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GEOTHERMAL HOT LINE

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DEPARTMENT OF CONSERVATION

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Scenes from *Before the Drilling Begins,* a videotape under preparation by the California Department of Conservation, Division of Oil and Gas.

The videotape shows environmental documentation processes and well pad engineering practices used at The Geysers Geothermal field. For further information on the videotape, including purchase details, contact Susan Hodgson (916) 445-9686.

Under the California Environmental Quality Act (CEQA), the Division of Oil and Gas is the lead agency for geothermal exploratory projects. To learn about the division CEQA procedures, see page 58.

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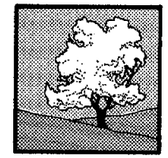
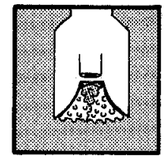
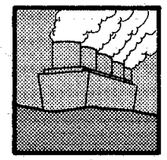
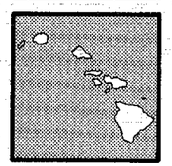
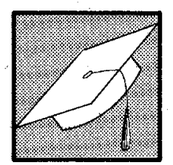










CEQA

The CEQA Review Process

by Bernd Beutenmuller
Environmental Planner
Division of Oil and Gas

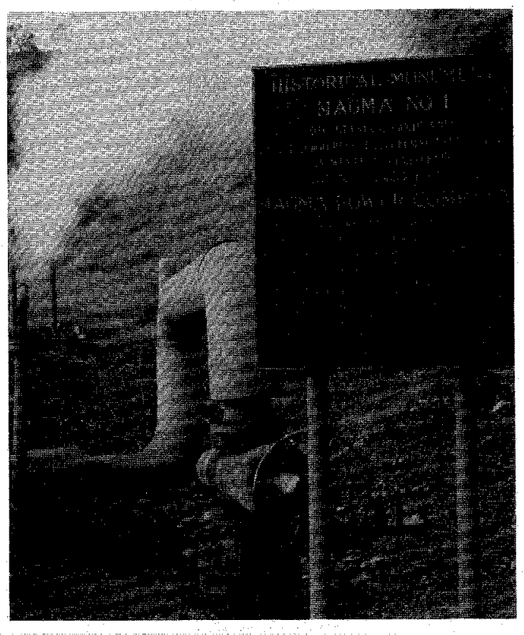
Under the California Environmental Quality Act (CEQA), governmental agencies must consider impacts that may result from the implementation of certain geothermal projects. As many projects require permits from different agencies before the applicant can proceed, overlapping agency studies could result. To minimize duplication of agency effort and unnecessary time delays, a CEQA procedure has been established. First, one of the permitting agencies with jurisdiction over a proposed project is designated as the "lead agency." The remaining permitting agencies function as "responsible agencies." The Division of Oil and Gas has been designated by the California State Legislature (Sec. 3715.5, Public Resources Code) as the lead agency under CEQA for all geothermal exploratory drilling projects occurring on private and state lands in California. A lead agency is responsible for preparing project environmental documentation.

View of The Geysers Geothermal field. Photos by Susan F. Hodgson.

WHAT IS AN EXPLORATORY PROJECT?

A geothermal exploratory project is one composed of not more than six wells whose chief and original purpose is to evaluate the presence and characteristics of geothermal resources prior to starting a geothermal field development project. The wells must be at least one-half mile from the surface location of any existing geothermal well capable of producing geothermal resources in commercial quantities.

In preparing an environmental document for an exploratory project, the description of the potential environmental impacts of a project shall be limited to the proposed drill sites, the proposed wells, and any roads or



Site of geothermal well Magma 1 at The Geysers Geothermal field. The well is the first commercial geothermal steam well drilled in the Western Hemisphere.

other facilities that may be required. The environmental document for an exploratory project does not need to describe the environmental impacts of any future development projects.

To be considered "exploratory," a proposed geothermal well must be at least one-half mile, surface distance, from any existing geothermal well with commercial capability. A geothermal well that meets any one of the following criteria is considered to have commercial capability.

1. A well that is supplying a geothermal resource to an existing power plant or other facility to generate electricity.

2. A well that has been production tested and is scheduled to supply a geothermal resource to a power plant or other facility to generate electricity for which:

   - An application is pending before the California Energy Commission or the California Public Utilities Commission; or
   - The California Energy Commission or California Public Utilities has approved a site; or
   - A contract has been executed between the supplier and a user and conditions have been fulfilled that commit the user to build a facility.

3. A well that is supplying a geothermal resource or has been completed and scheduled to supply a geothermal resource to facilities existing, under construction, or committed for construction, or for nonelectric use of geothermal resources, including (but not limited to) space heating or food processing.

4. A well that has been production tested and, in the operator's opinion, is able to supply sufficient geothermal energy to justify construction of a facility to utilize the energy, and has been designated capable of production by the State Oil and Gas Supervisor.

5. A well that has been production tested and found by the supervisor, after a public hearing, to be capable of producing sufficient geothermal energy to be a commercially viable geothermal development project.

WHAT IS A FIELD DEVELOPMENT PROJECT?

A geothermal field development project means a project composed of any combination of geothermal wells, resource transportation lines, production equipment, roads, and other facilities necessary to supply geothermal energy to any particular heat utilization equipment for its productive life. All project activity will be within an area delineated by the applicant.

WHO SHOULD THE APPLICANT CONTACT FIRST?

Exploratory Projects

An applicant should telephone the CEQA Unit of the Division of Oil and Gas in Sacramento before anything else is done. The number is (916) 323-2732. After the proposed project is explained, a member of the CEQA Unit will outline what needs to be done to process the application most expeditiously. Often, the division will contact other permitting agencies to discuss what documentation will be the most appropriate.

Development Projects

An applicant should contact the planning department responsible for issuing the use permit in the county or city in which the project would be implemented. Counties and/or cities have been designated as the lead agencies for all development well projects.

HOW LONG WILL THE CEQA PROCESS TAKE?

Exploratory Projects (Lead Agency)

When the Division of Oil and Gas accepts as complete the application for a geothermal exploratory project, the division must prepare or cause the preparation of the appropriate environmental document and make a decision on the project within 135 days. This time limit is measured from the date when the application is accepted as complete, which must be determined within 30 days after the application is received. During the application adequacy period, the division determines whether the project will require a Notice of Exemption, Negative Declaration, or an Environmental Impact Report.

Development Projects (Lead Agency)

A county or city is the lead agency for geothermal development drilling projects. These bodies, by law, have up to one year in which to develop an environmental document and render a project decision.

Responsible Agency Time Limits

Agencies that issue permits (in addition to the lead agency), whether the geothermal project is exploratory or developmental, have a maximum of 180 days in which to render their decisions after the lead agency has approved the project. They have 180 days from the submittal of the application if time has lapsed between the submittal and the lead agency decision.

Typically, when the division is the lead agency, responsible agencies are the county, the Regional Water Quality Control Board, and the local Air Pollution Control District.

WHAT DO I NEED TO SUBMIT TO THE DIVISION FOR MY CEQA APPLICATION?
(Remember to call the division's CEQA Unit before submitting any paperwork.)

An application for a geothermal exploratory project must include:

1. A statement declaring that the purpose of the proposed project is to evaluate the presence and characteristics of geothermal resources, and that the surface location of each well in the project is at least one-half mile from the surface location of an existing well capable of producing geothermal resources in commercial quantities.

2. The following information in narrative form:

   - A description of the project including a regional map with the location of the proposed well(s).
   - A statement of whether or not the project is compatible with existing zoning and state and local plans.
   - A description of the environmental setting.
   - A description of probable short-term and long-term environmental effects of the project.

Deer at The Geysers Geothermal field.

   - A description, acceptable to the project sponsor, of measures that mitigate a project's probable environmental effects.
   - A description of any significant adverse environmental impacts that the project sponsor cannot mitigate.
   - A statement that the sponsor agrees to provide additional environmental information the division may need to complete any environmental documents required by CEQA.

WHAT KIND OF ENVIRONMENTAL DOCUMENTS ARE THERE?
Notice of Exemption

A Notice of Exemption (NOE) is a brief notice that may be filed by the lead agency. The NOE is filed after an agency has determined that a project will not have a significant effect on the environment and that the project, therefore, is exempt from further environmental review requirements.

Negative Declaration

A Negative Declaration is a written statement by the lead agency briefly describing the reasons why a proposed project (which would not normally be considered exempt from CEQA) will, in this particular case, not have a significant effect on the environment and, therefore, does not require the preparation of an Environmental Impact Report (EIR).

Environmental Impact Report (EIR)

An EIR is a detailed statement prepared under CEQA. An EIR describes and analyzes the potential significant environmental effects of a project. In an EIR, ways are discussed to mitigate or avoid these effects.

WHAT IS THE COST?

The legislative act (AB 2644-1978) designating the division as lead agency in the CEQA process for geothermal exploratory projects did not provide funding. The division, therefore, must charge an applicant for division hours spent and costs incurred on each project. The charges depend on the project scope and the required environmental documentation. These dollar amounts are <u>very general</u> estimates:

- Projects Resulting in a Notice of Exemption: Up to $500.00
- Projects Resulting in a Negative Declaration: $500.00--$2,500.00
- Projects Resulting in an EIR: $7,000.00--$10,000.00

Such fees are billed monthly or quarterly, depending on current Department of Conservation Accounting Office procedures.

The fees are separate from division Notice of Intention to Drill application fees, annual well fees, and bonding costs. Also, each responsible agency that issues a permit for a project charges its own application fees.

Project (County)	OPERATOR	APPLICATION RECEIVED	NOTICE OF PREPARATION ISSUED	SITE VISIT	NOTICE OF PREPARATION COMPLETE	APPLICATION COMPLETE	NOTICE OF EXEMPTION ISSUED	NEGATIVE DECLARATION ISSUED FOR REVIEW	NEGATIVE DECLARATION REVIEW COMPLETE	DRAFT EIR ISSUED FOR REVIEW	DRAFT EIR PUBLIC HEARING	DRAFT EIR REVIEW COMPLETE	FINAL EIR ISSUED	NOTICE OF DETERMINATION ISSUED
The Geysers Exploratory Project (Lake County)	XYZ Corp.	5/1/84	5/2/84	5/24/84	5/31/84	5/31/84	NA	NA	NA	7/25/84	8/17/84	8/24/84	9/19/84	9/26/84
Honey Lake Exploratory Project (Lassen County)	Geo-X Corp.	3/5/84	NA	4/13/84	NA	NA	NA	3/23/84	4/23/84	NA	NA	NA	NA	5/4/84
Sierra Temperature Gradient Project (Mono County)	County Planning Department	8/9/84	NA	NA	NA	NA	8/24/84	NA	NA	NA	NA	NA	NA	NA

Time frames and steps for geothermal exploratory projects may vary depending on whether an EIR, Negative Declaration, or Notice of Exemption was prepared. Projects and dates shown are hypothetical. The actual time frames depend on the project proposal.

How to Work Under CEQA

by Susan F. Hodgson

An Environmental Consultant

"Keep on talking to everyone involved. That's the most important thing to remember while preparing an EIR or other document for the CEQA process," said Kim Erickson, Associate Planner for George S. Nolte and Associates, a firm that has prepared many California environmental reports. "Make sure that if a problem is found, everyone becomes aware of it as soon as possible," she added.

"Even though a developer must pay for EIR preparation, the EIR is an unbiased informational document that is written at the request of the CEQA lead agency. An EIR does not necessarily reflect a developer's conclusions about the proposed project. This is one part of the EIR process that confuses some developers," Ms. Erickson concluded.

A Geothermal Developer

"The CEQA process fosters beneficial communication between industry and government," said Mike Cale, Senior Environmental Coordinator for GEO Operator Corporation. "Through CEQA, project constraints are found early on. By addressing these, a better project is more quickly designed. Then, once you get to a permit hearing," said Cale, "you've solved most problems."

When asked about advice for new geothermal developers, Cale didn't hesitate. "A company must work with someone familiar with the CEQA process, local issues, and local and state governmental bureaucratic procedures. This must be someone who can work easily in this situation and is not frustrated by it. This can either be someone employed full-time by the company or a consultant."

"Environmental sensitivity is important," said Cale. "The intent of CEQA is good. Sometimes it can be a little cumbersome in the way it is put into play. Overall, it has had a good effect on all types of projects, not just those developed by the geothermal industry."

A County Planning Director

"I see all types of EIR's," said Alex Hinds, Lake County Planning Director. "Good ones (and most for The Geysers area are good) clearly identify project impacts and present state-of-the-art mitigation measures. Concerns are addressed head on and everyone's attention is focused on solving problems.

"Bad EIR's are another story. Typically, they offer extensive descriptions of the environment. They present little insight on project impacts and even less on problem solutions. In such cases, the EIR itself becomes the issue rather than the project. Unnecessary controversy develops around the document.

"When an EIR doesn't identify issues, a project can be delayed by lawsuits resulting in court action. These may challenge the EIR's adequacy.

"EIR's begin with a geothermal developer who must write complete and accurate project descriptions for whoever prepares the EIR. Such descriptions form the basis of an EIR and the basis of any permitted activity.

"The CEQA process for geothermal projects is good. It helps to identify problems and find solutions. It's benefitted the community. CEQA provides a public forum where the pros and cons of each issue are discussed. Here in Lake County, many citizens have a lot of experience with geothermal matters.

"In the mid-1970's, before AB 2644 was passed, the lead agency for geothermal projects was the county of origin. Then, geothermal developers sometimes had to produce full EIR's when they proposed exploratory projects. This meant the EIR's had to address field development and power plant issues, as well.

"Today, this isn't true. AB 2644 sets specific time limits for the CEQA process, which is good.

"I think, generally speaking, the division has done a good job. But I think a local agency makes just as appropriate a lead agency. Overall, AB 2644 was a good bill," he concluded.

Lead Agency Environmental Planner

"Call me before you do anything that would cost you money or waste your time," said Bernd Beutenmuller, Division of Oil and Gas Environmental Planner. The division is the lead agency for geothermal exploratory projects.

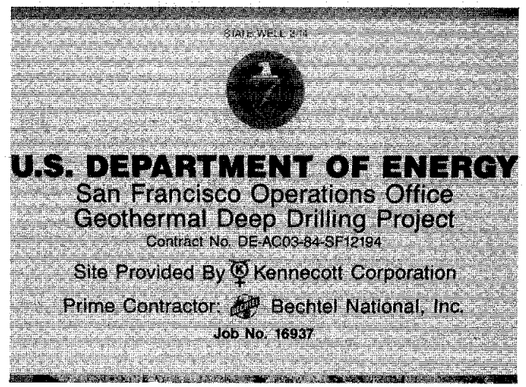
"You may not need to do something, or you may need to do it differently. This is the most important thing for an applicant to realize," Bernd added. "Only people who've never gone through the CEQA process fail to contact me at the very start."

"When this happens, loss of time, money, and potential project denial can occur. Sometimes, I'll get a large batch of information a potential developer has paid someone to put together, and it really isn't what I need.

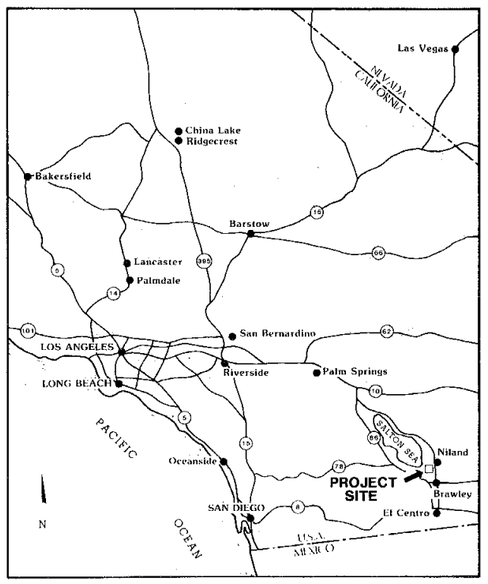
"With all CEQA parties cooperating, unsatisfactory project aspects can be resolved before final project decisions are made," he concluded.

Imperial Valley

Salton Sea Scientific Drilling Project



"I hope this project will be a model for future projects, and that it will demonstrate how government, industry, and the scientific community can join to expand scientific knowledge," said Pat Collins, Under Secretary of the U.S. Dept. of Energy. Collins spoke at the official groundbreaking ceremony of the Salton Sea Scientific Drilling Program. The ceremony was held on October 18, 1984, near the drill site in the Imperial Valley, close to Niland, California.



The production well, State Well 2-14, will be drilled to a depth of 10,000 feet. Drilling will start in July 1985. In mid-January the site was being drained. The well is expected to reach a temperature of 300°C at a depth of about 4,000 feet, and the brine to have salinities of 250,000 to 300,000 milligrams per liter. An injection well will be drilled nearby.

Opportunities for downhole experiments will be available during drilling and for the following year. Program goals are to assess the energy potential of the hydrothermal reservoir, understand the structure, and provide opportunities for basic research. Much overlap is expected in the drilling and engineering portions of the program and the basic scientific experiments.

The drilling and engineering portion of the program is directed by the Geothermal and Hydropower Technologies Division of the DOE. Program manager is Ray Wallace. Bechtel National Inc. was awarded a $5.3 million contract by the DOE to plan and manage the drilling program and data acquisition; design and construct brine treatment facilities; and undertake a comprehensive resource evaluation.

The Salton Sea Scientific Drilling Project represents the first of a series of government-sponsored research efforts of the DOE-U.S. Geological Survey-National Science Foundation Continental Scientific Drilling Program. The Science Coordinating Committee will supervise research proposal processing for these three agencies. Worldwide scientific participation is encouraged, according to Ron Toms, Chief of the Technology Development Branch.

The remainder of this article reproduces part of a memorandum by the Science Coordinating Committee written to "All who have expressed interest in the Salton Sea Scientific Experiments Program."

For addresses of individuals mentioned in the memorandum, copies of the complete memorandum (which includes several "Attachments" not duplicated here), or further project information, contact Dr. Daniel F. Weill (ER-15), Chairman of the Science Coordinating Committee SSSDP, Germantown Building, U.S. Dept. of Energy, Washington, D.C. 20545.

Groundbreaking ceremonies were held on dry land, across the road from the well-site-to-be. Participants in the ceremonies, from left to right, were Richard DuVal, Manager of the San Francisco Operations Office-DOE; Wilbur Thompson, representative of the California State Lands Commission; W. Patrick Collins, Under Secretary of the DOE; Robert Dimock, Vice President of Project Development-Kennecott; John Mock, Director of Geothermal Technologies-DOE; Wilfred Elders, project chief scientist; George Wang, Manager of Research and Engineering-Bechtel Group, Inc.; and Harvey Brush, Executive Vice President, Bechtel Group, Inc.

The well is expected to reach a depth of 10,000 feet. An injection well will be drilled nearby.

- Although no additional funding for basic science experiments was provided in FY-85 for the Salton Sea Scientific Drilling Project (SSSDP), it is clear that the intent of Congress in creating the SSSDP was to provide a unique opportunity for improving our scientific understanding of the hydrothermal system. Consequently, NSF, USGS and DOE have assumed a responsibility for coordinating the SSSDP science program under the guidelines of the recently signed Interagency Accord on Continental Scientific Drilling.

- SSSDP proposals will be competing with existing programs for limited funds. Under the circumstances, it is not possible to define a dollar amount set aside for SSSDP work. Programmatic priorities within the agencies limit the maximum funds for SSSDP basic research projects to $500,000 in FY-85 at NSF and the same amount at DOE-Office of Basic Energy Sciences (OBES). DOE-GHTD (Geothermal and Hydropower Technologies Division) will devote an additional $1 million for projects aimed at understanding and evaluating the geothermal reservoir. The USGS will assume responsibility for funding all approved projects by USGS personnel.

- NSF will accept proposals from university and industry-based scientists. DOE-OBES will accept proposals from university, industry, and national laboratory scientists. DOE-GHTD will also accept proposals from these sources. The USGS will accept proposals from within its organization.

- In deciding which agency an unsolicited proposal should be sent to, the following should be considered.

1. Obviously, all proposals should be aimed quite specifically at taking advantage of the particular opportunities made possible by the SSSDP.

2. NSF has the most broadly defined scientific mission.

3. DOE-OBES also has quite broad interests in supporting fundamental research that will help solve the nation's long-range energy problems.

4. DOE-GHTD is interested in all projects that are fundamentally related to understanding and evaluating the geothermal reservoir.

5. All participating agencies realize that their science interests in the SSSDP overlap to some extent and will, therefore, closely coordinate their proposal evaluation efforts.

6. When submitting proposals to a particular agency, please send information copies to the other participating agencies.

- The deadline for submission of research proposals for FY-85 funding is October 31, 1984. Although FY-86 budgets are not yet determined, the participating agencies regard the SSSDP as a continuing opportunity extending into FY-86 and beyond.

Not far from the Salton Sea, Mexico is involved in extensive drilling at Cerro Prieto Geothermal field. At the request of Alfredo Mañón, Executive Coordinator for the Comisión Federal de Electricidad at Cerro Prieto, we are happy to transmit the following notice:

> The Comisión Federal de Electricidad (CFE), which is operating and managing the Cerro Prieto Geothermal field about 20 miles south of the U.S.-Mexican border, is presently drilling a number of deep exploratory wells in that field to establish the eastern boundary of the thermal anomaly.
>
> Well M-203 reached about 4200m depth, and Well N-204 is planned to reach between 4500-5000m depth.
>
> The CFE is willing to provide cuttings of these deep wells to groups who would study them and share the results with CFE and the geothermal community in general. These groups should write to:
>
> Ing. Alfredo Mañón
> Coordinador Executivo de Cerro Prieto
> Comisión Federal de Electricidad
> P. O. Box 248
> Calexico, CA 92231
>
> Because of lack of foreign currency (i.e. U.S.) CFE is not logging these deep wells. If somebody would be willing to run wireline logs in these exploratory wells or share some of the cost, please contact Ing. Mañón.

A 132-page publication, "Proposed Scientific Activities for the Salton Sea Scientific Drilling Project," LBL/17716, a report of the Experiments Panel organized by the Institute of Geophysics and Planetary Physics, University of California, is available. Copies, for $14.50, may be ordered from the National Technical Information Service, U.S. Dept. of Commerce, Springfield, Virginia 22161.

Union Oil Geothermal Development in the Imperial Valley

Olin D. Whitescarver
District Operations Manager
Union Oil Company of California

Union Oil Company's most recent sustained efforts towards utilization of the geothermal resources of the Imperial Valley began early in 1975 with the drilling of a geothermal discovery well about 2 miles north of Brawley. Subsequent well drilling and testing led to the construction and start-up of a 10 megawatt power generation facility in June 1980. The Brawley generation facility is co-owned by Southern California Edison (50 percent) and a consortium of the Los Angeles Department of Water and Power and the municipal utilities of Pasadena, Riverside, and Burbank.

A similar effort was later undertaken near the southern edge of the Salton Sea where Union, Mono Power Company, and Southern Pacific Land Company developed steam resources sufficient to supply another 10 megawatt power generation facility. The Salton Sea generation facility, owned and operated by Southern California Edison, began operating in July 1982.

Operations of both facilities have been continuous since the start-ups.

Discussion

The Brawley and Salton Sea geothermal resources are categorized as hot, hypersaline brines with temperatures over 500°F and the total dissolved solids over 20 percent. The resources are utilized with flash processes in which the wells flow spontaneously and the brine pressure is reduced, allowing a portion of the brine to flash to steam. The steam is separated from the brine and routed through a turbine-generator. The brine and condensed steam are injected back into the geothermal reservoir. The turbine-generator steam supply requirements are similar for both facilities. The steam delivery pressure to the plant is 100 psig, and steam quality is maintained as clean and dry as reasonably possible.

The difference between the two production techniques being employed is that at Brawley the process retains all of the dissolved solids in solution, whereas, at the Salton Sea, the supersaturated materials are allowed to precipitate and are removed from the brine. A comparison of the two production techniques is shown by the simple schematics in Figures 1 and 2.

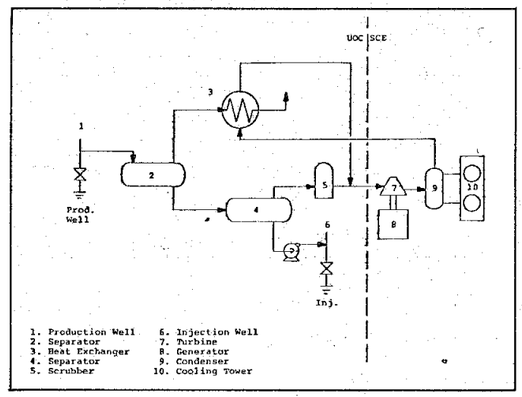


Figure 1-Brawley production schematic.

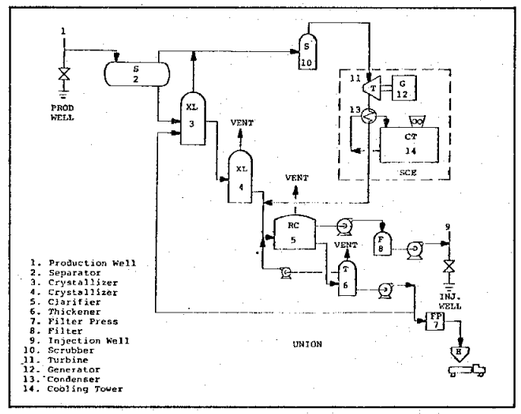


Figure 2-Salton Sea production schematic.

The generation facilities for the two projects were sized to represent completely integrated commercial units. They were designed to provide full-scale, on-line operating experience and yet be small enough that process changes could be accomplished easily and economically. The units have been very successful for developing and demonstrating the technical and economic feasibility of utilizing the hypersaline resource.

The following table presents comparisons and operating statistics for the two resources.

Table 1. Geothermal Project Statistics.

Item	Brawley	Salton Sea
Resource temperature (°F)	520	525
Resource depth (feet)	7,500	3,500
Total Dissolved Solids in Brine (ppm)	200,000	215,000
Generation facility start-up	June 1980	July 1982
Cumulative generation (Million Kw-hr.)	126	158
Cumulative capacity factor (%)	34	82
Cumulative availability (%)	71	91
Highest monthly capacity factor (%)	98	107
Cumulative production (billion lbs.)	22	23
Oil energy equivalent (barrels)	212,000	266,000

Note: Cumulative numbers are from start-up through September 1984.

The lower capacity factor for Brawley does not mean that one production system is superior to the other. The Salton Sea plant benefited immensely from our earlier learning experience at Brawley. We have been more successful in anticipating and resolving the problem areas in the second facility.

Conclusions

We have learned a great deal from our experience operating the Brawley and Salton Sea facilities.

Technical - Precipitation deposits (scale) and pipe and equipment corrosion were considered to be the two major technical obstacles to be overcome. Scale problems have been controlled to the point that we are now achieving 9-month runs between cleanouts. We are attempting to extend that to 12-month intervals.

The brines have proven to be even more aggressive from the corrosion standpoint than originally anticipated. Corrosion mitigation should be a fundamental consideration in the design of any similar facility.

Environmental - Brawley has been in full operation for over 4 years, and the Salton Sea for over 2 years. To date, we have seen no long-term detrimental impact on the agricultural community, nor any evidence of geothermally-induced subsidence or seismicity. We are demonstrating that we are good neighbors and that geothermal development is compatible with agricultural land use.

Harnessing the geothermal resources of the Imperial Valley was a vision that is becoming a reality. Time, patience, effort, risk capital, a stable economy, stable energy prices, and stable and supportive government regulatory policies are the ingredients needed to bring it to fruition. We expect it all to happen.

Coso

Coso Update

"California Energy Company, Inc. has drilled two additional wells at the Coso KGRA since the Hot Line's July 1984 article was printed," said Dick Adams, Vice-President of Operations for the company. "This raises our total to 8 wells."

Adams referred to a project in which his company (in conjunction with the U.S. Navy) will explore for, develop, and produce geothermal fluids at Coso KGRA. The company will also generate electricity from the fluids, build electrical transmission lines, and transfer the electricity to the Navy.

Temperatures of the two new wells (16-8 and 15-8) mentioned by Adams range between 400°F and 500°F. The wells were drilled to depths between 2,500 ft. and 4,000 ft.

"Well 16-8 was tested for 32 days," said Adams. "Its productive capacity exceeds 10 megawatts. Well 15-8 is being tested."

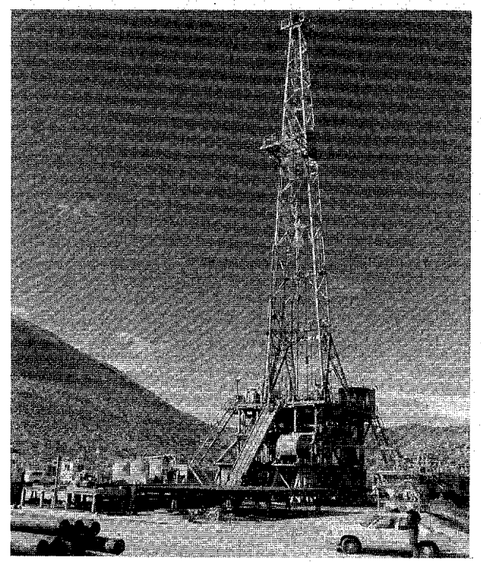
California Energy Company, Inc. has requested bids to drill two additional wells from a well pad immediately west of the main pad where the first 6 wells were drilled.

DWP Begins Drilling at Coso

Three exploratory wells will be drilled in a 6-month period on Los Angeles Department of Water and Power (DWP) leases in the Coso KGRA.

"The resource assessment data collected during this phase of the program will be used to determine DWP's future development of geothermal power generation in the Coso area," said Project Manager Wesley W. Pepper.

If the wells are successful, the DWP plans to install a demonstration geothermal power plant before constructing a commercial generating system.



A DWP well site in the Coso KGRA.

PURPA

Geothermal Development in an Era of Excess Capacity: A Look at PURPA
by Priscilla C. Grew, Commissioner, California Public Utilities Commission

The following material is excerpted from an address by Dr. Priscilla Grew to participants in the U.S. Dept. of Energy Geothermal Program Review at El Centro, California in October 1984.

• • •

The California Public Utilities Commission is still working on the implementation at the state level of the federal Public Utility Regulatory Policies Act (PURPA) of 1978. At the Commission, we are doing the implementation through a proceeding called an Order Instituting Rulemaking (OIR-2).

In December 1979, the Commission adopted "avoided cost" as the reasonable basis for payment by a utility to purchase power from small power producers. California thus acted a few months before the Federal Energy Regulatory Commission (FERC) issued its final rules implementing Section 210 of PURPA. In September 1980, the PUC began OIR-2, the proceeding for state implementation of Section 210. The Commission issued the first big decision on OIR-2 in January 1982.

In the January 1982 order, the Commission set forth the basic methodology under which utilities were to develop standard offers to purchase power from small independent power producers with qualifying facilities (QF's). The offers were to be based on full avoided cost.

On December 30, 1982, the Commission reached a decision on the issues and methodology for calculation of avoided energy and capacity payments, performance requirements, and termination procedures for the first three standard offers. The energy and capacity payments in these offers were based on short-run avoided costs. The Commission adopted energy payments derived from full avoided costs, that is, short-run variable operating

costs -- the added running costs that a utility would incur in generating additional kilowatt-hours at the margin. The decision adopted the full cost of a combustion turbine as a proxy for shortage costs. Shortage cost means the cost of incremental capacity to meet additional incremental demand, and hence avoid a shortage.

Energy payments under the short-run standard offers are based on energy costs, essentially oil or gas costs, recalculated every three months. Utilities' short-run avoided costs have proved to be more volatile than many observers had originally expected. We saw first a drastic run-up in fuel oil and gas prices; then, a decline in oil prices. The QF industry found that the price uncertainty posed under the short-run standard offers makes it extremely difficult to arrange financing for potential QF projects. QF's told the Commission that those who hold the financing purse strings, both lenders and equity investors, are reluctant to commit capital when a project's payment stream is so uncertain.

When the Commission's first OIR-2 decision was issued, oil and gas prices were steadily rising. Although the three largest electric utilities were ordered to file applications with proposed standard offers based on long-run avoided costs, most of our attention and that of the QF industry was directed to perfecting standard offers based on short-run avoided costs. As oil prices started to decline, QF's then became much more interested in standard offers that would produce prices based on long-run, presumably less volatile, avoided costs.

The Commission realized that if it did not adopt a standard offer based on long-run avoided costs as an alternative to the existing short-run standard offers, the pressure for nonstandard contracts between utilities and QF's could steadily increase. Such nonstandard contract negotiations pose problems for everyone.

QF's typically ask for various types of up-front price certainty so they can finance projects. Utilities are faced with ensuring that the nonstandard contract has adequate protective provisions to make it a secure venture for them and their ratepayers. Furthermore, the utilities operating under our regulation are concerned about ultimate cost recovery, and worry that the prudence of nonstandard contracts will be successfully challenged in their energy cost recovery proceedings. Also, the long-term value of new QF capacity in the utilities' resource plans may not be accurately reflected by the existing standard offers that base prices on fluctuating short-run avoided costs.

The threshold problem is picking a method to calculate long-run avoided costs. To value QF power reasonably in the long run, we must make many assumptions about the utilities' future generation mix and costs. There are different ways of arriving at estimates of long-run avoided costs and the future value of QF power, but all involve proxies or the creation of a utility's generation mix and costs on a composite basis viewed at some future time. The "generation resource plan" approach, for example, would evaluate the weighted capacity and energy costs associated with the utility's projected mix of resource additions without the availability of QF power. Some parties argue that we should use a coal plant as the assumed resource addition that would be deferred by long-term QF power. Another method of getting at long-run avoided costs is by forecasting short-run avoided costs into the future. Under this approach, the value of QF power is computed on the general assumption that the utility does not make any new plant investments except in short-run peaking capacity to maintain system reliability.

In September 1983, the Commission approved an interim Standard Offer No. 4, a standard contract based on

an interim set of long-run avoided costs. The 15-year forecast of avoided costs that forms the basis of the price schedules in Standard Offer No. 4 resulted from a negotiating conference involving the Commission staff, the utilities, and QF representatives. The three payment options under Standard Offer No. 4 were initially approved for 1-or 2-year trials. The options are: (1) a payment stream fixed for 10 years following a forecast of increasing payments; (2) a payment stream fixed for 10 years and levelized; and (3) forecasted incremental heat rate payments.

The Commission initially allowed the utilities to hold out Standard Offer No. 4 for a limited period. Any QF signing up for a contract in that time would be able to rely on the terms of that particular contract, even if the PUC later adopted different parameters for Standard Offer No. 4. Recently, the Commission further extended the period during which the utilities will be able to sign up QF's under interim Standard Offer No. 4.

This extension was granted because the process of determining long-run avoided costs is taking longer than the Commission had anticipated. The first step toward this decision is the choice of a methodology for calculating long-run avoided costs. Different methodologies have been proposed by the Commission staff, the utilities, and the QF industry. Hearings on these proposals were concluded in August, and the issues are now being studied. The Commission may decide on a methodology by the end of the year; hearings would then be held in 1985 on the proper calculation of prices using the adopted methodology.

In its implementation of PURPA, California has worked toward developing a regulated marketplace that uses a single methodology to value both increments in the supply of electricity and reductions in demand from conservation and load management. The Commission, through the OIR-2 proceeding, sets the prices for energy and capacity in this marketplace. These prices are the bases not only for payments to independent power producers, but also for cost-effectiveness evaluations of a utility's own generation projects, off-system purchases, and conservation programs. Over 1,000 megawatts of independent power production have come on line in California in the last four years, clearly showing that QF's under PURPA can provide price-sensitive, short lead-time increments in generating capacity.

Many observers feel that the tough problems facing California's electric supply planners over the rest of the 1980's are likely not to be of shortage, but rather of excess capacity. At issue will be what portion of California's incremental power supplies will come from in-state alternative resources, what remaining portion will be imported over new or existing transmission lines from the Pacific Northwest or Southwest, and the extent to which these new resources will displace California's still significant reliance on oil and gas for electrical generation.

During the ten years from 1984 to 1993, Southern California Edison plans to add 2190 megawatts of "alternative/renewable resources." As of January 1, 1984, about 1230 megawatts of these resources - 56 percent - were in operation on a demonstration basis, under construction, or committed under a power purchase contract.

Similar figures for Pacific Gas and Electric Company (PG&E) show 1725 megawatts of committed projects late in 1983, representing about 64 percent of PG&E's planned additions of alternative resources over the next ten years. Both utilities appear to have more than enough projects committed or under active discussion

to meet their alternative resource goals for the next ten years.

There may also be a long-term firm surplus for as much as 2000 average megawatts available in the Pacific Northwest for sale to California utilities. Purchase by California of any appreciable portion of this surplus would probably require the addition of a third 500 kV AC transmission line to the Pacific Intertie linking the two regions. Such a project could add 1000 megawatts to the capacity of the Intertie, and proponents argue that it could be completed by 1990.

California's long-run avoided costs are a crucial economic issue in the current discussions over the expansion of the Pacific Intertie and the sale to California utilities of the Northwest's firm surplus power. In recent months, the federal government has become a much more active player in this area. In July 1984, Congress authorized the Secretary of Energy to participate in the construction of whatever additional transmission facilities he deems necessary to permit mutually beneficial power sales between the Northwest and California.

The Department of Energy (DOE) has been the catalyst for recent meetings among interested parties. The DOE intends to issue a conceptual plan for construction of a third 500 kV AC line in November 1984. PG&E has indicated that it will seek a share in the ownership of the third AC line. Edison is discussing with the Bonneville Power Administration (BPA) an increase in Edison's existing 550 MW capacity purchase; this increase is contingent upon the planned upgrade of the DC intertie.

The discussions of an expanded Intertie have occurred in the context of other major issues outstanding between the two regions. In past years, California utilities have received important benefits from purchases of nonfirm energy that has exceeded the Northwest's needs in average or wet years. Our Commission and the California utilities have been active before the Federal Energy Regulatory Commission (FERC) in challenging the reasonableness of the nonfirm rates charged by BPA in recent years. The Commission has expressed concern that BPA's new Intertie Access Policy, intended in part to facilitate new firm power transactions, will also restrict competition among Northwest utilities for nonfirm sales to California, thus raising the price. The policy has already prevented economical purchases from Canadian hydroelectric projects, which could have been wheeled through BPA. The controversy over the Intertie Access Policy illustrates the unavoidable connection between firm and nonfirm purchases from the Northwest. We are going to have to consider firm contracts, nonfirm pricing, and access policies together in evaluating the costs and benefits of expanding the intertie with the Northwest.

Considerations other than price may also influence the ultimate amounts of QF generation or purchased power bought by the utilities. Recently, considerable attention has been focused on transmission constraints, which may impact both QF development and out-of-state purchases. Since October 1982, PG&E has been uprating the AC Pacific Intertie from 2800 to 3200 megawatts, and perhaps ultimately to 4000 megawatts. Originally scheduled to be implemented last summer, the uprate to 3200 megawatts has been delayed due to stability problems, which may occur in Southern California when large amounts of power are being simultaneously imported from both the Northwest and Southwest. The uprate to 4000 megawatts may not be feasible due to the simultaneous transfer problem.

Those of you in the audience who are involved in geothermal development are probably aware of the transmission constraints on QF development that PG&E maintains now exist over

most of Northern California. This problem is undoubtedly one of the "growing pains" of QF generation. The existing transmission systems were not designed for a dispersed system of a large number of small QF generators. The problem is compounded by the remote locations of many of the state's alternative resources. Last spring, the Commission began an investigation to explore first, the specific PG&E problem, and second, generic issues related to QF access to transmission capacity over the longer term. In August, the Commission approved a stipulation among the parties to the investigation, which put in place an interim solution to the transmission constraint in PG&E's territory.

According to the stipulation, QF's in the affected area will be assessed a maximum of 1.7 mills per kilowatthour for power sold to PG&E, up to an operating level equal to a 60 percent capacity factor. In return, PG&E will agree to begin the line upgrades and operational changes necessary to accommodate an additional 990 megawatts of QF's in the northern portion of its service territory. 1.2 of the 1.7 mills per kilowatt-hour assessment is refundable, depending on the Commission's ultimate decision on QF cost responsibility for transmission improvements. All other utilities responding to the investigation have reported only scattered areas in which transmission limitations may occur due to foreseeable QF development.

The debate about potential transmission limitations on QF development is another indication that we may begin to see some constraints on the ability of California's utilities to accept QF power. With stable oil prices, abundant gas supplies, moderate demand growth, and large amounts of excess capacity in adjoining regions, it appears increasingly likely that we will see economic pressures that may limit the growth of QF generation. The regulated market for incremental generation created by PURPA responded strongly to the conditions prevailing 5 years ago: skyrocketing oil prices, insecure oil supplies, threat of gas shortages, and a perceived need for substantial increases in generating capacity.

Today, the conditions are different. California is fortunate to have largely escaped the overly ambitious baseload construction programs that in many regions are a legacy of the 1970's. We now have to be aware of the interplay between alternative resources and interregional power transfers in assessing California's energy future. Both sources of power are key elements of our resource planning as we develop new energy sources for California in this era, perhaps a brief one, of excess capacity.

Utah

Cove Fort Development

The City of Provo, Utah, is working to establish an agreement with Utah Power and Light Company so that geothermally produced electricity will be wheeled to Provo from two dry-steam wells 130 miles south of Cove Fort, Utah.

The two wells are part of a geothermal area under development by Mother Earth Industries. The steam is high quality, and additional wells are planned. Power output from the area could reach 200 megawatts.

According to the Geothermal Resources Council Bulletin, the initial purchase of 2.8 megawatts of electricity will cost Provo citizens about $.06 per kilowatt hour. The price is higher

than Provo's average power cost, but the city is willing to pay the premium to facilitate Cove Fort geothermal development.

Roosevelt Hot Springs

A 20 megawatt power plant, owned by Utah Power and Light Company, began operations at Roosevelt Hot Springs on July 31, 1984. The $35 million facility, 12 miles east of Milford, Utah, is the first unit going into production in the geothermal field, and the first geothermal power plant to operate in Utah. The field may be capable of producing from 200 to 400 megawatts of electricity over a 4-year period.

Plant design and construction is by Gibbs and Hill of San Jose, California. The turbine-generator unit was purchased from General Electric.

Cerro Prieto

Status of the Cerro Prieto Project

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Excerpted from the U.S. Dept. of Energy program review held at El Centro, California in 1984.

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As part of its program in geothermal energy funded by the U.S. Dept. of Energy/Geothermal and Hydropower Technologies Division under the Reservoir Definition Program, Lawrence Berkeley Laboratory (LBL) has continued to carry out studies of the Cerro Prieto geothermal system and has kept abreast of the latest developments at the field (Fig. 1). The FY1984 effort has been significantly smaller than in previous years because of the lack of a formal agreement for continued technical cooperation between DOE and the Comisión Federal de Electricidad of Mexico (CFE), operator and manager of the Cerro Prieto field. The earlier agreement (Witherspoon et al., 1978) expired in July 1982;

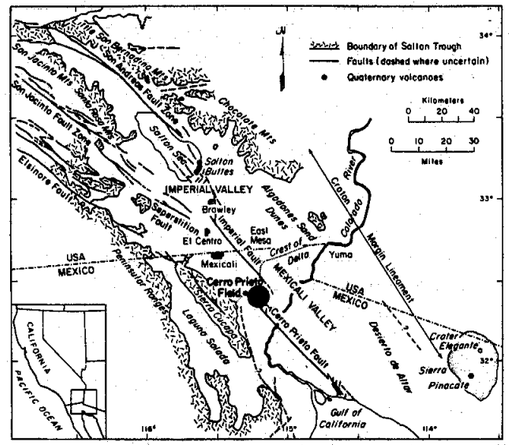


Figure 1. Regional geology of the Salton Trough and location of the Cerro Prieto field.

a new 3-year agreement is expected to be signed before the end of 1984.

Recent LBL studies on Cerro Prieto have been restricted mainly to analyzing field data gathered earlier and to updating the models of this geothermal field on the basis of new well data and studies performed by CFE.

Recent Field Activities

In September 1984, one of the two 110-MWe turbogenerators of power plant CPII was placed in operation, increasing the installed generating

Power plant control panels, Cerro Prieto Power Plant Unit 2, October 1984. Photos by Susan F. Hodgson.

capacity at Cerro Prieto to 290 MWe. The second 110-MWe unit of CPII is planned to be added to the system in December 1984. The construction of power plant CPIII continued; it should be operational in mid-1985, bringing the total installed capacity at the field to 620 MWe.

The drilling activity at Cerro Prieto continued at full pace. New production wells were drilled to replace older ones and to supply steam to the new power plants. Deep exploration wells were drilled to outline the boundaries of the thermal anomaly and to locate more precisely the hot fluid recharge area. Between April 1983 and September 1984, 16 wells were completed (Fig. 2, Table 1).

The wells of the E-series in the western part of the field tap the lower reservoir in that area, replacing or supplementing the fluid output of older, shallower wells.

The 200-series wells drilled in the eastern part of the system are exploratory. Well M-203 is presently the deepest at Cerro Prieto, with a total depth of 3995 m. Data from these wells were used to make a map showing the depth to the 300°C isotherm. Some of the deep eastern wells were drilled under very dif-

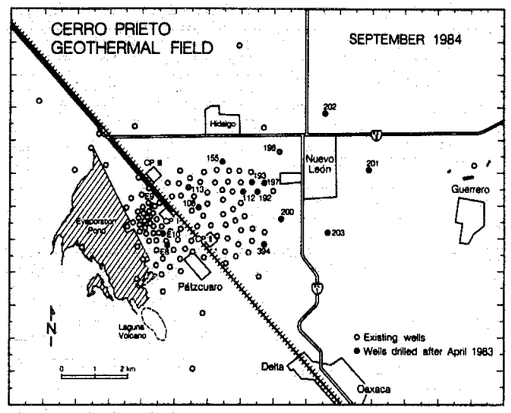


Figure 2. Location of wells drilled between April 1983 and September 1984 (from Mañón, 1984).

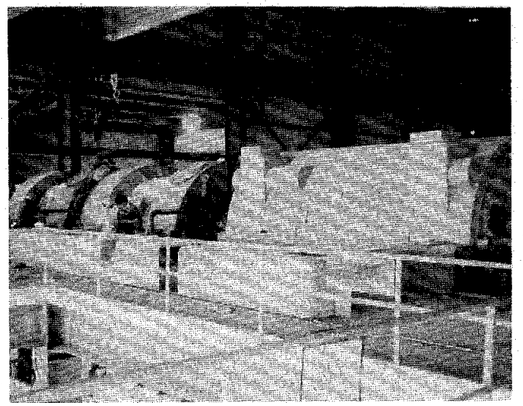
Table 1. Wells completed at Cerro Prieto between April 1983 and September 1984.

Well	Total Depth (m)	Open Intervals (m)
E-8	1796	1513-1794
E-9	1714	1479-1702
E-10	1814	1515-1807
M-108	2211	1896-2211
M-112	3622	2409-2801 & 3370-3622
M-113	2041	1771-2040
M-155	2526	2358-2525
M-192	2906	2596-2906
M-193	2226	1924-2226
M-197	2790	2578-2786
M-198	2797	2494-2622
M-200	2841	2482-2834
M-201	3610	OBSTRUCTED
M-202	3987	3712-3987
M-203	3995	3537-3993
T-394	3019	2684-3013

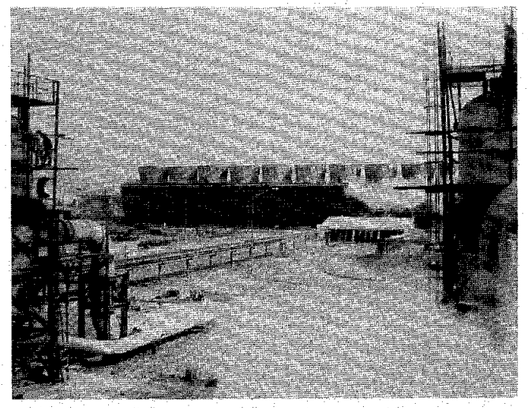
Note: Data from F. J. Bermejo and C. A. Esquer, personal communications, 1984.

ficult conditions. One example is well M-112, which encountered temperatures above 300°C from about 2000 m to its deepest point (3622 m) and met with numerous lost-circulation zones (Mañón, 1984).

The rate of fluid production and the average enthalpy of the produced fluid have remained relatively con-



Turbines inside Cerro Prieto Power Plant Unit 2. Electricity generated by the 220 megawatt plant will be purchased by San Diego Gas and Electric Company (150 MWe) and Southern California Edison (70 MWe).



View of the cooling towers from Cerro Prieto Power Plant Unit 2.

stant since late 1982, varying between 4300 and 4700 tonnes/hour and between 1410 and 1450 kJ/kg, respectively. The rate of fluid production has increased since September 1984, when one of the new turbogenerators in power plant CPII came on line. Table 2 shows the total annual steam-brine production and electrical generation at Cerro Prieto since power production began in 1973.

Table 2. Annual output at Cerro Prieto Geothermal field.

Year	Steam-brine mixture production (tonnes x 10^6)	Electrical generation (GWh)	Specific fluid consumption (tonnes/MWh)
1973	10.2	193	52.8
1974	18.7	463	40.4
1975	19.1	518	36.9
1976	22.1	579	38.2
1977	23.8	592	40.2
1978	22.0	598	36.8
1979	38.2	953	40.1
1980	33.1	915	36.2
1981	33.0	954	34.6
1982	38.7	1263	30.6
1983	39.5	1220	32.4
	298.4	8248	

Note: Data from Mañón (1984).

In response to fluid extraction (with no brine reinjection), the pressure in the shallow western reservoir has been gradually dropping. This is indicated by changes in the water level in well M-6 west of the production region.

Apart from activities related to electrical power production, CFE has recently begun at Cerro Prieto a number of demonstration projects related to the direct use of geothermal fluids (Mañón, 1984). The projects include fish farming, greenhouse agriculture, absorption refrigeration, and mineral extraction.

CFE recently granted a license to a private company to utilize the geothermal waste heat for food production and industrial use. The Baja California State government and a private concern are working on an agreement to establish farms and industries that require low-cost process heat. A plant for extracting 100,000 tonnes/year of potassium chloride from the separated brines is being

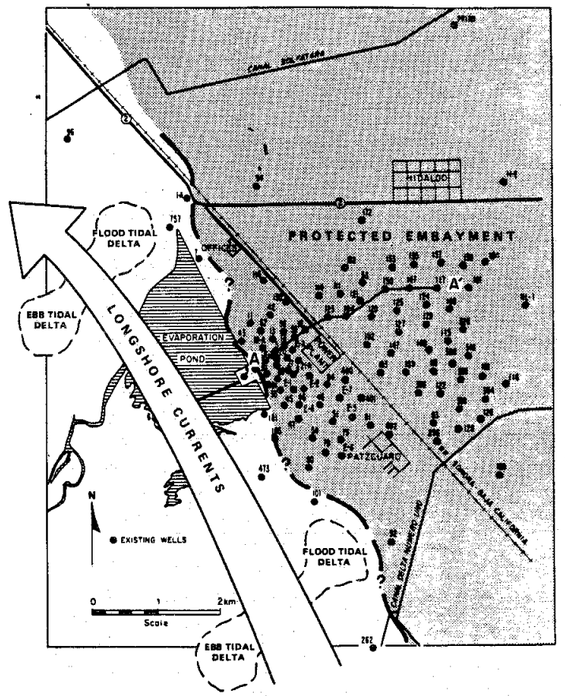


Figure 3. Schematic paleoenvironmental map of the deeper part of the Cerro Prieto section (from Halfman et al., 1984b).

built west of the Cerro Prieto field. Construction of the evaporation ponds for this plant is nearly complete (Mañón, 1984).

Recent Studies

Over the past 7 years, great advances have been made toward understanding the Cerro Prieto system, both in its natural state and under exploitation. A large body of information is included in the numerous reports and papers published since 1977. Most of these are included in the proceedings of the four symposia held on Cerro Prieto (LBL, 1978 and 1981; CFE, 1979 and 1982), and many have recently been summarized in three review papers (Lippmann, 1983; Lippmann et al., 1984; Mañón, 1984). Discussions of some later studies that were not included in these publications follow.

Work has continued on updating the hydrogeologic model for Cerro Prieto developed by Halfman et al. (1984a). Data obtained from recently completed wells confirm the soundness of that model. The depositional environments of the various sedimentary units found at the reservoir level were derived from the study of dipmeter logs. They were shown to correspond to a coastal system (Halfman et al., 1984b). Along a west-to-east line, one would find, in succession, longshore current, shoreline, and protected embayment deposits (Fig. 3). By establishing the characteristics of the coastal depositional environment of the sedimentary rocks forming the Cerro Prieto geothermal reservoir and its caprock, it was simple to explain the change in lithology and disappearance of different units. The new analysis should be useful for locating and designing the completion of new wells in the field.

The results of an extensive geologic study were reported by Cobo et al. (1984). On the basis of cuttings, cores, and wireline log data, they developed a geologic model of the Cerro Prieto field. Their model suggests that a major fracture and a set of radial faults might be the main conductors of geothermal fluids in the system. Some features of this model disagree with those developed by Halfman et al. Efforts will be made to integrate features of both into a single hydrogeologic model of the field.

On the basis of whole rock analyses, Reed (1984), suggests that the Cerro Prieto volcano is derived from the partial melting of granitic basement rocks and not from differentiation of gabbroic intrusions. The small magma chamber associated with the volcano had insufficient volume to retain the heat to drive the present hydrothermal system. Reed contends that the volcanism and the current hydrothermal activity are both the result of heat transferred to the crust by gabbroic intrusions.

On the basis of geochemical and reservoir engineering, Truesdell et al. (1984) conclude that the localized boiling occurring in the shallow western Cerro Prieto reservoir has produced excess steam and increased the enthalpy of the produced fluids. This boiling also caused mineral deposition around the wells, thereby decreasing the permeability and the fluid flow. In the shallow western reservoir, the inflow of colder waters has limited the extent of aquifer boiling and permeability loss. However, according to these authors, such recharge might not occur in the deeper reservoir at Cerro Prieto, and injection of waste brine might be required to decrease boiling and prevent loss of production due to mineral precipitation.

Wilt et al. (1984) continued their analysis of dipole-dipole resistivity data. The trend of increasing apparent resistivity associated with the shallow reservoir in the western part of Cerro Prieto was reversed in the period between fall 1981 and spring 1983. This change is interpreted to be caused by the collapse of boiling zones around the production wells due to a progressive cooling of the reservoir by the influx of cold recharge waters. On the other hand, in the eastern part of the field, the decrease in resistivity intensified, possibly as a result of the continuing influx of hotter, saline waters from depths greater than 3 km.

The analysis by Grannell et al. (1984) of gravity and leveling data obtained since 1978 at Cerro Prieto indicates that subsidence persists, possibly as a result of fluid production and partial recharge. Modeling of the gravity changes indicates a probable density increase, perhaps due to compaction within the reservoir.

Extensive reprocessing of the Cerro Prieto seismic reflection data (Blakeslee, 1984) has shown that the production region coincides with a zone of reflection attenuation and that a region of high-velocity events rimmed that zone. Blakeslee suggests that this concurrency may prove to be a valuable discriminant for locating geothermal reservoirs using seismic reflection.

Other recent papers have analyzed or summarized some of the reservoir engineering data collected on Cerro Prieto. A method to compute the bottom-hole enthalpy in a well and its change with wellhead conditions has been developed by Hiriart and Sánchez (1984) and applied to Cerro Prieto well M-147. Iglesias et al. (1983) have described a method for using productivity curves to determine the reservoir pressure, mass productivity index, thermal power productivity index, and radius of influence of liquid-fed geothermal wells. They applied their method to a number of Cerro Prieto wells. The petrophysical properties of Cerro Prieto reservoir sandstones were discussed by Contreras et al. (1984) and summarized in a review paper.

The results of numerical modeling studies of the field (Ayuso et al., 1984) suggest that the planned 620-MWe generating capacity could be maintained through the year 1998. These studies are still in progress.

Final Remarks

The joint U.S.-Mexican studies on Cerro Prieto (and Los Azufres) are expected to intensify once the new DOE/CFE agreement on geothermal energy is signed. This agreement includes cooperative activities in Geology and Hydrogeology, Geophysics, Geochemistry, Reservoir Engineering, Reinjection, Subsidence and Induced Seismicity, Geochemical Engineering and Materials, Energy Conversion Technology, and Information Exchange. Soon we hope to be able to report on the new results obtained under this international cooperative effort.

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Japan

Japanese Hot Spring

This hot spring, "Big Hell," is in Fuji-Hakone-Izu National Park, Southwest of Tokyo, Japan. A small building and people are at the base of the steam. The hot spring is at Owokudani in the center of the Hakone volcanic range. The thermal waters have a temperature range of 10°C to 20°C. Sulfurous gas rises from the vents. Photo by Mary C. Woods.

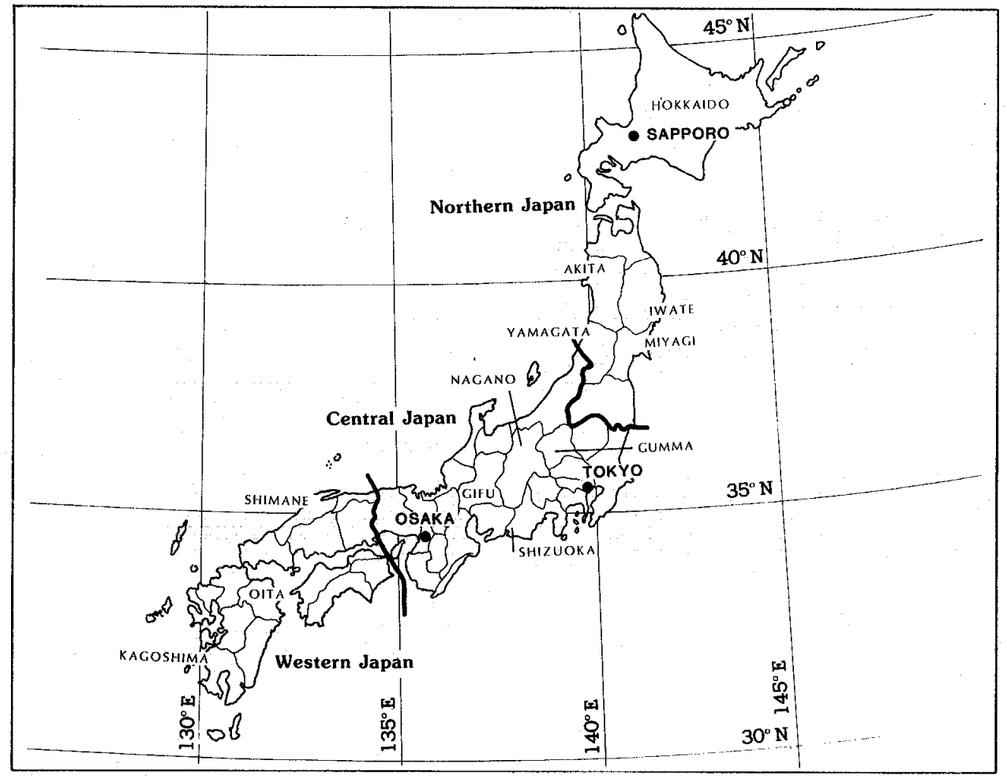
Direct-Use Geothermal Projects in Japan, 1984

by Dr. Mitsuru Sekioka
Professor of Geoscience
Institute of Geosciences and Astronomy
The National Defense Academy
Hashirimizu, Yokosuka
Kanagawa 239, Japan

Dr. Sekioka.

Dr. Sekioka arranged material in this article in a poster display that won first place at the Geothermal Resources Council 1984 Annual Meeting.

He has kindly allowed the Geothermal Hot Line to publish information from the display.

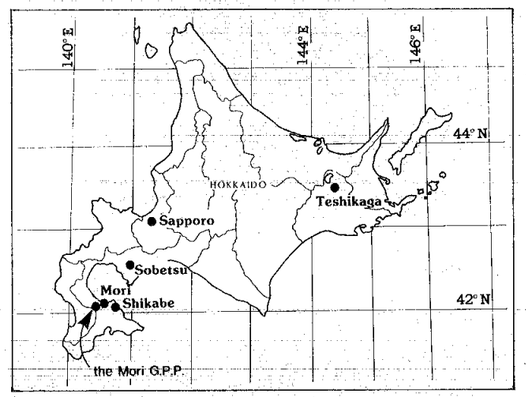


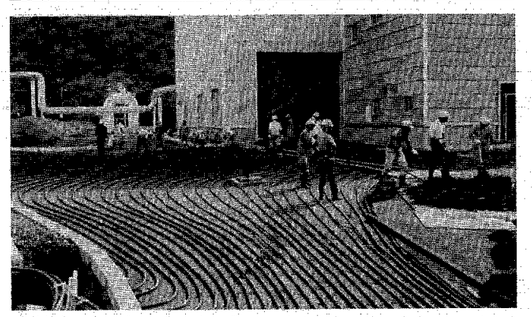
Japan. Data on named prefectures are included in the article.

	Northern Japan	Central Japan	Western Japan	Total
Fish breeding	10	7	21	38
Horticulture	6	1.5	4.5	12
Space heating and/or hot domestic water supply	1	4	*	5
Snow melting	0.75	0.75		1.5
Process heating	1		*	1
Leisure facilities	*	0.5	*	0.5
Stock breeding			*	0
Total	18.75	13.75	25.5	58MWt

* less than 0.1 MWt or uncertainty

A tentative estimate of direct-use geothermal energy in Japan--annual mean value.

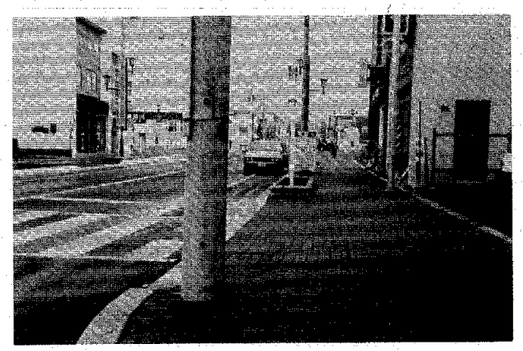




Hokkaido Prefecture. A horticultural project in Mori includes 255 greenhouses, 59,460m^2, 45~60^{o}C. Another Mori project has 33 greenhouses, 16,530m^2, 85^{o}C, 205 t/hr. of fresh water heat-exchanged with geothermal water from the Mori G.P.P. (50 MW). A snow-melting project (see photo) in Mori is undertaken on a 450m road with 50^{o}C condensed water from the Mori G.P.P.*

In Shikabe, there are 23 eel-breeding ponds with 75^{o}C water.

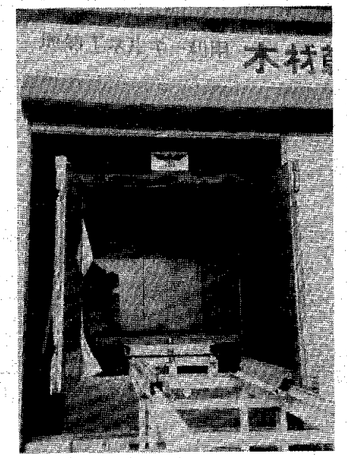
** G.P.P. stands for geothermal power plant throughout the article.*



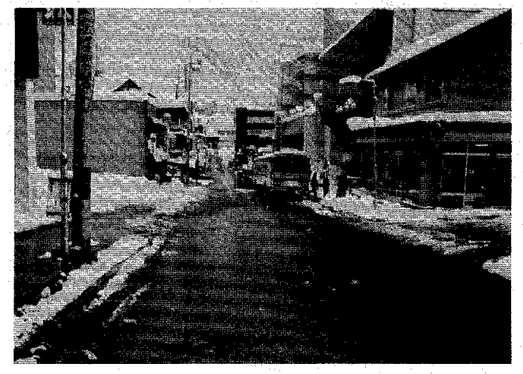
Teshikaga, in Hokkaido Prefecture, has several direct-use projects. Step 1 of a cascading loop consists of district heating, 85^{o}C, 135 t/hr. (5 local government buildings (7343m^2) and 8 welfare and commercial buildings).

Step 2 consists of 60^{o}C, 14.4 t/hr. water for heating downtown stores and 60^{o}C, 56.4 t/hr. water for bathing. Step 3 is snow-melting, 40^{o}C, 14 t/hr., on a 118m road with embedded pipes.

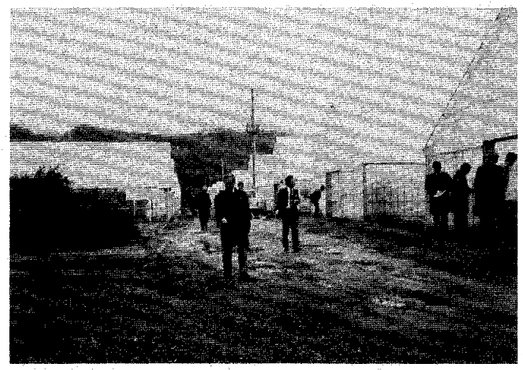
The photo is of downtown stores and part of the 118m roadway.



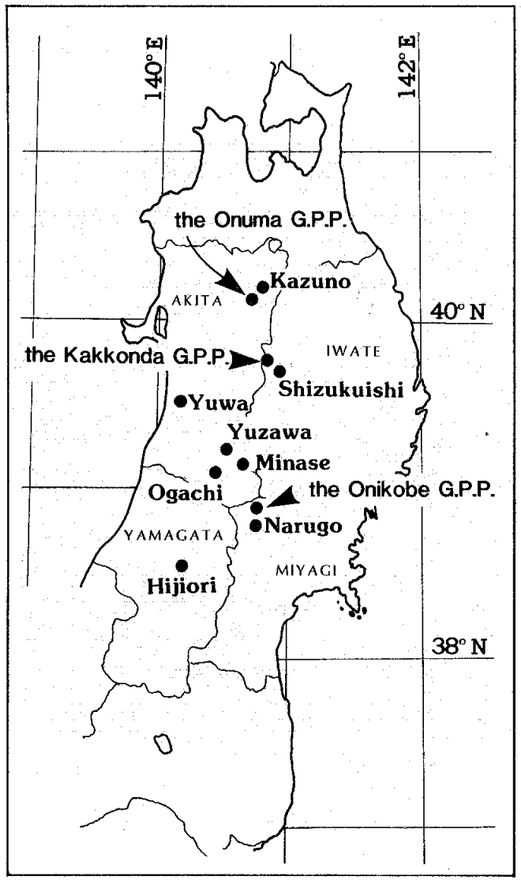
Hokkaido Prefecture. Timber drying, 16.2m^3/mon., in Teshikaga; 84^{o}C, 15 t/hr.



Hokkaido Prefecture. Snow melting in Sapporo. 83^{o}C, 30.6 t/hr., 1653m of roadway with embedded pipes.

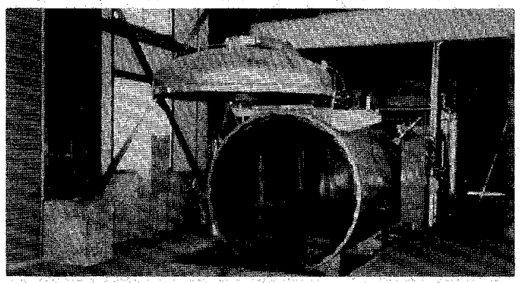


Hokkaido Prefecture. Horticultural projects in Sobetsu. 65^{o}C, 74.4 t/hr., 33 greenhouses (17,518m^2). Produce includes cucumbers, tomatoes, and greens.

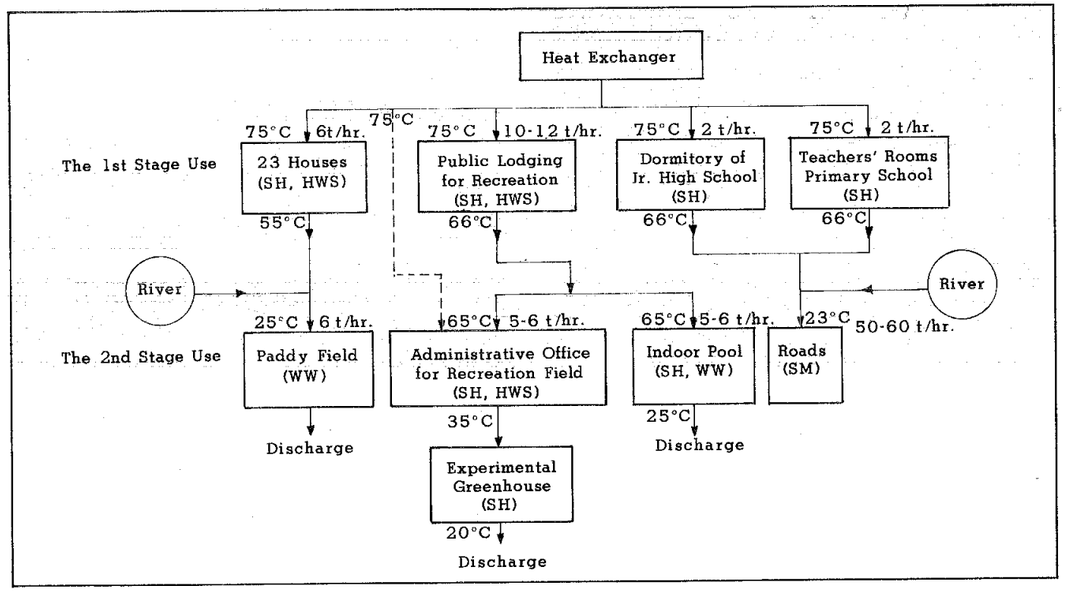


Akita Prefecture. In Yuwa, a National Project was started in FY 1980. Pumping and injection tests are underway. Horticultural uses are expected.

In Kazuno, a National Project is underway, started in FY 1980. Fresh-heated water, 70^{o}C, 150 t/hr., is heat exchanged with geothermal water from the Onuma G.P.P. (10 MW). The following projects are planned: district heating, domestic hot-water supply, horticultural, and fish breeding.



A cascading loop at Yuzawa, Akita Prefecture, includes: Step 1 (see photo) timber drying (13,000m^3/y of cedar) with 2 t/hr. of 120^{o}C water heated by bark boiler from 75^{o}C; and, Step 2, fish breeding in 18 breeding ponds, 1657.8m^3. Tilapia, a freshwater fish, are raised.

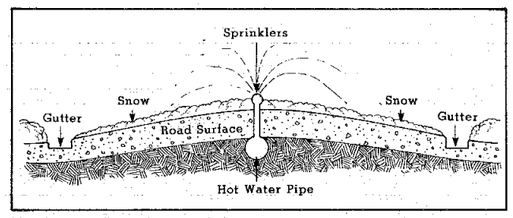


The consecutive multi-stage utilization system in Ogachi, Akita Pref., SH: Space heating, HWS: hot water supply, SM: snow-melting, and WW: water warming.

Cascading loop, Ogachi, Akita Prefecture. Note differences of rice growth in the two photos. Photo left is the control field. Photo right is the warmed field.

Horticultural project at Minase, Akita Prefecture. 95°C, 14 t/hr., 7 greenhouses (1676m²) at the Prefectural Geothermal Research Center.

Other projects at Minase involve domestic hot water supply, agricultural produce drying operations (93°C, 14 t/hr.), and bean sprout culture.

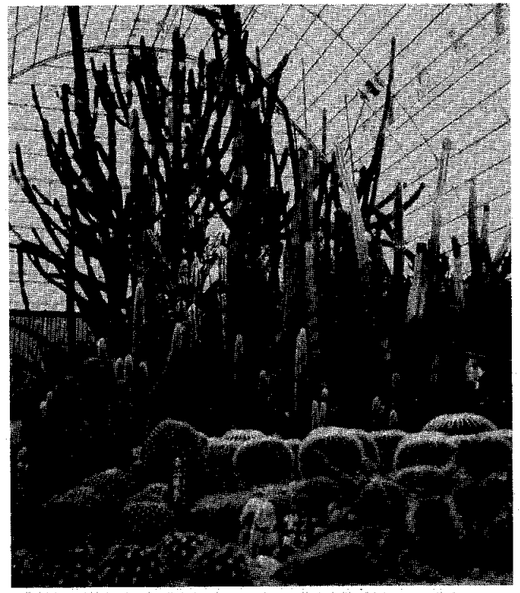


In the Prefecture of Iwate, the Shizukuishi National Project was started in FY 1980.

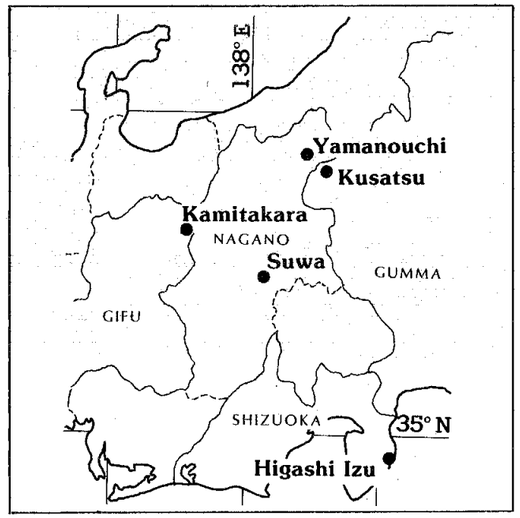
Fresh-heated water, 115°C, 800 t/hr., was heat exchanged with geothermal water from the Kakkonda G.P.P. (50 MW). Proposed projects include district heating, horticulture, food processing, and fish breeding.

At Hijiori in Yamagata Prefecture, there is a snow-melting (sprinkling) project for a 333m road and 2000m² parking zone.

The diagram is of the Hijiori snow-melting, sprinkling system.



In the Prefecture of Miyagi, at Narugo, leisure facilities (98°C, 24 t/hr.) include three greenhouses and 3630m² of tropical botanic gardens.



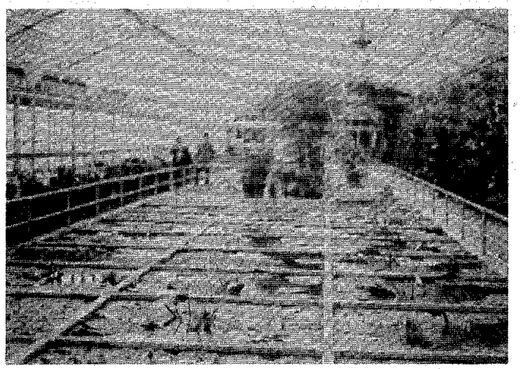
In the Prefecture of Gumma, at Kusatsu, there is a project providing domestic hot water, 54°C, 46 t/hr., for 935 residences, 132 hotels and inns, and 78 condominiums.

Also a snow-melting project uses 38°C water, 18 t/hr., for a total of 1501m of roadway with embedded pipes.

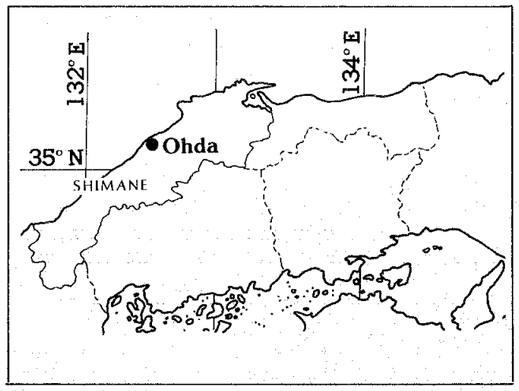
In the Prefecture of Nagano, in Yamanouchi, there is a snow-melting project with 2-row pipes for 3050m of roadway.

In Suwa, space-heating projects at 65°C exist for a 10,000m² hospital and a 9000m² office building.

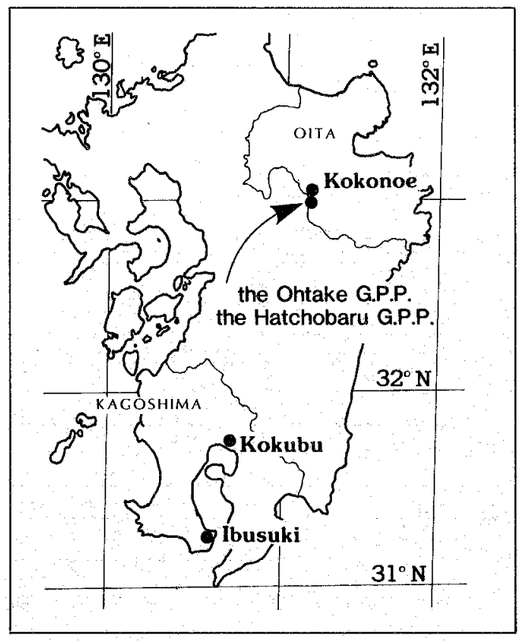
In the Prefecture of Gifu, at Kamitakara, there is a de-icing project (70°C, 15 t/hr.) with 2-row pipes on a 869m road.



In the Prefecture of Shizuoka in Higashi Izu, leisure facilities include an alligator farm and a tropical botanical garden. There are 13 greenhouses, 4000m^2, and 19 ponds. These contain 6,400 species of tropical plants and 450 crocodilians representing 27 species.

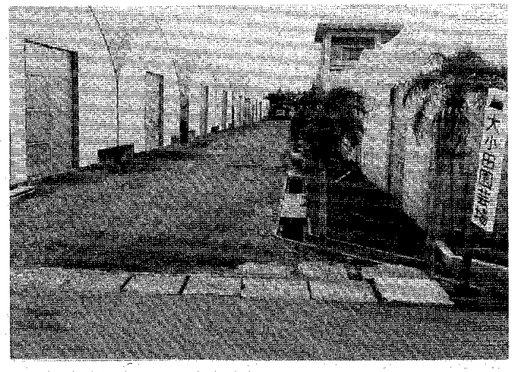


In the Prefecture of Shimane, at Ohda, there is a snow-melting project, 20°C, 2.5t/hr. for a 1215m roadway, with sprinkling.

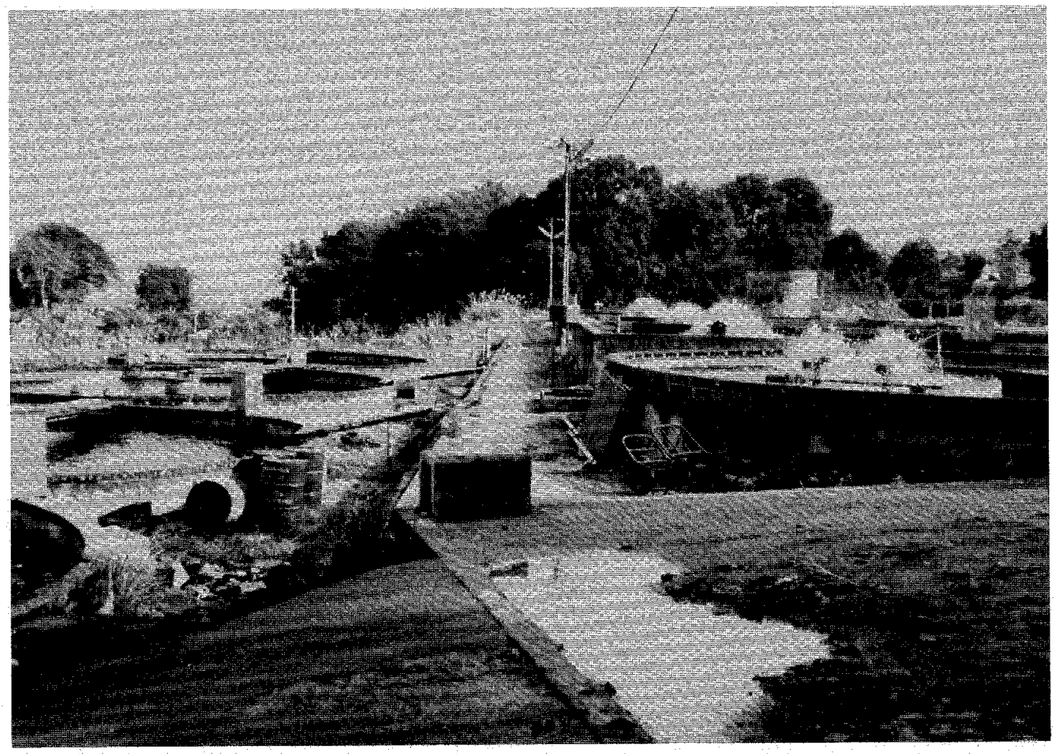


Prefecture of Oita, at Kokonoe. District-heating and domestic hot-water supply projects use fresh, heated water of 80°C, 170 t/hr. The water is heat-exchanged with geothermal water from the Ohtake (12 MW) and the Hatchobaru G.P.P. (55 MW), and heats 129 residences, 30 inns, and 2 greenhouses.

Prefecture of Kagoshima, at Kokubu, is the site of a brewing project for rice vinegar of 600 kl/y. The brewery is heated by geothermal water to keep the room temperature between 15°C and 25°C.



Prefecture of Kagoshima at Ibusuki. Tropical plants, vegetables, and fruits are grown in a horticultural project with 165,300m^2 of greenhouse space.



Prefecture of Kagoshima at Ibusuki. A fish-breeding project uses water from 24°C~30°C. The eel, carp, and tilapia breeding ponds cover a total area of 71,850m^2.

Sweden

Swedish Geothermal Development

Sweden's first production plant for geothermal energy is now being built at Lund, on the southern tip of the country, about 20 miles north of Malmö. The first geothermal production well in Sweden was drilled in the Lund area, at Flackarp. An injection well was drilled at Värpinge in the fall of 1983. The wells were connected by a 2.4 kilometer pipeline.

The Flackarp well is 764 meters deep and has a flow of 35 to 50 liters per second of 23°C geothermal water under normal conditions. The water is piped to Källby. There, it is cooled to about 10°C using heated waste water in a heat exchanger at the sewage treatment plant. The cooled water is piped to the 684-meter deep injection well in Värpinge.

Four wells, 700 meters deep, are slated to be drilled and completed west of Lund. These wells, together with a heat pump, will soon be part of the large district heating system. Each well will have a capacity of about 100 liters per second, corresponding to the heat used annually by 2,500 single-family homes.

The heat pump plant is next to the Lund district heating plant. With a flow of 200 liters of geothermal water a second and a temperature drop of about 17°C, the heat pump capacity is about 20 megawatts.

The geothermal water will be piped through more than 5 kilometers of pipeline. The 600mm pipes are made of fiberglass to withstand the high salt content of the geothermal water.

For further information, contact The Lund Energy Authority, Box 1726, S-221 01 Lund, Sweden.

Research

GARF Aquaculture Research

The Geothermal Aquaculture Research Foundation (GARF) was founded in 1979 as an educational extension service to help people establishing commercial geothermal aquaculture projects. The foundation studies geothermal water chemistry and the animals suitable for aquaculture. These include freshwater shrimp and other fish such as tilapia (see article on Japanese low-temperature geothermal development in this Hot Line issue).

A company called Idaho Fish Breeders in Buhl, Idaho, currently raises 300,000 lbs. of catfish a year and 150,000 lbs. of tilapia a year according to Tim Gunning, the foundation's Assistant Director.

Personnel of the Geothermal Aquaculture Research Foundation are good sources of suggestions for aquaculture projects. They will tell you about developers who stock ponds before determining the water chemistry, a practice which has proved fatal to thousands of fish. They can offer ideas for successful approaches to aquaculture.

Foundation membership is $75.00 a year for individuals and $200 a year for corporations. A monthly publication is distributed.

For further information, contact Leroy Headlee, Director, Geothermal Aquaculture Research Foundation, 1321 Warm Springs Avenue, Boise, Idaho 83712. (208) 344-6163.

Puna Geothermal Research Facility

(The following article was excerpted from an address by Dr. Patrick Takahashi at the Tenth Workshop on Geothermal Reservoir Engineering at Stanford University.)

Well HGP-A, drilled in 1976, was the first successful geothermal well in Hawaii. The well is on the southeastern slopes of Mauna Loa volcano, in the Kiluea East Rift Zone, Island of Hawaii. A 3.5 megawatt wellhead generator project was constructed at the well site.

Today, a research laboratory, called the Puna Geothermal Research Facility, is under construction adjacent to the well site. The laboratory will focus on geothermal applications research. Hopes are that geothermally-related high technology growth will develop at the site. The laboratory will be dedicated and ready for operation at the end of August 1985.

The Hawaii Natural Energy Center has set aside a pool of funds to support a research team at the laboratory. The team will work towards removing silica and H_2S from geothermal brines and utilizing these by-products to benefit local industry.

The laboratory will be used, as well, to support the Community Geothermal Technology Program. Under this program, University of Hawaii faculty will assist small businesses and individuals to bring their ideas to the market place. Grants up to $10,000 will be provided for each project.

The Pacific International Center for High Technology Research has selected geothermal applications as an area for emphasis. Taiwan and Japan have expressed interest in joining the center's activities.

A top researcher is being sought to head the Puna Geothermal Research Facility.

For further information, contact Dr. Patrick K. Takahashi, Director, Hawaii Natural Energy Institute, University of Hawaii, 2540 Dole Street, Honolulu, Hawaii 96822. (808) 948-8366.

Basic Geothermal Research and Technology Transfer
by Pat Collins
Under Secretary
U.S. Dept. of Energy

The following material was excerpted from a speech by Pat Collins, Under Secretary, U.S. Dept. of Energy. The speech was delivered in El Centro, California, in October 1984 at the groundbreaking ceremony of the Salton Sea Scientific Drilling Program. Among other topics, Mr. Collins discussed U.S. Department of Energy policies towards basic geothermal research and geothermal technology transfer.

• • •

In what ways can the Department of Energy make the biggest contribution to the development of renewable fuels? The Reagan administration believes a primary role for DOE is to conduct the basic and fundamental research which would be too risky and expensive for private industry to pursue. For it is through research that we will make the technological breakthroughs which will enable alternate sources of energy to be cost competitive.

I think that the projects that are going on here in the Imperial Valley exemplify the way a partnership between government and industry should work. The Imperial Valley is the richest known hydrothermal resource base in the U.S., and you have made it a showcase for hydrothermal technologies -- materials, components, monitoring systems, drilling techniques, and instrumentation.

As a vital part of DOE's energy research program, we are especially concerned that information about new and promising technologies .... and

proven technologies for that matter .... be widely disseminated to other researchers, to the business community, and to potential consumers or users of the technology. It makes sense for the Department of Energy to serve as the central point of contact for information exchange, and we have launched a comprehensive program to make sure that this happens.

We call our program "Technology Transfer 80's." This effort consists of three main elements:

First, DOE has assumed a major role in technology transfer to and among state and local governments and the private sector. This effort can take many forms, including workshops, publications, one-on-one discussions between DOE scientists and private entrepreneurs, and hands-on demonstrations at industrial sites.

Second, we have just completed this month a national awards program to recognize energy innovation and promote transfer of energy technology. One of the top award winners was Utah Power and Light Company. In a partnership with Phillips Petroleum, the company constructed a 1.6 MW geothermal generating unit. Its advanced rotary separator turbine produced 20 percent more electricity than a conventional turbine while using the same amount of geothermal fluid. The company also demonstrated the potential of significant energy savings over the long term as a result of additional use of this technology.

The third part of our technology transfer program is a search for innovation within the Department of Energy. To date, some 61 proposals have been submitted from our own staff members on how best to design and conduct effective technology transfer programs. We are already implementing a number of these.

Technology transfer, however, must not stop at our own national borders. Increasing renewable energy sources is especially important to the many developing nations for whom dependence on imported oil is a crippling expense. For some of these countries, renewable energy may already be cost competitive with fossil fuels. These countries also can provide valuable markets for the American renewable industry.

I am sure that you are all familiar with the Renewable Energy Industry Development Act, signed by President Reagan this year, to provide government assistance to industry efforts to bring renewable technology to the export marketplace. You in the geothermal industry have been leading the way. Our geothermal market now extends worldwide as a result of your efforts in spreading geothermal technology, service, and know-how.

• • •

Department of Energy Fiscal Year 1985 Budget--Geothermal Reservoir Definition, Brine Injection, Stimulation

Reservoir Technology:	
Lawrence Berkeley Laboratory:	
Program Guidance	$ 200K
Reservoir Analysis	$ 400K
Fracture Mapping	$ 150K
Vertical Seismic Profiling	$ 50K
Stanford:	
Workshop and Seminars	$ 42K
Adsorption of Water on Cores	$ 60K
Well-test Analysis and Experiments	$ 200K
Depletion Model	$ 100K
Oregon DOGAMI:	
Cascades Investigation	$ 160K
Idaho Operations Office DOE:	
Cost-shared Drilling	$1000K
Measurements in Holes	$ 375K
University of Utah Research Inst.:	
Geophysical Fracture Detection	$ 200K
U.S. Geological Survey:	
Seismic Techniques	$ 100K
Electrical Techniques	$ 50K
Geochemical Techniques	$ 20K
Gravimetry Support	$ 10K
Brine Injection:	
Lawrence Berkeley Laboratory:	
Analysis of Injection	$ 300K
Stanford:	
Injection of Tracers	$ 200K
Lawrence Livermore Laboratory:	
Seismic Monitoring	$ 100K
Idaho National Engineering Lab:	
Injection Models	$ 500K
University of Utah Research Inst.:	
Injection Backflow	$ 200K
Stimulation:	
Sandia National Laboratory:	
Permeability Enhancement	$ 650K

The DOE Hydrothermal Research Program

Reservoir definition, brine injection, and reservoir stimulation technologies are major elements of the U.S. Dept. of Energy (DOE) Hydrothermal Research Program. They account for nearly 50 percent of the 1985 fiscal year hydrothermal research budget.

The reservoir technology projects include:

1. development of methods for characterizing and mapping reservoir parameters, processes, and spatial dimensions.

2. development of methods to predict and monitor reservoir changes from fluid extraction.

3. evaluation of existing methods and development of new methods for predicting fault and fracture locations, and for mapping faults and fractures in geothermal reservoirs.

4. testing of new analysis techniques using field case studies.

Brine injection projects include:

1. development of physical and mathematical models to determine the behavior of geothermal reservoirs during injection.

2. tracer testing to determine rapid flow paths between wells.

3. analysis of pressure responses in the field to injection into one or more wells.

Some of the work is carried out under cooperative research agreements with foreign institutions. These joint projects include work with ENEL of Italy on the adsorption of water on core samples from Larderello; the development and testing of down-hole fluid samplers; and injection testing in the Latera field.

Cooperative work with New Zealand includes interpretation of well tests in Broadlands, and injection and tracer testing at Broadlands, Wairakei, and Kawerau. Work in Mexico at the Los Azufres field focuses on reservoir behavior, well test analysis, injection and tracer testing, and wellbore deliverability.

Studies are being undertaken to improve understanding of reservoir production phenomena in order to develop the capability of tailoring stimulation techniques and methods to specific reservoir types. Research into borehole and formation interaction will include fracture permeability studies and fracture characterization. Advanced stimulation methods will be addressed through systems analysis and experiments.

The DOE is planning to begin cooperative drilling in the Cascades Range to assess new approaches in exploration technology. Proposals are being requested to drill thermal gradient test holes to depths of 3,000 ft. or greater. Projects will be cost-shared with industry on a 50-50 basis. Through analysis of well logs, rock samples, and fluid specimens from these holes, the DOE hopes to determine the effectiveness of this exploration technology in characterizing the geothermal resources in the Cascades.

The DOE also is co-sponsoring investigations by the Oregon Department of Geology and Mineral Industries to

identify other exploration technologies that are successful in the Cascades.

In related research, the U.S. Geological Survey (USGS) has a major investigation underway to assess the geothermal resource potential of the Cascades. The DOE is sharing the cost of two projects initiated by the USGS that will evaluate the usefulness of certain seismic and electrical exploration techniques in volcanic regions.

The DOE is approaching the drilling phase in the Salton Sea Scientific Drilling Program. This deep drilling program will test the existence of additional geothermal resources beneath the presently discovered hydrothermal reservoir in the Salton Sea area. Bechtel National Inc., the prime contractor for the project, has subcontracted several elements, including well design and geothermal tests and measurements. Additional subcontracting is in progress. Drilling is expected to begin sometime in April and terminate about four months later. An injection well will be drilled consecutively.

The well is scheduled to be cored intermittently at five sections through the first 4,000 feet. The well will be logged prior to casing. Two short-term flow tests may be performed at selected fracture zones. Two long-term (30-day) flow tests are scheduled when the well is completed to a total depth of about 10,000 feet. The well will be available for scientific experimentation for about 1 year.

A significant event in 1984 was the establishment of an industry peer review group of reservoir engineers and geologists. The group will hold periodic discussions with the Lawrence Berkeley Laboratory (LBL) on directions for DOE-sponsored research in understanding geothermal reservoirs. Only minor redirection will be possible for DOE projects this year. Some significant changes can be expected for the future.

Industry Advisory Panel Meets

The first meeting of the Industry Advisory Panel on Geothermal Reservoir Definition was held in August 1984 at Lawrence Berkeley Laboratory. The purpose of the meeting was to determine research needs of the geothermal industry and reveiw the ability of U.S. Dept. of Energy-funded projects to meet these needs.

Among the panel's recommendations were continuing the Dept. of Energy Hydrothermal Research Program, which is felt to be relevant to industry needs; requesting DOE budget details for 1985 and 1986; and requesting periodical statements from the DOE about its geothermal program. The panel feels these program descriptions should be widely disseminated through publication in geothermal journals. The second panel meeting is scheduled for February 1985.

Technology

Lost Circulation Plugging Model

A viscometric flow model has been developed by Sandia National Laboratories to simulate the fluid dynamics in the region of an isolated crack. The precise geometry consists of a vertical annulus concentrically intersecting a thin, horizontally-oriented, disk-shaped fracture. A Bingham fluid is forced to flow in the annulus due to an axial pressure gradient. The nature of the radial flow in the crack has been investigated.

Analysis shows that for this geometry, there are cases in which the radial velocities are zero, i.e. the crack seals. The existence of such cases is, however, limited to fluids with a high yield stress, cracks of thin width, and small differences between downhole annular fluid pressures and surrounding formation pressures. These findings suggest that a limited class of fractures may be plugged due to the finite yield stress of the fluid. Work is in progress to understand the effects of adding particulate material to the drilling fluid as a means of plugging larger fractures. For further information, contact B. Caskey, (505) 844-8835, or R. C. Givler, (505) 846-6413.

Radar Fracture Mapping

Southwest Research Institute is supporting Sandia National Laboratories in developing a borehole radar system for detecting geothermal fractures located away from the borehole. The system is based on a VHF borehole directional antenna design by Sandia. Concurrent with the overall design work, the initial phase of the development also includes construction of an outdoor antenna development facility. Here, directional antennas will be designed and tested.

Design of the directional antennas, transmitter, receiver, downhole and uphole sections of the control system, and the data control communication subsystem, is underway. Construction and testing of the breadboard circuits for the transmitter, receiver, and control circuitry are also in progress. The electrical design of the system and construction of the antenna development facility are progressing. Mechanical design work is expected to start by the end of FY 1984. For further information, contact H. Chang, (505) 844-7488.

Finance

CEC Geothermal Grant Program

The California Energy Commission's Geothermal Grant Program for Local Governments provides for the distribution of funds received by the state from geothermal leases on federal lands. These funds are made available as grants to local jurisdictions for geothermal planning, development, and mitigation activities. The CEC has approximately $1 million available for grants during the current funding cycle.

Grant proposals to plan for or assess potential problems related to the development of new geothermal resource areas, and grant proposals to mitigate impacts in areas of existing geothermal development are encouraged. In addition, joint projects by public and private entities and projects that provide a direct economic stimulus to a community are sought. A private entity may participate in the grant program if an eligible, local jurisdiction is either a partner in the project or a recipient of benefits resulting from the project.

Preliminary Applications Deadline	10/84
Results of Preliminary Application Evaluation	11/84
Final Applications Deadlines	01/85
Energy Commission Approval	03/85
Legislative Approval	07/85

Questions regarding the grant program should be directed to Michael Smith, at (916) 324-3502.

Two CEC Grant Projects

by Michael Smith
California Energy Commission

Fort Bidwell

In July 1984, the California Energy Commission (CEC) awarded the Fort Bidwell Indian Community (FBIC) a

grant of $19,800. The FBIC provided a match contribution of $12,430. The grant was awarded through the Geothermal Grant Program for Local Governments. The object of the grant was to explore for high-temperature geothermal resources capable of generating electricity.

The FBIC is a small community in the northern end of Surprise Valley in Modoc County. Area geothermal studies began in 1920, when a well drilled on the reservation yielded 113°F hot water.

In June 1980, the CEC provided contract funds to drill a low-temperature geothermal well on the reservation. The well, FB-1, was drilled to 500 feet and yielded an artesian flow of about 400 gallons per minute at 116°F. The hot water is presently used to heat the FBIC's administration offices, gymnasium, classrooms, clinic and an apartment building.

In December 1982, as the first step in a planned economic development program, the CEC awarded the FBIC its first geothermal grant to drill a second low-temperature well. The well was successfully drilled to 720 ft. and produced 94°F artesian water.

The purpose of the 1984 grant was to determine whether or not a high-temperature resource underlies the FBIC by drilling a well to 2,000 ft. To carry out this plan, well FB-2 was deepened to 1,300ft., where a stronger artesian flow of about 2,000 gpm of 97°F water was encountered. Well problems at this time made deeper drilling impossible.

Though the well's target depth was not achieved, well FB-2 is by far more productive than any other well in Surprise Valley. Presently, it is used in a pilot aquaculture project where 13,000 catfish are raised in two fiberglass raceways. The aquaculture project provides local employment opportunities for FBIC residents.

Anderson Springs

Anderson Springs is a small, residential community about 4 miles northwest of Middletown in Lake County. From 1920 to 1981, the community's domestic water was provided by a private water company. In 1981, the Anderson Springs Community Services District (ASCSD) purchased the private system, which had become inadequate to meet the community's domestic water needs. In addition, activities at four geothermal power plant sites in the Gunning Creek watershed led to deposition of sediments and other contaminants into Gunning Creek, adversely affecting Anderson Springs' domestic water supply.

In 1982, the CEC awarded the ASCSD two grants totaling $152,000. The money was granted to develop a new domestic water supply and to install a pipeline from the water supply to the community.

The ASCSD received an additional $323,646 for the pipeline from Aminoil, Occidental Geothermal Company, and Lake County.

The California Department of Water Resources provided $520,000 for the new distribution system within the community itself.

New CEC Program

Assembly Bill 3897 (The Rosenthal/ Naylor Act) has been signed into law. Sponsored by the California Energy Commission (CEC) and supported by major energy companies, independent energy producers, and private energy research organizations, the legislation establishes a state revolving loan and grant account of about $6 million to finance energy research, development, and demonstration (RD&D) projects.

AB 3897 has the following objectives:

- Make existing energy technologies more efficient and cost-effective;
- Develop new and advanced energy sources and technologies;
- Reduce ratepayer costs by increasing California's energy system reliability and security.

Successful implementation of legislation will require the cooperation of California's business and professional community, the state's utilities, small businesses, ratepayer and consumer interests, energy research organizations, independent energy producers, and federal, state, and local governmental entities. The bill becomes effective and the money becomes available in July 1985.

More specific guidelines about the program, and information on how you could participate, will be available from the CEC in the spring of 1985.

The CEC Supports Geothermal Energy

Since August 1984, the California Energy Commission has provided technical assistance to both public and private developers of geothermal, wind, and photovoltaic projects. Such assistance may include engineering and economic feasibility analysis, and for geothermal projects, resource assessment of low- to moderate-temperate resources.

The commission's objective in funding this program is to promote these alternative technologies by reducing a portion of the development risk. Applicants who are selected for the program will be provided technical assistance by commission staff working with the following consultants:

- The Berkeley Group, Inc. for geothermal resource assessment
- The Oregon Institute of Technology Geo-Heat Center for geothermal feasibility and engineering analysis
- San Diego State University for photovoltaic projects
- Science Applications, Inc. for wind projects

The commission is especially interested in providing assistance to developers who will be in a position to construct a project with minimal assistance. Applicants who desire assistance with resource confirmation at a specific location; economic evaluation of a project; review of work previously conducted; or preliminary feasibility analysis of a proposed project will be given priority. In addition, applicants who seek limited technical assistance regarding equipment selection also will be given priority.

All public and private developers of geothermal, wind, and photovoltaic projects are eligible for this program. The number of applicants that can be provided technical assistance under the program is limited. If you are interested in applying for such assistance, contact: The California Energy Commission, Office of Small Power Producers, 1516 9th Street, Sacramento, CA 95814. Telephone (916) 324-3509.

Leases

Beckwourth Peak No Longer KGRA

Beckwourth Peak KGRA, T. 22-23N., R. 14E, M.D.B.&M. no longer has KGRA status. Such designation was revoked on August 17, 1984, by Robert M. Anderson, Deputy State Director, Mineral Resources, Bureau of Land Management. The former KGRA included 2,558 acres.

Lease Sale Schedule as of 1/11/85

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
Glass Mountain, California	3/26/85
Inventory of tracts remaining in KGRA's in California	6/25/85
Lightening Dock/Radium Springs/Socorro Peak, New Mexico	8/21/85
Lassen, California	8/29/85

Federal Geothermal Leasing Activities in California, 12/21/84

UTILIZATION

	TOTAL THROUGH FY 84					TOTAL THROUGH FY 85				
KGRA	PRODUCING WELLS	PRODUCIBLE WELLS	INJECTION WELLS	PRODUCING LEASES	CAPACITY MW	PRODUCING WELLS	PRODUCIBLE WELLS	INJECTION WELLS	PRODUCING LEASES	CAPACITY MW
GYSERS	60	25	5	10	350	64	29	5	11	350
IMPERIAL VALLEY	9	12	6	1	10	13	12	6	1	10
TOTAL:	69	37	11	11	360	77	41	11	12	360

DRILLING

	TEMPERATURE GRADIENT HOLES		EXPLORATORY WELLS		DEVELOPMENT WELLS		SUSPENDED WELLS	PLUG & ABANDND	CURRENTLY DRILLING
KGRA	DRILLED FY 84	EXPECTED FY 85	DRILLED FY 84	EXPECTED FY 85	DRILLED FY 84	EXPECTED FY 85	UP TO 12-13-84	UP TO 12-13-84	12-13-84
GEYSERS	1	0	1	1	16	15	5	7	1
GLASS MTN	1	10	1	2	0	0			
IMPERIAL VALLEY	2	2	0	0	1	5			
MONO LONG VALLEY	0	2	0	2	0	0			
TOTAL:	4	14	2	5	17	20			

UNIT AGREEMENT

TOTAL APPROVED THROUGH FY 84			APPROVAL EXPECTED IN FY 85		
UNIT	NUMBER	IN KGRA	UNIT	NUMBER	IN KGRA
GLASS MTN	1	YES	INYO DOMES	1	YES
MONO LONG VALLEY	1	YES	PARADISE VALLEY	1	PARTIALLY
TRUCKHAVEN	1	NO	STEPHENS PASS	1	NO
EAST MESA	1	YES	WEED	1	NO
SOUTHERN EAST MESA	1	YES			
TOTAL:	5		TOTAL:	4	

Courses and Meetings

Symposium on Hydrothermal Alteration of Geothermal Brine Chemistry, Processing, and Mineral Recovery, Sheraton Plaza, Palm Springs, California, June 5-7 (field trip to the Salton Sea and Brawley Geothermal fields on June 7).

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

Geothermal Resources Council 1985 Annual Meeting, Kona Surf Hotel, Kailua-Kona, Hawaii, August 26-30, 1985. A workshop, Drilling of High Temperature Geothermal Wells, will be held on August 23-25 before the meeting. A second workshop, Engineering and Economic Assessment of Geothermal Resources--Steps Toward a Financial Analysis will follow the meeting and be held from August 31-September 1. For further information, contact the GRC, P.O. Box 1350, Davis, California 95617-1350.

Graduate Diploma Program in Geothermics

A Graduate Diploma Program in Geothermics is available from the Autonomous University of Baja California, Institute of Engineering, Mexicali, B.C., Mexico. The program began in 1983, and is undertaken in collaboration with the Comisión Federal de Electricidad and the Instituto de Investigaciones Eléctricas. The program is designed for persons wishing to specialize in geothermal energy, and aims to instill overall knowledge of all stages of a geothermal power project. Courses, seminars, and practical studies are offered in Spanish. Some teachers and administrators are bilingual.

The program lasts one year. It consists of a one-week introductory seminar, three 14-week academic periods, with 2 weeks for final evaluation of each period. Fourteen courses are offered, and daily field practices at Cerro Prieto Geothermal field are part of the program.

The first academic period focuses on fundamental analysis of geothermal phenomena. The second period covers the techniques of geothermal fluid management. The design, drilling, termination, operation, and maintenance of geothermal wells are analyzed. In the third academic period, concepts related to reservoir exploration are analyzed.

For further information, write the Universidad Autónoma de Baja California, Instituto de Ingeniería, Coordinación del Programa de Geotermia, Unidad Universitaria Mexicali, Blvd. Benito Juárez s/n, Mexicali, Baja California, C.P. 21290, Mexico. Telephone (656) 641-50.

International School of Geothermics

The International Institute for Geothermal Research of Pisa, sponsored by UNESCO, held its first geothermal training program in 1970. Demand for geothermal courses increased, and, in 1985, a new International School of Geothermics was created. The new curriculum consists of:

1. *Long-term Courses* (few months duration). These are multi-disciplinary courses dealing with the main branches of applied geothermics or geothermal technologies, starting from the basic concepts. They are directed at individuals who are approaching geothermics for the first time and, in particular, individuals who have already some experience in specific sectors and wish to widen their knowledge.

2. *Short Monographic Courses* (one or a few weeks duration). These are highly specialized courses taught

by experts, and directed at individuals with a fair degree of experience in geothermics and a solid background preparation.

3. *Seminars* (1-or 2-weeks duration) describing state-of-the-art of the research methodologies and utilization technologies or the development of geothermal projects; stimulating discussions, debates, and a lively exchange of ideas.

The long-term courses will be offered annually, on a routine basis, in Italy. The short courses and seminars will, on the contrary, be organized according to prevailing circumstances, opportunities, and requests or suggestions submitted to the school. The courses may be held abroad.

The school will be pleased to provide detailed information on its activities to individuals or organizations, and will carefully examine all proposals of collaboration.

For further information on all aspects, please contact: International School of Geothermics, Via del Buongusto, n. 1, 56100 Pisa, Italy, Phone: (050) 41503 or 46069.

Stanford Geothermal Program Seminars

The following seminars are scheduled as part of the Stanford Geothermal Program. All will be held in Room 124, Noble Building, Stanford University, from 1:15 to 2:30 p.m. The seminars are open to the public and are free of charge.

For further information, contact Jon Gudmundsson, Petroleum Engineering Dept., Mitchell Bldg., Room 360, Stanford University, at (415) 497-1218.

DATE	TITLE	SPEAKER
January 31	Practical Aspects of Well Testing Using Quartz Crystal Transducers	Roger Harrison, BGI
February 7	Modeling the Olkaria Geothermal Field, Kenya	Bo Bodvarsson, Lawrence Berkeley Laboratory
February 14	Development Strategy at Coso Geothermal Field	Jim Moor, California Energy Company, Inc.
February 21	Temperature-Pressure Spinner Surveys in Wells at The Geysers	Andy Drenick, GEO
February 28	Origin of Reservoir Fluids at Baca Geothermal Field	Al Truesdell, U.S. Geological Survey
March 7	Permits for Exploration and Development of Geothermal Power in California	Doug Stockton, California Division of Oil and Gas

Maps

Geothermal Resources of Hawaii. 1983. By Hawaii Institute of Geophysics, University of Hawaii. Scale 1:500,000. Free. Available from the Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822.

Geothermal Resources and Temperature Gradients of Oklahoma, 1984. (GM-23). By the Oklahoma Geological Survey. 1:500,000. $2.00. Available from the Oklahoma Geological Survey, 830 Van Vleet Oval, Norman, Oklahoma 73019. (405) 325-3031.

Publications

New Data Base Online

The H.W. Wilson Company, publishers of the Readers' Guide to Periodical Literature and more than a dozen other publication indexes, has placed its databases into an online information retrieval system, called Wilsonline. Data appear in Wilsonline 2-to-4 months before becoming available in the printed indexes.

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Encyclopedic dictionary of exploration geophysics. Second edition. By Robert E. Sheriff. 1984. $25.00; SEG members $20.00. Published by and available from the Society of Exploration Geophysicists, P.O. Box 702740, Tulsa Oklahoma.

Both the original edition of the dictionary and new second edition were compiled for practical geophysicists rather than for researchers or other specialists. Common geologic terms are included. Much seismological terminology is listed. In the second edition, new terms have been added and definitions updated.

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ASTM environmental publications. Published by and available from the American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103. Free.

The publication list features four volumes of the 1984 edition of the Annual Book of ASTM Standards. This contains nearly 400 documents on water and environmental technology, atmospheric analysis, occupational health and safety, pesticides, resource recovery, waste disposal, and hazardous substances and oil spill response.

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Recent publications on geothermal energy. Free. Published by and available from the U.C. Lawrence Berkeley Laboratory, Earth Sciences Division Reference Room, Building 90, Room 1070, Berkeley, CA 94720.

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1984 Pacific Coast oil directory. By Pacific Oil World. $37.10. Available from Petroleum Publishers Inc., P.O. Box 129, Brea, CA 92621.

The publication includes company principals and key personnel of oil, gas, and energy operators, oil tool and instrumentation manufacturers, suppliers, oilfield service companies, engineering and construction firms, drilling and oilwell servicing contractors, refiners and petro-chemical manufacturers, pipeliners, industry associations, governmental agencies, and consultants and independents.

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Information about a series of data bases and publications (all in French) that include information on geothermal energy is available from the Centre de documentation scientifique et technique, Division valorisation, 26, rue Boyer, 75971 Paris Cedex 20, France.

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Brown University Technical Reports

The following publications are published by Brown University and are available from Dr. Ronald DiPippo, Division of Engineering, Box D, Brown University, Providence, Rhode Island 02912, (401) 863-1410. Publications in stock are free. For publications out-of-stock, Xeroxing costs are charged.

Report Number	*Title*
GEOFLO/1	Waste Heat Rejection in Geothermal Power Plants

GEOFLO/2	Prediction of the Entropy Production and Pressure Losses in Two-Phase Flow from the Mixing Length Theory
GEOFLO/3	Flow in Geothermal Wells: Part I. Fundamentals of Two-Phase Flow by the Method of Irreversible Thermodynamics
GEOFLO/4	Flow in Geothermal Wells: Part II. Working Equations for One-Dimensional Flow through a Circular Vertical Channel
GEOFLO/5	Flow in Geothermal Wells: Part III. Calculation Model for Self-Flowing Well
GEOFLO/6	Flow in Geothermal Wells: Part IV. Transition Criteria for Two-Phase Flow Patterns
GEOFLO/7	A Selective Annotated Guide to the Literature
GEOFLO/8	Executive Summary: The Next Steps in Two-Phase Flow
GEOFLO/9	Average Field Equations for Multiphase Flows
GEOFLO/10	The Physics of Two-Phase Flow: Choked Flow
GEOFLO/11	Two-Phase Flow in Horizontal Pipes
GEOFLO/12	Continuum Modeling of Two-Phase Flows
GEOFLO/13	Two-Phase Flow in a Vertical Pipe and the Phenomenon of Choking: Homogeneous Diffusion Model, Part I. Homogeneous Flow Models
GEOFLO/14	Two-Phase Flow in a Vertical Pipe and the Phenomenon of Choking: Homogeneous Diffusion Model, Part II. The Case of Downflow
GEOFLO/15	The Effect of Expansion-Ratio Limitations on Positive-Displacement, Total-Flow Geothermal Power Systems
GEOFLO/16	Design and Operation of a Two-Phase Flow Research Facility
GEOFLO/17	Void Fraction Correlations in Two-Phase Horizontal Flow
GEOFLO/18	Mathematical Criteria for Choking in Two-Phase Flow in Geothermal Pipes
GEOFLO/19	Two-Phase Fluid Flow Through Nozzles and Abrupt Enlargements
GEOFLO/20	An Investigation of Single-Substance Horizontal Two-Phase Flow
TWOPHASE/1	Similarity Considerations in One-Component Two-Phase Flow

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Potential geothermal energy use at the Naval Air Rework Facilities, Norfolk, Va., and Jacksonville, Fla., and at the Naval Shipyard, Charleston, S.C. NWC TP 6535. By J. Costain, L. Glover, and R. Newman. 1984. Published by the Naval Weapons Center, China Lake, CA 93555. Limited distribution.

The U.S. Navy Facilities Energy Research and Development Program is a major part of an effort to solve energy problems. The program focuses on energy technologies being developed outside the Navy (e.g., by the U.S. Dept. of Energy and by industry) that can be adapted for Navy use.

In an earlier survey of Navy and Marine Corps installations on the Atlantic Coastal Plain, the Applied Physics Laboratory (APL) of Johns Hopkins University, Laurel, Md., identified facilities in Norfolk, Va., North-central Florida, and Charleston, S.C., as potentially feasible for development of geothermal systems (Naval Weapons Center, 1983; Johns Hopkins University, 1982).

This report contains studies prepared by Virginia Polytechnic Institute and State University, Blacksburg, Va., on the geophysical and geologic aspects of geothermal energy potential for the Norfolk, Jacksonville, Fla., and Charleston areas.

The report also contains summaries prepared by APL of the engineering and economic factors affecting possible use of geothermal energy at the Norfolk Naval Air Rework Facility (NARF); the Jacksonville NARF; Cecil Field Naval Air Station; Naval Training Center, Orlando; the Charleston Naval Shipyard; and the Polaris Missile Facility Atlantic, Charleston. The Norfolk and Jacksonville NARF's were identified as the two installations best suited for geothermal energy use. The report contains economic analyses developed by APL for possible geothermal systems at these facilities.

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The following Open-File Reports are published by and available from the Open-File Services Section, Western Distribution Branch, USGS, Box 25425, Federal Center, Denver, CO 80225. Phone (303) 236-7476.

Data from pumping and injection tests and chemical sampling in the geothermal aquifer at Klamath Falls, Oregon. OF 84-0146. By S. Benson, C. Janik, D. Long, R. Solbau, P. Lienau et al. 1984. Microfiche $3.50, paper $14.25.

Mineral and geothermal resource potential of the Mount Adams Wilderness and contiguous roadless area, Skamania and Yakima Counties, Washington. OF 83-0474. By W. Hildreth, J. Fierstein, M. Miller. 35p. Microfiche, $3.50, paper $4.75.

Geothermal resources of Sao Miguel Island, Azores, Portugal. OF 84-0287. By W. Duffield and L. Muffler. 22p. Microfiche $3.50, paper $3.00.

Summary report on the regional geology, petroleum potential, environmental consideration for development, and estimates of undiscovered recoverable oil and gas resources of the United States Gulf of Mexico continental margin in the area of proposed oil and gas lease sales nos. 81 and 84. Ed. by R. Foote. OF 84-0339. Microfiche $3.50, paper $25.25.

A section of the report on unconventional energy resources concerns geothermal development in lease sales nos. 81 and 84 planning areas.

Major and trace element analyses of drill cores from thermal areas in Yellowstone National Park, Wyoming. OF 84-0373. By M. Beeson and K. Bargar. 40p. Microfiche $3.50, paper $5.25.

Geohydrology, aqueous geochemistry, and thermal regime of the Soda Lakes and Upsal Hogback geothermal systems, Churchill County, Nevada. WRI 84-4054. By F. Olmsted, A. Welch, A. Van Denburgh, and S. Ingebritsen. 1984. $25. 166p. 2 over-sized sheets.

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The following publications are available from the National Technical Information Service, U.S. Dept. of Commerce, Springfield, Virginia 22161. All microfiche copies are $4.50 each. Costs vary for the printed copies.

Environmental

Survey of environmental regulations applying to geothermal exploration, development, and use. PB 84-173665. By Gene V. Beeland. $22.00.

California

Correlation of wireline log characteristics with hydrothermal alteration and other reservoir properties of the Salton Sea and Westmorland Geothermal fields, Imperial Valley, California, USA. LA-10128-MS. By F.S. Muramoto and W.A. Elders. 1984. $11.50. 100p.

Well log interpretation of certain geothermal fields in the Imperial Valley, California. LA-10067-MS. By I. Ershaghi and D. Abdassah. 1984. $7.00. 23p.

Drilling and thermal gradient measurements at U.S. Marine Corps Air Ground Combat Center, Twentynine Palms, California. DOE/SF/11956-1. By D. Trexler, T. Flynn, and G. Ghusn, Jr. Jr. 1984. $11.50. 79p.

Proceedings of the workshop on geophysical modeling of the Long Valley Caldera. LBL-18106. Edited by N. Goldstein. $11.50. 90p.

Hawaii

Geothermal resources assessment in Hawaii. DOE/SF/10819-T1. By D.M. Thomas. 1984. $14.50. 114p.

Idaho

Petrographic analysis and correlation of volcanic rocks in Bostic 1-A well near Mountain Home, Idaho. LA-9966-HDR. By B. Arney, J. Gardner, and S. Belluomini. 1984. $8.50. 29p.

Nebraska

An inventory of geothermal resources in Nebraska. DOE/ET/27205-T1. By W. Gosnold and D. Eversoll. 1983. $23.50. 290p.

Nevada

Geologic and hydrologic research on the Moana Geothermal System, Washoe County Nevada. DOE/RA/50075-2. By T. Flynn and G. Ghusn, Jr. 1983. $16.00. 148p.

Geochemistry, age and strontium isotope composition of late Tertiary and Quaternary basalts and andesites in Western Nevada and their relation to geothermal potential. DOE/RA/50075-1. By L.A. Fultz, E.J. Bell, and D.T. Trexler. 1983. $17.50. 170p.

New Mexico and Texas

New Mexico State University campus geothermal demonstration project. DOE/ID/12137-T1. By R.A. Cunniff, K.P. Fisher, and P. Chintawonranich. 1984. $25.00.

Low-temperature geothermal potential of the Ojo Caliente Warm Springs Area, Northern New Mexico. LA-10105-OBES. By F.D. Vuataz, J. Stix, F. Goff, and C.F. Pearson. 1984. $10.00. 56p.

Workshop on CSDP data needs for the Baca Geothermal field: a summary. LBL-17695. By D. Mangold and C. Tsang. 1984. $14.50. 132p.

State-coupled low temperature geothermal resource assessment program, fiscal year 1982. (for New Mexico) DOE/ID/01717-4. By L. Icerman. 1983. $23.50.

Geothermal exploration in Trans-Pecos, Texas/New Mexico. DOE/ID/12080-T1. By R. Roy, B. Taylor, and M. Miklas. 1983. $14.50. 121p.

Integration of geothermal data along the Balcones/Ouachita Trend, Central Texas. DOE/ID/12057-T8. By C.M. Woodruff, C. Gever, F. Snyder, and D. Wuerch. 1983. $10.00.

Listing of scientific data on the Baca Geothermal field. LBL-17675. By R. Spencer and C.F. Tsang. 1984. $14.50.

Washington State

Chemical analyses for thermal and mineral springs examined in 1982-1983. DOE/ET/27014-T18. By M. Korosec. 1984. $7.00. 8p.

Low-temperature geothermal resource evaluation of the Moses Lake-Ritzville-Connell area, Washington. DOE/ET/27014-T8. By S. Widness. 1983. $8.50. 27p.

Geological and geothermal investigation of the lower Wind River Valley, Southwestern Washington Cascade Range. DOE/ET/27014-T9. By D. Berri and M. Korosec. 1983. $10.00. 48p.

Geophysical logs from water wells in the Yakima Area, Washington. DOE/ET/27014-T15. By J.H. Biggane. 1983. $10.00.

Geophysical logs from selected wells in Eastern Washington. DOE/ET/27014-T16. By K. Stoffel and S. Widness. 1983. $11.50.

The 1983 temperature gradient and heat flow drilling project for the State of Washington. DOE/ET/27014-T12. By M. Korosec. 1983. $7.00. 11p.

Principal facts and a discussion of terrain correction methods for the complete Bouguer gravity anomaly map of the Cascade Mountains, Washington. DOE/ET/27014-T11. By Z. Danes and W. Phillips. 1983. $16.00. 161p.

Fluid-temperature logs for selected wells in Eastern Washington. DOE/ET/27014-T14. By K. Stoffel and S. Widness. 1983. $28.00. 351p.

Preparation of residual gravity maps for the Southern Cascade Mountains, Washington, using Fourier analysis. DOE/ET/27014-T10. By D. Dishberger. 1983. $8.50.

Summary of geothermal exploration activity in the State of Washington from 1978 to 1983. DOE/ET/27014-T19. By M. Korosec. 1984. $8.50. 42p.

Targeting geothermal exploration sites in the Mount St. Helens area using soil mercury surveys. DOE/ET/27014-T17. By J. Holmes and K. Waugh. 1983. $8.50.

Wyoming

Geothermal resources of the Laramie, Hanna, and Shirley Basins, Wyoming. DOE/ID/12026-T7. By B. Hinckley and H. Heasler. 1984. $8.50. 26p.

The Cody hydrothermal system. DOE/ID/12026-T4. By H. Heasler. 1982. $7.00. 10p.

The Thermopolis hydrothermal system, with an analysis of Hot Springs State Park. DOE/ID/12026-T5. By B.S. Hinckley, H.P. Heasler, and J.K. King. 1982. $8.50. 42p.

Chemical analyses of selected thermal springs and wells in Wyoming. DOE/ID/12026-T6. 1984. $7.00. 3p.

Japan and Taiwan

Investigations of water-rock interaction in geothermal systems of Japan and Taiwan. DOE/ID/12148-T1. By J.G. Liou and R.N. Guillemette. 1984. $25.00. 190p.

Annual Reports

Geothermal technology development program annual progress report October 1982 - September 1983. SAND84-1028. J.R. Kelsey, editor. 1983. $17.50. 200p.

The status of research and development projects in the DOE sponsored-Geothermal Technology Development Program is described. Program management is provided by Sandia National Laboratories.

Annual Report 1983, Earth Sciences Division, Lawrence Berkeley Laboratory. LBL-16920. 1984. $20.50. 229p.

Geothermal Reservoir Engineering Research at Stanford University. SGP-TR-76. 1983. $14.50. 135p.

Fracture Mapping

Subsurface fracture mapping from geothermal wellbores. DOE/AL/16863-T1. By B.A. Hartenbaum and G. Rawson. 1983. $19.00

Geopressured

Consolidation of geologic studies of geopressured geothermal resources in Texas. DOE/ET/27111-12. By T. Ewing, N. Tyler, R. Morton, and M. Light. 1984. $16.00. 142p.

Drilling and completion test well and disposal well, Sweet Lake Geopressured-Geothermal Project, Vol. 1, annual report for 12/1/79 - 2/27/81. DOE/NV/10081-1. R. Rodgers, editor. $29.50.

Microseismic monitoring of Chocolate Bayou, Texas, the Pleasant Bayou No. 2 geopressured/geothermal energy test well program. DOE/ET/27111-11. By F. Mauk, B. Kimball, and R. Davis. 1984. $16.00.

Brine and gas recovery from geopressured systems: I. parametric calculations. DOE/NV/10150-4. By S. Garg and T. Riney. 1984. $11.50.

Sweet Lake geopressured-geothermal project, Magma Gulf-technadril/DOE AMOCO Fee, Vol. II surface installations reservoir testing. DOE/NV/10081-2. Ed. by K. Hoffman. 124p. $14.50.

Groundwater and Irrigation

Near-surface groundwater responses to injection of geothermal wastes. DOE/ID/12347-T1. By S. C. Arnold. $16.00. 138p.

Evaluation of irrigation management procedures for geothermal effluent. DOE/ID/12167-T1. By C.E. Brockway, C.W. Robbins, C.W. Robison, G.S. Johnson. 1984. $10.00. 46p.

Hot Dry Rock

Environmental studies conducted at the Fenton Hill hot dry rock geothermal development site. LA-9967-MS. By F.R. Miera, G. Langhorst, S. McEllin, and C. Montoya. 1984. $7.00. 19p.

H_2S

The direct chlorination process for geothermal power plant off-gas--hydrogen sulfide abatement. DOE/SF/11664-T3. By A.V. Sims. 1983. $10.00. 56p.

Technology

Numerical results for the solution of the Graetz problem for a Bingham plastic in laminar tube flow with constant wall temperature. SAND84-0956. By B.F. Blackwell. 1984. $7.00. 17p.

Improved seal for geothermal drill bit. DOE/CE/15104-T1. By R.F. Evans. 1984. $8.50. 27p.

Phase 1 theoretical description, a geological formation-drill string dynamic interaction finite element program (GEODYN). SAND84-7101. By J.A. Baird, M.C. Apostal, R.L. Rotelli, M.A. Tinianow, B.A. Wormley. 1984. $17.50.

Phase 1 user instruction manual, a geologic formation--drill string dynamic interaction finite element program (GEODYN). SAND84-7102. By M.A. Tinianow, R.L. Rotelli, T.A. Baird. 1984. $28.00.

Geothermal technology publications and related reports: a bibliography January through December 1983. SAND84-1767. By D. Cooper. 1984. $8.50. 30p.

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ORD publications announcement. Publications of the Environmental Protection Agency Office of Research and Development. Published 3-4 times a year.

Survey of environmental regulations applying to geothermal exploration, development, and use. EPA 600/S2-84-082. ORD No. 24082.

Analysis of geothermal wastes for hazardous components. EPA 600/S2-83-030. ORD No. 23030.

All publications are free of charge. Send ORD number to ORD Publications, P.O. Box 15948, Cincinnati, Ohio 45215.

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Some new California Energy Commission publications follow, published by and available from the California Energy Commission Accounting Office, 1516 Ninth Street, MS-2, Sacramento, California 95814.

Publications catalog. 1984. California Energy Commission.

Annual research, development and demonstration report. P500-84-009. First copy free. Additional copies are $6.20.

Relative cost of electricity production. P300-84-014. $1.60.

Evaluation of a superheater-enhanced geothermal steam power plant at The Geysers. P700-84-003. $3.10.

Technical assessment manual ($3.10) and Technical assessment manual appendices ($6.60). P300-84-013 and P300-84-013A.

CEC estimates for 23 electricity generation technology and fuel combinations. Vapor and liquid geothermal technologies are included.

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

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The following publications are published by and available from the California Division of Mines and Geology, P.O. Box 2980, Sacramento, CA 95812.

The open-file reports can be viewed at DMG offices in Los Angeles, Pleasant Hill, and at 2815 O Street, Sacramento, California 95816. Xeroxed copies must be ordered from the Sacramento P.O. Box 2980 address.

An annotated bibliography of geothermal information published or authored by staff of the California Division of Mines and Geology 1960-1984. SP69. By Leslie G. Youngs. $2.00.

Geothermal Energy at Long Beach Naval Shipyard and Naval Station and at Seal Beach Naval Weapons Station, California. Open-file report 84-50 Sac. By Chris T. Higgins and Rodger H. Chapman. 1984. Xeroxed copy is $10.00.

Reconnaissance of geothermal resources near U.S. Naval facilities in the San Diego area, California. Open-file report 84-33 Sac. By Leslie G. Youngs. 1984. Xeroxed copy is $8.00.

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Publication list, published by and available from the Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, Oregon 97601.

About 100 geothermal publications are available from OIT, including summary papers, technical reports, and technical assistance feasibility studies of the States of Washington, Arizona, California, Nevada, Oregon, and Utah.

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Analysis and interpretation of data obtained in tests of the geothermal aquifer at Klamath Falls, Oregon. WRI 84-4216. Ed. by E. Sammel. 1984. Microfiche $3.50, paper $22.00. Published by and available from Open-File Services Section, Western Distribution Branch, USGS, Box 25425, Federal Center, Denver, Colorado 80225.

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Geothermal resources of Hawaii. 1983. Geothermal data compiled and interpreted by the Hawaii Institute of Geophysics, University of Hawaii. Scale 1:500,000. Free. Copies of the map are available from the Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822.

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The USGS in Alaska: accomplishments during 1981. C0868. Edited by W. Coonrad and R. Elliott. 1984. Free. 162p.

Contains a two-page summary of "Geothermal studies in Alaska; conditions at Prudhoe Bay" by A. H. Lachenbruch, J. Sass, B. Marshall, T. Moses, R. Munroe, and E. Smith.

Published by and available from the Eastern Distribution Branch, Text Products Section, USGS, 604 S. Pickett Street, Alexandria, VA 22304.

California Wells

CDOG Collects Geothermal Well Data

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

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

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

Drilling Permits for Geothermal Wells Approved July-Dec. 1984 by the California Division of Oil and Gas

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
DISTRICT G1	S E P T E M B E R		
Lassen County			
9/20/84	CHS-AMEDEE TEST WELL JOINT VENTURE "CHS" 1 (035-90070)	8/28N/16E	Fr NE cor 488m S 854m W 1,200m GR.
Plumas County			
9/19/84	COUNTY OF SIERRA "SV" 2 (063-90015)	13/22N/15E	Fr SE cor 488m N 823m W 1,487m GR.

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
Sierra County			
9/19/84	COUNTY OF SIERRA "SV" 1 (091-90003)	5/21N/15E	Fr NW cor 402m S 628m E 1,487m GR.
9/19/84	COUNTY OF SIERRA "SV" 3 (091-90005)	8/21N/15E	Fr SE cor 209m N 483m W 1,496m GR.
9/19/84	COUNTY OF SIERRA "SV" 4 (091-90006)	18/20N/15E	Fr SE cor 595m N 1,690m W 1,484m GR.
	N O V E M B E R		
Mono County			
11/14/84	MAMMOTH-PACIFIC "MBP" 3 (051-90043)	32/3S/28E	Fr ctr of sec 47m N 528m W 2,230m GR.
DISTRICT G2	J U L Y		
Imperial County			
7/16/84	CHEVRON GEOTHERMAL CO. "HGU" 57 (025-90590)	34/16S/14E	Fr NE cor 84m S 305m W +3m KB.
7/16/84	CHEVRON GEOTHERMAL CO. "HGU" 103 (025-90591)	33/16S/14E	Fr SW cor 385m N 241m E +3m KB.
7/16/84	CHEVRON GEOTHERMAL CO. "HGU" 105 (025-90592)	33/16S/14E	Fr SW cor 357m N 291m E +3m KB.
7/30/84	UNION OIL COMPANY 84-2 (025-90595)	5/12S/13E	Fr NW cor 750m S 320m E -69m KB.
7/30/84	UNION OIL COMPANY 84-1 (025-90594)	5/12S/13E	Fr NW cor 722m S 97m E -65m KB.
7/31/84	IMPERIAL ENERGY CORP. "Salton Sea" 1 (025-90596)	36/11S/13E	Fr SE cor 742m N 195m W -64m KB.
	A U G U S T		
Imperial County			
8/1/84	REPUBLIC GEOTHERMAL, INC. "Britz" 4 (025-90593)	21/11S/14E	Fr NW cor 55m S 80m E -52m KB,
8/15/84	KENNECOTT CORP. P6-1 (025-90597)	6/11S/14E	Fr NW cor 804m S 804m E -68m KB.
8/15/84	KENNECOTT CORP. P6-3 (025-90598)	9/10S/13E	Fr NW cor 1,609m S 1,609m E -68m KB.

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
8/15/84	KENNECOTT CORP. P6-4 (025-90599)	34/12S/12E	Fr SE cor 804m N Om W -68m KB.
8/30/84	CHEVRON GEOTHERMAL CO. "HGU" 53 (025-90600)	34/16S/14E	Fr NE cor 85m S 325m W +3m KB.
8/30/84			
8/30/84	CHEVRON GEOTHERMAL CO. "HGU" 55 (025-90601)	24/16S/14E	Fr NE cor 85m S 315m W +3m KB.
8/30/84	CHEVRON GEOTHERMAL CO. "HGU" 152 (025-90602)	30/16S/14E	Fr SE cor 269m N 111m W +3m KB.
8/30/84	CHEVRON GEOTHERMAL CO. "HGU" 153 (025-90603)	30/16S/14E	Fr SE cor 269m N 122m W +3m KB.

S E P T E M B E R

Imperial County

9/18/84	IMPERIAL MAGMA M-16 (025-90604)	33/11S/13E	Fr SE cor 99m N 69m W -60m KB.

O C T O B E R

Imperial County

10/9/84	IMPERIAL MAGMA M-5 (025-90606)	33/11S/13E	Fr SE cor 83m N 867m W -63m KB.
10/9/84	IMPERIAL MAGMA M-7 (025-90607)	33/11S/13E	Fr SE cor 164m N 867m W -63m KB.
10/9/84	IMPERIAL MAGMA M-12 (025-90608)	33/11S/13E	Fr SE cor 114m N 586m W -63m KB.
10/9/84	IMPERIAL MAGMA M-14 (025-90609)	33/11S/13E	Fr SE cor 53m N 610m W -63m KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 51 (025-90610)	34/16S/14E	Fr NE cor 85m S 336m W +3 KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 52 (025-90611)	34/16S/14E	Fr NE cor 59m S 335m W +3 KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 54 (025-90612)	34/16S/14E	Fr NE cor 59m S 325m W +3m KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 56 (025-90613)	34/16S/14E	Fr NE cor 59m S 315m W +3m KB.

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 151 (025-90614)	30/16S/14E	Fr SE cor 373m N 109m W +3 KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 153 (025-90615)	30/16S/14E	Fr SE cor 378m N 119m W +3m KB.
10/22/84	CHEVRON GEOTHERMAL CO. "HGU" 155 (025-90616)	30/16S/14E	Fr SE cor 373m N 131m W +3m KB.
10/26/84	UNION OIL COMPANY "Truckhaven" 2 (025-90605)	5/11S/10E	Fr NW cor 783m S 64m E -19m KB.
10/29/84	REPUBLIC GEOTHERMAL, INC. "Fee" 6 (025-90617)	17/11S/14E	Fr NW cor 730m S 761m E -50 KB.

N O V E M B E R

Imperial County

11/5/84	IMPERIAL MAGMA M-9 (025-90618)	33/11S/13E	Fr SE cor 144m N 867m W -62m KB.
11/5/84	IMPERIAL MAGMA M-10 (025-90619)	33/11S/13E	Fr SE cor 114m N 647m W -62m KB.
11/5/84	IMPERIAL MAGMA M-11 (025-90620)	33/11S/13E	Fr SE cor 114m N 616m W -62m KB.
11/5/84	IMPERIAL MAGMA M-13 (025-90621)	33/11S/13E	Fr SE cor 53m N 647m W -62m KB.
11/5/84	IMPERIAL MAGMA M-15 (025-90622)	33/11S/13E	Fr SE cor 53m N 586m W -62m KB.

D E C E M B E R

Imperial County

12/13/84	IMPERIAL MAGMA IW-1 (025-90623)	34/11S/13E	Fr SW cor 1,177m N 760m E -68m KB.
12/13/84	IMPERIAL MAGMA IW-2 (025-90624)	34/11S/13E	Fr SW cor 1,208m N 760m E -68m KB.
12/13/84	IMPERIAL MAGMA IW-3 (025-90625)	34/11S/13E	Fr SW cor 1,328m N 760m E -68m KB.

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
12/13/84	IMPERIAL MAGMA IW-4 (025-90626)	34/11S/13E	Fr SW cor 1,548m N 33m E -70m KB.
12/13/84	IMPERIAL MAGMA IW-6 (025-90627)	34/11S/13E	Fr SW cor 1,548m N 402m E -70m KB.
12/13/84	IMPERIAL MAGMA IW-7 (025-90628)	34/11S/13E	Fr SW cor 1,548m N 372m E -70m KB.

DISTRICT G3

J U L Y

Sonoma County

7/17/84	UNION OIL COMPANY "GDC" 27 (097-90622)	28/11N/8W	Fr NW cor 640m S 629m E 874m KB.
7/30/84	GRI OPERATOR CORP. "Prati" 29 (097-90623)	36/12N/9W	Fr NW cor 251m S 15m E 994m KB.
7/30/84	GRI OPERATOR CORP. "Prati" 27 (097-90624)	36/12N/9W	Fr NW cor 251m S 15m E 994m KB.
7/30/84	GRI OPERATOR CORP. "Rorabaugh" A-25	14/11N/9W	Fr SW cor 335m N 314m E 759m KB.

A U G U S T

Lake County

8/10/84	AMINOIL USA, INC. "Barrows" 4 (033-90495)	36/11N/8W	Fr NW cor 444m S 367m E 605m KB.
8/24/84	MCR GEOTHERMAL CORP. "Coleman" 5-5 (033-90496)	5/11N/8W	Fr NW cor 767m S 285m E 813m KB.

Sonoma County

8/6/84	GRI OPERATOR CORP. "BR" 10 (097-90626)	-/11N/9W	Fr NE cor sec. 9 549m S 3,079m W 609m GR.
8/6/84	GRI OPERATOR CORP. "BR" 12 (097-90627)	-/11N/9W	Fr NE cor sec. 9, 1,036m S 1,341m W 609m GR.

S E P T E M B E R

Sonoma County

9/20/84	GRI OPERATOR CORP. "BR" 5 (097-90628)	-/11N/9W	Fr SE cor 833m N 3,407m W 741m GL.

Date Notice Received	Operator, Well No. & API No.	Sec. T. R.	Location and Elevation
9/25/84	GRI OPERATOR CORP. "Prati" 32 (097-90630)	35/12N/9W	Fr NW cor 1,188m S 316m E 645m GL.

O C T O B E R

Lake County

10/10/84	GEYSERS GEOTHERMAL CO. "McKinley" 10 (033-90497)	35/11N/8W	Fr NW cor 305m S 473m E 732m GR.
10/18/84	UNION OIL COMPANY "California St" 92A-6 (033-90498)	6/11N/8W	Fr NE cor 268m S 668m W 871m KB.

Sonoma County

10/24/84	UNION OIL COMPANY "GDC" 24 (097-90634)	20/11N/8W	Fr SW cor 99m N 9m E 614m KB.

N O V E M B E R

Lake County

11/15/84	GEYSERS GEOTHERMAL CO. "McKinley" 11 (033-90500)	35/11N/8W	Fr NW cor 274m S 471m E 740m KB.

Sonoma County

10/31/84	UNION OIL COMPANY "GDC" 29 (097-90635)	28/11N/8W	Fr SE cor 533m N 149m W 867m KB.

D E C E M B E R

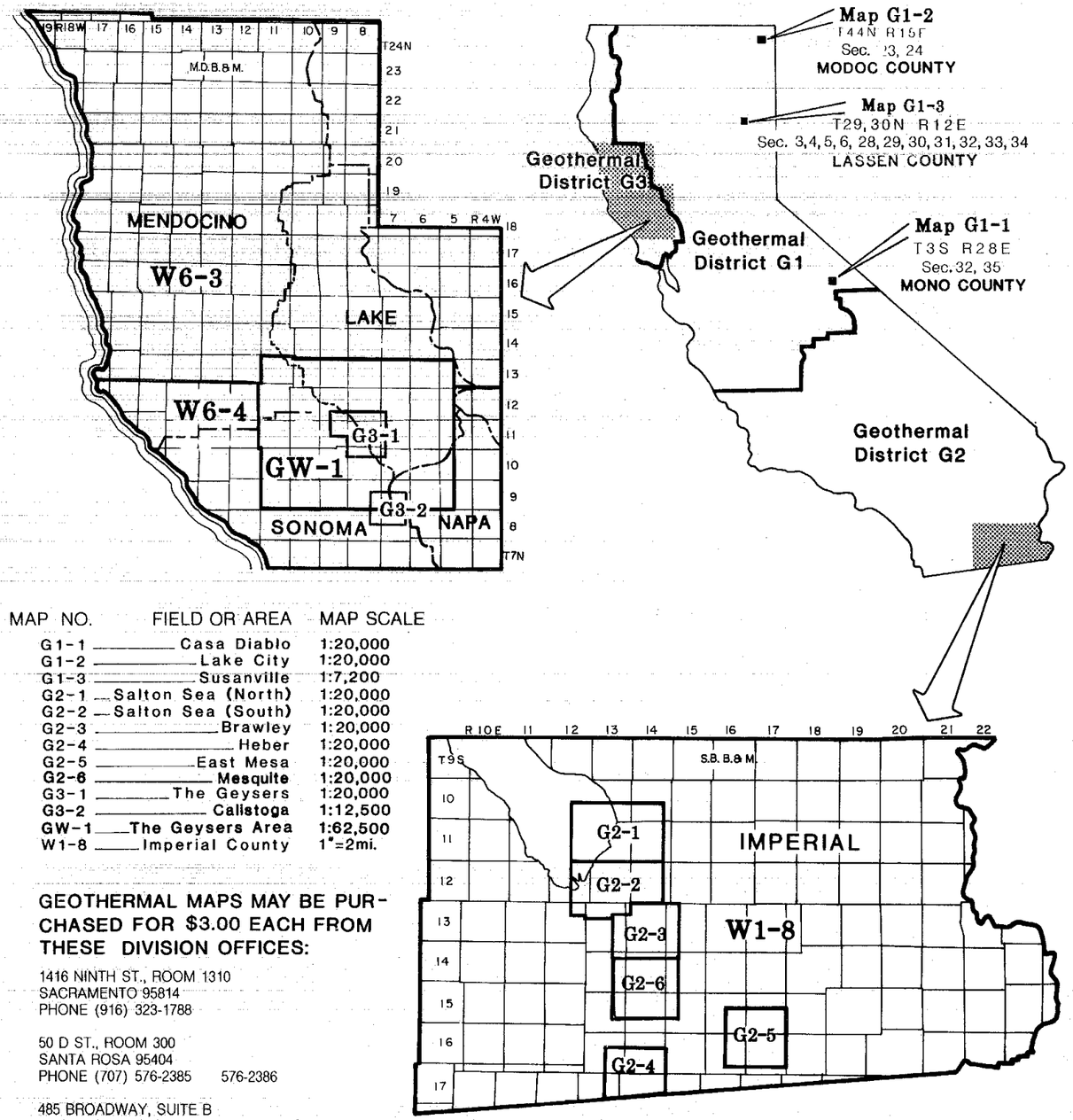
Lake County

11/30/84	MCR GEOTHERMAL CORP. "Coleman" 1A-5 (033-90501)	5/11N/8W	Fr NW cor 778m S 319m E 813m KB.
12/10/84	MCR GEOTHERMAL CORP. "Coleman" 6-6 (033-90502)	6/11N/8W	Fr NE cor 1,169m S 129m W 909m KB.

Sonoma County

12/4/84	UNION OIL COMPANY "Sulphur Bank" 28 (097-90637)	12/11N/9W	Fr SW cor 178m N 650m E 641m KB.
12/4/84	UNION OIL COMPANY "GDC" 25 (097-90638)	20/11N/8W	Fr SW cor 86m N 2m E 619m KB.
12/4/84	UNION OIL COMPANY "Angeli" 3 (097-90639)	20/11N/8W	Fr SE cor 762m N 122m W 1,045m KB.

California Division of Oil and Gas
GEOTHERMAL MAPS



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

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

1416 NINTH ST., ROOM 1310
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PHONE (707) 576-2385 576-2386

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

TR02 (2-85-DWRR-14C)

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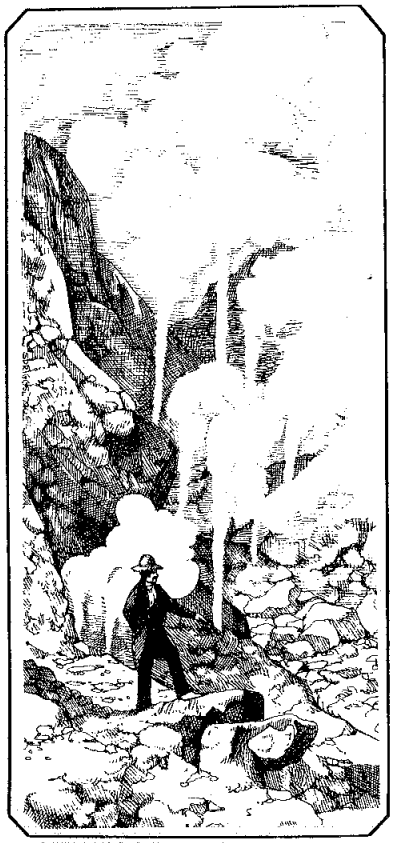

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