of Iceland, in cooperation with the University of Iceland, Reykjavik, sponsored by the UN University.

Fundamentals of Slope Stability, College of Engineering, University of Nevada-Reno, March 23-27, 1981.

Third Symposium on the Cerro Prieto Geothermal Field, St. Francis Hotel, San Francisco, California, March 24-26, 1981.

Discussions of ongoing programs investigating geology, geophysics, geochemistry, subsidence, and reservoir engineering will occur at the symposium. New technical topics and geothermal area in the Mexicali Valley will be cover

A field trip for up to 120 people is scheduled for The Geysers Geothermal field on March 27, 1981.

For information, contact Werner Schw University of California, Lawrence Berkeley Laboratory, Earth Sciences Division, Berkeley, California 94720. Phone (415) 486-6756, FTS 451-6756.

An Introduction to Geothermal Resourc with an Emphasis on Power Production, Introductory Short Court No. 10 of th Geothermal Resources Council. Sherat Anaheim Hotel, Anaheim, California, March 25-26, 1981.

Geothermal resource types and uses will be discussed in this basic cours For further information, contact the Geothermal Resources Council, P.O. Bo 98, Davis, California 95616.

The First Sino/US Geothermal Resource Conference and Exhibition, Tianjin Gu Hotel, Tianjin, People's Republic of China, April 5-11, 1981.

The conference is sponsored by the St Scientific and Technological Commissi and the City of Tianjin and, in the U by the Oregon Institute of Technology and China Consulting Group, Inc. The conference is scheduled for April 5-1 but may be extended for 3 days, depen upon the attendance, which is by invitation only.

Companies interested in applying for exhibition space should contact Exhibition Management International, Inc., P.O. Box 7252, Dallas, Texas 85

Energie 81: 3rd International Week o Energy Sources, C.I.P. Palais des Con Porte Maillot, Paris, France, April 6-11, 1981.

Energie 81 will have lectures and exhibits on new sources of energy. The exhibition will include all equipment, services, and research for solar, wind, geothermal, and other types of energy.

For further information, contact Bernard Leon, Manager, Energiexpo, 8 rue de La Michodiere, 75002 Paris, France.

United Nations Conference on New and Renewable Energy, Nairobi, Kenya, August 10-21, 1981.

The conference, on new and renewable energy sources, will be attended by scientists, engineers, and energy experts. They will discuss types of energy, including solar, hydropower, and geothermal.

For information, contact Mohamed Ghorab, Secretary General of the Conference on New and Renewable Energy, United Nations, New York, New York 10017.

United Nations Small Energy Resources Conference, Biltmore Hotel, Los Angeles, California, September 9-18, 1981.

Conference co-sponsors are the State of California, the United Nations Institute for Training and Research, the United Nations Development Programme, the United Nations Environment Programme, the Federal Government of Mexico (through the Comision Federal de Electricidad), the United States Department of Energy, and the Interstate Oil Compact Commission.

Over 100 countries will be represented at the conference. The participants will be specialists in the fields of geology, engineering, economics, environmental analysis, planning, and energy.

Electrical and direct heat uses of geothermal energy are on the conference agenda, along with coal, hydropower, solar, oil, gas, and several other energy sources.

Much of the conference will cover institutional problems--including technology transfer, environmental issues, and economic and financial issues.

Conference participation is by invitation only. For further information, contact UNITAR, 801 U.N. Plaza, Room 316, New York, New York 10017.

Geothermal Resources Council 1981 Annual Meeting, Shamrock Hilton, Houston, Texas, October 25-29, 1981.

For further information, contact Beverly Hall, Geothermal Resources Council, P. O. Box 98, Davis, California 95616.

Audiovisual

The following list of geothermal films was compiled by the Geothermal Resources Council. They are available for rent or loan.

Power Generation

"Harnessing the Earth's Energy" (20 minutes/16mm), Union Oil Company, contact Sandy Leavell, (213) 977-6823.

"Geothermal: Energy from the Earth" (25 minutes/16mm & video), Thermal Power Company, contact Jake Rudisill, (415) 981-5700, x-443.

"The Ballad of Steamy Valley" (The Geysers, 25 minutes/16mm), Pacific Gas & Electric Company, contact George Cozard, (415) 781-4211, x-3481.

"Mitsubishi Geothermal Power Plant" (Hatchobaru Power Station, 25 minutes/16mm), Mitsubishi International Corporation, contact Bill Tanaka, (415) 981-1910.

"Challenge Geothermal Energy" (Construction Record of Hatchobaru Geothermal Power Plant, 20 minutes/16mm), Mitsubishi International Corporation, contact Bill Tanaka, (415) 981-1910.

"A Challenge to Geothermal Development" (Construction Record of 10 MW Onuma Geothermal Power Plant, 20 minutes/16mm), Mitsubishi International Corporation, contact Bill Tanaka (415) 981-1910.

"Buried Thunder" (14 minutes/16mm), Phillips Petroleum Company, available from Geothermal Resources Council, contact Elaine Clark, (916) 758-2360.

Direct Use

Hungarian Film (20 minutes/16mm), produced by the Hungarian government, available from the Geothermal Resources Council, contact Elaine Clark, (916) 758-2360.

"A Gift from the Earth" (20 minutes/16mm), Argonne National Laboratory, (312) 971-5771.

General

"Geothermal: The Roaring Resource" (20 minutes/16mm), California Department of Water Resources, contact Larry Hobson/Clay Dudley, (916) 445-7595.

"The Imperial Valley Environmental Project" (15 minutes/16mm), Lawrence Livermore Laboratory, contact Technical Information Department, (415) 422-5277.

"Tah One Lat Clah (Keeper of the Fire)" (Mt. St. Helens, not yet completed), contact Mike Lienau, (503) 882-1754.

"Geothermal Energy from Hot Dry Rock" (13 minutes), Los Alamos Scientific Laboratory, Film Library, (505) 667-4446.

"Big Hole Drilling Technology," U.S. Department of Energy Film Library, (615) 576-1285.

Publications

We have learned of two newsletters and a journal not included in the list of geothermal newsletters and small journals compiled for the July 1980 issue of the Geothermal Hot Line.

The Geyser is available at $135 per year or $180 for foreign subscribers wishing airmail service. Write to The Geyser, P.O. Box 1738, Santa Monica, California 90406.

Geothermal Materials Review, prepared by Radian Corporation under a DOE contract, is free. Write to Bill Robnett, Radian Corporation, P.O. Box 9948, Austin, Texas 78766.

Geothermics, an international journal reporting research and development of geothermal energy, is published quarterly. 1980 subscription rates were $61.00 for one year, $115.90 for two years, and $30.00 for an individual if the person's library or organization subscribes.

*

Every month, the Earth Sciences Division of Lawrence Berkeley Laboratory publishes reports describing the development of geothermal resources. For a free, up-to-date bibliography, write to Ms. Orah Goldman, U.C. Lawrence Berkeley Laboratory, Earth Sciences Division Reference Room, Building 90, Room 1070, Berkeley, California 94720.

Two of the current LBL reports on geothermal topics, available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161, are:

Analysis of production decline in geothermal reservoirs, LBL-11215 (GREMP-10), by Elliot J. Zais and Gunnar Bodvarsson, September 1980, $8.00; and

Reservoir simulation studies: Wairakei Geothermal field, New Zealand, LBL-11497 (GREMP-11), by J. W. Pritchett, L. F. Rice, and S. K. Garg, January 1980, $9.00.

*

Publications catalog, California Energy Commission (CEC). Free. Available from the CEC, Publications Unit - MS50, 1111 Howe Avenue, Suite 613, Sacramento, California 95825.

List of CEC publications, including several on geothermal development.

*

Publications catalogue, American Society for Testing and Materials (ASTM). Free. Available from the ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Publications by the ASTM; publications distributed by the ASTM; journals, and data on the organization itself are included.

*

Geothermal world directory, 1979/1980 edition. $50.00. 570 pages. Available from the Geothermal World Corporation (1979), 18014 Sherman Way, Reseda, California 91335.

Part I is a directory listing U.S. governmental agencies. Part II contains articles on geothermal topics.

*

Preliminary inventory of western U.S. cities with proximate hydrothermal potential. Vol. I - report, $5.00, Vol. II - state maps depicting inventoried cities and hydrothermal resources, $7.00. Available from Eliot Allen and Associates, Inc., 5006 Commercial Street, S.E., Salem, Oregon 97302 (Phone: (503) 371-4561).

Cities in eight western states within 5 miles or less of a confirmed thermal spring or well measuring 50°F or more are included. City population growth and heating load characteristics are tentatively identified.

The states included are Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, and Washington. The report is intended as a preliminary aid for geothermal resource planning and commercialization projects.

*

An assessment of geothermal development in the Imperial Valley of California. Vol. I - Environment, health, and socioeconomics. Edited by David Layton. $10.75 (microfiche copy $3.50); Vol. II - Environmental Control Technology. Edited by William Morris and John Hill. $7.25 (microfiche copy $3.50). Both volumes available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

The Imperial Valley of California has vast hot water reservoirs, nearly one-third of the nation's identified hot-water resources. It is hoped these volumes, assessing the impacts of geothermal development in the Imperial Valley, will be used as models for understanding geothermal impacts from liquid-dominated resources in other regions of the country.

*

A short history of the development of direct-use geothermal energy in Susanville, California, is available from the City of Susanville, 66 N. Lassen Street, Susanville, California 96130. The description should be of interest to other cities considering similar development.

*

Quantitative assessment of low-temperature geothermal resources of the United States under 100°C. U.S. Geological Survey Circular, number not assigned. Planned for December 1981. The format will be similar to that used for Circulars 726 and 790.

*

Geothermal energy as a source of electricity. By Ronald DiPippo. Free. Available from Geothermal Books, R.

DiPippo, Box D, Brown University, Providence, Rhode Island 02912. (A sourcebook on the production of electricity from geothermal energy, described in the July 1980 Geothermal Hot Line, may be ordered, free of charge, from the same address.)

This book is about the design and operation of geothermal power plants throughout the world. Dr. DiPippo writes that the installed electrical capacity from geothermal power plants has now reached 1,750 Megawatts of electricity, and soon will increase.

*

Direct utilization of geothermal energy: a technical handbook. Edited by David N. Anderson, Geothermal Resources Council and John W. Lund, Oregon Institute of Technology. Cost $10.00. Available from the National Technical Information Center, U.S. Dept. of Commerce, Springfield, VA 22161.

The nature and occurrence of low-temperature geothermal resources, along with their development, utilization, economics, financing, and regulation, are described in the publication. A nontechnical edition of the publication, called "Direct utilization guide," Geothermal Resource Council Special Report No. 8, is edited by the same persons and available from the same address. Cost $8.00.

*

Benefit/Cost analysis for research in geothermal log interpretation, final report LA-7922MS. $9.00. Available from NTIS, U.S. Dept. of Commerce, Springfield, Virginia 22161.

*

Chemical analysis of waters from springs and wells from the Clear Lake volcanic area, Northern California. By J. M. Thompson, F. E. Goff, and J. M. Donnelly. Open-file report 78-425. Available from the U.S. Geological Survey, Menlo Park, California 94025.

About 500 chemical analyses of thermal water samples from the Clear Lake volcanic area. Collection and analytical methods are discussed.

*

Geothermal prospecting in The Geysers-Clear Lake area, Northern California. By F. E. Goff, Julie M. Donnelly, J. M. Thompson, and B. Carter Hearn, Jr. Paper published in the August 1977 issue of Geology, v. 5, p. 509-515.

The paper illustrates how the geochemistry of thermal waters combined with mapping and geophysical studies have been used to define boundaries of the geothermal steam field in The Geysers-Clear Lake area, California.

*

A reevaluation of geothermal potential of the Wilbur Hot Springs area, California. By J. M. Thompson. Paper presented at the 1979 annual meeting of the Geothermal Resources Council (GRC). Available as part of the meeting transactions: Expanding the geothermal frontier. Geothermal Resources Council transactions, vol. 3. $25.00 (California residents add 6 percent sales tax). Available from the Geothermal Resources Council, P. O. Box 98, Davis, California 95616.

The geothermal potential of the Wilbur Hot Springs area is evaluated from studies of local thermal brines and gases.

*

Chemical studies of selected trace elements in hot-spring drainages of Yellowstone National Park. By R. E. Stauffer, E. A. Jenne, and J. W. Ball. $2.75. Available from the Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

The report discusses the geohydrology of geothermal systems.

*

Thermal springs list for the United States. National Oceanic and Atmosphere Administration Key to Geophysical Records Documentation No. 12. Compiled by Berry, Grim, and Ikelman. Free. 59 pages. 2 maps. Available from NOAA/NGSDC Datamapping group, Code D64, 325 Broadway, Boulder, Colorado 80303.

Natural surface hydrothermal feature locations and temperatures, arranged alphabetically by state. Included are springs, pools, mud pots, mud volcanoes, geysers, fumaroles, and steam vents at temperatures of 20°C (68°F) or greater.

*

Geothermal energy update, GEU-80/10. Free. Available from the United States Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830

Useful information for all phases of geothermal development.

*

Geysers and geothermal energy. By John S. Rinehart. $19.80. Available from Springer-Verlag New York Inc., P.O. Box 2485, Secaucus, New Jersey 07094.

The interplay of heat, water, and rock that form geysers is described. Emphasis is on the hydrologic and geologic settings and structures of geysers, their function, and interaction with the environment.

*

Geothermal energy research development and demonstration program, fourth annual report of the Interagency Geothermal Coordinating Council. DOE/RA-0050. Printed copies $9.25. Microfiche $4.00. Available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

The Interagency Geothermal Coordinating Council was established by Congress to facilitate residential, industrial, commercial, and utility use of geothermal power. The report summarizes the federal program's goals, strategy, plans, and achievements.

*

Summaries, sixth workshop on geothermal reservoir engineering; December 16-18, 1980. Limited quantity of preliminary copies, free. Available from Stanford Geothermal Program, Stanford University, Stanford, California 94305.

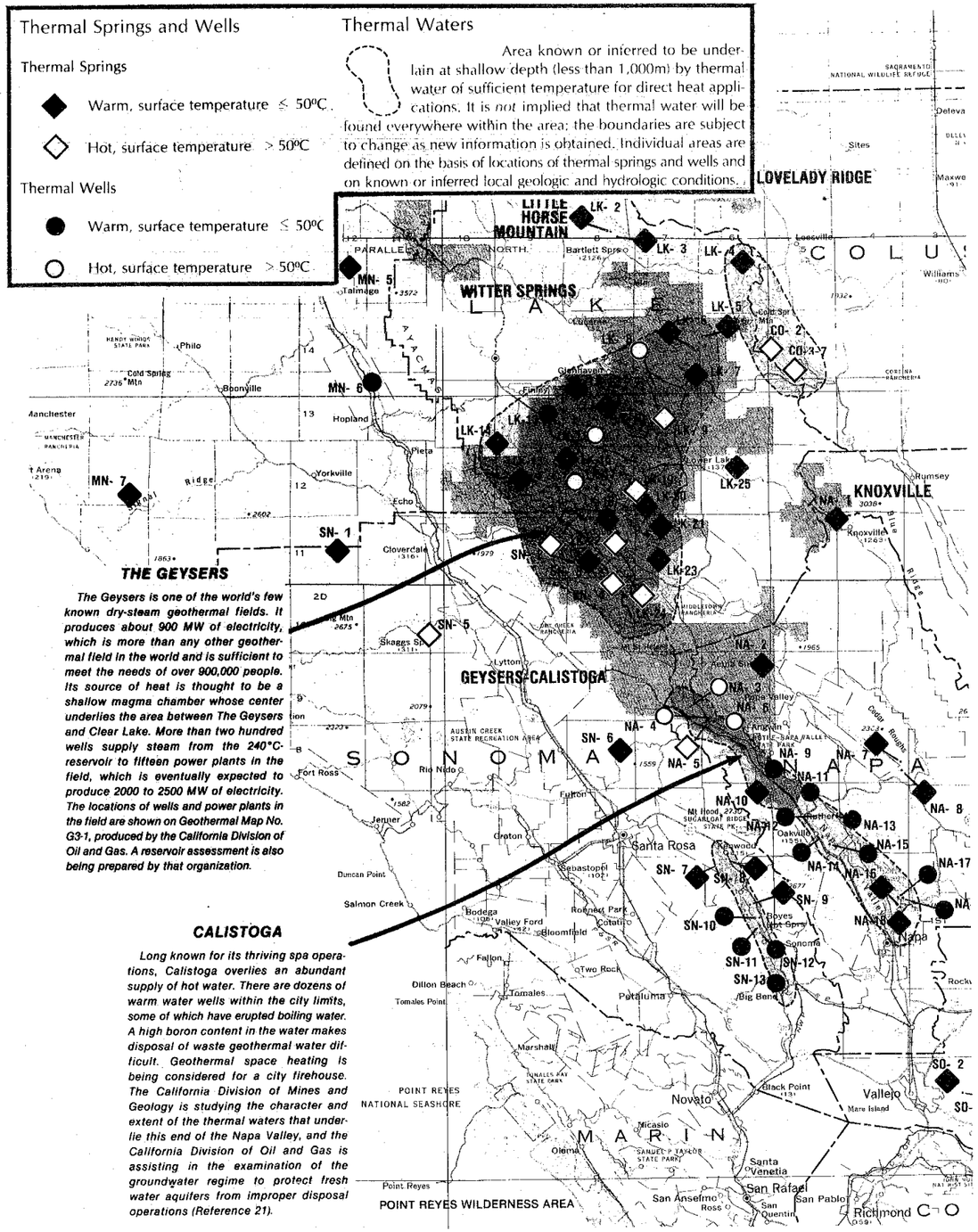
The volume includes a paper by Herman Dykstra, "Production History of The Geysers Steam field." The paper, with tables and figures, was excerpted from Mr. Dykstra's section of a report soon to be published by the California Division of Oil and Gas titled, A Reservoir Assessment of The Geysers Geothermal field.

Maps

New DOE Geothermal Maps

Idaho, New Mexico, Utah, and California geothermal energy maps. Issued under a Department of Energy (DOE) program in cooperation with the National Oceanic and Atmospheric Administration and the U.S. Geological Survey Geothermal Assessment Program. Available from: Idaho map (free) - Idaho Department of Water Resources, 450 State Street, Boise, Idaho 83702; New Mexico map (free) - New Mexico Energy Institute, New Mexico State University, Box 3E1, Las Cruces, New Mexico 88003; Utah map (free) - Utah Geological and Mineral Survey, 606 Black Hawk Way, Salt Lake City, Utah 84108; California map (free) - California Division of Mines and Geology, 2815 "O" Street, Sacramento, California 95816.

Arizona, Nevada, and Oregon maps are available from addresses printed in the January 1980 Geothermal Hot Line.



THE GEYSERS

The Geysers is one of the world's few known dry-steam geothermal fields. It produces about 900 MW of electricity, which is more than any other geothermal field in the world and is sufficient to meet the needs of over 900,000 people. Its source of heat is thought to be a shallow magma chamber whose center underlies the area between The Geysers and Clear Lake. More than two hundred wells supply steam from the 240°C reservoir to fifteen power plants in the field, which is eventually expected to produce 2000 to 2500 MW of electricity. The locations of wells and power plants in the field are shown on Geothermal Map No. G3-1, produced by the California Division of Oil and Gas. A reservoir assessment is also being prepared by that organization.

CALISTOGA

Long known for its thriving spa operations, Calistoga overlies an abundant supply of hot water. There are dozens of warm water wells within the city limits, some of which have erupted boiling water. A high boron content in the water makes disposal of waste geothermal water difficult. Geothermal space heating is being considered for a city firehouse. The California Division of Mines and Geology is studying the character and extent of the thermal waters that underlie this end of the Napa Valley, and the California Division of Oil and Gas is assisting in the examination of the groundwater regime to protect fresh water aquifers from improper disposal operations (Reference 21).

The Geysers Geothermal field portion of the new DOE California geothermal energy map.

Geothermal Energy Maps

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) has recently produced three geothermal energy maps for the U.S. Geological Survey. These maps cover 1) the Western United States, 2) Alaska and Hawaii, and 3) the Texas-Louisiana onshore and offshore coastal plain area. The maps are part of USGS Circular 790, "Assessment of Geothermal Resources of the United States-1978," edited by L.J.P. Muffler (1979). This publication, including the three folded maps, is available free of charge from:

Branch of Distribution
U.S. Geological Survey
1200 South Eads Street
Arlington, VA 22202

The maps are also available, either rolled (sent in a mailing tube) or folded, from:

Distribution Division
Code C44
NOAA/NOS
Riverdale, MD 20840

The cost of each map sent from the National Ocean Survey (NOS) is $2.50 (total of $7.50 for all three maps). Specify complete map name and how maps are to be mailed (folded or rolled).

The names of the maps, some of the map specifications, and the types of data presented on each are as follows:

Map 1: Geothermal Energy in the Western United States
Scale: 1:2,500,000
Size: 34 by 46 inches
Approximate area covered: Central Texas to Canada and Pacific Ocean to longitude of western Kansas
Types of data shown on map:
Hydrothermal convection systems (reservoir temperatures greater than 90°C)
Igneous systems (volcanoes and young lava fields)
Low-temperature geothermal waters (thermal springs and areas favorable for discovery and development of low-temperature geothermal resources)
Regional heat flow (including both individual heat flow measurements and generalized contours)
Known Geothermal Resources Areas

Map 2: Geothermal Energy in Alaska and Hawaii
Scale: 1:5,000,000 (for Alaska); 1:2,500,000 (for Hawaii)
Size: 22½ by 34 inches
Types of data shown on map:
Hydrothermal convection systems (reservoir temperatures greater than 90°C)
Igneous systems (volcanoes and young lava fields)
Rift zones of Hawaiian volcanoes
Thermal springs
Heat flow
Known Geothermal Resources Areas

Map 3: Geopressured-Geothermal Energy in Reservoir Fluids of the Northern Gulf of Mexico Basin
Scale: 1:1,000,000
Size: 28 by 47½ inches
Approximate area covered: Continental shelf break in Gulf of Mexico northward to about 31°N in Texas and Louisiana; Mississippi Delta west to longitude of Laredo, Texas.
Types of data shown on map:
Contours showing depth to top of geopressurized zone
Contours showing thermal energy in sand beds
Hatching showing relative concentrations of methane energy in sand beds
Areas (fairways and prospects) considered to have high potential for development of geopressured geothermal resources
Temperatures at 15,000 feet in selected wells (three temperature ranges shown)

LASL Geothermal Gradient Map

Los Alamos Scientific Laboratory has published a "Geothermal Gradient Map of the Conterminous United States." Color-coded regional conductive gradients are plotted on the map. The gradients were calculated from down-hole temperatures measured at regular intervals.

Copies of the map are available from the Hot Dry Rock Geothermal Program Office, MS 575, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545.

Availability of Digitized Data:

Most of the data shown on the maps are also available from NGSDC in a digitized format. For details, contact:

Paul J. Grim
Code D64
NOAA/EDIS/NGSDC
Boulder, CO 80303

Telephone: (303) 499-1000, ext. 6418;
FTS 323-6418

California Wells

Well Data Available

A computer-generated file of production and injection statistics may be purchased for all California geothermal wells with records open to public inspection. Available from the California Division of Oil and Gas in Sacramento, the list includes records for about 75 wells and costs $50.00.

DRILLING PERMITS APPROVED IN 1980

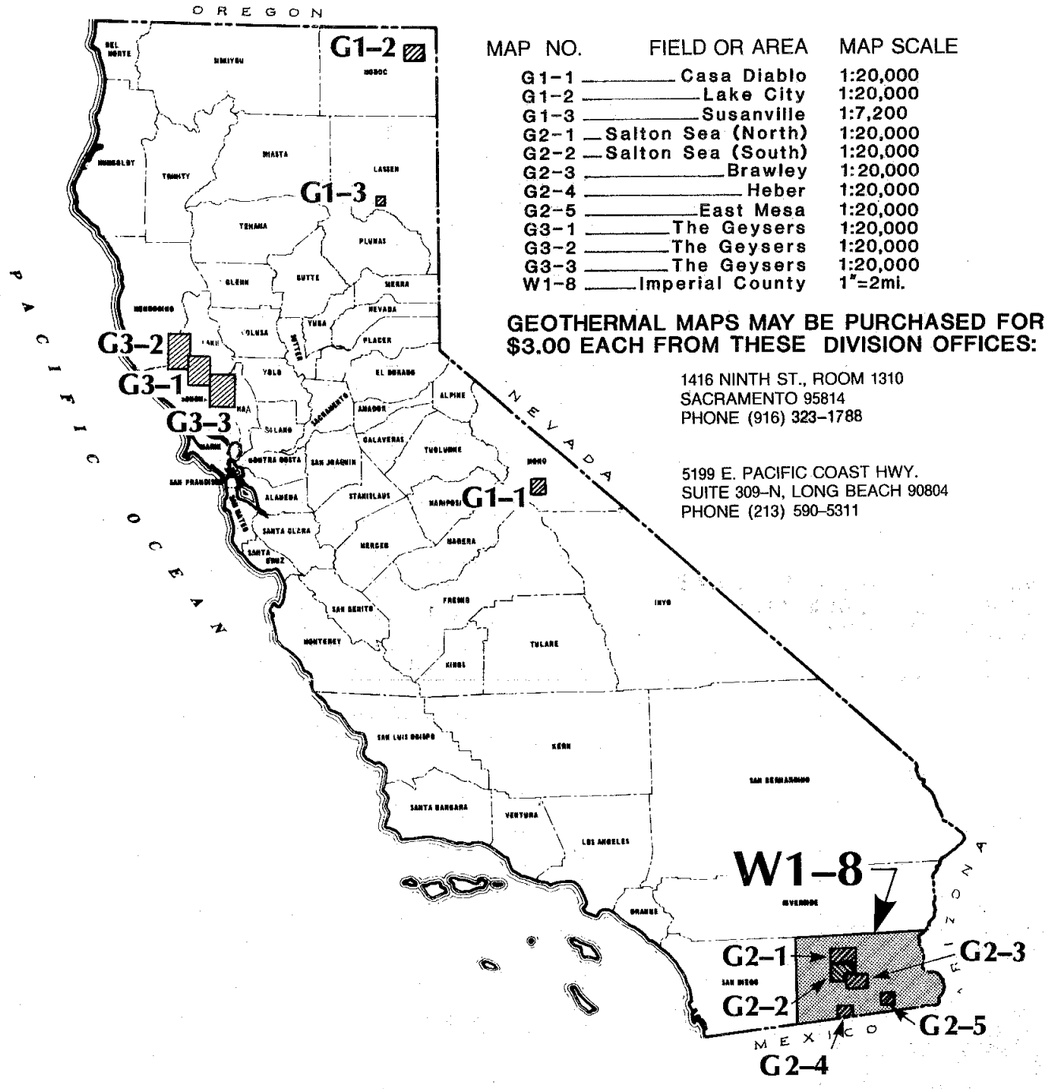
Date Notice Received	Operator, Well No.	API No.	Sec.	T.	R.	Location, Elevation
	Lake County					
3/13/80	Phillips Petroleum Company "Audrey A" 1	033-90287	8	13N	7W	Fr. NE cor. 260m. S, 330m. W. 512m. GR.
3/13/80	Phillips Petroleum Company "Audrey A" 1-A	033-90288	8	13N	7W	Fr. NE cor. 254m. S, 330m. W. 512m. GR.
10/11/80	Republic Geothermal, Inc. "Robbins" 1	033-90296	5	10N	8W	Fr. NW cor. 711m. S, 168m. E. 676m. KB.
10/11/80	Republic Geothermal, Inc. "Robbins" 2	033-90297	20	12N	7W	Fr. NW cor. 731m. S, 168m. E. 676m. KB.
10/11/80	Republic Geothermal, Inc. "Robbins" 3	033-90298	20	12N	7W	Fr. NW cor. 107m. S, 1372m. E. 669m. KB.
10/11/80	Republic Geothermal, Inc. "Robbins" 4	033-90299	20	12N	7W	Fr. NW cor. 1234m. S, 1158m. E. 676m. KB.
10/11/80	Republic Geothermal, Inc. "Robbins" 5	033-90300	20	12N	7W	Fr. NW cor. 1458m. S, 76m. E 694m. KB.
10/11/80	Republic Geothermal, Inc. "Robbins" 6	033-90301	20	12N	7W	Fr. NW cor. 1478m. S, 76m. E. 694m. KB.
10/11/80	Occidental Geothermal, Inc. "68A-21"	033-90290	21	11N	8W	Fr. SE cor. 107m. N, 454m. W. 1128m. GR.
12/13/80	Aminoil USA, Inc. "86A-34"	033-90339	34	11N	8W	Fr. SE cor. 286m. N, 43m. W. 1000m. GR.

Date Notice Received	Operator, Well No.	API No.	Sec.	T.	R.	Location, Elevation
	Sonoma County					
6/16/80	Union Oil Company of Calif. "LF State 4597" 34	097-90450	18	11N	8W	Fr. SE cor. 195m. N, 42m. W. 877m.m. KB.
6/17/80	Union Oil Company of Calif. "DX State 4596" 50	097-90454	7	11N	8W	Fr. NE cor. 737.6m. W, 135.6m. S. 1026.14m. KB.
6/17/80	Union Oil Company of Calif. "DX State 4596" 51	097-90455	7	11N	8W	Fr. NE cor. 737.6m. W, 148.6m. S. 1026.14m. KB.
7/15/80	Union Oil Company of Calif. "Angeli" 2	097-90457	20	11N	8W	Fr. SE cor. 762m. N, 121.9m. W. 1044.5m. KB.
9/13/80	Thermogenics, Inc. "Rorabaugh" A-13	097-90462	14	11N	9W	Fr. NW cor. 663.7m. E, 661.2m. S. 539.2m. KB
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 6	097-90468	13	11N	9W	Fr. SW cor. 603.5m. N, 888.5m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 7	097-90469	13	11N	9W	Fr. SW cor. 613.3m. N, 892.5m. E 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 8	097-90470	13	11N	9W	Fr. SW cor. 623m. N, 896.7m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 9	097-90471	13	11N	9W	Fr. SW cor. 632.8m. N, 900.7m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 10	097-90472	13	11N	9W	Fr. SW cor. 642.5m. N, 905m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 11	097-90473	13	11N	9W	Fr. SW cor. 652.3m. N, 908.6m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 12	097-90474	13	11N	9W	Fr. SW cor. 662m. N, 913.2m. E. 532.1m. KB.
9/25/80	Geothermal Kinetics, Inc. "Rorabaugh" 13	097-90475	13	11N	9W	Fr. SW cor. 678.2m. N, 917.5m. E. 532.1m. KB.
10/11/80	Anadarko Production Co. "Exploratory Site" C	097-90459	5	10N	8W	Fr. SE cor. 335.28m. N, 536.44m. W. 631.71m. DF.
10/11/80	GRI Operator Corporation "Aidlin" 4	097-90476	32	12N	9W	Fr. SE cor. 76.2m. N, 45.7m. W. 609m. GR.
10/11/80	GRI Operator Corporation "Prati" 1	097-90477	36	12N	9W	Fr. SE cor. 199+m. N, 216+m. W. 938.8m. GR.
11/25/80	Union Oil Company of Calif. "Modini" 1	097-90480	27	11N	8W	Fr. SW cor. 30m. N, 259m. E. 1006m. KB.

Date Notice Received	Operator, Well No.	API No.	Sec.	T.	R.	Location, Elevation
12/13/80	Union Oil Company of Calif. "DX State 4596" 57	097-90482	7	11N	8W	Fr. NE cor. 469.4m. S, 99.7m. W. 1055m. GR.
12/13/80	Union Oil Company of Calif. "Modini" 2	097-90481	27	11N	8W	Fr. SW cor. 46m. N, 259m. E. 1006m. KB.
12/13/80	Aminoil USA, Inc. "56B-34"	097-90479	34	11N	8W	Fr. SE cor. 311m. N, 558m. W. 957m. GR.
		Imperial County				
7/5/80	City of El Centro "Thermal" 1	025-90310	32	15S	14E	Fr. SE cor. 183m. N, 479m. W. -15m. GR.
7/5/80	City of El Centro "Thermal" 2	025-90311	32	15S	14E	Fr. SE cor. 183m. N, 479m. W. -15m. GR.
7/5/80	McCulloch Geothermal Corp. "Lacey" 1-28	025-90312	28	14S	14E	Fr. NW cor. 91m. S, 1000m E. -38m. KB.
8/16/80	Union Oil Company of Calif. "S.H. Elmore" 1	025-90313	36	13S	15E	Fr. NE cor. 549m. S, 396m. W. -14m. KB.
8/16/80	Union Oil Company of Calif. "Meyer" 1	025-90314	8	13S	16E	Fr. SW cor. 244m. N, 76m. E. 2m. KB.
8/16/80	Republic Geothermal, Inc. "Britz" 3	025-90315	21	11S	14E	Fr. NW cor. 55m. S, 67m. E. -53m. KB.
9/6/80	Union Oil Company of Calif. "Veysey" 11	025-90316	16	13S	14E	Fr. SW cor. 120m. N, 800m. E. -38m. KB.
9/29/80	Phillips Petroleum Co. "Borchard" A-2	025-90348	5	14S	16E	Fr. SE cor. 406m. N, 50m. W. -1m. KB.
9/29/80	Phillips Petroleum Co. "Borchard" C-1	025-90350	7	14S	16E	Fr. SW cor. 610m. N, 305m. E. -10m. KB.
9/29/80	Phillips Petroleum Co. "Borchard" A-3	025-90349	8	14S	16E	Fr. NE cor. 305m. S, 579m. W. -3m. KB.
9/29/80	Phillips Petroleum Co. "Volker" A-1	025-90346	17	14S	16E	Fr. SW cor. 549m. N, 61m. E. -6m. KB.
9/29/80	Phillips Petroleum Co. "Fussell" A-1	025-90347	8	14S	16E	Fr. SW cor. 564m. N, 350m. E. -7m. KB.
10/6/80	Imperial Magma "Baretta" 1	025-90351	34	11S	13E	Fr. SE cor. 856m. N, 59m. W -67m. GR.
10/6/80	Imperial Magma "Elmore" 2	025-90352	26	11S	13E	Fr. SW cor. 43m N, 56m. E. -69m. GR.
11/6/80	MCR Geothermal Corp. "Kershaw" 1-3	025-90353	3	13S	14E	Fr. SW cor. 675m. N, 369m. E. -34m. GR.
		Napa County				
9/6/80	Constance S. Wilson "Wilson" 1	055-90048	36	9N	7W	Fr. SE cor. 975m. N, 31m. W. 184m. PT.
		Lassen County				
9/11/80	City of Susanville "Susan" 1	035-90063	31	30N	12E	Fr. SE cor. 380m. N, 137m. E. 1283m. GR.

GEOTHERMAL MAPS

California Division of Oil and Gas



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
G3-1	The Geysers	1:20,000
G3-2	The Geysers	1:20,000
G3-3	The Geysers	1:20,000
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
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