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# GEOTHERMAL HOT LINE

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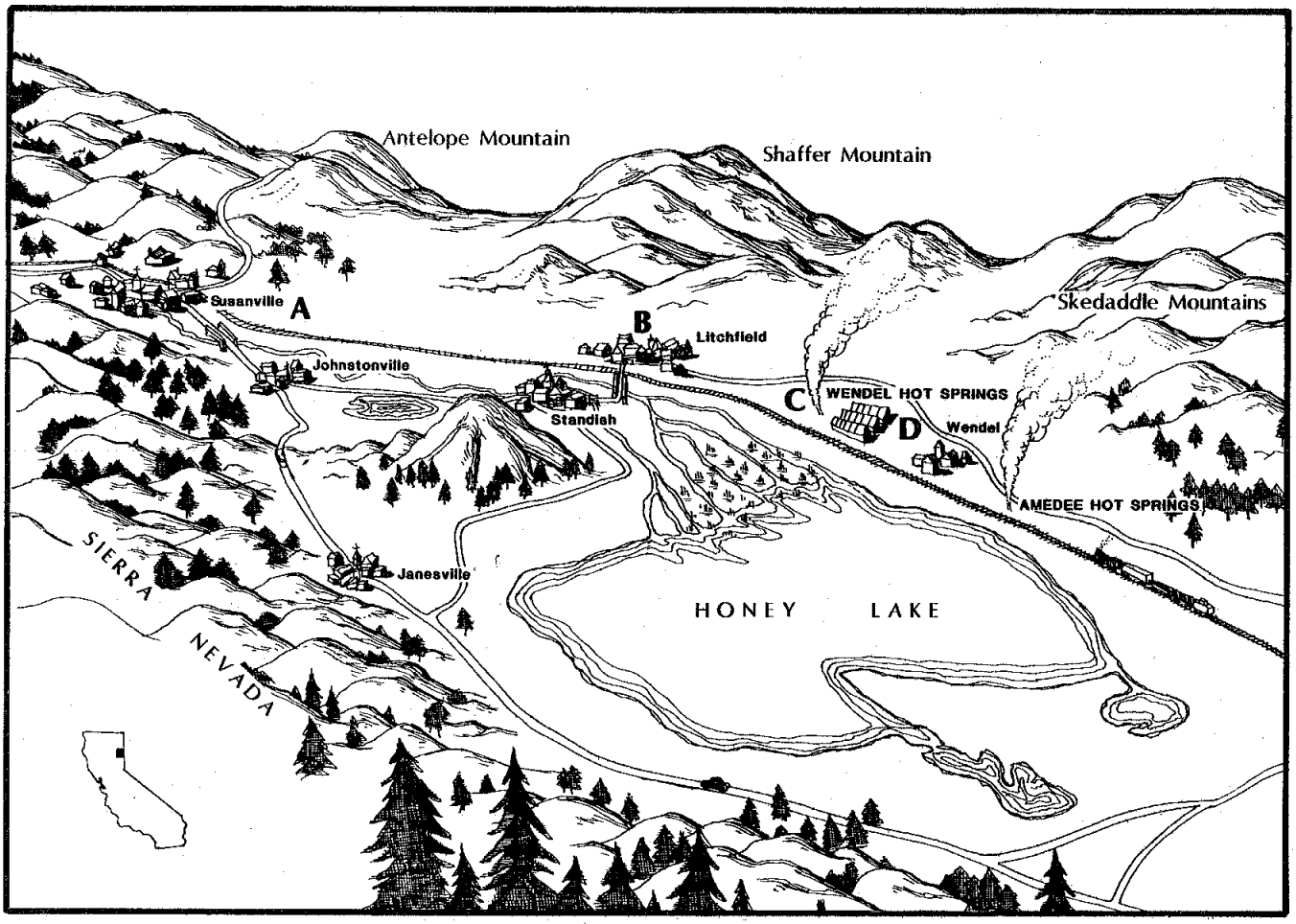


A. SUSANVILLE SPACE-HEATING PROJECT
B. LITCHFIELD TEMPERATURE-OBSERVATION HOLES
C. WENDEL COGENERATION POWER PLANT
D. HONEY LAKE HYDROPONIC FARMS

## HONEY LAKE VALLEY GEOTHERMAL PROJECTS

by Dick Thomas

### A. Susanville Space-Heating Project

The discovery of a resistivity anomaly at Susanville, California suggests to geologists the presence of a low-temperature geothermal reservoir beneath the city. In an attempt to define the extent of the reservoir, the U.S. Water and Power Resources Service (WPRS-formerly Bureau of Reclamation), drilled 19 shallow and intermediate depth temperature-observation holes in the city from 1975 to 1979. Engineers from Lawrence Berkeley Laboratory and the city's consultant, Subir Sanyal, are currently evaluating the results of this drilling program.

As a result of, and concurrent with, the WPRS effort, the city entered into a cost-sharing contract with the Department

*(Continued on page 4)*

## HOT LINE EDITORIAL

by M. G. Mefferd
State Oil and Gas Supervisor

In the July 1978 Hot Line editorial, we expressed our disappointment with the Federal Government's decision to fund a flash technology demonstration project in New Mexico instead of a binary cycle hot water demonstration power plant at Heber in the Imperial Valley. At that time, we pointed out the critical need to design, build, and test a prototype plant in the valley to demonstrate the feasibility of producing electricity from the hot water anomalies.

It was our feeling that a successfully operating binary cycle plant would provide the information needed to attract investors to the geothermal industry, resulting in a significant energy supply contribution for this type of geothermal resource. However, without federal backing, we felt the project would be seriously delayed, if not indefinitely postponed.

We are happy to learn that the Department of Energy is appropriating $8 million towards the construction of a binary cycle demonstration project. Although the site for the plant has not been chosen, it is encouraging to note that San Diego Gas and Electric Company has resubmitted this proposal for such a facility at Heber. The California Energy Commission and the Public Utilities Commission have both adopted resolutions favoring construction of the facility. We commend their actions and lend our support.



Beginning with this issue, the Hot Line will be published twice a year instead of quarterly. *(No December issue was published in 1979.)*

The Division of Oil and Gas has a very small publications staff, and it has been difficult to gather and publish meaningful material within the time constraints of a quarterly schedule. In addition, there are now quite a few geothermal news publications that were not in print when the Hot Line was established, and a great deal of geothermal information is readily available.

I want to thank those of you who returned the Readers Survey printed in the September issue. Geothermal energy is such a broad and expanding topic that it is important to know which aspects you consider to be the most important. Your survey responses will help us in selecting the material that we publish.

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**Priscilla C. Grew,** Director
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**M. G. Mefferd,** State Oil and Gas Supervisor

**A. D. Stockton,** Geothermal Officer

**Susan F. Hodgson,** Editor
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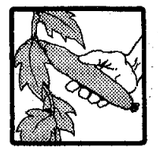
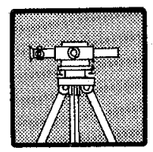
# IN THIS ISSUE

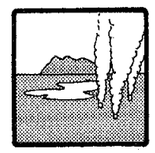




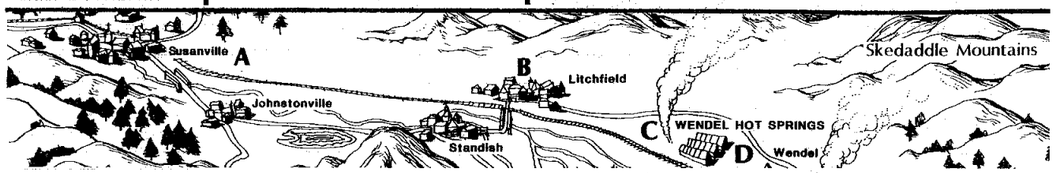








# Low-Temperature Development




*Continued from page 1*

of Energy (DOE) to build a geothermal space-heating system for 23 public buildings. The $340,000 design and engineering phase of the project will be followed by the construction phase, to which the DOE has committed $1,600,000, subject to successful negotiation of a contract in February 1980. The city itself will provide staff time and lend institutional support to the project.

The construction phase will begin in the spring of 1980 when two production and two injection wells will be drilled. If water extracted from these wells is too cool for direct use, the temperature of the system could be raised with the heat obtained by burning abundant wood wastes recovered from local forests. The water temperature of one geothermal well drilled in Susanville is 71°C (160°F).

According to Phil Edwardes, Susanville Geothermal Principal Investigator, city planners would like to expand the city's industrial base. Edwardes said that if the geothermal project is successful, the city intends to pipe surplus geothermal water from the heating district to several industrial parks east and south of the city. Prospective industrial concerns would provide their own distribution lines inside the parks.

## B. Litchfield Temperature-Observation Holes

As part of an extensive resource identification program developed for the Honey Lake Valley, the Water and Power Resources Service (WPRS-formerly Bureau of Reclamation) will continue to drill temperature-observation holes 10 miles east of Susanville, near the town of Litchfield. According to Lyle Tomlin of WPRS, if there is local support for developing the resource, geothermal water in the area could be used for space-heating at the nearby California Correctional Center and for agricultural projects.

Five, shallow, temperature-observation holes were completed by WPRS in 1975 during the initial drilling phase. Temperature logs from these holes indicate the existence of a hot water source 1¼ miles west of the center of the Litchfield resistivity anomaly. The log from one 150-foot (46m) hole shows a thermal gradient of 3.2°C per 10m (17°F per 100 feet) and a maximum downhole temperature of 28°C (82°F). In an attempt to further define the extent of the reservoir, the WPRS ran deep reflection and shallow refraction seismic surveys and drilled five more temperature-observation holes in 1977.

If a WPRS drilling rig is available, drilling of 6-to 8-additional, shallow temperature-observation holes could begin in early 1980. An evaluation of logs from these holes could lead to the drilling of two deeper (1500-foot, 457m) temperature-observation holes.

## C. Wendel Cogeneration Power Plant

An agreement to study the feasibility of using both geothermal water and wood wastes to provide energy for a proposed 55 MWe power plant, near Wendel (28 miles east of Susanville) has been signed by the California Department of Water Resources (DWR), the U.S. Forest Service, and the Oakland-based GeoProducts Corporation.

In this project, geothermal energy from one or more production wells would be used to preheat boiler feedwater and to



*Wendel Hot Springs. View from the top of a ridge of tufa, northeast of the hot springs. The Sierra Nevada range is in the background. Photos by Dick Thomas.*

dry wood wastes from local forests. The dried wood wastes would be burned to superheat the feedwater, producing steam to run a conventional turbine generator.

Under the agreement, GeoProducts Corporation would own and operate the plant. Power generated by the plant would be sold to DWR for use in the State Water Project. According to Ron Nicols, DWR project manager, the DWR is committed to developing renewable energy resources to meet the energy needs of the State Water Project. If the local utility should decide to participate in the project, DWR would allow them a share of up to 15 MWe of power. In addition, GeoProducts Corporation is studying the possibility of using the plant's 38°C (100°F) effluent to heat 200 hydroponic greenhouses, similar to those built nearby at Honey Lake Hydroponic Farms.

The U.S. Department of Energy (DOE) granted $200,000 to DWR to fund specific tasks under the first phase of the feasibility study, including drilling and evaluating five 1000-foot (305m) temperature-observation holes. The permits for this work have been issued by the Division of Oil and Gas and Lassen County. The holes are to be drilled by February 1980, and data collected from them used to decide on a site for a deeper exploratory well.

It is hoped that at least 120°C (248°F) water will be found, similar to that recovered from a nearby Gulf Mineral Resources well drilled in 1973. The remainder of the funds will be used to complete wood-fuel availability studies and preliminary design work.

To date, GeoProducts Corporation has spent over $600,000 on preliminary project feasibility studies. Funding for the remainder of studies for the first phase will be provided by the U.S. Forest Service ($300,000), GeoProducts Corporation ($150,000), and DWR ($150,000). At a later date, GeoProducts will ask the DOE for an additional $700,000 to fund the deep exploratory well.

## D. Honey Lake Hydroponic Farms

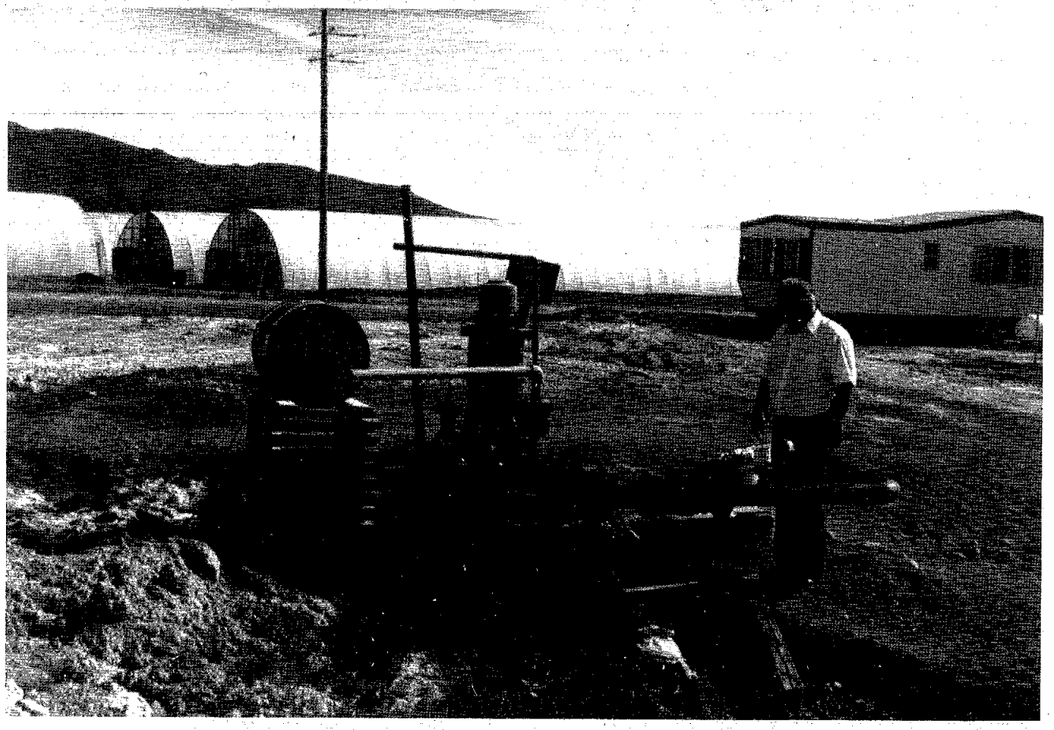
The Honey Lake Hydroponic Farms Corporation operates 31 geothermally heated greenhouses about 28 miles east of Susanville. The complex, near Wendel Hot Springs, consists of metal-framed Quonset huts heated with 102°C

(216°F) water pumped from a nearby, 630-foot (192 meter) geothermal well. The hot water is piped through a distribution system into radiators suspended at both ends of the greenhouses. Large fans blow heated air through 12-inch and 18-inch perforated plastic ducts extending through the building. During the winter, a temperature of 21°C (70°F) is maintained in the greenhouses, even when outside temperatures drop to -29°C (-20°F). The waste water is disposed of at the surface, behind the complex.

In the greenhouses, the plants are grown in plastic-lined troughs. They are nourished with a modified water system, called the Nutrient Film Technique, by adding nutrient salts to fresh water circulating through the troughs.

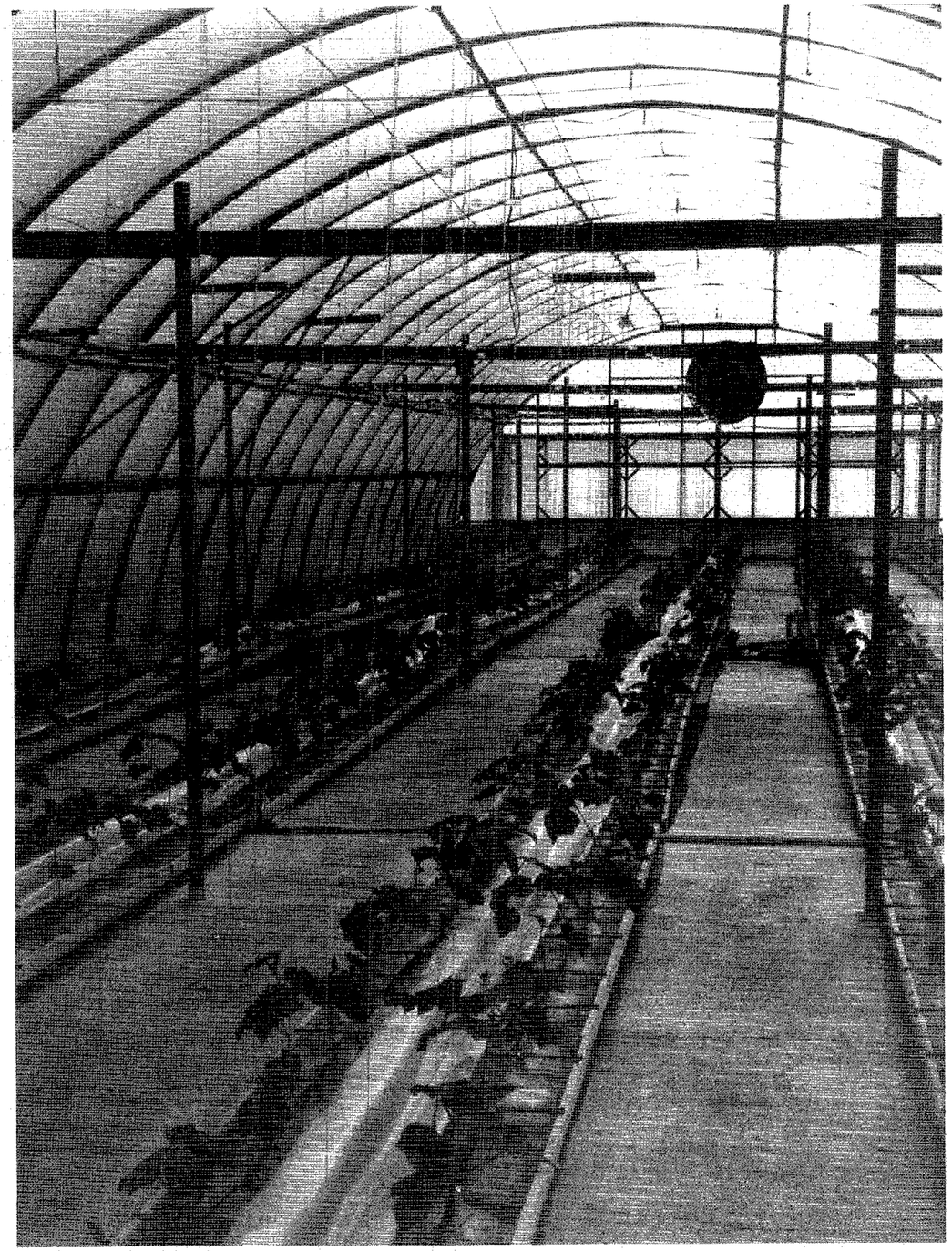
Last year, 70,000 pounds of English cucumbers were harvested in one month from 20 greenhouses, in a production area totaling 1.33 acres. Future plans are to raise 15 greenhouses of Sandra cucumbers and 5 greenhouses each of Daleva cucumbers, yellow bell peppers, and Kentucky Wonder green beans.

A packing shed is under construction and work on a 95,000 square foot earthen-floor greenhouse is scheduled to begin in January.

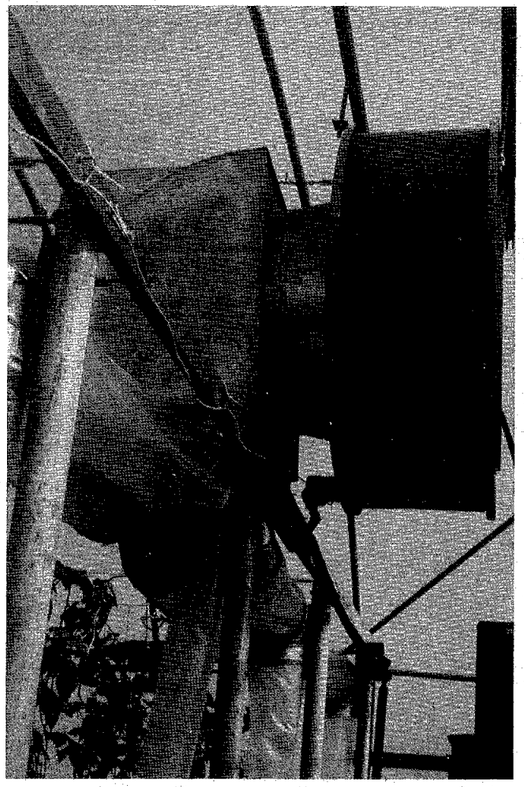


*Thirty-one greenhouses at Honey Lake Hydroponic Farms are heated with hot water pumped from this well, Honey Lake Hydroponic Farms "Wendel" 1, drilled in 1962 to 630 feet by Magma Power Company. The pump is at the center of the photo and the flow line to the right. One main pipeline was laid between the two rows of greenhouses, and smaller lines connect each greenhouse with the main system.*

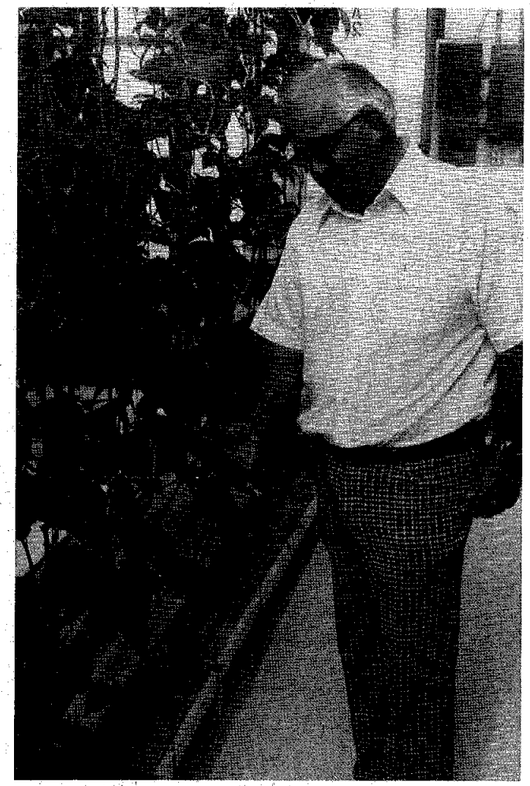




*Inside a greenhouse. The ribs of the Quonset hut are covered with 8mm polyethylene plastic. The rows of young cucumbers are planted in troughs.*



*Close-up of radiator-fan unit. Air is warmed by geothermal water circulated through the radiator, and blown through the clear-plastic perforated ducts that extend through the greenhouse.*



*John Blair, an owner of the Honey Lake Hydroponic Farms, holds an English cucumber inside one of the geothermally-heated greenhouses.*

## Susanville Geothermal Field

A portion of Lassen County has been designated as Susanville Geothermal field by the State Oil and Gas Supervisor. Parts of Secs. 28 through 34, T. 30N, R. 12E, and Secs. 3 through 6, T. 29N, R. 12E, M.D. B.&M. are in this field, which presently includes 22 low-temperature geothermal wells and temperature-observation holes. No high-temperature geothermal development is expected in the area.

Division geothermal map G1-3 of the Susanville area is now available. Information on ordering this map is on the inside back cover of the Hot Line.

## Direct-Heat Cost Estimates Available

Copies of a Cost-Estimating Mini-Computer Code are available, free of charge, from EG & G Idaho, Inc. Estimates that can be made with this code include the capital, operating, and unit-heating costs for five types of direct-heat geothermal projects: commercial greenhouses, single dwellings, large apartments, schools, and hospitals.

In the future, estimates in metric units will be available from EG & G, along with those for a heating-district model. For copies, write to H. R. Hilker, EG & G Idaho, Inc., P. O. Box 1625, Idaho Falls, Idaho 83415.



## Alcohol for Gasohol Using Geothermal Energy

At the Department of Energy's Raft River site in Idaho, researchers have used moderate-temperature geothermal water (about 116°C or 240°F) to distill sugar-beet syrup into alcohol. The alcohol can be added to gasoline to make gasohol, which usually contains 10 percent alcohol.

In the low-cost experiment, the geothermal water was used to ferment the liquid as well as to supply the heat energy for distillation. Researchers plan to evaluate geothermal applications for distilling alcohol from other materials such as forest slash, wheat straw, pine chips, surplus farm crops, and other renewable products.

The operating contractor for the sugarbeet project was EG & G Idaho, Inc. Scientists from Colorado State University will participate in future research.

## Potato Peelings Dried with Geothermal Energy

Representatives of McDonald's fast food restaurants are working with Department of Energy scientists to study the use of hydrothermal systems for drying potato peelings. The peelings will be added to McDonald's french fries. The dried product has a high (12 percent) protein value and is also in demand as livestock feed.

A fluidized bed is used to dry the peelings, and EG & G, Idaho is managing the experiment.

## Radial-Inflow Turbine at Raft River

The "world's largest" radial-inflow turbine will be installed by EG & G Idaho, Inc. in its 5 MWe thermal-loop power plant in the Raft River Valley of Idaho. This plant will be run with energy extracted from low-to medium-temperature geothermal resources 149°C (300°F).

The radial-inflow turbine was constructed by Elliott Company of Jeanette, Pennsylvania. Until now, the radial-flow turbine has been used for smaller projects. However, according to Jack Ramstahler of EG & G, the 5 MWe radial-inflow turbine may prove economically competitive with the axial-flow turbine currently used by all utilities.

## Raising Fish in Geothermal Waters

Fish reach market size faster when they are raised in geothermal waters instead of open ponds, according to Dr. M. H. Beleau of the University of Idaho and Dr. J. F. Sullivan of EG & G, Idaho.

Following a year-long study of the effects of geothermal water on catfish, carp, and tropical fish, the two scientists reported considerably faster growth for the fish that were raised in the water drawn from wells at the Department of Energy, Raft River geothermal site in Idaho.

Catfish, for example, reached market size in 10 months in Raft River water, Dr. Beleau noted. This growth takes 16 or 17 months in open ponds. The carp, he said, reached market size even faster. The rapid growth rate resulted from a constant supply of warm water. Fish growth slows whenever the water temperature drops.

# The Geysers

## Reservoir Expert Studies The Geysers

Herman Dykstra, under a contract with the California Division of Oil and Gas, has begun reviewing and compiling reservoir engineering data for The Geysers Geothermal field. He is studying well records and production data for wells drilled at The Geysers to assess the nature of The Geysers reservoir, including the steam reserves. His conclusions will be speculative to a certain degree. This is because the assessment requires material balance calculations based on the average pressure of the reservoir, which can't be calculated for undeveloped areas of the reservoir.

Mr. Dykstra is well known for his work in oil and gas field reservoir evaluation. Geothermal reservoirs with which he has worked include the reservoir in the Heber area of the Imperial Valley and the Momotomba reservoir in Nicaragua. His study for the division is financed by a grant from the Department of Energy.

## Power Plant Update

Two 110 MWe power plants are under construction in The Geysers Geothermal field and are expected to be generating electricity in 1980. Four 110 MWe plants, one 66 MWe plant, and two 55 MWe plants are in various stages of the permitting process. The total power generated by these plants will be 616 MWe and will raise the power generated at The Geysers to 1,279 MWe by 1984 or 1985.

## The Geysers As A Tourist Attraction

Over 20,000 people visited The Geysers Geothermal field in 1979. According to Harry Bain of Union Oil Company, the tourist load amounts to 1 visitor for every 10 workers at the geothermal field on an average work day.

# Imperial Valley

## Imperial Valley Survey

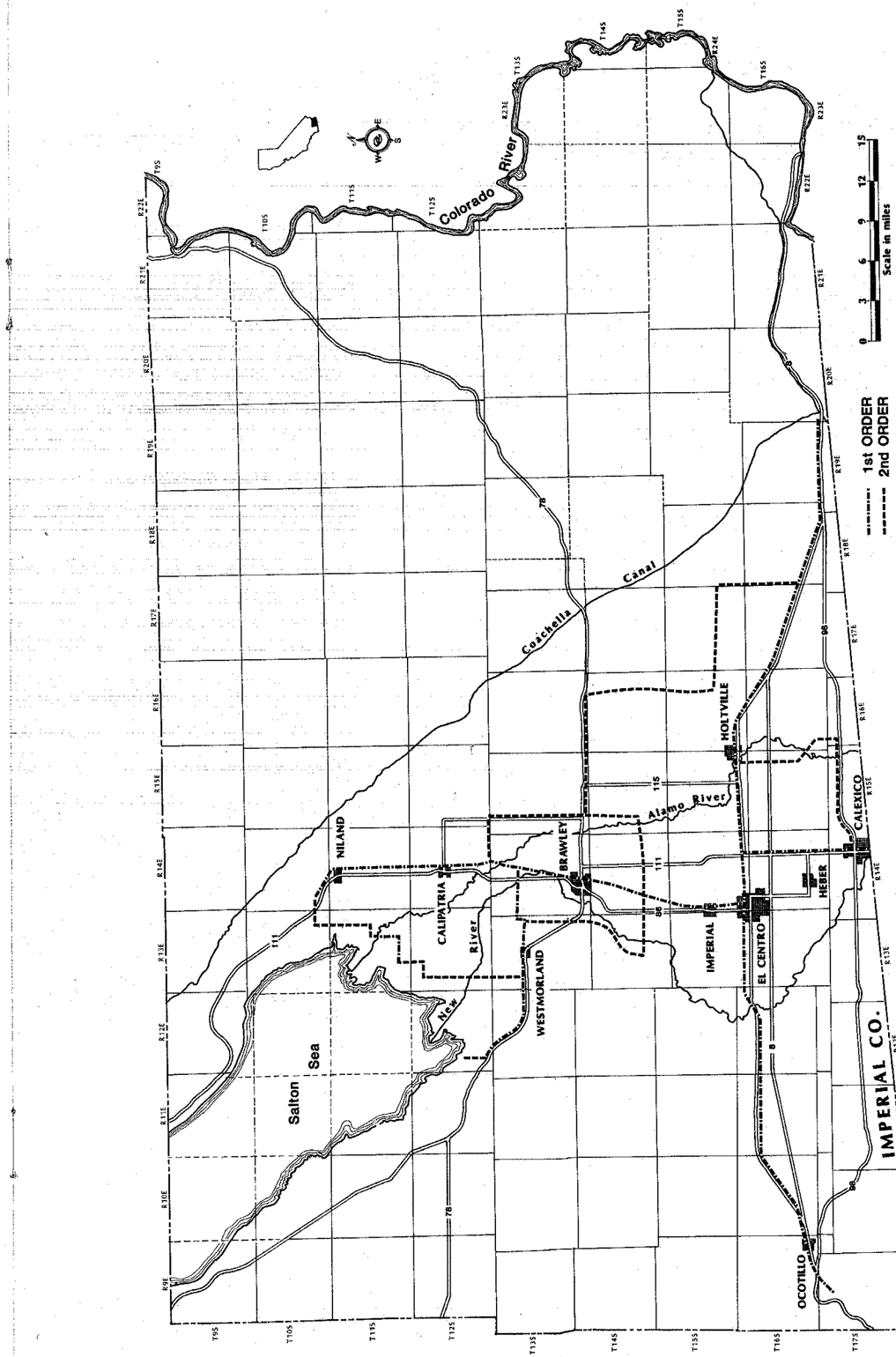
Plans for a January 1980 releveling survey of the Imperial Valley were made at a meeting of the Imperial Valley Geothermal Detection Committee (IVGDC) on December 6, 1979. Although surveys of the Imperial Valley were begun after the 1940 earthquake, the basic net used today was run in 1971 and 1973, and extended in a 1975-1976 resurvey. In 1978, a releveling program by the National Geodetic Survey was tied to the survey net. Data from the 1978 level adjustment will be available soon.

The purpose of the most recent surveys has been to collect a data base against which any subsidence caused by future large-scale geothermal production in the valley may be measured. Although such production has not begun, valley subsidence, caused by tectonic activity, has been calibrated using the survey net.

Doug Stockton, Geothermal Officer of the California Division of Oil and Gas, (CDOG), currently is chairman of the IVGDC (which was originally organized by the division). Also present at the December meeting were representatives from Imperial County, Union Oil Company, Lawrence Livermore Laboratory, Imperial Irrigation District, U.S. Geological Survey, U.S. Water and Power Resources Service, Imperial Magma, San Diego Gas and Electric Company, Southern Pacific Land Company, McCulloch Geothermal, Mono Power Company, Chevron USA Inc., and the California Energy Commission.

A subcommittee was formed at the meeting to solicit funding for the survey.



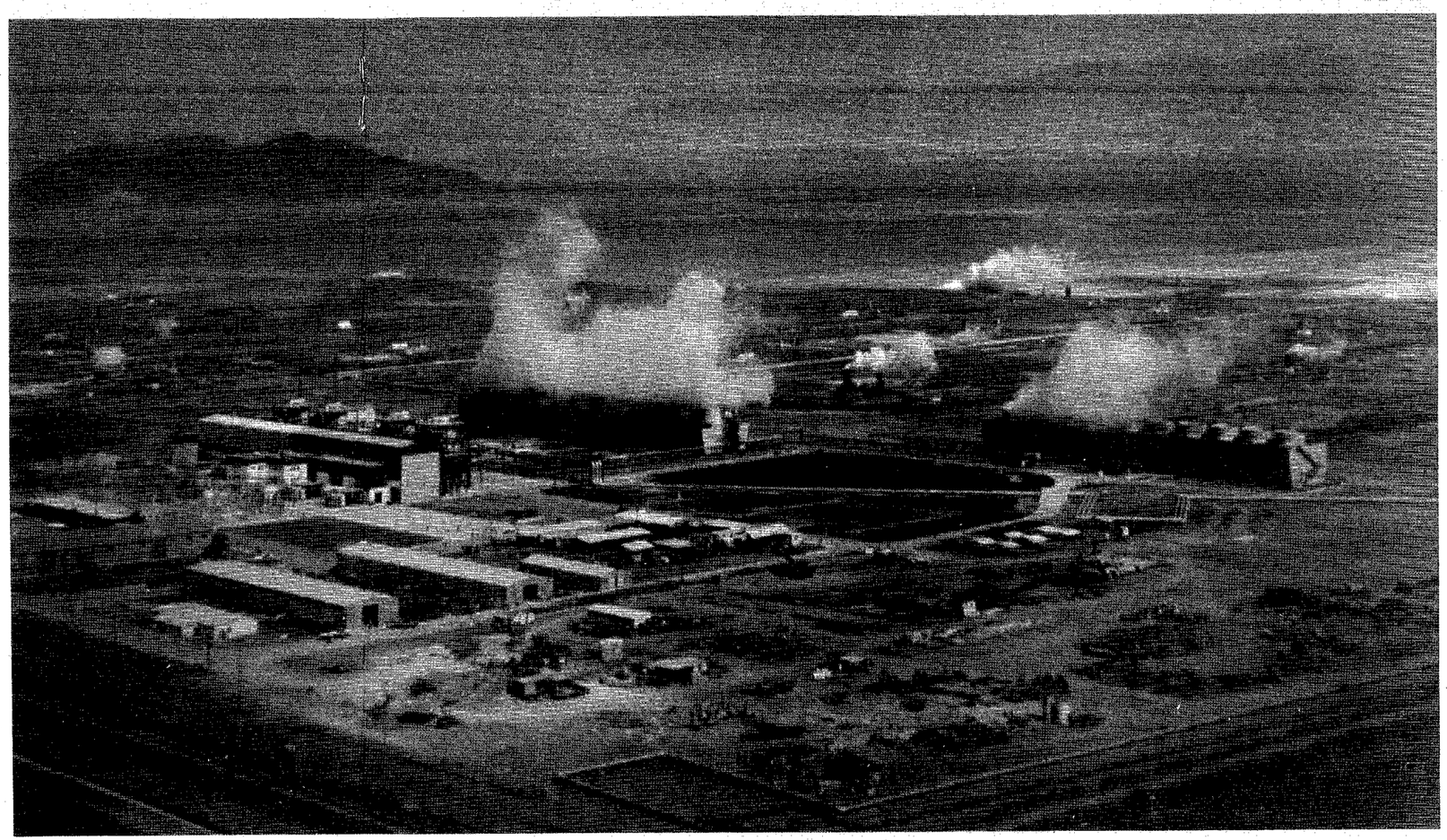



*Level net for the 1980 survey of the Imperial Valley. The net consists of about 200 miles of first order level lines and 270 miles of second order level lines. The net is tied into three bench marks located at the northern, eastern, and western sides of the valley.*

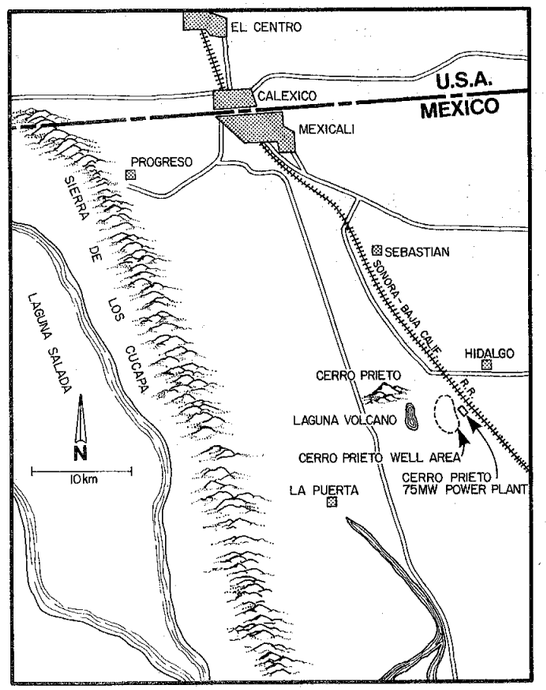
# Cerro Prieto Geothermal Field

by Susan Hodgson

The Second Symposium on Cerro Prieto Geothermal field was held on October 17-19, 1979, in Mexicali, Baja California. Over 300 people attended the symposium to learn about the latest research on the field. The research is carried out under the aegis of an international cooperative agreement between Mexico and the United States, created to develop an intensive research program for Cerro Prieto field. On July 21, 1977, the agreement was signed by the Comision Federal de Electricidad and the Energy Research and Development Agency, now the Department of Energy. Under the agreement, supervision of Mexican activities is carried out by the Coordinadora Ejecutiva de Cerro Prieto of the Comision Federal de Electricidad. U.S. participation is coordinated by Lawrence Berkeley Laboratory.



*Aerial view of Cerro Prieto Geothermal field. The volcano named Cerro Prieto and the Cucapa Range are in the background. In front of Cerro Prieto and behind the cooling towers is the field evaporation pond. The power plant is at photo left. Some wells and pipelines are visible. Photo from the Comision Federal de Electricidad.*

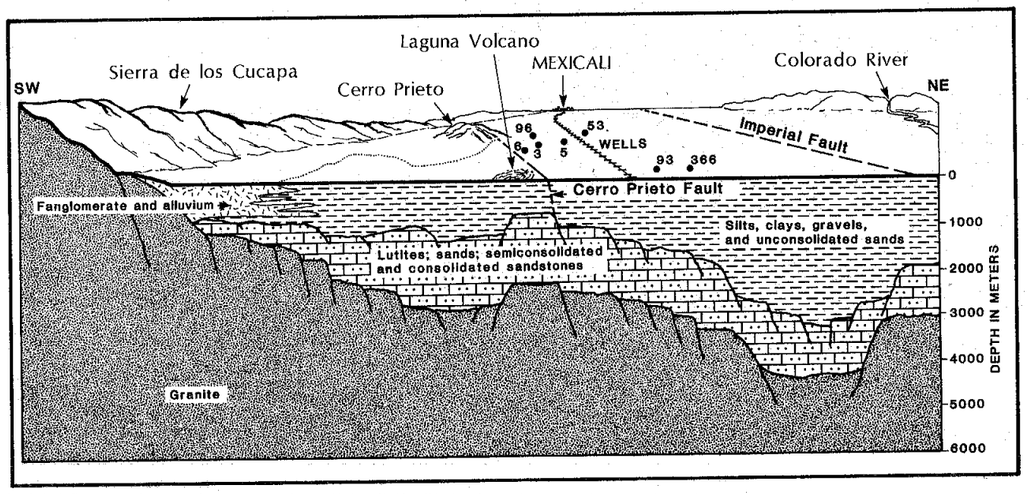



*Cerro Prieto Geothermal field is in a flat, poorly drained area of the Mexicali Valley, about 35km south of Mexicali, Baja California. The field, about 30km in size, lies within the Salton trough structural depression near the eastern flank of the Sierra de los Cucapa.*

*Cross section of Cerro Prieto Geothermal field, adapted from a diagram prepared for the Comision Federal de Electricidad. Wells drilled at Cerro Prieto produce hot water from permeable strata found at an average depth of 1,700-2,300-2,900 m. The water is saline, with high concentrations of carbon dioxide, potassium, silica, and calcium. A typical analysis of the formation water is: 4,800 ppm Na; 8,800 ppm Cl; 1,200 ppm K; 300 ppm Ca; 600 ppm $SiO_2$; 3,800 ppm $HCO_3$; 14,800 TDS; and 560 ppm $H_2S$.*

*According to a report by R. Prian C., Asesor de la Comision Federal de Electricidad, the field includes at least two main reservoirs, 300 meters apart, and a shallow secondary lenticular reservoir, which is present in only part of the field. The sediments that make up the reservoir were deposited in one of several paleochannels that could be the distributaries or the main channel of a deltaic paleosystem. These reservoirs are in several fault blocks within the area labeled "Lutites, sands, semiconsolidated and consolidated sandstones" on the diagram.*

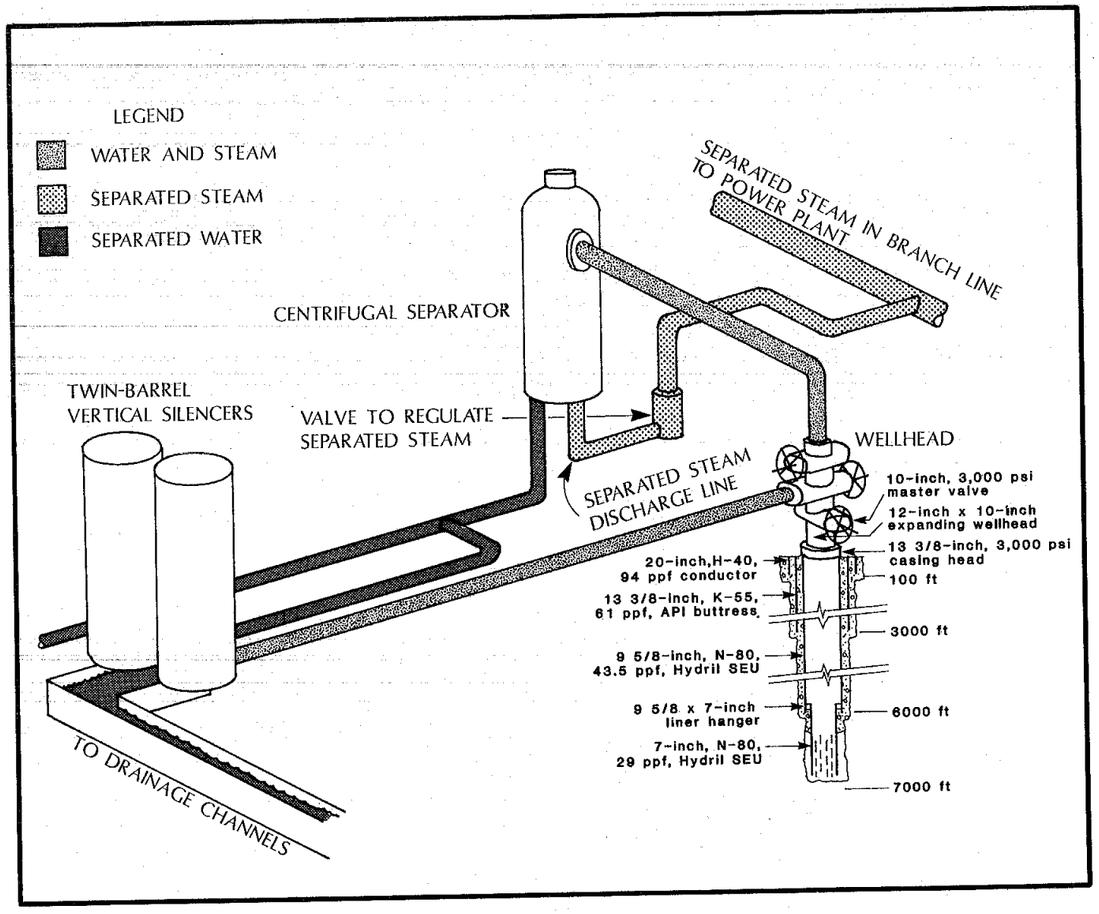
*The geothermal field area is highly fractured. The main fault system trends in a NW-SE direction, and parallels the major fault systems in the area such as the Imperial, Cucapa, Laguna Salada, San Andreas, and San Jacinto faults. Heat from very deep regions passes through these fractures, raising the temperatures of water in the adjacent sediments. Probably, the reservoirs are being recharged with water from the Colorado River.*






*Completed at a depth of 2,500 meters (about 8,200 feet), this well is currently the southernmost well drilled in the field. Geothermal exploration at Cerro Prieto began in 1959 when the first shallow exploratory wells were drilled. In 1964, the first deep, exploratory wells, extending to the granitic basement, were drilled. One of these wells, M-3, was extended to a depth of 2,547 meters (about 8,354 feet), and two of the wells, M-3 and M-5, were producers. In 1966, the drilling program was undertaken and more successful wells were added to the field.*

*Presently, in Cerro Prieto, about 27 production wells are supplying about 1,432 tons of steam per hour to the power plant to generate 150 MWe. For August 1979, the average water/steam ratio was 2.06, and the average enthalpy of the produced fluids was 333kcal./kg. Photos by Susan Hodgson.*




*Typical well site installation at Cerro Prieto Geothermal field, adapted from a drawing created for the Comision Federal de Electricidad. Casing data from "How Geothermal Wells are Completed and Produced" by Robert E. Snyder, October 1979, World Oil.*

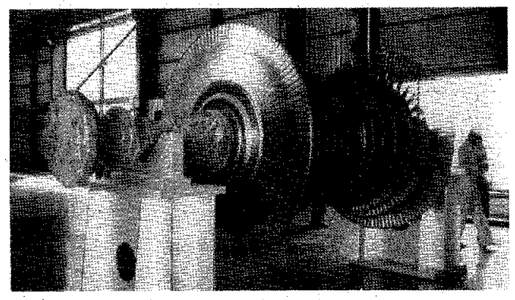
*At an average well site, about 200-250 tons per hour of water and steam are produced from the reservoir, where temperatures range between about 250° to 350°C (482° to 662°F). After the produced water and steam flow through a separator, the separated water discharges into large silencers before flowing through a system of channels into a 16km² evaporation pond.*

*About 3000 cu. meters an hour of brine enters the pond. Most of the brine is diluted 10 times with agricultural waste water from the Mexicali Valley and rediverted into a nearby river. Potassium chloride is extracted from some brine at an experimental brine-processing plant at the field. Eventually, a larger plant will be constructed for producing all the potassium chloride needed by Mexico.*

*About 20 percent of the brine passing into the evaporation pond can be used for steam production. For this reason, a 30 MWe instantaneous evaporation plant that will use steam from a second flashing is scheduled to be built near the evaporation pond by April 1982.*

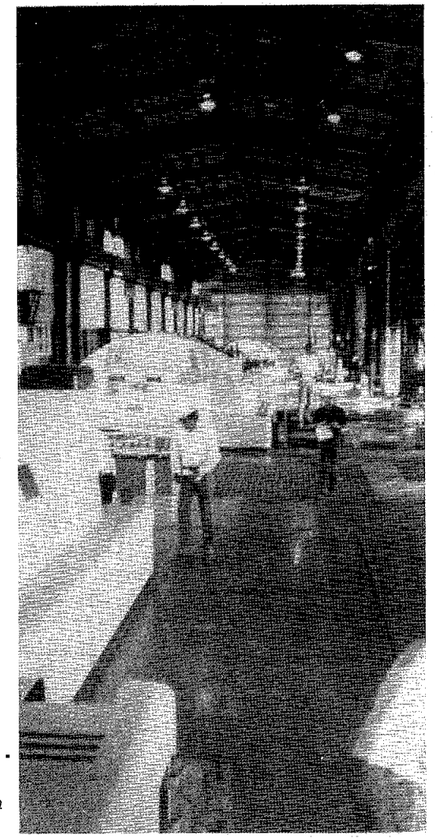


*Control room, Cerro Prieto geothermal power plant. Plant turbines, generators, and transmission lines are operated from this panel.*



*At Cerro Prieto, 150 MWe is generated by four Toshiba impulse double-flow turbines, such as the replacement turbine shown in the photo. So far, this replacement turbine has not been needed, indicating that field separating and purifying equipment have been performing well, that construction material appropriate for corrosion resistance was selected, and that the turbine was well designed.*

*Admission steam pressure at the plant is 5.27 kg./cm.² Man. (about 75 psig), and exhaust steam pressure is 89 mm mercury abs. (about 1.7 psia). The steam admission temperature is 160°C (320°F) and the steam flow to a turbine equals 285,450 kg./hr. (627,990 lb./hr.). Hydrogen-cooled, self-excited, electric generators, are coupled directly to each turbine, and rotate at 3,600 r.p.m.*



*Turbine room at the power plant.*

*Three of the four turbines in operation are pictured.*

# China Lake

Coso Contract Awarded

California Energy Company, Inc., a private company based in Santa Rosa, California, and the U.S. Navy have signed a 25-year contract to develop the geothermal energy resources at Coso Naval Weapons Center, China Lake, California. The contract for the estimated $90 million project is the first of its kind to be negotiated between a federal agency and a private company. Under the terms of the agreement, California Energy Company will evaluate the resource, develop the geothermal steam field, construct an electrical power plant, and operate the plant at no capital cost to the Navy.

The agreement calls for the ultimate production of 75 MWe of continuous power, providing electrical power not only to the China Lake Naval Center, but also to other naval installations in Southern California. The Navy will purchase electricity from California Energy Company at a cost below the commercial rate when the power plant comes on line in the mid-1980's.

The Navy will retain title to the land, the geothermal resource, and the electricity produced.

The first well for the project is slated to be drilled by June 1980. If the well is successful, two confirmation wells will be drilled and the reservoir tested by the end of 1980 or early 1981. Well costs are expected to be about $1 million per well.

For further information, contact S. G. Payne, Public Affairs Officer, Naval Weapons Center, China Lake, California 93555. Phone (714) 939-3511, (AUTOVON) 245-3511.

# Hot Dry Rock

Hot Dry Rock Exploration

A contract to investigate the hot dry rock potential of a portion of Maryland and Virginia has been awarded by Los Alamos Scientific Laboratory (LASL) to D'Appolonia Consulting Engineers, Inc., of Pittsburgh, Pennsylvania.

Morton C. Smith, Deputy Manager of LASL's Hot Dry Rock Geothermal Development Program, said D'Appolonia will gather data on the geology, geophysics, heat flow, land ownership and drilling constraints of a 200-square mile area extending from Chesapeake Bay near Crisfield, Maryland, to Wallops Island, Virginia. The purpose of this study (and a parallel study at Mountain Home, Idaho, by Harding-Lawson Associates) is to locate a site for a hot dry rock experimental system similar to the one operating at Fenton Hill, New Mexico.

For additional information on the project, contact Morton C. Smith, LASL, (505) 667-3185.

U.S.-West German Hot Dry Rock Agreement

A five-year contract to conduct a geothermal hot dry rock project near Santa Fe, New Mexico, has been signed by the United States and the Federal Republic of Germany. Under the terms of the agreement, which was negotiated through the International Energy Agency, West German scientists and technicians will participate in planning and conducting experiments and will obtain data derived from the project. Project researchers will develop and test materials, drilling equipment, and borehole instrumentation at the Fenton Hill site, west of Santa Fe.

Los Alamos Scientific Laboratory scientists say the Fenton Hill project, started in 1974, could lead to the construction and operation of a 3- to 10-MWe power plant at the site by 1986.

At Fenton Hill, heat for power generation is "mined" with two 9 5/8-inch diameter dry wells that are drilled nearly 2 miles deep and are about 250 feet apart at the surface. Through hydraulic fracturing, water is injected into these holes, cracking the hot granitic bedrock and exposing large surfaces of rock. Afterwards, cold water is pumped down one hole. The water passes over the hot rock surface, heats up, and rises through the second hole.

Insulated piping carries the hot water through a heat exchanger, where, in a commercial power system, the energy would be used to generate electricity. The water is then recirculated down-hole in this closed-looped system.



# Core & Well Data

Core Repository Open

Cuttings and core samples from 83 geothermal wells have been collected and information on the samples made available, under the Industrial Coupled Program, sponsored by the Department of Energy - Division of Geothermal Energy. Information on this program is available from P. M. Wright, UURI/Earth Science Laboratory, 420 Cipeta Way, Suite 120, University Research Park, Salt Lake City, Utah 84108. Phone: (581) 766-7162.

A wide variety of lithologies, ideal for log interpretation studies and comparisons, are represented by the samples. Among the areas sampled are Coso, in California; Raft River, in Idaho; Cove Fort, Cove Fort-Sulphurdale, and Roosevelt Hot Springs, in Utah; and San Emidio, Soda Lake, Beowawe, Baltazor, Still Water, Desert Peak, and Humboldt House, in Nevada. Total weight of the samples is 14,200 lbs. chips, and 11,100 lbs. core; total footage equals 136,000 ft. chips, and 6,080 ft. core.

Well Data Available

Scientists at Lawrence Livermore Laboratory are compiling well data on all ongoing or planned wells funded by the Department of Energy (DOE).

The initial computerized data base will include information on all DOE-funded wells proposed or drilled deeper than 300 meters, and on wells of special scientific importance. All holes drilled into basement rock fall into the latter category, and many geothermal wells are included in this project. Drill-hole information supplied by the U.S. Geological Survey will also be incorporated.

To date, information on 300-400 wells is tabulated and available to the public. For information, contact: Mr. Bern Qualheim, University of California, Lawrence Livermore Laboratory, P.O. Box 808 L-222, Livermore, California 94550. Phone: (415) 422-1373.

# Development

1980 USGS Geothermal Research Program

The U.S. Geological Survey has announced a geothermal research program for fiscal year 1980. The purpose of the program is to understand the nature, distribution, and energy potential of the country's geothermal resources. The program is divided into five phases:

1. National and regional resource inventory;
2. Exploration and assessment technology;
3. Resource characterization;
4. Geologic controls of subsurface porosity and permeability; and
5. Geoenvironmental effects of production of geothermal energy.

The program budget of almost $10 million is down from the 1979 budget of almost $12 million. About 15 percent of the funds support research outside of the USGS through extramural grants and contracts.

For further information, contact W.A.

Duffield, USGS Geothermal Program Coordinator, 345 Middlefield Road, Menlo Park, California 94025.

Roosevelt Hot Springs

Three companies -- O'Brien Resources Corporation, Thermal Power Company, and Amax Exploration, Inc., -- have joined Phillips Petroleum Corporation in unitizing the production of their individual interests in the Roosevelt geothermal resource area near Milford, Utah. To date, seven successful wells have been completed in the field, 5 by Phillips and 2 by the three other companies.

The companies are planning a staged development program, starting with the construction of a 20 MWe power plant. Following this, two 55 MWe plants are scheduled for completion in 1986.

# Leases

LEASE SALE SCHEDULE AS OF 1/15/80

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.

| Location of KGRA | Latest Sale Date Scheduled | Original Sale Date |
|---|---|---|
| San Emidio Desert and Steamboat Springs<br>OR | 03/25/80 | 04/ ?/80 |
| The Alvord/Crump Geyser/Klamath Falls/Burns Butte<br>OR | 04/29/80 | 04/29/80 |
| Gerlach/Dixie Valley/Darrough HS/Elko HS<br>NV | 03/25/80 | 04/ ?/80 |
| Gillard Hot Springs and Clifton<br>AZ | 05/30/80 | 08/ ?/79 |
| Mono-Long Valley<br>CA | 04/17/80 | 02/ /79 |
| The Geysers (MRL)<br>CA | 07/15/80 | 05/ ?/79 |
| Island Park<br>(Idaho and Montana) | 09/30/80 | 10/ ?/79 |
| Lassen Hot Spring<br>CA | 09/ ?/80 | 03/ ?/80 |
| Belknap-Foley Hot Springs<br>OR | 10/30/80 | 07/06/78 |
| Indian Heaven and Mt. St. Helens<br>WA | 10/30/80 | 03/19/79 |
| McCredie<br>OR | 10/30/80 | 10/05/78 |
| Newberry Caldera<br>OR | 10/30/80 | 05/01/80 |
| Beckwourth Peak<br>CA | 11/? /80 | 06/? /79 |
| Coso Hot Spring<br>CA | 12/ ?/80 | 12/ ?/80 |
| Corwin Springs<br>MT | 12/? /80 | 12/? /80 |



# Conferences & Courses

The National Groundwater Geothermal Heat Pump Conference and Exposition, Fawcett Center for Tomorrow, Ohio State University, Columbus, Ohio, February 11-12, 1980

This conference will be an opportunity for HVAC and water-well contractors, engineers, and scientists to discuss the design, installation, and operation of groundwater geothermal pumps. Conference leader is Dr. Jay H. Lehr, Executive Director of the National Water Well Association.

Registration after January 3, 1980 is $115.00, which includes two luncheons, one dinner, and a copy of the conference proceedings.

For further information, contact NWWA Heat Pump Conference, 500 W. Wilson Bridge Road, Worthington, Ohio 43085. Phone (614) 846-9355.

Geothermal Reservoir Well Stimulation Symposium, San Francisco Hilton and Tower, San Francisco, California, February 7, 1980

The symposium is sponsored by the Department of Energy. It will bring together technical people working in the area of geothermal well stimulation to present and discuss their views on this topic. Papers to be presented will discuss and offer solutions to problems of design, logistics, performance, and evaluation.

The registration fee is $25, and includes a copy of the proceedings to be published after the symposium.

For further information and registration forms contact:

Geothermal Reservoir Well Stimulation Symposium, Petroleum Training and Technical Services, 2227 W. Lindsey, Ste. 1201, Norman, Oklahoma 73069.

The Third Invitational Well Testing Symposium, Lawrence Berkeley Laboratory, Auditorium Building 50, March 26-28, 1980

Well testing in low-permeability environments will be discussed.

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

Iceland-"80"

The Rocky Mountain Section of the Geothermal Resources Council is sponsoring a 7-day field trip to Iceland from May 24 through May 30, 1980. The trip will include visits to several regional space-heating districts and the Krafla power plant and the opportunity to see industrial direct-use applications.

The trip will be limited to 30 persons. For further information, write to Jay D. Dick, Iceland-"80", Rocky Mountain Section - GRC, 1361 South Glencoe, Denver, Colorado 80222.

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

The results of ongoing programs investigating the geology, geophysics, geochemistry, subsidence, and reservoir engineering will be summarized at this symposium. New technical topics and geothermal areas in the Mexicali Valley will be discussed.

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

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

GRC Courses and Meetings

The following courses and meetings have been scheduled for 1980 by the Geothermal Resources Council. Asterisks (*) indicate that dates and locations may vary. For further information, write the Geothermal Resources Council, P.O. Box 98, Davis, California 95616.

Technical Training Course No. 2 (TTC#2), Geophysical Exploration Methods for Geothermal Resources, San Diego, CA, January 23-25, 1980

Management Survey Course No. 2 (MSC#2), A Survey of Geophysical Exploration Methods for Geothermal Resources, San Diego, CA, January 24-25, 1980

Management Survey Course No. 3 (MSC#3), Environmental Requirements and Control Technology for Geothermal Resources, Northern California, February 14-15, 1980*

Management Survey Course No. 4 (MSC#4), Structure of a Geothermal Exploration and Development Program, Palm Springs, CA, March 10-11, 1980*

Technical Training Course No. 3 (TTC#3), Drilling and Completion of Geothermal Wells, Albuquerque, NM, March 24-26, 1980*

Special Short Course No. 9 (SSC#9), An Introduction to Geothermal Resources, San Francisco, CA April 10-11, 1980*

Management Survey Course No. 5 (MSC#5), Economics of Geothermal Exploration and Development, Denver, CO, May 6-7, 1980*

Management Survey Course No. 6 (MSC#6), Financing Geothermal Ventures, Denver, CO, May 8-9, 1980*

Symposium on the Commercial Uses of Geothermal Heat (Tentative), Boise, ID, June 18-20, 1980

Technical Training Course No. 4 (TTC#4), Geologic Fundamentals and Techniques for Geothermal Exploration and Development, Klamath Falls, OR, July 22-25, 1980*

1980 Annual Meeting, Salt Lake City, UT, September 8-11, 1980

Technical Training Course No. 5 (TTC#5), Evaluation of a Single-Phase Geothermal Reservoir, Imperial Valley, CA, October 20-22, 1980*

Technical Training Course No. 6 (TTC#6), Evaluation of a Two-Phase Geothermal Reservoir, Imperial Valley, October 22-24, 1980*

Technical Training Course No. 7 (TTC#7), Geochemical Fundamentals and Techniques for Geothermal Exploration and Reservoir Evaluation, Reno, NV, November 5-7, 1980*

# Publications

Every month, the Earth Sciences Division of Lawrence Berkeley Laboratory publishes new 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 (both free of charge) are:



Guidelines manual for surface monitoring of geothermal areas, LBL-8617, by C. J. Van Til, May 1979; and

Modeling heat and mass transfer at the Mesa geothermal anomaly, Imperial Valley, California, LBL-8784 (GREMP-3), by D. R. Kassoy and K. P. Goyal, February 1979.

☆

Information to aid developers of Washington State's geothermal resources will be available early in 1980. The information will include maps depicting the geothermal leasing status of federal land areas and data on geothermal assessment. A handbook will be available with leasing procedures, drilling regulations, and water law.

Hopefully, the distribution of these materials will help to accelerate commercial development of Washington's low-temperature geothermal resources. For further information, contact Steve Craig, Washington State Energy Office, (206) 754-1361.

☆

Geology and Geothermics of the Salton Trough. By W. A. Elders. $5.00, plus tax, plus $1.00 for postage and handling. 110 pages. Available from the University of California Bookstore, University of California, Riverside, CA 92521.

This guidebook contains a road log and 17 articles on the geology and geothermics of the Salton Trough. It was prepared for the 1979 annual meeting of the Geological Society of America.

☆

Geothermal investment and policy analysis with evaluation of California and Utah resource areas. October 1979. By Thomas Cassel, Robert Edelstein, Peter Blair, and Chris Amundsen. $15.00. Available from Dr. Thomas Cassel, Technecon Analytic Research, Inc., 2400 Chestnut Street, Philadelphia, Pennsylvania 19103. Phone (215) 561-5462. Soon to be published by the Department of Energy.

This report describes a geothermal investment decision model that, joined with a site-specific stochastic cash-flow model, can be used to estimate the conditional probability of a positive decision to invest in the development of a geothermal resource area. The cash-flow model and the investment decision model are used in assessing the development potential of nine geothermal resource areas in California and Utah.

☆

Expanding the geothermal frontier. Geothermal Resources Council transactions, vol. 3. $25.00 (California residents add 6 percent sales tax). Also for sale are copies of six field-trip guidebooks prepared for the field trips offered at the 1979 annual meeting. $5.00 each (California residents add 6 percent sales tax). Available from the Geothermal Resources Council, P. O. Box 98, Davis, California 95616.

The transactions include papers written on all aspects of geothermal resources, and the papers presented at the Geothermal Resources Council Annual Meeting September 1979 in Reno.

☆

The hydrothermal system of Long Valley Caldera, California, U.S. Geol. Survey Prof. Paper 1044-A. $2.50. Published by and available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402.

Results from the numerical simulation of the Long Valley hydrothermal system permit a useful determination of the general relationship between heat flow and the depth and duration of fluid flow as well as the effective hydraulic characteristics of the reservoir.

☆

Geothermal environmental projects publication list with abstracts, 1975 through 1978. 1979. By Y. E. Ricker and L. R. Anspaugh. $6.00. Microfiche $3.00. Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

This list includes publications resulting from or concerning geothermal environmental projects conducted by the Environmental Sciences Division at Lawrence Livermore Laboratory (LLL). Other pertinent LLL publications and several publications from other agencies that have collaborated in the Imperial Valley environmental projects are included as well.

☆

The geothermal resource, earth's natural heat providing energy now. $55.00 plus tax. 200 pages. Soft cover. Published by and available from Petroleum Information Corporation, P.O. Box 2612, Denver, Colorado 80201.

An overview of geothermal energy and its worldwide applications are described in this volume. The publication also contains geothermal well completion records dating back more than 50 years and a 24-page bibliography organized by topic and area.

☆

Methods for improving geothermal exploration and assessment technology. Department of Energy (DOE) Program Research and Development Announcement DE-RA07-79ET27077. Free. Available from the Department of Energy, Idaho Operations Office, 550 Second Street, Idaho Falls, Idaho 83401.

Some material in this publication is outdated because the filing date has passed for submitting proposals to the DOE on developing and/or advancing technology for the detection and/or delineation of hydrothermal geothermal resources. However, the publication also includes a source list for data on Utah geothermal areas (mostly Roosevelt Steam field) and nine pages of references taken from the "Annotated Bibliography of the Geology of the Roosevelt Hot Springs Known Geothermal Resource Area and the Adjacent Mineral Mountains, March 1978", by D. Brooks McKinney (September 1978) IDO/78-1701.b.1.1.4.

☆

A sourcebook on the production of electricity from geothermal energy. Edited by J. Kestin, R. DiPippo, H.E. Khalifa, and D.J. Ryley. About 750 pages. Geothermal energy as a source of electricity: a worldwide survey of the design and operation of geothermal power plants. By R. DiPippo. About 40 pages.

The Department of Energy has sponsored the production of these two volumes about geothermal power plants and plans to distribute them widely. To obtain a copy of either or both, contact R. DiPippo, Box D, Brown University, Providence, Rhode Island 02912.

☆

Arizona, Nevada, and Oregon 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: Nevada map ($2.50 per map) - Nevada Bureau of Mines and Geology, University of Nevada, Reno, Nevada 89557 (or in person from Room 310, Scrugham Engineering - Mines Building on the University campus in Reno); Oregon map (free - one per person) - Donald Hull, Department of Geology and Mineral Industries, Administrative Office, 1069 State Office Building, Portland, Oregon 97201; Arizona map ($2.00 per map) - Dick Hahman, Bureau of Geology and Mineral Technology, 845 N. Park Avenue, Tucson, Arizona 85719.

Maps for Idaho, Montana, and Utah will be available in the next few months. Within five years, the DOE plans to have made a detailed study of the geothermal resources in all 50 states.

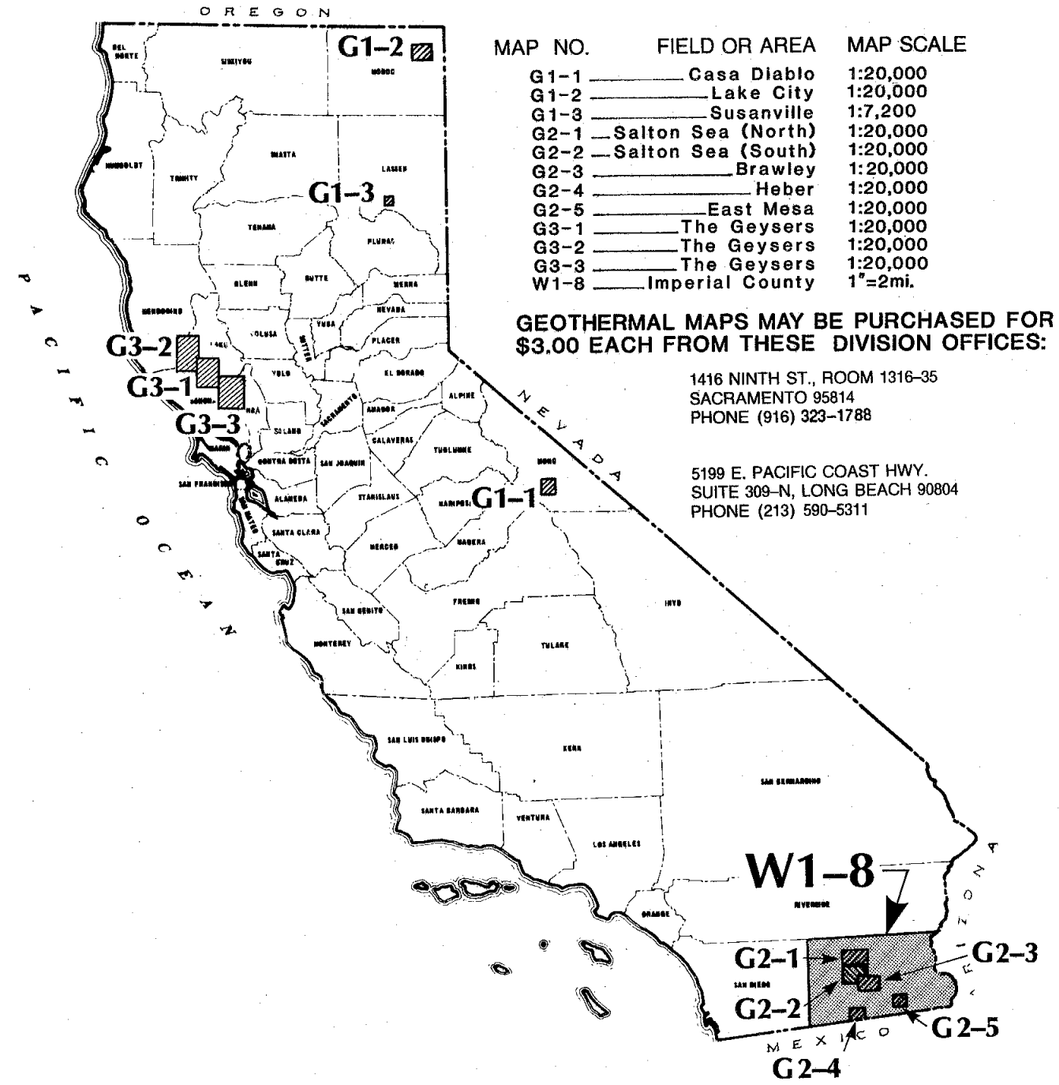
☆

A geologic and geophysical investigation of the Beowawe Geothermal area, north-central Nevada. $6.00 (California residents add 6 percent sales tax). Available from the School of Earth Sciences, Stanford University, Stanford, California 94305.

The publication summarizes geologic and geophysical studies of Beowawe, an area with high-temperature hot springs and geysers. Included in the volume are bipole-dipole resistivity data collected by scientists at Lawrence Berkeley Laboratory. The data are integrated to produce a model for the modern geothermal system at Beowawe.



## 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 1316-35
SACRAMENTO 95814
PHONE (916) 323-1788

5199 E. PACIFIC COAST HWY.
SUITE 309-N, LONG BEACH 90804
PHONE (213) 590-5311

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CALIFORNIA DIVISION OF OIL AND GAS
1416 NINTH STREET, ROOM 1316–35
SACRAMENTO, CA.95814