GEOTHERMAL PUBLIC INFORMATION ISSUE

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Nontechinical Geothermal Public Information: Views

Geothermal projects can live or die by expressions of public opinion just as surely as by reservoir management techniques. Today, as the industry continues to emphasize developmental activities, public visibility continues to increase and public beliefs move to the forefront of concern.

This concern was recognized at the recent Geothermal Resources Council meeting in Santa Rosa. Almost 10 percent of the attendees came to a preliminary meeting on nontechinical geothermal public information, cochaired by Anna Carter and me. The topic was, should the 1990 Geothermal Resources Council (GRC) meeting in Hawaii include a special session on geothermal public information? The answers were uniformly positive. And, I am pleased to announce, the GRC has approved a Geothermal Public Information Special Session for the meeting, which we will again cochair.

by Susan F. Hodgson

What comments were made at the preliminary meeting on geothermal nontechinical public information? Many people said it's important to identify the groups needing information about geothermal development, such as the news media,
legislators, the general public, communities near geothermal development, stockholders, school children, environmental organizations, and personnel in regulatory and utility organizations.

John Geyer pointed out that the goal of all outreach should be one of a "consistent and expected presence." Several people said that members of the geothermal community can help each other by networking and developing a central database. Everyone does not have to reinvent the wheel. Many public-information facts are helpful to everyone.

However, Janet Bowers mentioned that we must "educate ourselves first, getting these facts straight as to environmental impacts, megawatts on line, etc."

Sally Collins said that good public-information programs are tailored to specific situations. Measurement instruments can be built into programs to gauge their effectiveness.

Many thought news-media coverage should have a higher priority. Press releases, talking with editorial boards of newspapers and magazines, and being available for interviews on local radio and television stations are inexpensive ways to get exposure, and the time to do it is before a crisis hits.

And, meeting attendees said we need to talk among ourselves about public information issues and programs. I hope the public information articles in this Hot Line issue are a good first step in this regard.

Everyone needs to know what nontechnical geothermal public information products are available and how to order them. Unfortunately, no master list exists, and many, still-useful items are forgotten every year.

For this reason, the Division of Oil and Gas has undertaken to make a worldwide survey of available nontechnical geothermal public information. A copy of the survey is in this Hot Line issue. If you have not yet filled one out, please do so now and return it to the division, as soon as possible, with TWO COPIES OF EACH REVIEWED ITEM. One of the copies will be given to the Geothermal Resources Council (GRC), and displayed at the 1990 GRC meeting in Hawaii. The second copy will be kept in the division's archives.

Each item will be entered on a master list of nontechnical geothermal public-information items. The list will be distributed to the geothermal community, published in the Geothermal Hot Line, and sent to each contributor.

Send the survey form and the copies of each item to: Susan F. Hodgson, Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, California 95814.

Thank you for your help.

A Special Session on Geothermal Public Information will be held in Hawaii.

...
The Newberry Volcano Geothermal Public Information Program

Background

The Deschutes National Forest is in Central Oregon, an area famous for its beauty, diversity, and recreational opportunities. Two areas in the forest have high geothermal potential: one is just west of Bend, Oregon, near the Three Sisters Wilderness Area (where land has been leased for geothermal development), and the other is the Newberry Volcano area.

About two-thirds of all federal geothermal leases in Oregon and Washington (250,000 acres) are in this forest, and half of these are on the Newberry Volcano (125,000 acres). Newberry Volcano is the site of the only Known Geothermal Resource Area (KGRA) not yet leased in the Pacific Northwest. (Note: All KGRA's are classified by the Bureau of Land Management, BLM.)

Of the 31,200 acres in the KGRA, 11,360 acres lie within the caldera rim, an area closed to geothermal leasing and development by the U.S. Forest Service due to the intensive recreational use and confined nature of the caldera. The remaining 20,000 acres in the KGRA await completion of an Environmental Impact Statement to determine where and under what conditions leasing should occur. The area is one of the Forest Service's highest priorities for mineral projects in the Pacific Northwest.

Over 30 shallow, temperature-gradient wells have been drilled at Newberry since 1975; 7 of these were drilled to depths greater than 4,000 feet. The hottest temperature recorded is 509°F at a depth of just over 3,000 feet, inside the caldera. In May 1988, the BLM approved a GEO Newberry Inc. proposal for drilling the first deep production well (10,000 feet) at Newberry. While this well has not yet been drilled, exploration interest in Newberry remains high. According to 1985 Bonneville Power Administration (BPA) estimates, a potential for 1,000 to 2,000 megawatts may exist at Newberry Volcano.

Complex Boundaries

A number of superimposed boundaries from a number of different entities exist at Newberry. These boundaries cause some of the complexities found in managing and developing geothermal resources at Newberry Volcano. For these and other reasons, planning for and managing geothermal resources on Newberry is complicated, and has the potential for controversy.

The headline

By Sally Collins, Lands and Minerals Staff Officer, U.S. Forest Service, Deschutes National Forest, Bend, Oregon

Lava Cone, Newberry Volcano.

Shing in the forest.

Proposed Newberry GEO Inc. drilling site.

Geothermal leasing in Oregon, including pending leases.

A timber harvest at Newberry.

Within this latter boundary, the state would likely impose some surface restrictions on power-plant sitings.

The National Natural Landmark system, designated to identify and preserve significant national features, is overseen by the National Park Service. Under this system, the Park Service encourages landowners to impose restrictions. The
Community leaders at The Geysers Geothermal field.

Community leaders at The Geysers Geothermal field.

The leaders visited a drill site near Reno, Nevada.

Park Service has identified a 17,400-acre area at Newberry as a National Natural Landmark. This designation—one of only six in Oregon—publicly highlights the national significance of the features at Newberry.

Over the last few years, a community group in Central Oregon has initiated an effort to have Newberry Crater and surrounding areas designated by Congress as a National Monument. This effort, fueled in part by geothermal activities at Newberry, continues to accelerate. The proposal—to establish a 62,000-acre monument administered by the Forest Service—would protect and encourage the interpretation of important geologic features in the Newberry area.

Under the proposal, geothermal leasing would be permitted (with no surface occupancy restrictions) for one-half mile into the monument boundaries. This stipulation would provide some opportunity for slant drilling, as no surface developments would be permitted inside the monument boundaries. Provisions will be included in the legislative language to ensure geothermal development outside the boundaries is not restricted. The proposal provides for compensation of existing leaseholders who have leases within the boundary, and eliminates the need for completion of the EIS in the KORA to allow for a competitive lease sale. The proposal has broad-based support in Central Oregon, and was introduced into both houses of Congress by members of the Oregon delegation in November 1989.

Aside from the monument proposal, the Forest Service’s “Forest Plan” for Deschutes National Forest identifies management requirements for Newberry. In addition to its policy of no lease boundaries on the rim of the caldera, the Forest Service has identified in this plan a number of management boundaries in the Newberry area that could affect geothermal development: timber management areas, bald eagle habitat areas, recreation and scenic areas, research natural areas, and special-interest areas. While geothermal development is compatible with most of these, some management restrictions will likely apply.

The Newberry Volcano, A Geothermal Public Information Program

For the last few years, heated debates over the development of geothermal energy projects have occurred in the Crater Lake area, which is fewer than 100 miles south of Newberry. When the Forest Service received the well proposal for Newberry and saw that KORA leasing efforts at Newberry were off to a start, it was reasonable to assume that some heated exchanges were on their way to Central Oregon.

To deal with this potential for controversy, personnel at the Deschutes National Forest developed the strategy of distributing their own geothermal data before the issue of geothermal development received widespread viability. The Forest Service made a conscious decision to meet with the press before articles were written, and with both the public and our own employees before they read about geothermal development in the newspapers. The reasons for this were obvious, but sometimes forgotten: when people are uninformed, they tend to react emotionally, often out of fear of the unknown.

The Forest Service wanted to be sure that the Central Oregon community really understood geothermal energy, what the resource was, how it is developed, the basic technology for electricity production, and the environmental effects. Then, with a solid factual basis, the public could form reasoned opinions about geothermal.

The Forest Service ran somewhat of a risk in doing this. As employees, we were not in a position to promote or discourage development of any of the resources we managed, and it was important in this case to remain neutral as well. We went to great pains to maintain this neutrality, to present all available information, and to look at all viewpoints. Needless to say, by virtue of the attention we gave the issue, we were accused of promoting geothermal development—particularly at first. We had a fine line to walk in this regard and still do, but feel that the effort has been well worth it.

Program Activities

The Forest Service public information strategy combines tours, training, displays, and public meetings.

Community Leaders’ Trip

In October 1987, the Deschutes National Forest, in conjunction with the BLM and the BPA, took 12 members of the Central Oregon community on a weekend trip to California and Nevada. The object of the trip was to look at current geothermal technology. We saw different levels of development and impacts, letting tour members understand what might come soon to Central Oregon. The members included a county commissioner, a chamber of commerce representative, a county planner, a Mt. Bachelor Ski Corporation representative, a water commissioner, environmental group members, a state representative, and a rural electric cooperative board member.

The group toured The Geysers and saw large-scale development. They visited smaller power plants in various stages of development around Reno, Nevada. They saw, first-hand, the state-of-the-art geothermal resource development technology used for exploration, production, and electrical power generation.

The trip has paid off in more ways than can be described here. A few examples will illustrate the value of this kind of effort:

- One conservation group representative headed off a National Sierra Club appeal on GEO’s drilling proposal, citing the strong, local conservation group’s support for the good geothermal planning that had gone into the effort.
- An Oregon natural resource representative of a conservation group went against the group’s president and stated support for GEO’s drilling project, even after the organization had publicized its pledge to fight the geothermal development statewide.
- Another conservation group member discovered erroneous information being distributed about geothermal by another federal agency and contacted the Forest Service to intervene. She would not have known it was misleading had she not taken the weekend trip.
- This has opened an important dialogue between the Forest Service and this agency.
- Presentations on geothermal development are being made throughout the community by many trip members. And, more importantly, their informal conversations about geothermal energy are expanding the network of informed people in Central Oregon.

The Forest Service continues to meet with these people and has recently expanded the group to include people in the northern part of the forest, where geothermal exploration is just starting.

Witnessing a flow test near Reno, Nevada.
Deschutes National Forest Management Team

Trip

Following the Community Leaders’ Trip, the Forest Service took its management team on a similar trip. The group consisted of managers of wildlife, timber, recreation, engineering, minerals, and watersheds. The forest managers learned what is involved in geothermal development so they could respond to requests and questions with accurate information. In addition to going to The Geysers, the group traveled to two other California areas: the Imperial Valley and Mammoth Lakes. They saw a variety of technologies and projects in various stages of development.

Other Tours

A number of other tours were undertaken as part of the geothermal strategy. In September 1988, the interdisciplin- ary team planning the leasing of the Newberry KGRA traveled to the Fishlake National Forest in Utah to look at geothermal-development issues there. In the spring of 1989, several managers of the Regional Forest Service Office in Portland traveled to California and Utah to look at geothermal development. In addition, dozens of local tours to Newberry have been made and continue to be undertaken.

Training Sessions

In February 1988, the Forest Service, in conjunction with the BLM, Bonneville Power Authority (BPA), and the Pacific Northwestern Chapter of the Geothermal Resources Council (GRC), sponsored a 2-day introductory training session at Central Oregon Community College (COCC) in Bend. This course, modeled after the introductory course of the national GRC, attracted participants from a number of agencies throughout the northwest. The reason for holding the meeting, however, was to train Forest Service field people who manage a variety of resource programs. These are the on-the-ground people who need to know how geothermal development activities will affect the programs they manage.

In April 1989, the Deschutes National Forest sponsored a 4-week introductory geothermal class at COCC for any interested person in the Central Oregon community. Over 40 people attended the course, emphasizing the interest shown by the community.

In November 1989, the Regional Office of the Forest Service sponsored a course in Geothermal Regulations for Deschutes employees. This course will be expanded this spring to a one-day community college course. In addition, the Forest Service is working with the local chapter of the GRC to coordinate two introductory geothermal courses and a geothermal Public Information Forum in 1990.

In December of 1989, the Deschutes National Forest participated in a geothermal panel discussion for the Northwest Power Planning Council. The purpose of this presentation was to look for ways to facilitate geothermal development in the Pacific Northwest, a key part of which will be working with the public. There is a strong sense that unless a proactive public-information program is instituted and the public effectively involved in the process, geothermal development will not take hold in the Pacific Northwest.

Displays

With the support of the BPA, BLM, and the Pacific Northwest Chapter of the GRC, three geothermal displays have been developed. These have been used by the Forest Service to interpret geothermal resources for the public and possible resource development in Central Oregon. The display at Lava Lands Visitor Center made its debut in the spring of 1989, and will reach thousands of visitors stopping at the center each year.

A portable display was also developed, showing the tours, press coverage, and public-involvement efforts to date. The display was exhibited at the national GRC meeting in San Diego in 1988, and has traveled to numerous other meetings in Oregon and Washington. The third display, two relief models of Newberry Volcano, will be used in helping the public understand drilling and leasing proposals at Newberry.

Program Evaluation

What have the Forest Service’s public awareness efforts accomplished? They certainly have generated a lot of enthusiasm for involvement in geothermal planning efforts in the community and in the Forest Service, itself, and have also provided the basis for a factual response to geothermal proposals. Those involved in planning and executing the strategy have learned a lot about making such a strategy successful and where the pitfalls are. We have come to a number of conclusions that we fully intend to draw upon in future efforts. Some of the conclusions are:

1. A public-awareness strategy, like a marketing strategy, must be carefully planned (preferably written) and followed. It need not be extensive, but should include, at a minimum, a list of what is to be done, when, by whom, and how much it will cost. This puts the strategy creators in the position of managing the program, rather than others (the news media, special-interest groups, other public agencies, other companies) managing it for you—and not always to your liking.

2. The strategy must be proactive, not reactive. It is critical that it be initiated before a controversy ensues, if at all possible.

3. The selection and order of activities are very important. One activity builds on another. The timing of these activities, relative to other issues in the community, can affect the attention given to them.

4. The strategy must focus on the right people. All too often, we talk to people who already know what we want to tell them or who we know agree with us. These are generally not the people we need to spend our valuable and limited time and energy trying to reach.

5. Information must be presented objectively, factually, and unemotionally, and must not—at all costs—be viewed as a “sell-job.” Teach, don’t tell. This means dialogue, not one-way communication. People are instantly suspicious of being told how environmentally sound a project is, especially by the company proposing it, when this is done in an obvious selling manner.

6. A public-awareness strategy works best when it includes both the company proposing a project and the agencies involved. The agencies must be neutral, as this introduces objectivity into the program.

7. A public-awareness strategy takes a lot of time. The Forest Service planned for much more than could be accomplished. Rather than sacrifice quality, activities were postponed that were not critical to the overall plan. It is also critical to offer followup activities, (e.g., meetings, tours, informal discussions, etc.) that are also time consuming. Once people become involved, they need to be kept involved, so they are there when you need them.

8. Local support is the key to success of any geothermal project. Facilitating the understanding of a project is the best way to gain that support. From an industry standpoint, the best way to avoid administrative log jams is to build local support with a public-involvement strategy. Working together with local conservation groups, chamber of commerce representatives, and others in the community will—in the long run—take you much further than lobbying at...
The Consensus Process: Creating a National Monument Designation for Newberry Volcano

Almost 2 years ago in the Deschutes National Forest, it seemed as though Newberry Volcano crumbled. Actually, what ignited was not energy from the earth, but community interest when geothermal drilling proposals for forest leases hit the press in the fall of 1987. The event signaled to the public the possible construction of power plants on volcano flanks. Through efforts of the U.S. Forest Service and many others, that interest has evolved into a long, sometimes frustrating (but very successful) consensus process that may result in a National Monument Designation for Newberry Volcano. The following are my reflections on our experiences with this consensus process.

The group of people involved in the consensus process came from the timber industry, geothermal companies, recreation users, wildlife interests, tourism concerns, local government, the U.S. Bureau of Land Management, and the U.S. Forest Service. Representatives of these groups were contacted and all joined the monument committee—necessarily met internal and external assaults, albeit with difficulty, yet continually resurfaced, mostly intact. What held the group together for several important reasons, with the process? How were they able to agree on a package that satisfied everyone’s interests substantially? And finally, will the agreements be sustained through the rigors of the national legislative process?

The Tensions That Pulled It Apart

The monument committee had to contend with a variety of issues that threatened to bring the group’s effort to a crash-halt. 1. Initially, the group lacked good operating guidelines. Without clear rules by which agreements could be made, the agreements were not trusted. People felt left out of the process, that they were being treated unfairly, or that they were being manipulated. 2. Some individuals brought prior opinions about others to the consensus process. Previous experiences with specific individuals clouded some people’s ability to trust others in the group, despite good-faith efforts. 3. Physical distance played a role in communication breakdowns. Those who had to travel great distances missed some informal, spur of the moment meetings. They had to trust others to represent their interests fairly. 4. New people continued to enter the process after sensitive issues had been made by the group. This caused frustration and backtracking, and slowed down the process. 5. Many of the consensus participants reported to other entities, such as boards of directors, state groups, or immediate supervisors. While most operated as legitimate representatives for their interests and had the authority to negotiate for their interests, external pressures clearly came into play on numerous occasions.

6. Corporate philosophy, whether from a private or public corporation, appeared to conflict with the concept of consensus. Some individuals continued to operate as if they were closing a business deal or playing a hand of poker, trying to outmaneuver an opponent. Focusing on interests, not positions; explaining why; and openly sharing information made some people uncomfortable. In the end, some individuals truly did not catch on to the idea of a consensus. 7. Unrelated political tensions facing national environmental and industry groups played a role in committee negotiations with such groups. Specifically, the old-growth/spotted-owl issue was heating up at the same time the monument issue surfaced, with some environmental groups in Oregon critized for giving up too much too soon in that process. Initially, this made it difficult for the national groups to support the monument legislation, because it appeared to them as too much was given up in the process. 8. Pressures increased when the economic status of some of the participants changed in the process, and travel was constrained.

9. The consensus process took a tremendous amount of time and, toward the end of the process, most people had little energy left for dealing with much of the controversy.

The Glue That Held It Together

At a number of points in this process, most of us in the Forest Service would have given odds that the proposal would be dropped, that it could not overcome the pressures and interests involved; and yet, the process overcame the obstacles, time and time again. We have concluded that the group held together for several important reasons. 1. As the proposal evolved, almost all participants stood to gain more by supporting the proposal than by not supporting it—to varying degrees of course. Geothermal companies, though they lose lease rights inside the monument, acquire equal-use rights, noncompetitively, closer to the heat source in the volcano. Timber interests maintain a boundary that has minimal effect on long-term timber supply. Environmentalists get a monument that protects the area, and government sees benefits to tourism, and the federal government may avoid years of appeals and litigation over where geothermal leasing can take place. 2. After 18 months of involvement, most individuals were dedicated to the process and wanted to see it completed. 3. Most of the key individuals involved in the process had consensual personalities. They were good listeners, were willing to work towards mutual goals, and had a strong sense of personal and professional integrity. They encouraged people to think in terms of what they wanted, not what they thought they should get or what they stood to lose. 4. As time went on and people understood one another better, personal bonds, even friendships, developed. These bonds meant as much to some participants as the agreements. Most participants knew that they would be working together on future issues (e.g., geothermal development activities outside of the monument proposal). To some, it was critical that relationships remained intact to ensure more ease in reaching approval for these future projects.

Role of the U.S. Forest Service

The U.S. Forest Service played a key role in this effort and will likely be called upon to serve in similar roles elsewhere. The proponents of the monument were local professionals—doctors, attorneys, and business people who had little time and experience coordinating an effort of this magnitude. While they abounded in self-confidence and enthusiasm, they generally did not have the skills or experience to draw on. The Forest Service did, and it played an indispensable role in advising, coaching, facilitating, and supporting the group as it moved forward. Also, the Forest Service had most of the information needed to make the resource decisions called for by such an effort.

To Summarize, the Forest Service:

1. Encouraged the committee to include all parties affected by the process,
2. Organized the field trip to Mt. St. Helens National Monument/Columbia Gorge,
3. Conducted a structure and process for conducting business
4. Provided facilitators and mediators
5. Provided resource data and conducted analyses
6. Provided legislative drafting services
7. Offered the skills and knowledge of resource experts, especially in geology and landscape architecture,
8. Served as the key link between the committee, Congress, the BLM, and the U.S. Forest Service's Washington, D.C. office staff, and
9. Offered critical advice on public-involvement efforts and interpersonal-communications needs.

In addition, in the year prior to the monument proposal development, the Forest Service conducted an extensive public-outreach effort on geothermal resources, by coordinating and offering classes at the Deschutes National Forest, providing a display at Lava Lands Visitor Center, giving numerous presentations, and leading a tour of geothermal

GEOThermal HOT LINE
power for community leaders, the Forest Service established a strong, open dialogue with the community on geothermal resource development. Individuals involved in these efforts played an effective, key role in the monument process.

Role of Others

A number of others played important roles in the monument effort, and, without their participation, significantly different outcomes might have occurred. The news media, particularly in Bend, was very supportive of the consensus effort and gave it fair and consistent coverage. The BLM was responsible for some of the more delicate negotiations on compensating geothermal leaseholders. These efforts, mostly invisible to and out of the hands of the monument committee, were some of the most difficult of the process.

The office of Congressman Bob Smith (R-OR) made important contacts in Washington, D.C. and was consistently available for advice and organizational support. It was clear to everyone that this proposal was important to them, and they responded quickly to every request.

The Legislative Affairs Staff for the Forest Service in Washington, D.C. was similarly connected to the process. They provided advice on a daily basis and steered the process in a direction that would most likely result in the agency's approval. Similarly, the chair of the monument committee is due much credit for holding the committee together over the two-year period. His willingness to listen to all sides, to openly discuss the issues, and to negotiate reasonable compromises between the interests were key factors in holding the effort together.

Why Public Meetings Don't Work

A public meeting—series of meetings—may meet the letter of the law, and even the intent of the law, but in all likelihood it won't build support for a project, it won't develop the public trust in the proponent or the agency promoting or permitting the project, and may very well ring the death knell for a project. How can this be? We're required by a plethora of laws to their opinions, often without all of the facts. Clearly, the meetings often come too late in the public-involvement process.

2. Many public meetings are poorly managed and facilitated. An agency that calls a meeting is often doing it to satisfy an obligation. It tends to convey the sense that the decision is already made anyway, and that input isn't really going to make that much difference. The words may not say this, but the public's perception is that this is the case. This impression results from unclear objectives, unfocused discussion, and poor direction and leadership.

3. Public meetings are overused. People have been to hundreds of these meetings, many of them unproductive. It shouldn't be too surprising that people don't come to lots of meetings, unless they are angry and want to vent their anger. However, just because they don't come doesn't mean there is no opposition to (or support for) a project. Often, individuals have elected to give their input in the form of protests, appeals, and marches on the governor's office.

4. Public meetings are impersonal. Information is passed in one direction only, and no effective dialogue is developed. No personal relationships form, and no trust is encouraged.

5. Public meetings often set a convenient stage for opponents of a project to rally the support to kill it, right then and there. Armed with inaccurate information and intense emotions, one project opponent can do more to stop a project in a single emotional speech (especially with a ready audience and the press on hand) than a proponent can possibly hope to combat, armed with the best data and rationale. Is it fair to do this to a legitimate project? I maintain we do it all the time.

Public meetings are not inherently bad, they simply need to be carefully orchestrated as part of a more complete and effective plan for public outreach that develops trust through dialogue, and understanding through proactive, participatory education programs.

Combating NIMBY: How To Build Public Support

Conventional marketing approaches can work when you are selling a project to an engineer or industrial plant operator. But the strategy will fail, possibly embarrassing your chances to permit a project, when you attempt to sell your alternative energy project to the public.

A public relations problem, labeled with the trendy acronym NIMBY “not in my backyard”, has become an increasingly popular response to new development. Indeed, the NIMBY phenomenon is part of our inheritance as power-plant builders.

NIMBY describes an understandable, thoroughly American trait. Everyone will defend their property if they believe it is threatened.

But NIMBY has become more than a matter of dollars and cents. NIMBY opposition often takes a nastier turn, where project opponents enlist environmentalists to join them. By the time this opposition reaches outside the neighborhood it may be too late to contain it through mitigation. When things escalate, the opponents often take an “all or nothing” position.

by Robert Kahn
President of Robert D. Kahn & Co. Inc., a public relations firm in Sacramento, California.


by Sally Collins
Lands and Minerals Staff Officer
U.S. Forest Service
Deschutes National Forest

by Robert Kahn
President of Robert D. Kahn & Co. Inc., a public relations firm in Sacramento, California.

Study how decisions are made in the community. Observe several city council meetings; watch the dynamics of the city's leadership. Find out who the town's opinion makers are and the role the media plays in town. Determine what is the town's most important new economic trend: is the community growing or declining? What are its aspirations?

It is also important to identify competitive forces in the area. Is anyone planning a similar project? Has a previous developer sounded people on it?

Your research will lead to a comprehensive assessment of the community. The report will help you determine whether or not to build there. If environmentalists defeated a solid waste plant the year before, what chances do you think you'll have to site a waste-energy project? Perhaps another community will be more hospitable.

Announcing the Project

Once you've determined to move ahead, carefully plan the official announcement of the project. Chose in the town's leadership well before you make your formal announcement. Also be sure to inform your future neighbors at this stage. If possible, accompany citizens to attend the press conference. It helps to be welcomed to town by the head of the Chamber of Commerce, local construction trade union, or government group. These groups' support will be vital if the project becomes controversial later on.

Selling Your Project to the Public

Emphasize the project's benefits to whomever you're speaking with in the community. Show how the project will improve air quality by displacing existing pollutants. Emphasize the employment potential of the project and show it its value to the total tax base.

Provide ample information about the project--to your supporters and your opponents. Be as generous distributing information about the project to the community as you have been thorough in collecting information about it.

Since you'll probably be preparing an EIR, be forthcoming on every aspect of your project in advance--all of it will come out eventually anyway, and you'll look better if you volunteer detailed information of your project before you're required to do so. A key advantage of full disclosure is that you enhance the credibility of the project's positive aspects when you "tell all."

Countering Opposition

An attack on the project can come from disgruntled neighbors, from unions (if you're nonunion), or from self-proclaimed environmentalists, or from a combination of the above. You may also have behind-the-scenes opposition developing from the local utility, powerful real estate interests, or competitors.

Don't panic. If you've laid the groundwork properly for the project, your supporters will be willing to stand by you. Their support is necessary because politicians typically watch carefully to see who fields the largest crowd. A project developer needn't show that he or she has stronger support than the opposition, but he or she must demonstrate credible support--enough to show the politicians that they won't lose office for supporting the project.

Building public support in the middle of a controversy is nearly impossible. It's always hard to get people to help you, particularly if you are despised when you ask. You need people to send in letters to the newspaper; contact local decision makers; attend public meetings; speak out in support of the project; and host community-open your plans well before the project starts. You can build trust by being open and proactive; disclosure won't help you if it comes about as a result of pressure.

The National Energy Strategy, January 1990 Update

The new National Energy Strategy will play an important role in determining the mix of energy technologies the Bush Administration and Congress will support during the coming years. Admiral Watkins, Secretary of Energy, has formed a task force to write the strategy. This task force is seeking input from the public. Admiral Watkins stated recently that public input will form the most important data base for development of the strategy.

Energy technologies that are not mentioned in the National Energy Strategy are not likely to receive support from the top management of the U.S. Department of Energy (DOE) or from the Congress. The impact of this strategy on the entire geothermal industry could be significant, for better or for worse. A negative evaluation would make it more difficult to obtain tax, royalty, and lease treatment favorable to continued geothermal development. Geothermal energy might not receive favorable treatment from regulating bodies and environmental groups. And federal and state geothermal programs could suffer. In short, geothermal energy could become a nonissue.

Geothermal Outreach in Utah

On October 1989, about 40 people attended an all-day seminar for Utah geothermal developers and regulators. The seminar, first of an annual series, was held to bring Utah's geothermal community together for education and informational exchanges. The seminar was organized by the University of Utah Research Institute (UURI), and sponsored by UURI and the Utah Department of Natural Resources.

Highlights of the first session included a discussion of future electrical demand by consultant John Geyer. John concluded that the utilities will soon be faced with a deficit of generating capacity, with aging plants, and with increased pressure to limit carbon-dioxide emissions because of concerns about the greenhouse effect.
The geothermal community has not done its job in getting the word out. Lack of credible information hurts developers when they interact with regulators, causes environmental groups to campaign against geothermal energy when they should be supportive, makes it difficult for companies to obtain proper tax, royalty, and leasing treatments from state and federal governments, and for federal and state agencies to maintain their geothermal budgets.

Few of these items are problems for solar developers because the solar community spends a considerable amount of effort on education and communication as well as on lobbying at the federal and state levels. If our industry is to thrive, we must begin immediately to make up our deficit in public education. The UU1 seminar was conducted as a first step in this direction.

New Geothermal Group Formed

A new group has been formed, the Geothermal Association of Imperial County. Currently, membership is open to power producers and steam developers. The membership may be expanded in the future.

Geothermal Energy Education Office

A Geothermal Education Office has been established in Tiburon, California, by Mary Condy and Marilyn Nemenz. Ms. Condy and Nemenz created the office to help teachers find current, accurate information on geothermal energy. They would like everyone with printed materials, slides, or videos that teachers might wish to use, to send samples to their office. If you are a teacher, or just interested in energy education, ask to be on their mailing list. The office is at 664 Hilary Drive, Tiburon, California 94920. Phone 1-800-866-4GEO.

The meeting was a success and that there was something of interest for all.

We need education and communication about the potential of geothermal energy to provide a clean, reliable source of electricity, as well as home and industrial heat. Whereas the general public knows about traditional energy sources such as natural gas and coal, few people even know that the earth is hot inside and that this heat can supply a significant portion of our energy requirements without releasing gases that contribute to the greenhouse effect.

A feasibility study for a Geysers Area Geothermal Technology Center was prepared for Lake and Sonoma Counties in January 1987 by Blaney-Dyett, Urban and Regional Planners, MBT Associates, Architects. Plans for the complex include a vista point overlooking the field, an exhibit room, a picnic area, an office, a laboratory for geothermal studies, a small conference room, and parking facilities.

Geothermal operators at The Geysers were asked to rank the relative importance of the function of such a center. More than half indicated that visitor information was very important, and two thought this function would be somewhat important. No other function was ranked as highly, as the following summary of responses shows:

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<th>Number Ranking</th>
<th>Activity</th>
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<td>5</td>
<td>Visitor Information</td>
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<td>Research Library</td>
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Geothermal Development in Costa Rican National Parks: An Interview with Dr. Daniel Janzen

On July 25, 1989, 210,000 acres of Costa Rican tropical dry forest, cloud forest, and rain forest became Guanacaste National Park. The park is not comprised totally of pristine, natural areas. Old farms, pastures, and other long-cleared sites are included, as well. Dr. Daniel Janzen, a professor of biology at the University of Pennsylvania and a major force in the park's formation, believes enough undisturbed land is needed for infrastructural development, that "...the natural world is by far the most diverse and intricate..."

Few of these items are problems for solar developers because the solar community spends a considerable amount of effort on education and communication as well as on lobbying at the federal and state levels. If our industry is to thrive, we must begin immediately to make up our deficit in public education. The UU1 seminar was conducted as a first step in this direction.

The Geysers Technology Center on Hold

In February 1989, the Board of Supervisors for the County of Lake decided against committing funds to construct and operate a Geysers Area Geothermal Technology Center. Although public support and interest in the project was strong, the negative decision was made due to financial problems in the county, where a great deal of money is needed for infrastructural development.

At the meeting, the Board of Supervisors did choose a site for such a center. The selected location is on the eastern side of The Geysers Geothermal field, quite close to Route 175 and just north of the Socrates Mine Road turnout.

A feasibility study for a Geysers Area Geothermal Technology Center was prepared for Lake and Sonoma Counties in January 1987 by Blaney-Dyett, Urban and Regional Planners, MBT Associates, Architects. Plans for the complex include a vista point overlooking the field, an exhibit room, a picnic area, an office, a laboratory for geothermal studies, a small conference room, and parking facilities.

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Dr. Janzen feels that "social decisions" are pivotal reasons for the success of his 25 years of work in Costa Rica. In early 1989, he spoke at the University of California, Davis, about social influences in natural restoration work. I asked him, then, his opinion on the development of geothermal power projects within the boundaries of Costa Rican National Parks. This is what he said:

D.L.: They're thinking about opening another geothermal project inside our park.
S.H.: And what do you think of that?
D.L.: I don't know, I have no problem with any of that.
S.H.: You have any reservations?
D.L.: No. The way I see it is I don't mind at all paying 5 percent of the surface area of a big national park if you can keep society feeling like you and society are working together. That implies that the park and the project work together. It's not an adversarial situation. Rather, it is one where they work to minimize the damage from whatever the project is.

In general, what do you think geothermal companies can do to help preserve tropical areas or other natural areas as geothermal projects are undertaken?
D.L.: Oh, it varies from country to country. I won't try a generalization for all companies in all countries. What I would say is that the concept I just mentioned is terribly important for any area. This is that the interaction between the environment and the park

The park and project work together. It's not an adversarial situation.

Susan F. Hodgson

by Susan F. Hodgson

Geothermal Hotline

DIVISION OF OIL AND GAS
The Sierra Club recognizes that geothermal energy is a potentially plentiful and favorable energy source. The heat energy stored beneath the surface of the Earth is vast, and could itself, if available, supply all of the energy needs of humankind. Its availability for direct use and for conversion to other forms of energy is, however, presently restricted to the utilization of naturally occurring underground reservoirs of hot water or steam. These are limited in number and capacity, generally depletable, and in many cases geographically situated far from sites of energy demand. Also, the exploitation of these reservoirs is frequently accompanied by detrimental impacts on the environment. Among these are the emission of toxic gases and chemical substances which result in the degradation of air quality, the threat of water pollution, damage to living organisms, and hazards to public health. Additional problems arise from the heavy industrial character of geothermal operations for electrical generation; the frequent occurrence of exceptional natural, scenic, and archaeological values in geothermal resource areas; and the adverse effects that geothermal fluid removal may have on nearby hot springs and other natural thermal features.

This factual situation leads the Sierra Club to adopt a position of caution with regard to present geothermal technologies, to recognize that they cannot contribute more than a small percentage to the national energy supply, and to favor the advance of other methods of Earth heat utilization which can, for the most part, be developed independently of naturally occurring hydrothermal reservoirs.

Specifically, we favor and encourage:

1. Non-electrical, direct heat uses of Earth heat and geothermal fluids for space, agricultural, and industrial heating in situations and localities where naturally occurring hydrothermal features will not be degraded; and

D. J. I can’t speak for the old-world countries, but for any new-world country where a geothermal company is going into production or beginning to do exploratory work or anything like that, there are plenty of biologists locally in the conservation community, in the university community, who can be involved with them. If they say they can’t find people, it’s because they don’t want to find people. They’re there.

For further information, contact Dr. Janzen at the Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104. Telephone (215) 898-5636.

Sierra Club Policy: Geothermal Energy

Adopted November 15, 1980
Policy Code 3.1.1

The following policy on geothermal energy has been adopted by the Sierra Club Board of Directors, and reprinted with permission.

1. The basing of all federal and state geothermal leasing decisions and all geothermal project permitting decisions at all government levels on appropriate data regarding environmental and social impacts;

2. The resolution of land-use conflicts in geothermal resource areas by planning and zoning appropriate to the protection of natural, archaeological, and social values;

3. The protection of hot springs, geysers, thermal pools, and other thermal features and their ecological, educational, aesthetic, and recreational values;

4. The gathering of predvelopment baseline data, the monitoring of environmental impacts and cumulative effects, and the adoption of appropriate environmental and social safeguards in relation to existing and proposed development projects;

5. The development of improved directional drilling technologies for minimizing surface disturbance in resource production areas;

6. The development of methods for the containment of geothermal steam and brines and accompanying gases and chemical components within enclosed production systems; and

7. Geothermal reservoir management procedures that will allow a balance to be maintained, where possible, between field recharge and heat and fluid withdrawal.

EXCEPT WHERE DIRECT HEAT UTILIZATION FOR SPACE HEATING IN BUILDINGS AND LODGES IS COMPATIBLE WITH PRIMARY PRESERVATION PURPOSES, THE SIERRA CLUB OPPOSES GEOThermal LEASING OR DEVELOPMENT IN THE FOLLOWING AREAS:

1. Lands included in or adjacent to federal, state, or local park systems or in wildlife refuges and management areas;

2. Areas known to provide habitat for rare or endangered species;

3. Areas designated as valuable for archaeological remains;

4. Units of the National Wilderness Preservation System;

5. Units of the Wild and Scenic Rivers System;

6. Units of the National Trails System;

7. Areas reserved by the Secretary of the Interior or the Secretary of Agriculture for ecological, scenic, natural, wildlife, geological, educational, historical, or scientific value, including Primitive Areas, Roadless Areas, National Areas, and Pioneer Areas;

8. Areas of de facto wilderness under study by the Secretary of the Interior or the Secretary of Agriculture for reservation as part of one of the preservation systems listed above; and

9. Areas of de facto wilderness which are the subject of intensive study by recognized citizen groups or coalitions, resulting in formal proposals to the agencies and/or Congress for reservation as a part of one of the preservation systems listed above.

For further information, contact the Sierra Club, Public Affairs, 730 Polk Street, San Francisco, California 94109. Telephone (415) 776-2211. A copy of the above policy on geothermal energy is available for twenty-five cents.

NOTE: Doug Scott, Sierra Club conservation director, has distributed a letter dated November 1989, describing a Sierra Club "Clean Air Campaign." The club will be addressing proposals in the Bush Administration’s Clean Air Act (see Legislation in this issue).
"Over 700 people attended. It was our most successful meeting since 1985, in Hawaii," said Dave Anderson, Executive Director of the Geothermal Resources Council (GRC). "The exhibits were sold out. The poster sessions worked well, and the program was excellent!"

During the meeting, in his address to the membership, GRC president James Koenig stated that the GRC membership mirrors the geothermal industry, reflecting its new stability. "The theme of geothermal exploration has been replaced by development, with focus on concerns for commerce, regulations, finance, and environmental impacts," Mr. Koenig said. "Most new GRC members come from the engineering, supply, and finance communities."

Dr. Carol Otte, former president of Unocal Geothermal Division and now senior advisor for the company, spoke about the meeting's theme: three decades of development at The Geysers Geothermal field. "Anyone interested in energy has come to The Geysers," Dr. Otte said. "Development at The Geysers launched the U.S. geothermal industry. Today, development at The Geysers has reached its maturity. We at Unocal feel it is steam is a depletable resource. Early power plants have had a 30-year run. Unocal hopes the earlier plants will be retired. The key to the future is developing new exploratory techniques. Are there other resources completely hidden? To find them means diligence and hard work. We know how to drill for and produce a resource. The real challenge is in finding them. Geothermal is an important part of our energy mix. "Geothermal can't be part of the energy scheme unless risk capital is provided. The government must take the lead and establish long-term political and energy policies," Dr. Otte concluded.

"As the DOE geothermal program shifts focus to assist industry in resolving the issues that constrain hydrothermal resource development, we must carefully evaluate and make hard decisions with respect to the allocation of our limited financial resources," Mr. Loose said. "The DOE feels that the R & D support of the Geothermal Technology Division should be focused sharply and effectively on the major technical and financial hurdles identified by industry as the greatest inhibitors to increased hydrothermal development. Throughout the development of the National Energy Strategy, we intend to make renewable energy, including the geothermal options, the "good news story" at the department," he concluded.

Joseph W. Aidlin, long-time developer and supporter of geothermal energy, summed up the sentiments of many in a luncheon address when he said, "Geothermal will fit the future because it's based on the values and needs of the future. Today, we have a greater concern to use the resources of our society in ways that best complement our way of living. Geothermal energy fits this mold."

Ronald L. Loose, Director, Office of Renewable Energy Technologies, U.S. Department of Energy (DOE), also spoke. He said that by conservative estimates, the United States' geothermal resource accounts for nearly 40 percent of the nation's total renewable energy resource base.

The CEC hearing notice stated that "This information (the decline), if correct, has important implications for the CEC's electrical supply forecast, related transmission and power plant and siting cases, geothermal research and development, and general state energy policy."

Representatives from private geothermal steam-producers and power-plant operators, state agencies, public utilities, and the U.S. Department of Energy were among those asked to present testimony at the hearing. Questions to which they were asked to reply included: What is the extent of generation decline in the KGRA? What are the causes for this decline? What is the predicted extent of future decline? What measures could be taken to ameliorate the decline?

"Geothermal will fit the future because it's based on the values and needs of the future."


On a field trip to The Geysers Geothermal field. Photo by Susan F. Hodgson.

Are there measures which should be taken to preserve other KGRA?"
Unocal representative stated. "Unocal feels that measures already in place or identified at The Geysers can be effectively expanded to improve declining performances there."

Pacific Gas and Electric Company (PG&E) testimony included the following statements: "As a power-plant operator, PG&E is trying to extract the most value for its rate payers from the steam supply. For some time, PG&E has been implementing a program of modifying equipment at The Geysers to minimize the steam utilization rates. Several units have had turbine-tip seals, turbine water-wash systems, and/or condenser modifications installed. Changes to turbine casing drains and air ejectors have been made at some units to reduce steam consumption. PG&E will continue to evaluate these and other modifications for its units and implement them where it is economically justifiable to do so."

The Geysers have a long productive life. Measures to be taken in The Geysers and other fields, if necessary, are clearly going to be directed toward preservation of the resource for its best use now, and more particularly for the energy and environmentally sensitive years ahead. The Geysers, therefore, should properly become a model for U.S. geothermal provinces for the long-term objective of improving their accuracy. Third, the advisory committee may make recommendations to the Energy Commission, the Department of Energy, and other appropriate parties regarding the efficient management of the steam resource."

U.S. Department of Energy

In addition to the activities of the CEC, the Geothermal Technology Division of the U.S. Department of Energy (DOE) announced that, because of the situation at The Geysers, it will participate in what Director John E. Mock called "...a broadly supported, highly focused research effort."

The Geothermal Technology Division has "...embarked on a Program of modifying and comprised of experts representing the developers and operators at The Geysers. In addition, the California Division of Oil and Gas and the California State Lands Commission will be represented."

The advisory committee will prepare the generation and energy projections for The Geysers to submit them to the Energy Commission in January 1990 for use in the upcoming Electricity Report. Second, the advisory committee will initiate a thorough review of the existing reservoir models and numerical codes with the long-term objective of improving their accuracy. Third, the advisory committee may make recommendations to the Energy Commission, the Department of Energy, and other appropriate parties regarding the efficient management of the steam resource."

The advisory committee will focus on specific issues and the following recommendations have been made:
- Developing and field testing new geophysical equipment designed for surface and downhole measurement of electromagnetics and seismic attenuation to map fracture location and orientation;
- An analysis of production and interference test data to refine computer models of The Geysers. The models are needed to confirm methods that predict reservoir processes and evaluate the response of the system to development;
- The development of equipment and methodology to identify stresses carrying injected fluids and to determine whether or not fluid injection and production produce strong, recognizable signals; and
- The development of potential success and of field techniques for tracer injection, sampling, and interpretation.

"The potential for extending the life of The Geysers through improved power-plant turbine efficiency is another research area at The Geysers that the DOE will consider as a possible basis for cost sharing with industry," Dr. Mock said. "Both power-plant operators and DOE heat-cycle researchers have suggested investigating several means for reducing the amount of steam required per unit output of power."

"Industry must take the lead in defining the problem and prioritizing a research agenda. The national laboratories under contract to the Department of Energy will help," Dr. Mock concluded.

After the Santa Rosa meeting, Dr. Mock and Marshall Reed, a Geothermal Technology Division program manager, met with representatives of companies operating at The Geysers, representatives from federal and state agencies regulating the KGRA's development, and scientists from research organizations investigating The Geysers reservoir. At the meeting, the attendees were asked for research proposals for The Geysers.

From the proposals suggested, two studies have been chosen for immediate DOE funding:
- "A Thermodynamic Study of Hydrogen Chloride Vapor" - a study that is underway at Oakridge National Laboratory, and
- "The Development and Testing of Vapor-Phase Tracers" - a study that is underway at the University of Utah Research Institute.

The remaining proposals will be considered by the DOE and industry representatives for possible joint funding, or for funding by the DOE.

Q. California Energy Commission: What is the extent of generation decline in The Geysers KGRA?

A. Pacific Gas and Electric Co.: PG&E Geysers Power Plant is currently experiencing a steam shortfall of more than 300 MW, or about 22% of its installed megawatts.

A. California Department of Water Resources: The (Bottle Rock) Power Plant attained 25 MW after generation sporadically in 1985 and 1986. Since then, it has not operated for any extended period at all.

A. Sacramento Municipal Utility District: The decline in generation at (Power Plant) SMUD-CEO #1 is directly proportional to the number of raw wells being drilled in the reservoir.

A. Central California Power Agency No. 11 Coldwater Creek Geothermal Power Plant has not yet reached full power runs using both units. Problems in the steam lines, particularly well drilling (blockages) and corrosion, do not allow us to recognize or quantify a declining health resource. A declining problem is actually occurring within the steam supply area.

A. Northern California Power Agency: NCPA reduced the output of its geothermal power plants from 249 megawatts to 132 (MWW) in April of 1988 and reduced the output even further to 152 MWS in November of 1988. This reduction was not made for reasons of production but for the reason that NCPA's geothermal plants were running at only 30-40% capacity and the heat load reductions was to attempt to operate the plants on a more economic basis. The cutback, the NCPA's geothermal power plants feed the effect of reducing the fuel consumption for electricity at California's major power plants.


* All responses are quoted from testimony presented at the 9/21/98 California Energy Commission Informational Hearing on the decline of electrical power generation at The Geysers KGRA.
Dam Planned for The Geysers

The Northern California Power Agency (NCPA), a consortium of 12 California cities, and Geysers Geothermal Company are jointly proposing the construction of a dam on Big Sulphur Creek at The Geysers Geothermal field. The dam will be operated by NCPCA, who will manage it in accordance with a proposed joint, groundwater injection program. The injection program is designed to reduce steam-pressure declines and improve steam production on leases operated by the two companies. The proposed dam site is near the northern boundary of NCPA’s Geysers leasehold in Sonoma County.

Water yields from the proposed project are constrained by the amount of rainfall on the NCPA leasehold, the dam’s height, the installed pumping capacity, and the nature and extent of downstream-water use and associated water rights.

GEO Explains Corporate Situation

On May 1, 1989, Geothermal Resources International, Inc. (GEO) issued a statement regarding its geothermal projects and corporate affairs.

GEO, commenting on its Coldwater Creek Geothermal Project in The Geysers Geothermal field of Northern California, said the company continues to work towards establishing a cooperative funding plan, but little progress has been made during the past month. The objectives of such a plan, if agreed upon, would be to:

1) Provide for payment of nearly $6 million to project vendors, many of whom hold liens on the Coldwater Creek Geothermal Project and have the power to commence enforcement proceedings soon, and

2) Provide funds for two additional geothermal wells, installation of a corrosion-mitigation system, and improvements of certain existing wells.

Additionally, FRP will retain its undeveloped geothermal energy assets, located in the Salton Sea area of the Imperial Valley in Southern California and in the Medicine Lake area of Northern California, which (collectively) have a book value of approximately $22 million. The Calpine group will have a preferential right to fund future capital costs and to earn as much as a 50 percent interest in these undeveloped properties.

Half of Aidlin Plant Purchased

Fifty percent interest in the 20-megawatt Joseph W. Aidlin Geothermal Power Plant at The Geysers Geothermal field was purchased by Calpine Corporation and Metlife Capital Corporation. Calpine develops, owns, and operates power facilities throughout the United States. The company, established in 1984, is based in San Jose, California. Metlife is an affiliate of Metropolitan Life Insurance Company, based in Bellevue, Washington.

The two firms formed a partnership, Cloverdale Geothermal Partners, which purchased one-half of the plant from Geothermal Energy Partners Ltd., a partnership of two subsidiaries of Mission Power Engineering Company, of Irvine, California, itself an indirect subsidiary of SCECorp.

The Aidlin Power Plant is being operated by Calpine under a 5-year contract. The new plant began operating in May 1989.

Freeport-McMoran Resource Partners Announces Agreement To Sell Geothermal Energy Assets


Freeport-McMoran Resource Partners, Limited Partnership (NYSE: FTX), to a joint venture involving the Calpine group for a cash consideration of $254 million and a 55 percent interest in the joint venture after a defined payout of the Calpine group’s investment. FRP will recognize about $60 million in its financial statements as its investment of the 55 percent residual interest in the producing geothermal energy properties.
Unit 15 Sale Discussed

Pacific Gas and Electric Company (PG&E) is investigating the possible sale of its Unit 15 Geothermal Power Plant at The Geysers Geothermal field. The reason given by a PG&E spokesperson for the possible sale is "lack of steam available to operate the plant."

Unit 15 began operating in 1979. It was built for about $37 million. Discussions on the possible sale are underway with Oxbow Geothermal Corporation of Reno, Nevada, and other companies.

Old Letter Found

On January 26, 1908, the following letter was sent to the California State Mining Bureau, under the above letterhead.

Gen'l: 
I enclose pieces of ore which please identify. 
I have found a large ledge of it. 
Is there any use for it or value?

Yours respectfully, 
J. W. Gilham

As a reply from the Mining Bureau, "manganese ore" was penciled in at the bottom of the page.

Highland Springs is at the southwestern corner of Big Valley, in Lake County, California. The drawings and captions that follow are reproduced from the back of this sheet of stationery. The resort's claim to "no steep, narrow, or dusty roads in going to Highland Springs," may be a reference to the stagecoach roads used by visitors traveling to The Geysers Resort, today The Geysers Geothermal field.
A Visit to the California Geysers - 1888

by Dr. Winslow Anderson

This excerpt by Dr. Anderson is reprinted, with permission, from the August 1960 issue of the Mineral Information Service (now, California Geology). It is included for its details about The Geysers area, and for Dr. Anderson’s prose.

From 1847, when they were discovered, until the 1890’s, the geysers were inundated with more or less continuous descriptions of the wonders of The Geysers by writers, ranging from poets to professional tourists. The one quoted here is one of the last unexaggerated, but more interesting accounts. Its author was Winslow Anderson, M.D., who was awarded the annual prize of the Medical Society of the State of California for the year 1899 for the book in which it appears. The book, entitled Mineral Springs and Health Resorts of California, was a complete chemical analysis of every important mineral water in the world, published in 1892 by the Bancroft Company. It has been abridged by the omission of chemical analyses and medical recommendations, and republished as "The Geysers" and "Alum Springs." The reader should be warned that Dr. Anderson was a physician, not a geologist; although his accounts are no doubt useful medically, and is one of the most interest- ing of the travelogues of the day, his geology is not as good as in addition, some plots sooner have changed since 1888, and may be confusing to the modern day explorer.

The rarefied region--this breath of Health, nodding along the unbroken oaks and pines in the pine-clad mountains, still of momentous grandeur and beauty, dotted with dense groves of fern and wild flowers, and surrounded on all sides by the Sierras and the rugged coast ranges. The northern mountain overlooking this partially extinct volcano is Cloverdale, and 26 miles from Calistoga. This Plutonian realm is situated about 1,700 feet above the sea level, and is surrounded by the Sierra Nevada, part of Sonoma County, about 100 miles north of San Francisco, 16 miles from Cloverdale, and 56 miles from Calistoga. The hilly region was discovered by Mr. William B. Ellis. One day while hunting in that section of the country he ascended a mountain overlooking this partially extinct volcanic region, and came suddenly upon this wonderful scene. Such scenes in fear and astonishment he beheld for the first time The Geysers! He remained awe-struck for a few moments, and then hastened away to warn his companions that he had discovered the very mouth of the infernal regions! Since that time the present fame of those famous spring have been the object of wonder and admiration to all the many thousands who have seen them.

For many miles up the narrow mountain road which winds over this great waste of land, which is about three-quarters of a mile square, there is no other road to be seen for many miles, save the one that leads to the very mouth of the infernal regions! Since that time the present fame of those famous springs have been the object of wonder and admiration to all the many thousands who have seen them.

In the immediate vicinity of The Geysers several large deposits of sulfur and quicksilver have been mined and ores shipped to San Francisco.

Near these sulfur banks we found the famous "Indian Springs," at which the great Edward Faxon fished for many years, and was completely restored to health. Tradition informs us that our ancestors traveled to these springs to drink and bathe, and in the extreme mountainous parts of California, where all the gardians and beauty of the surrounding country. Leaving the Blooming Grotto, we now entered a deep and steep ravine, from which we were completely restored to health. Tradition informs us that our ancestors traveled to these springs to drink and bathe, and in the extreme mountainous parts of California, where all the gardians and beauty of the surrounding country. Leaving the Blooming Grotto, we now entered a deep and steep ravine, from which we were completely restored to health. Tradition informs us that our ancestors traveled to these springs to drink and bathe, and in the extreme mountainous parts of California, where all the gardians and beauty of the surrounding country.

As we drew nearer and nearer the sylvan resort our ears were filled with the sound of the mountain waters, as they rose several hundred feet into the air. In the morning the sun's rays caress the spiers so that they are not visible in the face above the ground.

You are now amid a long trail, such as the pilgrims of old, and with your guide you set out to cross the Plume River—this place on a bridge. Before doing so, however, your atten- tion is called to a cool, clear spring, known as "the ringspring. It is located near the edge of the Plume River, on the same side as the hotel. This large spring, on analysis, is found to contain valuable silica-chloride (lime) mineral waters. Immediately after crossing the Plume River, a change in the atmosphere becomes noticeable. On the side where the

The many cozy cottages, the hotel and grounds, are situated in a lovely dell on the side of the mountain opposite Geyser Colony. The huge oaks and pines afford pleasant shade to the traveler, sheltering him from the heat and rain, and enjoying the pure, dry, in- tertwining and exhilarating mountain atmosphere and picturesque scenery, which surrounds you on every side.

Having indulged in one of those special sulfur Hammam baths, where the air is saturated with white and pearly steaming up to the medicinal effects of the mineral ingredients, you are ready for dinner, and a good one it was during our visit to The Geysers in 1888.

The evenings are cool, clear and charming, inviting sound and refreshing sleep.

A Trip Through Geyser Colony

Bright and early next morning we set out for our trip "over the river" to his majesty's Plume River. In the summer season the best time to start out is from 4:30 to 5:00 a.m., in order that you may penetrate the thick forest of the Plume River, and without fear of disturbing the eyes of the Plume River, on the same side as the hotel. This large spring, on analysis, is found to contain valuable silica-chloride (lime) mineral waters. Immediately after crossing the Plume River, a change in the atmosphere becomes noticeable. On the side where the

The head and resort and the many picturesque and cozy cottages are built, the air is pure, clear and refreshing on the side where Geyser Colony is located, the atmosphere is mixed with the perfumes from the interior racines.

Near the path on the bank of the river, as you proceed up the course for many miles, you see all the grandeur and beauty of the country, which is far in height and breadth as the valley of the Plume River. The sun is setting in the mountains, and the mountains are in the rays of the sun. The sun is rising in the mountains, and the mountains are in the rays of the sun.

The rapidity with which the light of the sun is rising in the mountains, and the mountains are in the rays of the sun. The sun is rising in the mountains, and the mountains are in the rays of the sun.

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One of the most interesting springs is Geysir Caron is the "Devil's Cauldron," a large, boiling, circular spring of over seven feet in diameter and of unfathomable depth. The water has a temperature of 212° F. and is constantly boiling and bubbling. The spring is a black, sulfur-laden fluid as black as the inkless chalice of pitch. At the present moment "round about the cauldron git" they sit, in their imagination, the silent ghost of Bangor rising and manifesting in the flames of the "charred pot," and with a small stretch of the imagination you may more or less see and hear their hearty voices chanting a solemn incantation.

On analysis this remarkable fountain, having its source probably hundreds of feet below, yields water rich in sulphur, calcium and magnesium sulfates.

Next comes the "Devil'sCauldron" and the "Geysir Safinysyl," a retreating, scalding spring, which emits streams of boiling water to the height of 14 feet; then the "Devil's Polya," a little elevation where his Soniac Majesty (impenetrable) goes to drink the workings of his laboratory.

A little farther up and in the heart of the "Steamboat Geyser," which can be heard a mile or more away, blowing and moaning intermittently at high pressure. This is singly a true geyser. The steam is so hot that it does not begin to condense until it is ten feet or more from the surface. Eruptions are very rare here. One3-4 meters rise; but what makes the noise, as the steam is not visible. The temperature is 214°F. It is the "Devil's Cauldron." A little east of this is located "Alkali Lake," and the "Lava Beds." Here the cist is so great that churning hard on a produce a hollow sound. This evidently a natural vol- canic crater on a small scale. We now pass the "Indian spring" and come to another remarkable spring known as the "Devil's Terra Nova." This is one of the strongest vapor springs on the coast. The orifice is three feet in diameter, opening out of the side of the mountain with a huge boulder over- hanging it. The "Terra Nova" spring is about half a mile from the active springs in Geysir Canon. The water is emitted with such force that a large bunch of brush planted in front of it is immediately burned. The steam is above the boiling point and is sulfurous in character, and contains a large quantity of free sulfuric acid. Formerly a huge cone used to be seen here, and it was constructed over the crater; but it made such a noise as to keep the guests awake at night, and was blown away. The water is 217°F.

Your route now lies along the side of a mountain where a narrow space between the hot water and rock. Below you in the Plume River, and above you the snorting geysers. Boiling from the side of the solid, hot mountain are innumerable innumerable springs—the "Iron Acid" and the "Lemonade," whose waters vary in the proportion of sulfuric to the waters. The winter water is used in the parts of the mountains, and the lemonade spring from the fact that it is the first spring in California to contain free sulfuric acid.

The water is pleasantly sour, and with sugar and syrup, makes one of the sweetest lemonades. The name of the spring is "The Devil's Own, a large area in a small hole in the mountains where in your eyes but by the sight of the white mass. All over this region of subterranean steam the earth is covered with the gases: sulfur, chlorine, iron, magnesium, nitrates, etc., etc. In addition these fumaroles are fulminating and sulfurous.

Several miles above the Plume River has been con- structed a large and commodious bathing establishment, which is fitted up with all the latest conveniences and comforts that can be arranged.

The hot sulfurous water is used directly through the side of the mountain, which is a most suitable apartment wherever the bathe can enjoy the medicinal effects of the sul- forious fumes and steam vapors at any desired temperature. Therfore there is the pleasure and relaxation of the chattering hot springs, and comfortable dressing-rooms. One-half of the bathing facilities are for ladies and the other half for gentle- men. This bathing fluid is remarkable on account of the large amount of heat it holds in solution.

This is one of the best bathing waters on the coast. The waters and sulfur render the skin soft, white and elastic, cleansing the 7,000,000 little pores on the curious surface of an average-sized man.

A large swimming pond has been constructed by damming the Plume River. The water has a temperature of 215°F., and is a combination of all the mineral springs water. The Geysir Springs, hot and cold, flow daily about 100,000 gallons. The area covered is about 400 acres. Most of the activity, however, is confined to the "Devil's" or Geysir Canon, and comprises about 40 acres.
Remarks on Three Reservoirs: Wairakei, Larderello, and The Geysers - 1989

The following essay is based on a presentation by Dr. Ramey on September 13, 1989, to the Society of Petroleum Engineers and The Geysers Geothermal Association.

Larderello and Wairakei: Here are two totally mature systems that have gone through stages seen at The Geysers in recent years — rapid declines in rate, rapid declines in pressure, but then changes. Here are two systems that you would think were exhausted, and, instead, there’s a fresh wind blowing, and brand new plans to continue to extend the development of both reservoirs. Will this occur at The Geysers?

In the early 1960’s, the problem at Wairakei was that the pressure appeared to be dropping rapidly. I was asked to do the reservoir engineering and the thermal calculations for the field. It was plain that we were going to need heat balances like those used in steam-injection oil recovery. I began to search the literature on geothermal systems. Many conclusions were logical. One idea was that systems like Wairakei were big, active hydrothermal systems. There was natural recharge of surface waters at depth into them. If you could discover the recharge rate and produce at that rate, you’d have an inexhaustible energy source that would last forever. This seemed reasonable.

The only thing that I saw in the literature that didn’t make good sense was a comment that because all oil and gas reservoirs are closed systems, separate from any source of recharge, and because all hydrothermal geothermal systems are recharge systems subject to water influx, there’s nothing in oil and gas reservoir engineering that applies to geothermal systems. I knew this to be wrong, because I’d been doing water drive gas and oil reservoir performance matching and design for a long time.

The Wairakei steam field was originally a compressed, hot liquid field, unlike The Geysers in that it was mainly filled with liquid on discovery and development. My students and I were given the production history and asked to calculate what would happen in the future. We had already developed models for water-drive petroleum reservoirs. All we did was add energy balances and other features specific to a hot-water geothermal system. We correlated pressures with depth, time, and areal location, finding a good correlation all over the field. We did a performance match with several kinds of aquifers recharging the reservoir. The computer program was designed to select the aquifer by minimizing the difference between the measured and computed pressures.

On the first pass through the program, the program printed out “no recharge,” rejecting recharge on the basis of significant numbers. My reaction was surprise because I was convinced that Wairakei was a recharge system. Having reviewed field data, I was sure that there were leaks from the reservoir running to the surface. It appeared that natural recharge was small compared to production from wells. There was no reinjection.

The reservoir model used assumed there was an unknown reservoir, that it contained initially some pounds of steam and some pounds of water. It had an unknown volume and rock, and initially started at some temperature and pressure. There was natural, terrestrial heat flow through the system at the start. There could be recharge into the system of water at some enthalpy, perhaps unknown. Then, the system is produced. We measure what is produced (the mass and the enthalpy, among other things), and we measure the pressure and temperature at the wells.

The numbers that came from the performed match for the mass of water were very large. We didn’t realize it at the time, but the apparent compressibility of geothermal systems could be 100- or 1,000-fold larger than the isothermal compressibility of hot water. We decided that we had measured not only the reservoir fluid, but much of the aquifer recharge fluid, as well.

In trying to do this New Zealand study, I sought data about Larderello, in Italy. Larderello was a steam system, like The Geysers. The system was drilled around the turn of the century, and I was specially instructed in Larderello, expecting that there would be enough performance history that we could do performance matching. However, at the end of World War II, we bombed the Italian steam field, and the Germans blew up everything that we didn’t when they left. There wasn’t much old performance information.

I began to study The Geysers when I moved from Texas A & M to Stanford in 1966. We had just finished the Wairakei study. Although it looked like we had gotten a marvelous match and everything seemed to make good sense, one thing bothered me. We forecasted that in the future, liquid would begin to boil in the reservoir and form a steam cap, and that the steam cap would grow. We said it would become like a gas-cap oil reservoir, and the water that was left, the so-called immiscible water saturation, would have to vaporize. When it did, perhaps capillary pressure would begin to affect things. The temperature and pressure wouldn’t be those of a flat surface of water boiling on a stove above ground.

Instead, there should be vapor pressure suppression as the liquid saturation became lower and lower. As it became more and more difficult to vaporize the liquid, a good question was, How much of the liquid could actually boil? How much would affect performance? We didn’t know, and we began research to solve the problems.

In the fall of 1966, I was approached by Pacific Gas and Electric Company (PG&E) and asked if I could do the same kind of thing for The Geysers that I had done in New Zealand. Al Brace of PG&E handed me a piece of yellow-lined paper with a list of questions. He told me there was little data. The wells hadn’t been produced. He asked me how many megawatts could be installed, how long power production would last, and the other rather important questions we’re still wondering about.

When I began this study, I spent about a month in the offices of the Thermal Power Company on Market Street in San Francisco, reading all of the drilling tour reports. I met many geothermal pioneers who impressed me. From the steam production side, Mr. B. C. McCabe of Magna Power and Dan MacMillan of Thermal Power Company were giants. I admired both of those men and enjoyed talking with them.

Other pioneers worked for PG & E. Dean Worthington was a vice president who had the vision to recognize the future of a new energy source during a time the price of crude oil was at an all-time low.

We began to do engineering. At the time that this study was requested by PG&E, data for The Geysers were confusing. The pressures that we measured in the first set of pressure builds up in February 1967 indicated a broad range of pressures in the field. The original attempt to assess this thermal system was made assuming it was a recharge system, and that the steam bubble would be replaced by water coming in peripherally.

In the next year, the tax trial for the steam producers at The Geysers was held, and we were asked to prepare information for the producers. Within two weeks of the date of the trial, it still appeared that The Geysers was a recharge system. But a reservoir engineering study indicated that the rate of pressure decline had been too great to permit recharge. The original steam system appeared to be separated from the surrounding hydrosphere, and the steam was depleting.

An old geologic study of The Geysers published by Allen and Day in 1927 was found to support this discovery. They
pointed out that the steam wells drilled at The Geysers in the 1920's had encountered extremely high pressures. They said this proved that the steam in The Geysers steam zone largely responsible for the establishment of the depletion allowance for geothermal steam production.

The funding was from the California Energy Commission, the County of Lake, and Mendocino-Lake Community College District. The land for the project is leased by Lake County from the Neashams at no charge until commercial activities begin. The county is responsible for constructing and operating the geothermal system.

Mendocino-Lake Community College District is responsible for constructing and operating the agricultural greenhouse, and for offering vocational training courses on geothermal greenhouse operations.

At the center's dedication ceremony, Elaine H. Neasham received a plaque from Dr. Leroy R. Lowery, President, Mendocino-Lake Community College District. In prepared remarks, Mrs. Neasham said that her family wants to bring geothermal energy to the average person.

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"The system is designed with low maintenance in mind," said Kevin Rafferty, Research Associate at the Oregon Institute of Technology - Geo-Heat Center, while looking at the greenhouse heat exchanger, center photo.

"The geothermal water never contacts the greenhouse heating equipment, which forestalls corrosion. Instead, during the October-to-April heating season, geothermal water at 60°C enters the heat exchanger and is used to heat a closed loop of water to 54°C. The 54°C water goes to the fan-coil units, which heat the greenhouse. Now cooled to 40°C, the water is returned to the heat exchanger for reheating.

"Once the geothermal water in the heat-exchanger drops to 46°C, it is passed to the injection well," Mr. Rafferty concluded.

Lake County well "AG Park" 2 is a completed production well not yet on line. The well was drilled to a total depth of 180.4 meters and can produce 57.2°C hot water. The total mass flow rate for the well is 31,238.2 kilograms per hour.

Lake County well "AG Park" 1. The 491.1 meter-deep injection well was drilled behind the greenhouse.

Lake County well "AG Park" project by student Patty McCleary for Agr. 411 Lab. "Identifying and propagating local plants. Knowing their uses for medicinal purposes. Using herbs for landscaping."

Variable-speed drive panel at the well site of "AG Park" 3.

In summer months, the greenhouse must be cooled. Fans pull air in through fibrous, swamp-cooler pads, over which water is circulated. Airflow over the pads is controlled by opening and closing the louvered panels on the outside of the greenhouse (see photo).
Coming this fall --

Our Geothermal Courses
and other Horticulture Classes

Many of our Horticulture Classes in Lake County (listed under the heading of "Agriculture") will be taught in the new Elaine H. Neasham Greenhouse Center.

The geothermal greenhouse is heated by natural water wells, and the courses provide a unique opportunity in the state of California for vocational training in geothermal greenhouses.

Heading on a flyer distributed by Mendocino College, Lake County Center. For more information, call (707) 263-4944.

"Each small community has high expectations and specialized needs," said Ruth Lincoln, Director of the Mendocino College Lake County Center. "In Lake County," she continued, "this means geothermal energy. The college hopes to get even more involved in geothermal agricultural courses. Our work has attracted a high level of volunteerism. Two groups, Friends of the Greenhouse and the Horticultural Club, have been especially helpful."

The geothermal and irrigation supply systems for the greenhouse were designed by Brown & Caldwell Engineers. Technical assistance was supplied by the Oregon Institute of Technology - Geo-Heat Center.

The greenhouse construction, under the supervision of Gib Cooper, was undertaken by developmentally disabled adults through Koino Industries. These same individuals and others are being trained in greenhouse management and in bedding plants.

For further information on the Geothermal Agricultural Heat Center, contact Mark Dellinger, Lake County Geothermal Coordinator (707) 263-2221.

Mono County Update

Mammoth Chance

The proponents of Bonneville Pacific Corporation's Mammoth Chance Geothermal Project have filed an appeal with the Third District Appellate Court in which they challenge the December 1988 Writ of Mandamus decision by the Mono County Superior Court to set aside the use-permit issued for the project by the Mono County Board of Supervisors. A court date for the appeal has not been set.

Mammoth-Pacific II and III

On October 5, 1987, the Mono County Planning Commission issued a use-permit for the Mammoth-Pacific II Geothermal Power Plant and denied, without prejudice, the use-permit for the Mammoth-Pacific III Geothermal Power Plant. The Sierra Club and the California Department of Fish and Game (DFG) appealed the Mammoth-Pacific II decision to the Mono County Board of Supervisors, who rescinded the Mammoth-Pacific II use permit without prejudice on February 22, 1988.

Pacific Energy, the project proponent, then returned to the Board of Supervisors with evidence that refuted the allegations made by the Sierra Club and DFG regarding potential project impacts to local hydrologic resources and mule deer populations. On December 6, 1988, the Board of Supervisors reversed its earlier decision and reissued the use permit for the MP-II Project.

Subsequent to reissuing the use permit, DFG filed a petition for a Writ of Mandamus with Mono County Superior Court. However, the case never came to trial as extensive out-of-court meetings were conducted and a settlement was reached among DFG, Pacific Energy, and Mono County.

Today, the Mammoth-Pacific II project is permitted and well-pad construction and well-drilling operations are scheduled to begin in the late spring or early summer of 1990.

The Deep Magma Well

"I'm very pleased with the way it turned out. In Phase I, we accomplished what we set out to do," said James Dunn, project manager and supervisor of Sandia National Laboratories Geothermal Research Division. Dr. Dunn was referring to the U.S. Department of Energy (DOE), Magma Energy Program, whose 4-phase deep well is near Mammoth Lakes, California, in the Long Valley caldera. "We began drilling August 1, 1989, and stopped at 783 meters (2,568 feet). The well is straight, the casing has been cemented, and we hope to undertake Phase II in the summer of 1990. Then, we will drill to about 2,286 meters (7,500 feet).

"We have just finished coring 185 feet below the bottom hole," Dr. Dunn said, at a meeting in October 1989. "The..."
core samples are being analyzed by many geologists. We will learn more about the Bishop Tuff. We will core next year, as well. Then, we hope to be coring the interface between the Bishop Tuff and the Mt. Morrison roof pendant rock (the top of an old magma chamber).

"It would be so great to get some of the information from inside the caldera. It could change people's thinking or confirm their ideas of how a caldera works.

"This type of data doesn't exist anywhere else. Our greatest potential geothermal resource base is in a silicic caldera system. No one has tested this idea by drilling," Dr. Dunn said.

The $8 million, 3.8-mile-deep magma well, funded by the DOE Geothermal Technology Division, will be the deepest well ever drilled into an active caldera system. The project was undertaken to evaluate the use of magma as a high-quality, clean-energy alternative to fossil fuels. The deep well will be used to answer fundamental questions about the existence of magma at drillable depths and the ability of geophysical techniques to accurately locate magma bodies. The project is designed and managed by Sandia.

The well is also of significant interest to the Continental Scientific Drilling Program (CSDP), which is supported by the DOE's Basic Energy Sciences Division, the National Science Foundation, and the U.S. Geological Survey. As part of this program, scientific measurements will be made in the deep magma well to aid in understanding caldera-forming processes, and the conditions under which magma exists inside the earth's crust.

"While commercial power generation from magma might be 20- to 30-years away, information gained in this first-of-its-kind project will mark a major step in proving the idea can work," said Dr. Dunn.

Many believe magma to be a huge, potential energy resource. Magma bodies in the U.S., buried within 6 miles of the earth's surface and with temperatures higher than 600°C (1,112°F), are estimated to contain up to 500,000 quads of energy. (One quad -- a quadrillion British Thermal Units -- is the energy equivalent of 172 million barrels of oil, and California produces about one million barrels of oil a day.)

The Long Valley caldera is a large depression created by volcanic eruptions that occurred about 700,000 years ago. Located in the Inyo National Forest, about 3.5 miles northeast of the town of Mammoth Lakes, the well is being drilled on a feature called a resurgent dome -- a large, low, rounded hill that is the blistered-up floor of the caldera. At this site, a recent, subsurface magma flow created a measurable bulging of the earth's surface, an indication of the proximity of magma to the surface. "Our drilling site is 2 feet higher than it was 10 years ago," one scientist noted.

Over the past 15 years, hundreds of scientific investigators have used a variety of geophysical techniques in an attempt to define the caldera and the subsurface magma chamber. The chamber may contain as much as 200 cubic miles of magma, although a few tens of cubic miles is more probable.

According to John B. Rundle of Sandia's Geophysics Division, the roof of the chamber seems to be about 4 miles beneath the resurgent dome.

Plans call for the well to be drilled in four stages. Each stage will be followed by an extensive period of testing and evaluation. In Phase I, the well was drilled to a depth of 783 meters (2,568 feet). The second phase calls for drilling and casing the well to a depth of 2,286 meters (7,500 feet) in the summer of 1990. In Phase III, the well will be drilled and cased to 4,267 meters (14,000 feet). Phase IV, scheduled for the summer of 1992, calls for drilling the well to 6,096 meters (20,000 feet) or until a bottom-hole temperature of 500°C (930°F) is reached. The first two phases are expected to take fewer than 60 days for drilling, while the last two may take up to 90 days each. After the final drilling phase, site restoration will be undertaken, including regrading, reseeding, and replanting.

Critical project elements are the borehole measurements and experiments conducted at each stage:

1. The temperature and heat-flow measurements will define a thermal signature and help scientists determine if molten conditions exist beneath the caldera. The physical and geochemical analyses of cuttings will reveal the history and subsurface structure of the caldera.

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This hydraulic casing alignment tool holds the top of the casing straight as the couplings are screwed together. With the tool, 66 joints of 20-inch casing were run in about 6 hours, without cross-threading or coupling problems. The tool was developed with a grant from the DOE.

2. The analyses of fluids and gases encountered during and after the drilling will provide scientific data on the caldera's hydrothermal system and subsurface conditions. (Drilling equipment must be designed to withstand these conditions.)

3. The down-hole geophysical measurements will help define the extent of the magma body.
Geothermal District G2

The Geothermal Section of the Department of Conservation, Division of Oil and Gas, is divided into three district offices. Differences among the geothermal projects observed by the district offices reflect the variety of geothermal resources and development activities in the state. The last issue of the Geothermal Hot Line included a summary of geothermal activities in District G1. A summary of District G2 activities is presented here, and a summary of District G3 activities will appear in the next issue.

Geothermal District G2 encompasses 12 counties in Southern California. High-temperature electrical generation development occurs in the Imperial Valley and the Coso Geothermal Resource Area. Most of the high-temperature geothermal wells drilled in District G2 are development wells. This means they are drilled closer than 1/2 mile to a commercial geothermal well.

Low-temperature geothermal development is found throughout the district. Most low-temperature wells drilled in District G2 are exploratory wells, which means they are drilled farther than 1/2 mile from a commercial geothermal well.

The Division issues permits for well operations (e.g., drilling, plugging, etc.). To ensure compliance with permit stipulations, division engineers periodically inspect wells, operations, and equipment.

THE DIVISION OF OIL AND GAS

Regulates the DRILLING, OPERATION, MAINTENANCE, and ABANDONMENT of oil, gas, and geothermal wells.

Encourages the wise development of oil, gas, and geothermal resources through good conservation and engineering practices.

Ensures that over 12,000 Class II injection wells are operated properly.

Requires the use of proper well plugging and abandonment methods.

Requires measures that protect the environment and prevent subsidence.

Prevents, as far as possible, damage to life, health, property, and natural resources.

Protects underground and surface waters suitable for irrigation and domestic use.

Roadlog: Geothermal District G2, September 1989

1. Paso Robles Area

The tour begins in the northern portion of District G2, at Paso Robles in San Luis Obispo County.

There are several hot springs in Paso Robles, which became a famous resort spa in the 1870's. These springs have encouraged the development of low-temperature geothermal projects through the years.

In the fall of 1988, the City of Paso Robles, with California Energy Commission funding, drilled a low-temperature well, "Test Hole" 3. The well was drilled as an exploration well to assess the potential of the low-temperature geothermal resource.

The Coso Geothermal Resource Area is near Coso Hot Springs and inside the boundaries of the China Lake Naval Weapons Center. The geothermal reservoir at Coso is water-dominated, and well depths range from 460 to 2,130 meters (1,509 to 6,990 feet). The wells have been completed with temperatures over 370°C (700°F) and operating wellhead temperatures of up to 250°C (482°F).

The main water supply for the Tecopa Hot Springs Resort is a 48°C (118°F) natural spring. Generally, low-temperature wells drilled in the area penetrate a hot-water reservoir, which is 20 to 30 feet below the surface.

3. Tecopa Hot Springs Area

As we continue east on Highway 178, we come to the Tecopa area, which is in the middle of the Amargosa River Valley in the southeastern corner of Inyo County. Hot springs occur on the northwestern side of the Tecopa Hills, about 1 mile east of the Amargosa River.
around 70 meters (230 feet). Most of these wells were drilled with cable tools and have surface pipe cemented below the near-surface sand and gravel. Many of the older wells in the hot spring area were hand dug many years ago and produce only from the upper, and cooler groundwater strata. The wells produce from 38 to 95 liters per minute. (10- to 25-gallons per minute) of geothermal fluid.

In April 1980, the Inyo County Board of Supervisors issued a moratorium on drilling new geothermal wells in the Tecopa Hot Springs Area in an effort to protect the hot-water supply for Tecopa Hot Springs.

4. San Bernardino Geothermal Resource Area

From Tecopa Hot Springs, we travel southwest on Highway 127 to the San Bernardino Geothermal Area. This area of shallow, low-temperature geothermal resources is fault-controlled and was discovered while drilling for cold water.

The City of San Bernardino Municipal Water Department owns and operates a district-heating system in the downtown area. When pumped, each of the two production wells in the system can produce up to 18,800 liters/min. (5,000 gallons per minute) at 57°C (134°F).

Currently, the nearby cities of Loma Linda and Colton are investigating the possibilities of developing their own geothermal district-heating systems. Loma Linda has received funding from the California Energy Commission to assess the geothermal potential in the area, if the assessment is favorable, development may be started. Colton has just started the process for receiving assessment funding.

5. Twentynine Palms

Next, we journey east on Highway 10 to Twentynine Palms in the Mojave Desert. This south-central portion of San Bernardino County has four geothermal areas that were delineated in 1985 by the URS Corporation for the San Bernardino County Department of Housing and Community Development. Two of the areas were considered unsuitable for development. The report states that fluids of 71°C (161°F) occur at depths less than 122 meters (400 feet), with hotter fluids at greater depths. The report concludes it is feasible to use these geothermal fluids for space heating and cooling.

6. Desert Hot Springs Geothermal Resource Area

Now, we travel to the Coachella Valley at the northern end of the Salton Trough. Here, most of the City of Desert Hot Springs lies within the Desert Hot Springs Geothermal Field. The city, taking its name from the local hot springs, calls itself the “Spa City of the World”.

7. The Mecca Area

In the southern Coachella Valley, on the northwestern shore of the Salton Sea in Riverside County, several wells produce low-temperature geothermal fluids. The wells are about 213 to 274 meters (700 feet) deep, and produce geothermal fluids at 54°C (120°F). The fluids are used to heat greenhouse for the production of fresh flowers.

8. The Eastern Salton Sea Area

Several commercial, low-temperature geothermal spa and aquacultural developments are on the eastern shore of the Salton Sea. One, Pacific Aquafarms, raises tilapia (a fish native to Africa) in the produced water, which is relatively fresh for the Salton Sea area, with about 4,500 ppm total dissolved solids. The temperature of the reservoir is about 142°F, but the wells are about 125 meters (400 feet) deep.

9. Salton Sea Geothermal Field

Next, we travel south to the Salton Sea Geothermal Field. Located at the southeastern shore of the Salton Sea, the Salton Sea Geothermal field is the largest in the district. The geothermal power plants were generating 193.8 megawatts, net, of electricity in the field.

The Salton Sea geothermal reservoir is water-dominated, with 260°C (500°F) water at depth. The quality of the reservoir water is poor, with total dissolved solids averaging 200,000-300,000 ppm. The technology to produce and generate electricity from such fluids had to be developed before the field’s current projects could be undertaken.

The Salton Sea Geothermal field contains the largest geothermal production well in the world, “Vonderahe” 1, which is capable of producing over 960,000 kg/hr of fluid. The well is operated by Unocal Geothermal Division, a subsidiary of Unocal Corporation. The well supplies geothermal fluid to the Salton Sea Geothermal Project, Unit 3, a geothermal power plant that generates 475 megawatts, net, electricity. The plant is owned by Desert Power Company, a subsidiary of Unocal Corporation. Also, there is the Salton Sea Geothermal Project, Unit 1 – a 10 megawatt, net, power plant owned and operated by Earth Energy, Inc., another subsidiary of Unocal.
I down since June 1987 due to contractual disagreements between Chevron Geothermal (unit operator) and SDG&E. The plant has 13 production wells on the site that are produced with submersible pumps. The spent fluid is pumped into injection wells northwest of the power plant.

The second geothermal power plant in Heber Geothermal field is a dual-flash plant owned by Centennial and ERC, and operated by Imperial Power Services, Inc. The plant is rated at 47 megawatts, net, and is operated from 10 production wells on the plant site. The wells produce 3.68 million kilograms per hour (8.10 million pounds per hour) of geothermal fluid.

Four Magma Power Company geothermal power plants are operated in the field: Vulcan, generating 32 megawatts, net; and Del Ranch, J.J. Elmore, and Leathers, each generating 34 megawatts, net.

10. Heber Geothermal Field

Heber Geothermal field is about 1 mile south of Heber, California, in the southeastern portion of the Imperial Valley. The geothermal reservoir ranges in depth from 610 to 1,830 meters (2,000 to 6,000 feet) and produces 181°C (358°F) geothermal fluid. Geothermal production wells at Heber are operated by Chevron Geothermal Company, a subsidiary of Chevron USA Inc.

Two electrical generating plants are in the field. One, a binary plant rated at 45 megawatts, net, is operated by San Diego Gas and Electric Company (SDG&E). The plant has been shut down since June 1987 due to contractual disagreements between Chevron Geothermal (unit operator) and SDG&E. The plant has 13 production wells on the site that are produced with submersible pumps. The spent fluid is pumped into injection wells northwest of the power plant.

The dual-flash geothermal power plant, Heber Geothermal field.

11. East Mesa

East Mesa Geothermal field is in the eastern Imperial Valley, 6 miles southeast of the Town of Holtville and just north of Highway 8. All geothermal production and injection activities for this field are on federal lands; thus, the Bureau of Land Management, rather than the Division of Oil and Gas, holds all permitting authority. However, the division does maintain contact with operators in the field.

The East Mesa field reservoir is water-dominated and production wells range from 1,524 to 1,830 meters (5,000 to 6,000 feet) in depth. The produced fluid temperatures vary from 143°C to 176°C (290°F to 350°F).

Geothermal Resources International, Inc. (GEO) operates two geothermal power plants in the East Mesa field. One, the McCabe Power Plant, is a 13.4-megawatt, gross, binary plant. The second, the GEM 1 Power Plant, is less than one-half mile northwest. This is a 43-megawatt, gross, 40-megawatt, net, dual-flash plant. Fifty percent of the GEM I plant is owned by GEO East Mesa Limited Partnership, and 50 percent by a wholly-owned subsidiary of Mission Energy Company.

Ormesa Geothermal operates three binary electrical generating plants in the East Mesa field: the Ormesa I Power Plant, a 30-megawatt, gross, plant; the Ormesa IE Power Plant (an extension of Ormesa I), a 10-megawatt, gross, plant; and the Ormesa II Power Plant, a 20-megawatt, gross, plant.

Tests for Power Plant Ormesa 1H began on December 3, 1989. The acceptance test for the 12-megawatt, gross, power plant is scheduled for March 1990. Three production wells and 4 injection wells will be used to operate the 12 Ormat units at the power plant.
The Algodones Dune Field, East of East Mesa

Text and photos by Susan F. Hodgson

Mounded on the eastern flank of the Imperial Valley, labeled as "Sand Hills" on road maps, the beautiful Algodones Dune field stretches across Interstate 8 near the California-Arizona border.

West of the immense dunes stands the new GEM I, a 43-megawatt, gross, geothermal power plant in East Mesa Geothermal field.

View toward the northeast from the Salton Sink showing the Algodones Dunes in the middle ground and the Cargos Machachos Mountains in the background. The San Andreas fault possibly parallels the sand ridges in the foreground, although evidence is inconclusive. The All American Canal and U. S. Highway 8, photo right, transect the dunes in one of the remarkable flat floored, relatively sand-free depressions within the dune area. Photo by John S. Shelton. Caption and photo from the Geologic Atlas of California, prepared by the California Department of Conservation, Division of Mines and Geology. Reprinted with permission.

The Algodones Dunes are"...one of the most morphologically diverse and largest dune fields in North America. They trend NW-SE for 75 kilometers along the eastern side of the subduing Salton Trough," according to a guidebook of the American Association of Petroleum Geologists, Pacific Section. In May 1989, members of the organization visited the Algodones Dune Field on a field trip.

"Although the net direction of superimposed dune migration is to the NE, the seasonal wind directional changes cause the bedforms to reverse their migration direction." From the guidebook, prepared by Sweet, Haworth, and Kocurek, Dept. of Geological Sciences, University of Texas Austin, and Clark, Unocal, Brea, Ca.

After visiting the Algodones Dune field, I searched for information on geothermal exploration in the area. I learned of six temperature gradient wells that were drilled at the western edge of the dune field in Sec. 33, T.1S., R.19W. in the early 1970's. Two of the TG wells showed temperature reversals. Because of this feature, the wells, "USBR UCR 115 and DWR "Dunes" 1", are discussed in an interesting paper, "Critique of Geothermal Exploration Techniques," published by Tovi Meidav and Franco Tonani in the Proceedings, Second United Nations Symposium on the Development and Use of Geothermal Resources, May 20-29, 1975.

View of the Algodones Dunes from the Interstate 8 near the California-Arizona border.
Figure 2 is a schematic representation of a conceivable thermal water flow regime in a complex faulted area, which could explain the negative temperature gradients in the Dunes anomaly. It further demonstrates the dangers associated with neglecting the vagaries of vertical and lateral thermal-water flow. A steep, shallow-temperature gradient is a condition that could manifest the existence of an economic geothermal reservoir in the area, but could also indicate rapid upward flow due to the buoyancy of water in a normal-gradient area. Conversely, in an area of high infiltration rates of rainwater or strong lateral ground-water flow, the absence of a significant temperature gradient does not necessarily rule out the existence of a geothermal reservoir below. This is of special importance in grabens, where strong lateral flows could take place, but where geothermal reservoirs may occur. Finally, heat-flow measurements in a mountainous terrain must be compensated for terrain effects. Otherwise, genuine temperature anomalies may be masked by terrain effects, and false anomalies created in places.

Thus, near to so much geothermal development, the Algodones Dune field remains apart. It holds a different resource in reserve, that of repose and of rare, compelling beauty.
Power Plant GEM 1 on Line

On April 28, 1989, Geothermal Resources International, Inc. (GEO) announced the completion of a successful synchronization for one of the two 21.5-megawatt generating units at its GEM 1, East Mesa Geothermal Project in the Imperial Valley of Southern California.

According to GEO's chief executive officer Ronald P. Baldwin, the synchronization represents the first time the East Mesa Geothermal Project, begun in May 1988, has produced electricity that has been sold to Southern California Edison Company.

GEO owns a 50 percent partnership interest in the GEO East Mesa Limited Partnership, which in turn owns the 43-megawatt, gross, (40-megawatt, net) GEM 1 plant and the 13.4-megawatt, gross, B.C. McCabe Geothermal Power Plant, also in East Mesa.

Mr. Baldwin said that as a result of favorable treatment provided under existing tax law, certain geothermal expenditures produce significant tax benefits. GEO is actively pursuing a possible sale of its portion of the tax benefits inherent in the East Mesa geothermal project. GEO anticipates that this sale, if accomplished, might result in proceeds to the company of up to $12 million, after payment of related expenses.

Ormesa IE Update

On March 17, 1989, Ormat Energy Systems, Inc. announced the financial closing and full funding of the Ormesa IE Geothermal Project at East Mesa Geothermal field. The announcement follows the power plant's successful completion of the 25-day acceptance test.

The project was structured financially as a 20-year leveraged lease, with Constellation Investments, Inc. and Chrysler Capital Corporation providing the equity funds. Prudential Capital Corporation provided the long-term debt, the proceeds of which were used to pay off Bankers Trust Company and the Bank of Nova Scotia, who acted as the construction lenders.

Ormesa IE was completed in 6 months and is expected to sell about 8 megawatts, net, of electricity to Southern California Edison Company.

The project consists of 10 water-cooled Ormat energy converters, cooling towers, and related equipment. Geothermal water at a temperature below 300°F is pumped to the power plant units from 4 production wells.

Salton Sea Unit 3 Dedicated

On April 5, 1989, Unocal Corporation and its subsidiary, Desert Power, dedicated Salton Sea Unit 3, a 47.5-megawatt, net, geothermal power plant in the Imperial Valley. The new power plant, owned by Desert Power, began commercial operation on February 14, 1989. Geothermal wells producing the hot brine used to operate the power plant were drilled and are operated by Unocal Corporation.

"Unocal has been dedicated to technological innovation since it began in 1890, nearly a century ago," said Richard J. Stegemeier, Unocal's president and chief executive officer, in his remarks at the dedication ceremony. "And here we have an outstanding example of its value. It took 10 years of research and development for Unocal to solve the problems associated with the highly saline geothermal brines of the Salton Sea reservoir."

Construction of the $110 million steam-separation and power-generation facilities for Salton Sea Unit 3 began in December 1986. Electricity generated at the power plant is transmitted by the Imperial Irrigation District to Southern California Edison Company in the Coachella Valley.
Coso Phase I Completed

California Energy Company's Coso Geothermal Project is in the China Lake Naval Weapons Center in Inyo County, California. The project area includes 24,000 acres of federal land, including acreage under contract with the Navy and leased from the Bureau of Land Management.

When Phase 1 of the Coso Project was completed at the end of 1989, the project included nine geothermal power plants, generating a total of 230 megawatts, net. The electricity is sold under long-term power-sales contracts with Southern California Edison. In late 1989, six of the units were generating electricity: Navy Power Plant No.1, Units 1, 2, and 3; BLM East, Units 1 and 2; and BLM West, a one-unit plant.

"By the end of 1989, Navy Power Plant No.2, Units 4, 5, and 6, were synchronized," said Jim Moore, CEC senior vice president, exploration. "We will continue to explore and evaluate the resource at Coso. Over the next few years, we'll make appropriate decisions over where to expand the field," he concluded.

PUC Approves SDG&E Contract with Navy

On September 27, 1989, the California Public Utilities Commission (PUC) found reasonable a contract under which the United States Navy may purchase electricity from San Diego Gas & Electric (SDG&E) at a discount. The PUC concluded that utility customers are protected adequately under this arrangement.
extracted from the produced fluid. Then, one-half of the methane gas is burned in a reciprocating engine to generate electricity directly. The remaining gas is sold.

To generate additional electricity, exhaust heat from the engine is combined with heat from one-half of the produced fluid to heat isobutane in a binary power-plant cycle. The other half of the produced fluid bypasses the power plant. It is blended with used plant fluid and injected.

Funding for the demonstration plant is provided by the U.S. Department of Energy and the Electric Power Research Institute. The Ben Holt Company designed, procured materials, constructed, and operates the hybrid power plant. The Institute of Gas Technology of Chicago provides above-surface handling of the high-temperature, corrosive fluids.

A geopressured resource is characterized by methane dissolved in brine at high temperatures and pressures. It is hoped that energy can be recovered from the high-temperature brine, from the dissolved methane, and from the hydraulic energy of the high-pressure wellhead fluid.

Geopressed resources occur in Texas and Louisiana at depths of 10,000 to 20,000 feet, onshore and offshore, in a wide band extending from Louisiana to the Mexican border, and in many other locations, worldwide. Potential sites in the United States are outlined on the accompanying map.

Yellowstone Geyser Destroyed by Explosion

In September 1989, park officials reported a thermal explosion destroyed Park Chop Geyser in Yellowstone National Park, according to the San Francisco Chronicle. The geyser was part of the park's Norris Geyser Basin, the hottest and most seismically active geyser basin in the world.

A park spokesperson said experts believe the explosion occurred after a geyserite deposit blocked one of the geyser's vents. The explosion was witnessed by a park visitor, who said the geyser erupted to about 100 feet, or about three times its normal height. Rangers who came to the site found the geyser replaced by a pool of hot water.

Hawaii Update

Hawaii Geothermal Plant Closed

The State of Hawaii is permanently closing the Hawaii Geothermal Plant, a 3-megawatt geothermal power plant on the Island of Hawaii. The power plant will be shut down by the end of 1989. The action has been taken because it has not been possible to keep the power plant operating in an environmentally sound manner.

Geothermal well HGP-A, used to operate the single-flash power plant, will be shut down temporarily. This well was completed in 1976, with a bottom-hole temperature of 670°F. It was one of the hottest geothermal wells in the world.

by Gerald Leporence
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Ultimately, plans are to reactivate the well, possibly selling steam to the nearby Ormat Energy Systems project.
Scientific Observation Hole Program

The state's Scientific Observation Hole Program will start in December 1989. Four thousand feet deep, it will be drilled in the Kilauea East Rift Zone to gather scientific data about the area.

Exploration Wells

In November 1989, Trac/Mid-Pacific Geothermal Venture started drilling the first exploratory well under its permit to develop up to 100 megawatts of electrical power from the Kilauea Middle-East Rift Zone. The company has been involved in permitting and legal issues concerning this activity since 1992.

Puna Geothermal Venture

The Puna Geothermal Venture is owned by Ormat Energy Systems, Inc. The company plans to develop a 30-megawatt geothermal power plant on the Island of Hawaii in the Kilauea Lower East Rift Zone, and sell the electricity to Hawaii Electric Light Company, a local utility.

Presently, the Hawaii Department of Health is reviewing the company's request for authority to construct (air permit) 13 additional wells and the power plant itself. A contested case hearing concerning these activities has been requested by various organizations on the Island of Hawaii.

500-Megawatt Project

On November 1, 1989, Hawaiian Electric Company (HECO) received five technical proposals from consortia interested in designing, financing, developing, owning, and operating the geothermal steam fields, power plants, and island's under-water cable system that will provide the Island of Oahu with 500 megawatts of geothermally-produced electricity.

A working committee is evaluating the proposals. The geothermal development will occur in the Kilauea East Rift Zone on the Island of Hawaii.

The lead companies in the five responding consortia are: Mission Power Engineering Company; Mission Energy Company; Pacific Gas and Electric/Bechtel Generating Company; ABB (Asea Brown Boveri) Energy Ventures; and Kealoha Partners, Ltd. (a limited partnership of Phelan, Daniel, C. Ishii, and others).

Business proposals were received from the five consortia on December 1, 1989. HECO's intent is to begin negotiating with a "short list" of the consortia early in 1990, leading to a Power Purchase Agreement with one by the end of 1990. The State of Hawaii will participate in portions of the evaluation and negotiation process. Governor Waihee has indicated to proponents that he is willing to consider requests for indirect financial support of the project if he is convinced that the project would not be able to proceed without state support.

The first block of electricity to go on line would be about 25 megawatts, to be delivered in 1995. The 500-megawatt total would be reached about 15 years later.

The State Department of Business and Economic Development (DBED) has recently contracted with ERC Environmental and Energy Services Company (ERCE) of San Diego to prepare a Master Development Plan for the 500-megawatt geothermal/cable project; analyze overland transmission corridors for the inter-island cable system; and prepare an Environmental Impact Statement. Integral to and integrated in these three tasks is a major public-information and public-input program.

Public Information Program

The State of Hawaii has an aggressive public information/participation program. At least five public-participation meetings are scheduled to be held at four locations on the Islands of Hawaii, Maui, and Oahu. The initial round was held in October and November 1989. The next round will start in December 1989, with other rounds scheduled during 1990. All are facilitated by a professional mediator.

The DBED-contracted short video on geothermal development has been completed. The videotape includes footage on activities at The Geysers Geothermal field in Northern California. DBED has published documents in Honolulu, and is completing a second one in Hilo. The rooms contain every document pertinent to Hawaii's geothermal development and the underwater cable system. Anybody in Hawaii can telephone the document rooms on a toll-free line.

As the Hawaii geothermal program has taken shape, opposition has mounted. The major opponents are: The Pele Defense Fund, who oppose it on religious and Hawaiian cultural issues; the Rainforest Action Network, who are opposing it on a number of environmental and cultural issues besides rainforests; and certain community associations within the Puna District where geothermal development would occur.

The state's general position is to stress the importance of the need to reduce its 90-percent dependence on imported oil for electricity. Recently, the DBED has also stressed the global air-quality advantages offered by geothermal energy, and the disadvantages offered by fossil fuels. The general approach is to demonstrate the positive cultural, environmental, and social activities of the state. Factual information is offered to counteract inaccurate statements.

Submarine Power-Cable Tests Completed in Hawaii

In June 1989, the Hawaiian Electric Company (HECO) announced the completion of a successful, design-feasibility test for the submarine power cable to be used in the Hawaii Deep Water Cable (HDWC) research program.

The $2.6 million laboratory test was funded by the United States Department of Energy and conducted by Pirelli Cable Corporation of Milan, Italy. The cable will be used to transmit electricity generated by geothermal energy on the Island of Hawaii to the Islands of Maui and Oahu.

"Because of the extremely difficult environmental conditions involved in this project, we had to verify all mechanical and electrical characteristics essential to ensure survival of the cable during deployment and operation over its 30-year design life," said HDWC Program Manager William Bonnet. "This allows the U.S. to be on the frontier of new submarine cable technology, a technology that is applicable to other deep-water cable projects around the world."

The cable was selected after a rigorous technical and economic analysis of 251 candidate cable designs. The selected design is for a 300 KV DC, self-contained, oil-filled cable. Six thousand feet of the cable were fabricated by Pirelli for the testing program.

The cable was subjected to standard mechanical and electrical cable-industry tests, supplemented with tests designed to simulate the cable's experience in the most stressful parts of the cable route. The cable met or exceeded all design specifications. HECO has received a final report and a videotape of the laboratory testing in Milan from Pirelli Cable Corporation.

In November 1989, cable installation and retrieval procedures were tested successfully in the Alenuihaha Channel between the Islands of Hawaii and Maui. This completes the HDWC research program that began in 1982. It has received both federal and state funding.

Hawaiian PGV Plant Status

On September 25, 1989, Hawaiian Electric Industries, Inc. (HEI) of Honolulu, Hawaii, and Ormat Energy Systems, Inc. (OESI) of Sparks, Nevada, signed a Memorandum of Understanding (MOU) to develop jointly geothermal power plants on the Island of Hawaii.

Under the terms of the MOU, Ormat would sell 50 percent of its subsidiary, Puna Geothermal Venture (PGV) to the HEI subsidiary, Hawaiian Electric Renewable Systems (HERS). Ormat would continue to be the managing partner for geothermal projects to be developed by the partnership. However, on December 20, 1989, HERS announced that OESI had decided to terminate the negotiations.

"We understand that the decision by OESI was based on the inability of the parties to agree on certain business issues under discussion," said HERS president Alfred P. Manning.

PGV is the first company to receive the governmental approval necessary to develop a commercial geothermal power plant in Hawaii. A 25-megawatt power plant is expected to be operational by the end of 1990. PGV has a contract to sell electricity produced by the plant to Hawaii Electric Light Company, which serves the Island of Hawaii.

Besides PGV's 500-acre power plant site, PGV has surface rights to 10,000 acres in additional areas in the Puna District of the Island of Hawaii, with mineral-lease rights for 4,000 of these acres. A small experimental geothermal power plant owned by the State of Hawaii has operated in this area since 1982.

HROY Ram, president of Ormat Energy Systems, said: "We see a great deal of synergy in joining forces with HEI. Ormat brings 25 years of worldwide leadership in developing pollution-free power plants utilizing locally available heat sources, as well as a track record of developing and operating nine geothermal power plants, with two more under construction."

HEI president C. Dudley Pratt, Jr., said: "HEI is pleased to be an active participant in the development of geothermal energy in Hawaii. HEI is committed to being a leader in renewable energy development in the state, and our agreement with Ormat supports this goal."

We are extremely delighted with the results," said Hawaiian Electric Company President, Harwood D. Williamson, "for it not only proves the feasibility of laying and retrieving a deep-sea electric cable, but also moved Hawaii a step closer to the possibility of energy self-sufficiency."
Canadian Activity at Meager Creek

In April 1989, Canadian Crew Energy Corporation announced it had responded to a request from the British Columbia Power Authority to supply electrical power for the United States export market. The company has proposed to supply initially 60 megawatts of power from the Meager Creek Geothermal Cogeneration Project, with additional, phased, 50-megawatt increments being developed until the presently estimated electrical generation potential of 260 megawatts is reached. Subject to a favorable response from Powerex, and the demonstration by the company of the technical and economic feasibility of the project, the company intends to be in a position to produce and deliver electrical power by September 1992, with the full development of 260 megawatts being possible by 1998.

Pennon Holdings Ltd., indirectly the largest shareholder in the company, has agreed to lead a consortium of Canadian and overseas investors to fund the design and construction of the initial power plant. A letter of undertaking has been provided by Pennant relating to the initial project equity requirements of about $30 million for the development of the initial 60 megawatts. Subject to the company successfully negotiating long-term power supply contracts with Powerex, Pennant is prepared to provide 50 percent of this requirement through an equity investment in the company and, in addition, would endeavor to underwrite the other 50 percent of required funding from Canadian institutions or private investors. The company is pleased to have the financial commitment of the Pennant Group and the technical support of its engineering subsidiary, John Holland Holdings Ltd., an Australian construction group, for this project.

Mexican Development: An Interview with Rafael Molinar

"Exploration’s our priority. We want to find new geothermal fields in Mexico," said Rafael Molinar, Reserve Engineer at Mexico’s Comisión Federal de Electricidad. "We want to find high-temperature geothermal sites throughout our country. These need to be in places most strategic for participating in new industrial development.

The estimated cost for development and construction of the initial 60 megawatt facility is projected at about $150 million, which is proposed to be funded on an 80/20 debt/equity ratio. The total estimated cost of the project, if developed to its full potential, will be in the order of $500 million.

The Meager Creek project represents the first geothermal power project in Canada. Fully developed, the project will provide economic benefits to the Squamish-Lillooet region and the Province of British Columbia. The project area is located some 100 miles north of Vancouver, near the village of Pemberton.

The Meager Creek resource has been extensively researched and evaluated during a 10-year study carried out by B.C. Hydro and Power Authority, involving expenditures exceeding $30 million. Over 8,000 feet of diamond drilling was completed prior to the completion of three large-diameter, 8,000- to 9,000-foot deep, exploration wells at the site. Extensive environmental and other related studies have been carried out in relation to the project, which, when fully developed could provide in excess of 1,800 person-years of employment in the construction phases, and up to 200 direct and 600 indirect permanent jobs for operations. Substantial steady employment levels will occur during the 8-year construction schedule.

The design of the proposed geothermal power plant and cooling tower will ensure that no toxic pollutants are released to the atmosphere. Plant layout will be such that minimum disturbance will result to the Meager Creek Valley. Essentially, the power plant project will be environmentally benign. In addition, the geothermal energy constitutes a renewable energy resource if the reservoir is managed properly.

"As for low-temperature development," Mr. Molinar continued, "we have other sources to power such projects.

Low-temperature development is not needed by Mexico now as much as it is electrical generation. So, for us, such projects are not the best uses of time and money.

I asked Mr. Molinar about Los Azufres Geothermal field in central Mexico. He said six, 5-megawatt wellhead generators are operating in the field, along with the 50-megawatt Back power plant, purchased in the United States.

I asked about the ultimate electrical generation capacity of Los Azufres. Mr. Molinar said that such a prediction is difficult to make, and not really pertinent under the field’s current development plan. He said the field is being developed from the particular to the general. In other words, as producing wells are drilled, 5-megawatt wellhead generators are installed. Then, when enough successful wells exist, they’re connected to larger power plants. “The practice will continue until the field’s capacity is reached,” he said.

"At La Primavera Geothermal field, in west-central Mexico, about 12 wells have been drilled," Mr. Molinar added. "About 30 wells have been drilled at Los Humeros Geothermal field, in east-central Mexico. To date, no electricity has been generated from either field.

Loan for Costa Rica’s Electric Energy Sector

The Inter-American Development Bank announced the approval of a $182.8 million loan for a program to finance electricity generation, transmission, and distribution, as well as the reconditioning of generating units in Costa Rica.

The project, estimated to cost a total of $264.1 million, will enable Costa Rica to meet its growing demand for electric power, to improve the economy, efficiency, and reliability of its national system.

The project, to be executed by the Instituto Costarricense de Electricidad (ICE), will have four components. One is the construction of the Miravalles II geothermal plant, with a generating capacity of 55 megawatts. The project will include the production wells (3 of which have been drilled), 4 injection wells, plus the necessary equipment, valves, and pipes. The plant’s power house will be equipped with a turbine, a cooling tower, and a 62-MVA enhanced-capacity step-up substation.

Between 1970 and 1987, electrical energy usage in Costa Rica showed a rapid average increase of 8.9 percent annually. It decreased to 1.6 and 3.4 percent for 1982 and 1983, respectively, due to the country’s economic crisis. Between 1984 and 1987, demand grew at an average annual rate of 7.8 percent. Nearly 82 percent of Costa Rican homes are connected to electric service.

About 84 percent of the country’s installed generating capacity comes from hydroelectric plants, and the remaining 16 percent is of thermal origin. Between 1980 and 1986, thermal energy practically was eliminated when the Arenal, Corobici, and Ventanas-Garita hydroelectric plants, also financed by the IDB, came on line and produced a surplus of power. The surplus was exported to other countries through the interconnected Central American system. However, starting in 1986, Costa Rica was forced to import energy from Honduras. In 1987 when these imports reached 5.5 percent of total electrical consumption, it became necessary to restart thermoelectric generation using imported oil.

Since the electrical surplus of neighboring countries is diminishing, Costa Rica must expand its own generating and distribution capacity. Even when the geothermal plant of Miravalles I and Sandílill–which are also being financed by the IDB–is started operations in 1992 and 1993, respectively, the increase in demand will require additional expansion.
Central America

A symposium on the Energy and Mineral Potential of the Central American-Caribbean Region was held in San Jose, Costa Rica, in March 1989. The symposium was sponsored by the Circum-Pacific Council for Energy and Mineral Resources, the Ministerio de Recursos Naturales Energia y Minas, Costa Rica, and the Refinadora Costarricense de Petróleo.

The "Potential of Geothermal Resources" was the title of a technical session included in the symposium. The session was cochaired by Alfredo Mainieri of the Instituto Costarricense de Electricidad and David Sussman of Unocal Corporation.

A copy of all the papers presented at the symposium will be published in the first quarter of 1990 by the Circum-Pacific Council for Energy and Mineral Resources. For further information about this publication, contact Ms. Mary Stewart at (713) 622-1130.

The following material is excerpted from the papers prepared for the geothermal technical session. The information is reprinted courtesy of Mr. Sussman and Ms. Stewart.

Status and Geologic Setting of Geothermal Fields in Central America, Mexico, and the Caribbean

David Sussman

Unocal Geothermal Division, Santa Rosa, California 95405 USA

The 1989 installed geothermal capacity in Central America and the Caribbean is 869 megawatts, of which 71 percent is in Cerro Prieto field, Mexico. The project installed geothermal capacity of the region is 1,020 megawatts by 1992, reflecting power plants expected to be brought on line in Costa Rica, El Salvador, Guatemala, St. Lucia, and Mexico.

With few exceptions, high enthalpy geothermal fields in Central America and the Caribbean region are associated with active volcanic belts at plate boundaries. In Mexico, three high-enthalpy fields occur within the 1200 km-long Trans-Mexican Volcanic Belt (TMVB) along the western margin of the North American Plate. The 1100 km-long Central American volcanic belt and TMVB result from subduction of the Cocos Plate beneath the western margins of the Caribbean and North American Plates, respectively.

Several of the Central American and Mexican geothermal systems are related to young silicic volcanism (e.g., Los Humeros and La Primavera in Mexico, and Miravalles in Costa Rica). However, Momotombo (Nicaragua) and Ahuachapan (El Salvador) Geothermal fields appear to be associated with mafic- to intermediate-composition volcanic centers.

In addition to magmatic heat sources, Central America hosts an extensive system of grabens in and behind the volcanic arc. The intersection of tensional structures and young volcanic centers yields highly favorable settings for exploitable geothermal systems. Several geothermal fields are being explored in Honduras, all of which are well to the east of young volcanism. These fields are related to graben faults and are similar to geothermal areas under development in the Basin and Range Province of Nevada and Utah, USA.

In the eastern Caribbean, the density and volume of Quaternary volcanoes is lower than in Central America and Mexico. Relative plate velocity is low at the convergent boundary between the Caribbean and the North and South American Plates. To date, one geothermal field is operating at La Bouillante, Guadeloupe (4 megawatts) and a discovery well was drilled at Soufriere, St. Lucia.

Geophysical Exploration in Las Pailas Geothermal Field, Rincón De La Vieja, Guanacaste, Costa Rica

Arturo Quesada, Germán Leandri, Luis D. Morales

1 Escuela de Física, Universidad de El Salvador, San Salvador, El Salvador
2 Oficina Geofísica Aplicada, Instituto Costarricense de Electricidad, Aparto. 10032-1000 y Escuela Centroamericana de Geología, Universidad de Costa Rica, San José, Costa Rica
3 Centro de Investigaciones Geofísicas y Escuela Centroamericana de Geología, Universidad de Costa Rica, San José, Costa Rica

Geologic mapping and geophysical prospecting using electric, magnetic, and gravity methods have been conducted in the Las Pailas Geothermal field to evaluate its geologic and geophysical characteristics and geothermal potential. Las Pailas is located at the foot of the southern flank of the Rincón de La Vieja volcanic complex, in the volcanic cordillera of Guanacaste Province, Costa Rica.

Four rock units were mapped (from the oldest to youngest) at Las Pailas: an ignimbrite sequence, andesitic lavas, andesitic deposits, and Recent alluvium and colluvium.

The Bouguer gravity map (density 2.3 g/cm^3) of the region shows negative anomalies are related to thick ignimbrite sheets or to fractures, and positive anomalies are associated with hills formed by lava. Locally, an increased rise in gravity shows a positive increment to the northeast, which indicates a dip of the local basement to the southwest. In the local magnetic map, a negative anomaly stands at nearly 300 gammas, which coincides with the largest concentration of surface thermal manifestations. Negative magnetic anomalies dominate the remainder of the map, and could correspond with thick, hydrothermally altered igneous rocks in the subsurface.

The geoelectric model allows a detailed description of the strata, to a depth of 500-800 m, where the resistive basement (50-500 ohm-m) is detected. In the upper 200-300 m, layers of lavas, andesitic lavas, and pyroclastic flows with low secondary permeability, possibly clays. The lower conductive layer (15-25 ohm-m) is associated with possible lavas and hydrothermally altered pyroclastic flows with low secondary permeability, possibly clays. The lower conductive layer (15-25 ohm-m) may be affected by temperature and vertical convective flow, in addition to meteorization. Comparing these geoelectric results with the Miravalles field 20 km to the east, a high-enthalpy geothermal field between 200° and 250°C can be inferred at Las Pailas.

Based on the favorable geologic and geophysical characteristics of the area, further studies are recommended. Las Pailas represents a good prospect for geothermal development in Costa Rica.

Seismology Studies at the Miravalles Geothermal Project

Rafael Barquero

Secrección de Sismología e Ing. Sísmica, Diplo. de Geología J.C.E., Aparto. 10032, San José, Costa Rica

The Miravalles Geothermal Project (MGP) is in the Guanacaste mountain range, and inside the Miravalles volcanic caldera. The Guanacaste range is a chain of andesitic Quaternary stratovolcanoes aligned NW-SE, and composed of pyroclastic rocks, lava, and fluviolacustrine deposits. Glowing avalanche deposits formed gently sloping ignimbrite plateaus on both sides of the mountain range. These geologic units are under constant regional stress, derived from the subduction of the Cocos Plate under the Caribbean Plate and the regional uplift of the volcanic arc, resulting in a complex system of faults.

Las Pailas represents a good prospect for geothermal development in Costa Rica.

Geothermal Development in Nicaragua

Roger Arcia and E. Martinez Tijer

INE, Dirección General de Recursos Geoestéricos, Apartado Postal 55, Managua, Nicaragua

The Costa Rican Institute of Electricity (ICE) Geology Department started seismological and volcanological studies in the northeastern part of the country in 1974. Since May 1974, a network of 10 seismic stations has operated in the Guanacaste region. A local network was also set up at Miravalles to study in detail the microseismicity in this area. Microseismic observation at Miravalles has been very successful in determining background seismicity, stress field, seismic alignments, and active or potentially-active faults within the project area. Other specific techniques such as seismic noise and waveform tomography have been valuable tools for localizing the best geothermal resource areas.

Seismology Studies at the Miravalles Geothermal Project

Rafael Barquero

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With the beginning of operations of a 35-megawatt unit in Momotombo Geothermal field in August 1983, Nicaragua joined the group of countries that exploit geothermal resources to produce electricity.

Recently, a second 35-megawatt unit has been placed in service in Momotombo field, increasing installed capacity to 70-megawatts. The installed capacity from other sources
Considering the Current plans for Momotombo field include drilling four Geothermal exploration and development activities in the has ... is 690.9 Republic of Guatemala have been conducted by the Insti- Ministry of Energy and Mines of Guatemala and Los annual generation, detailed investigation and exploratory drilling for addi-'_

This translates to slightly more than 40 percent of the total 10 megawatts, each. The Coatepeque field is the subject of _ geothermal power generation. The acquired experience has highest priority prospect, having measured temperatures , an evaluation of the country's geothermal potential; estab-

Geothermal exploration and development activities in the Republic of Guatemala have been conducted by the Insti- Ministry of National Electric (INDE), Geothermal De-

velopment Unit, with the aim of using this resource to generate base-load electricity.

Status of Low- and Medium-enthalpy Geothermal Development in Ecuador

Excerpted from a report by Ing. Milito Balseca G., Instituto Nacional de Energía, Unidad Geotérmica, Av. Mariana de Jesús, No. 2107 y María de Ureña, P. O. Box 007 C. Quito, Ecuador.

Because of the variety of energy resources in Ecuador (oil, gas, and hydroelectric), the development of geothermal energy has been planned in terms of energy diversification, with the use of high-enthalpy resources for electrical gen-

eration and with the use of low- to medium-enthalpy re-

turn to substitute for and complement conventional energy resources in the industrial and agribusiness sectors of the country.

Ecuador's first geothermal studies were undertaken at the end of 1978 by the Instituto Ecuatoriano de Electrificación (INCELE). Basic information was compiled for distribution at the meeting between INCELE and the Organización Lau-

naoamericana de Energía (OLADE). In 1979, field recon-

naissance work was begun at a national level. The final report was completed in mid-1980.

At the conclusion of the report, several study areas were defined as priority locales, potentially interesting from the point of view of high, medium, and low-enthalpy resources. The reconnaissance study by OLADE-INCELE concen-

trated along the Andean cordillera, where the best geother-

nal surface manifestations are found. In this way, three areas were chosen for high-enthalpy projects (Priority A) and three for medium- and low-enthalpy projects (Priority B).

After the reconnaissance study, the Instituto Nacional de Energía, (INE) began its work in geothermal, mandated by the Law of Creation of the Institute, dedicating itself to the development and coordination of medium- and low-en-
thalpy geothermal projects for direct-heating use.

In its geothermal work, INE focused its interests in areas

with a hydrological system that includes surface manifesta-

tions, and in areas where a possible market exists for uses of direct heat (such as an industrial park).

INE, conscious of the large geothermal potential of the country, opened its doors to the investigation of this unconventional energy source, hoping that this may someday be accessible and usable on a large scale. It plans to meet the following objectives:

- To create an experimental demonstration project to study the technical feasibility of the use of this energy source in Ecuador, carried out by the country.
- To create, among the different state institutions, a group of technical experts capable in the areas of exploration, production, and end-uses of geothermal energy.
- To test whether the technical requirements for the devel-

opment of geothermal energy are completely compatible with the level of technical development of the country.

With a view towards achieving these objectives, INE began geothermal feasibility studies in 1982 in the areas covered by Priority B: the area around Volcan Illaló, near Quito, which is known as the project "Valle de los Chillos."

To advance the investigation and development of geother-

cal energy in Ecuador, INE has planned some studies as complementary activities to the two projects. These include the elaboration of a geothermal inventory with a data bank; an evaluation of the country's geothermal potential; establish-

ing a legal framework for developing this energy source in Ecuador; and planning other direct-use projects, both agricultural (e.g., greenhouses, dryers, etc.) and aquacultur-

al (fish-farming).

Prefeasibility Study of Geothermal Areas In Honduras

Wilmar Flores

Empresa Nacional De Energía Eléctrica, Tegucigalpa, Honduras

Between 1985 and 1987, the National Electric Company (ENEE) simultaneously conducted two geothermal resource evaluation projects. One of the projects was made in coop-

eration with US-AID and the other with PNUD. The first was a rapid evaluation of previously identified areas, con-

centrating ultimately on the Patanaros prospect. The sec-

ond project was an evaluation of central Honduras, involv-

ing detailed studies of the Azacualpa and San Ignacio areas, and the Comayagua and Sula Grabens.

Detailed studies at Patanaros, Azacualpa, and San Ignacio included geochemistry, geology, gravity, magnetics and electric resistivity studies, and several small-diameter gra-

ditic holes up to 680m deep. All of these studies (except drilling) were also carried out in the Comayagua and Sula Grabens.

In the thermal systems studied, no evidence exists for migmatic heat sources. The thermal fluids are probably heated by deep circulation of meteoric water along faults, creating conditions giving rise to temperatures around 170°C.

These data are interpreted to indicate that Patanaros is the highest priority prospect, having measured temperatures over 160°C at only 250m depth, and production data show-

ing a significant potential for energy production.

Geothermal Resources of El Salvador

Gustavo Cuellar

Geothermal Consultant, CEL, P.O. Box 41-078, San Salvador, El Salvador

El Salvador, a country almost entirely volcanic in origin, lies along the Pacific Ring of Fire. Volcanism has remained active here from the Tertiary until the present time. The principle Quaternary volcanic centers are on the edge of the central graben, which traverses the country in a NNW-ESE direction. The predominant geologic conditions in these volcanic areas are favorable for the existence of economi-

cally exploitable geothermal reservoirs.

Geoscientific studies have revealed the existence of a nearly continuous, shallow, thermal anomaly. These studies de-

fine areas with characteristics that justify their further evaluation for possible development.

The Ahuachapán Geothermal field, with an installed capaci-

ty of 95 megawatts, has produced a savings equivalent to $300 million through the replacement of oil imports by geothermal power generation. The acquired experience has permitted the consolidation of a national technical infra-

structure responsible for geothermal development in new areas.

In addition to Ahuachapán, the Chipilapa field in the eastern part of the country and the Berlín field in the west will begin commercial production in 1989, with an initial capacity of 10 megawatts, each. The Coatepeque field is the subject of detailed investigation and exploratory drilling for addi-

tional exploitation.

The total installed electric capacity in El Salvador is 690.9 megawatts. According to the National Energy Plan, this will have to increase by about 520 megawatts by the year 2000. Geothermal resources are programmed to satisfy about 38 percent of the additional requirements during this period. The additional 200 megawatts of geothermal en-

ergy will come from four different areas.

The National Energy Plan is already in progress, and has been fortified with ample concessional funds administered by European and North American Governments.

DIVISION OF OIL AND GAS

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GEOThermal HOT LINE

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New Geothermal Exploration in the Philippines

"We’re encouraging more private sector participation in resource development, including geothermal," said Wenceslao De La Paz, Executive Director of the Office of Energy Affairs of the Philippine Government. "Geothermal energy fills 8 percent of the country’s energy requirement of the Philippines. We hope to double this amount in the next 5 years. The Philippines is the second largest user of geothermal energy in the world."

Mr. De La Paz made the statement on October 2, 1989, as he and Stephen C. Lipman, president of Unocal Geothermal Division, signed an agreement by which Unocal will undertake geothermal exploratory activities in the southern portion of the Island of Luzon. The work will occur in a 699-square mile area at Mt. Isarog, a volcano in the Province of Camarines Sur.

Unocal currently produces 660 megawatts of electricity from geothermal power plants on Luzon through its subsidiary, Philippine Geothermal, Inc. Another 230 megawatts of electricity in the Philippines is generated from geothermal power plants owned by the Philippine National Oil Company.

Mr. Lipman said this is the first geothermal exploratory project since 1971 in which Unocal has been involved

Bechtel Group Part of Japanese Geothermal Development

Fujita Corporation USA, in conjunction with Waza Corporation of Japan and the Bechtel Group, will collaborate on the development of Japanese geothermal energy in the Fujita Geothermal field. Bechtel will conduct extensive feasibility studies for the development of the geothermal field. Based on the Bechtel study, Fujita and Waza propose to request that Bechtel proceed, on a phase-by-phase basis, to:

- Design and engineer a high-technology, state-of-the-art geothermal power plant; and
- Handle construction management and supervision for the construction of one or more geothermal power plants, including procurement of required materials and training manpower resources necessary for operations. Fujita and Waza will assist Bechtel in the mobilization, design, and development of the proposed Bechtel work. Fujita Corporation and Waza Corporation, headquartered in Tokyo, have been actively engaged in the development of this new geothermal energy source since May 1988. Kunaki Fujita, president of Fujita USA as well as Fujita Japan, has expressed his strong belief that Japan’s future energy demands can be achieved by utilizing Bechtel’s technology in conjunction with Japan’s geothermal resources.

by Susan F. Hodgson

DEVELOPMENT
TECHNOLOGY

Assessing Fluid Inclusions

"Fluid inclusion microthermometry is the most useful in terms of chemistry," said Joe Moore, Geochemistry Section Head at the University of Utah Research Institute (UURI). "It’s also a fast way to learn probable quantitative well temperatures. The process takes just a few hours, compared with regular thermal logs that take a few months to produce. In most cases, the inclusion temperatures are close to the temperatures measured by the thermal logs, but this is not always the case. That’s why temperature logs are run, as well.

"However, certainty increases once we find out that the measurements for the inclusion temperatures match those on the thermal logs," Dr. Moore continued. "Then, we can assume that the inclusion fluid chemistry and gas content match those in the modern geothermal system. We also know where the well has been drilled within this geothermal system.

"Fluid inclusion microthermometry is commonly used in geothermal fields all over the world and with good success," Dr. Moore concluded.

NOTE: The following paragraphs further explain fluid inclusion microthermometry. The material is excerpted, with permission, from the May-June 1989 issue of UURI Outlook.

"Fluids that circulate through hydrothermal systems are commonly preserved in small irregularities on the growing surfaces of the minerals they deposit and in microfractures formed after initial growth of the minerals (Fig. 1). Because fluid inclusions provide the most direct means of obtaining information on the compositions and temperatures of these fluids as they existed during mineral deposition, they have proven to be an important tool to the geothermal and mineral explorationist. Recent studies conducted at UURI have demonstrated that fluid-inclusion analysis can also provide essential data to the geothermal reservoir engineer.

"Chemical and thermal data can be obtained routinely on fluid inclusions contained in millimeter-sized cuttings of samples through microthermometric measurements. The trapping of a single-phase fluid consisting of either liquid or steam will produce an inclusion that contains both liquid and vapor phases when cooled to room temperature. Heating the inclusion to homogenize the fluid into a single phase yields an estimate of the trapping temperature. Variations in trapping temperatures provide information on the thermal history, size, and shape of a hydrothermal system.

"Information on the salinities and gas content of the inclusion fluids can be obtained from low-temperature phase changes since there is a direct relationship between the total dissolved solids content of a fluid and its freezing temperature. The relationship between the heating and freezing measurements yields information on the physical processes that have affected the thermal fluids. Processes such as boiling and mixing in the reservoir have a strong affect on the output of a geothermal power plant, and knowledge of these processes can be crucial in the siting of geothermal wells. Boiling and mixing have also been recognized as primary depositional mechanisms of precious metals in fossil hydrothermal systems."

Further information can be obtained from Dr. Moore at (801)524-3428.

Figure 1. Fluid inclusions in vein fluorite from a depth of 165 m in the Raça geothermal system. The inclcations are secondary, occurring along healed fractures. Microthermometric measurements indicate that the inclusions in this crystal formed at temperatures between 1,500°C and 2,150°C from fluids with apparent salinities that ranged from 0.0 to 0.5 equivalent weight percent NaCl. The large compositional range of these inclusions is probably due to variations in the gas content of the fluids. Compositional and thermal data on inclusions as small as 2- to 3-microns across can be obtained routinely.
Chemical Tracers for Geothermal Reservoir Analysis

Good geothermal chemical tracers have a number of important characteristics: (a) they are chemically stable under the high temperature and pressure conditions of geothermal reservoirs; (b) they are conservative (i.e., they are not adsorbed by and do not react with reservoir rocks); (c) they are detectable in very low concentrations, allowing dilution factors of 10^6 to 10^9 during transit through the reservoir; (d) they are environmentally safe; and (e) they are inexpensive to use.

It is important to have a number of different tracers available so several injection wells can be tagged independently. In the past, the primary tracers used by the geothermal industry were radioactive nuclides, halide ions, and organic dyes. Because of toxicity problems, government permitting, high natural background concentrations, and undocumented thermal instability, these compounds are either not suitable as tracers or are too difficult to use.

Excerpted, with permission, from UUIG Outlook, August-October 1989

The Effect of Ambient Temperature on Geothermal Binary-Plant Performance

The power output of geothermal binary plants is very sensitive to changes in the temperature of the surroundings. This phenomenon is often observed at such plants. Even though binary plants differ widely in the details of their designs, this effect can be easily understood for all binary plants with reference to an ideal binary cycle. Such a cycle appears as a triangle in a temperature-entropy diagram (Fig. 1).

The line from 1 to 2 in Figure 1 represents an isentropic expansion process (work output); the line from 2 to 3 stands for the isothermal heat rejection process (e.g., condensation); and the line from 3 to 1 is the heating process that occurs as the geothermal brine cools and transfers heat to a secondary liquid working fluid, such as isopentane.

All the processes are assumed ideal in this example (i.e., thermodynamically reversible). Hence, the brine cooling curve (not shown) would be coincident but countercurrent with the working fluid heating curve. Similarly, the exterior cooling medium would follow a path coincident but countercurrent with the heat rejection process, the line from 2 to 3.

The cycle performance is measured by the cycle efficiency, η, which is defined as the ratio of the net work output to the heat input. Alternatively, it may be thought of as the ratio of the net electrical kilowatts produced to the input thermal kilowatts. From elementary thermodynamics, the net work is the area inside the triangle 1-2-3, and the heat input is the area beneath the line 1-3-1. Thus, it is easy to show that

\[ η = \frac{T_{h} - T_{o}}{T_{h} + T_{o}} \]

where:
- \( T_{h} \) is the brine inlet temperature (kelvins)
- \( T_{o} \) is the brine outlet temperature (kelvins)

The effect of \( T_{h} \) on the ideal binary efficiency is shown in Figure 2 for several values of \( T_{o} \). The dependency of the efficiency on \( T_{h} \) is shown in Figure 3 for several values of \( T_{w} \).

To examine analytically how the cycle performance changes when the brine inlet temperature \( (T_{h}) \) or the brine outlet temperature \( (T_{o}) \) varies, we can imagine \( \Delta T_{h} \) or \( \Delta T_{o} \) imposed on the cycle as shown in Figure 1. The derivative of \( η \) with respect to \( T_{h} \), holding \( T_{o} \) constant, is simply

\[ \frac{-2T_{h}}{(T_{h} + T_{o})^3} \]

The derivative of \( η \) with respect to \( T_{o} \), holding \( T_{h} \) constant, is

\[ \frac{2T_{o}}{(T_{h} + T_{o})^3} \]

The ratio of the magnitudes of these two quantities reduces simply to \( T_{h}/T_{o} \), which obviously must always be greater than one. Thus, for equal changes in \( T_{h} \) and \( T_{o} \), the effect on \( η \) caused by a change in \( T_{h} \) at constant \( T_{o} \) will always be larger than that caused by a change in \( T_{o} \) at constant \( T_{h} \).

If \( T_{h} \) is larger than the lowest available ambient temperature, \( T_{w} \) (the "dead-state" temperature), then \( η \) will be less than the maximum possible cycle efficiency, \( η_{max} \), where \( η_{max} \) is given by

\[ \eta_{max} = \frac{T_{h} - T_{o}}{T_{h} + T_{o}} \]
To achieve this thermodynamically maximum efficiency, the brine would have to be cooled down to the dead-state temperature reversibly (i.e., by an ideal, frictionless process)—a practical impossibility. In reality, therefore, $T_o$ must always be greater than $T_L$, the difference being a function of the type of heat rejection system and of its design details. For any given system, $T_L$ will just be a function of $T_o$, and will float as $T_o$ varies because of changes in climatic conditions. Then, the power output will also float, even for a fixed brine inlet temperature and flow rate. Clearly, the best performance will be achieved when $T_L$ (and thus $T_o$) is the lowest. It follows then that a plant that just meets its design output when $T_o$ happens to be at its lowest expected value will not be able to produce its design output at other times—unless the brine flow rate is increased.

**Plant efficiency varies inversely with the outlet temperature.**

To summarize, the plant efficiency varies inversely with the outlet temperature. The effect on binary power plant efficiency from a change in outlet temperature at constant inlet temperature will always be greater than that from a change in inlet temperature at constant outlet temperature. If the outlet temperature decreases, power plant efficiency will increase. If the outlet temperature increases, power plant efficiency will decrease.

**ENERGY**

**California Energy Sources**

What were the sources for the total amount of energy used in California in 1988? To answer this question, these data were provided by Dale Rodman, California Energy Commission.

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<thead>
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<th>SOURCE</th>
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<tr>
<td>Oil and natural gas</td>
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<td>Hydropower</td>
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<td>Coal</td>
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**U.S. Energy Reserve Data**


**U.S. Reserves of Energy**

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>BBOE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>908.0</td>
</tr>
<tr>
<td>Photocconversion (Biomass)</td>
<td>57.7</td>
</tr>
<tr>
<td>Geothermal</td>
<td>42.5</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>39.9</td>
</tr>
<tr>
<td>Petroleum</td>
<td>26.9</td>
</tr>
<tr>
<td>Hydropower</td>
<td>10.0</td>
</tr>
<tr>
<td>Uranium</td>
<td>7.3</td>
</tr>
<tr>
<td>Photocconversion (Solar)</td>
<td>3.0</td>
</tr>
<tr>
<td>Wind</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>Shale Oil</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>Peat</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,096.2</td>
</tr>
</tbody>
</table>

*BBOE = Billion barrels of oil equivalent.
U.S. DOE Renewable Energy R&D Funding

The following table is reprinted from Power Surge, by Nancy Rader, which is reviewed in the Publications section.

U.S. Department of Energy Renewable Energy Research & Development Funding:
FY81 to FY90, by Technology
In Adjusted, 1990 dollars (Millions)

<table>
<thead>
<tr>
<th>FY81</th>
<th>FY82</th>
<th>FY83</th>
<th>FY84</th>
<th>FY85</th>
<th>FY86</th>
<th>FY87</th>
<th>FY88</th>
<th>FY89</th>
<th>FY90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Business</td>
<td>102.4</td>
<td>71.6</td>
<td>11.2</td>
<td>20.1</td>
<td>14.6</td>
<td>9.0</td>
<td>5.1</td>
<td>3.9</td>
<td>5.8</td>
</tr>
<tr>
<td>Photovoltaics</td>
<td>72.3</td>
<td>80.0</td>
<td>72.9</td>
<td>82.4</td>
<td>54.5</td>
<td>54.2</td>
<td>42.3</td>
<td>31.0</td>
<td>27.6</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>189.4</td>
<td>55.6</td>
<td>61.0</td>
<td>46.6</td>
<td>51.2</td>
<td>41.2</td>
<td>41.4</td>
<td>31.0</td>
<td>33.7</td>
</tr>
<tr>
<td>Biomass</td>
<td>99.0</td>
<td>18.5</td>
<td>84.5</td>
<td>34.2</td>
<td>36.6</td>
<td>25.8</td>
<td>26.9</td>
<td>70.6</td>
<td>13.6</td>
</tr>
<tr>
<td>Wind</td>
<td>55.0</td>
<td>21.6</td>
<td>39.5</td>
<td>33.0</td>
<td>33.3</td>
<td>31.2</td>
<td>39.0</td>
<td>9.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Geohydrothermal Systems</td>
<td>75.7</td>
<td>23.3</td>
<td>13.2</td>
<td>0.9</td>
<td>4.1</td>
<td>3.2</td>
<td>3.0</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Geothermal</td>
<td>1.2</td>
<td>5.2</td>
<td>4.0</td>
<td>5.4</td>
<td>3.4</td>
<td>2.8</td>
<td>3.4</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Groundwater</td>
<td>5.6</td>
<td>5.2</td>
<td>4.0</td>
<td>5.4</td>
<td>3.4</td>
<td>2.8</td>
<td>3.4</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Program Support</td>
<td>9.5</td>
<td>6.0</td>
<td>5.2</td>
<td>4.0</td>
<td>5.4</td>
<td>3.4</td>
<td>3.4</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Other</td>
<td>4.5</td>
<td>5.2</td>
<td>4.0</td>
<td>5.4</td>
<td>3.4</td>
<td>2.8</td>
<td>3.4</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>TOTAL EXPENDITURES</td>
<td>715.2</td>
<td>290.2</td>
<td>247.8</td>
<td>214.0</td>
<td>194.6</td>
<td>165.5</td>
<td>134.0</td>
<td>114.2</td>
<td>95.3</td>
</tr>
<tr>
<td>Geothermal</td>
<td>525.8</td>
<td>74.0</td>
<td>77.2</td>
<td>36.7</td>
<td>26.6</td>
<td>30.3</td>
<td>22.2</td>
<td>22.2</td>
<td>20.7</td>
</tr>
<tr>
<td>Heat pump</td>
<td>4.5</td>
<td>1.6</td>
<td>1.3</td>
<td>1.0</td>
<td>0.7</td>
<td>0.4</td>
<td>2.8</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>TOTAL RENNEWABLE</td>
<td>995.5</td>
<td>364.4</td>
<td>320.5</td>
<td>261.7</td>
<td>236.3</td>
<td>194.6</td>
<td>162.1</td>
<td>124.7</td>
<td>113.6</td>
</tr>
</tbody>
</table>

* Proposed by Reagan Administration shortly before tenure ended and resubmitted by Bush Administration. Note: Figures are adjusted to 1990 dollars for purpose of comparison with FY90 proposed funding levels.

Source: Congressional Research Service (FY81-FY89) and Dept. of Energy (FY90).

Geothermal Facts from the BLM

The following information is published by the Uintah District Office, Bureau of Land Management (BLM).

The Geysers Geothermal field, as of 9/89

I. Geysers KGRA: (Known Geothermal Resource Area)

282,002 acres total Federal leases: 10,929 acres
Federal acres producing: 7,941 acres

II. Geysers Production:

<table>
<thead>
<tr>
<th>Total field production</th>
<th>Federal production:</th>
</tr>
</thead>
<tbody>
<tr>
<td>720 wells</td>
<td>190 wells; 176 wells producing 725 megawatts (36.5 percent)</td>
</tr>
</tbody>
</table>

Assuming an average production requirement of 18,000 pounds of steam per megawatt, federal steam production equals 861,300 barrels of oil a month.

III. Federal Geothermal Operators/Lessors:

Geysers Geothermal Company; Northern California Power Agency; Santa Fe Geothermal, Inc.; Unocal; and the State of California, Department of Water Resources.

IV. Geothermal Well Data:

Average depth: 6,000 feet. Average drilling time: 45 days. Average cost: $150,000. Average production: 150,000 pounds steam/hour at 375 pounds per square inch and 400°F (equivalent to 330 barrels of oil per day). Heat energy of steam is 1,205 BTU/pound.

Wells are drilled directionally from multiple well pads. Wells are drilled with mud to the casing depth, then drilled to total depth with air. Wells are completed barefoot (open hole). Generally, wells that are not producible commercially are plugged back inside the casing. Then, a window is milled, and the well is drilled directionally to a new target. If successive redrills fail, the well will be converted to an injection well.

Also from the BLM

Current Geothermal Production on or from Federal Lands

I. The Geysers, Northern California

- Northern California Power Agency
- Sacramento Municipal Utility District
- Geysers Geothermal
- Santa Fe International Corporation
- Steam from federal leases is utilized by 20 additional facilities. Federal portion

333 MW

II. East Mesa, Southern California

- Ormat
- Osmet III
- GEO Operating Corporation
- GEM I
- GEM II & III

107 MW

III. Coso Hot Springs, Southern California

- California Energy BLM East

48 MW

IV. Wendel - Amadee, Northern California

- Hill Power/GeoProducts

8 MW

V. Dixie Valley, Central Nevada

- Orimex Corporation

70 MW

VI. Financial Benefits of Geothermal Development to Local Economies

Fifty percent of rents and royalties paid to the U.S. government are returned to the state in which the leases are located. The State of California distributes these monies as follows: (1) 40 percent to the county of origin, (2) 30 percent as grants to jurisdictions having geothermal resources, and (3) 30 percent to the Parklands and Resources Investment Fund.

VII. Federal Royalties


$12,000,000 $15,800,000 $13,000,000 $12,000,000 $12,000,000

V. Federal Drilling Activity Summary:

Wells Drilled Wells Worked Over Wells Abandoned

FY '85 20 7 1
FY '86 24 5 0
FY '87 24 8 1
FY '88 14 5 1
FY '89 (to 9/95) 15 3 1

IV. Federal Geothermal Operators/Lessors:

Geysers Geothermal Company; Northern California Power Agency; Santa Fe Geothermal, Inc.; Unocal; and the State of California, Department of Water Resources.

V. Geothermal Well Data:

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**DIVISION OF OIL AND GAS**

**GEOTHERMAL HOT LINE**
TRANSMISSION

Court Okays Federal Power Sales to Municipal Utilities

The right of the Western Area Power Administration (WAPA) to sell Bonneville Power Administration energy directly to municipal utilities has been confirmed by the U.S. District Court, Northern District of California.

The court’s ruling adjudicates a dispute that began in 1982, when the Northern California Power Agency (NCPA) contracted with WAPA to purchase power for use by six of its member utilities, the Cities of Alamed, Healdsburg, Lodi, Lompoc, Ukiah, and Santa Clara.

"This decision is a significant endorsement for a high degree of open trade and common sense in the electric utility field," said Michael W. McDonald, NCPC General Manager. "The court has affirmed WAPA’s right to market surplus federal power, Pacific Gas and Electric Company’s obligation to transmit it, and the rights of municipal utilities, unless contractually restricted, to buy energy from WAPA at the lowest-cost resource."

PUC Studies Transmission Project

The California Public Utilities Commission (PUC) held a Public Workshop to describe how the state and the energy utilities who propose building the California-Oregon Transmission Project (COTP) intend to evaluate the project prior to presenting it to the PUC for evaluation and approval.

The COTP is a proposed transmission line that would carry electricity from the Pacific Northwest to California. It would provide an additional source from which utilities serving California electricity consumers could purchase power.

Health Risks From Exposure to Electrical Facilities and Lines

The California Public Utilities Commission (PUC) announced the availability of its draft report on the possible health effects of exposure to electrical power systems. The report is part of a 3-year joint research program with the California Department of Health Services (DHS).

The report, prepared in cooperation with DHS, includes selected expert assessments of possible health risks from electrical and magnetic fields produced by electric utility facilities; discussions of further research needed to support possible regulatory consideration of the issue; a summary of recommendations and an introductory discussion by the PUC; and a chapter by the DHS outlining California’s proposed 3-year research program.

The program is being undertaken to comply with Senate Bill 2519 (Rosenthal) to look into the possible health effects associated with exposure to electrical power systems, including generating plants, substations, and transmission and distribution power lines. The draft report, now available, will be issued in final form to the legislature by September 1989. SB 2519 also requires that a separate progress report on the status of California’s 3-year research program be submitted to the legislature by December 1, 1990.

California’s study of the issue should provide an improved scientific basis for determining whether electric and magnetic fields from electrical power facilities pose a significant threat to public health, and whether regulatory action is warranted. The legislature’s decision to fund such a study was prompted by a series of studies reported by the State of New York in 1987, which suggested that power-line electrical and magnetic fields might cause adverse health effects besides those of burns, shocks, and electrocution.

The 500-page draft PUC report, Potential Health Effects of Electric Power Facilities, is available from the PUC for $20 (free to public agencies). Limit, 1 copy. Make check payable to the CPUC and send to: Documents Section, California Public Utilities Commission, 505 Van Ness Avenue, San Francisco, California 94102.

Sierra Pacific Power Seeks 200 Megawatts

Sierra Pacific Power Company is seeking proposals from utility and nonutility sources to supply up to 200 megawatts of long-term firm capacity to meet its energy needs between 1991 and 1997.

The Reno-based energy utility issued a request for proposals (RFP) on November 15, 1989. The company’s future energy requirements were identified in a 20-year Resource Plan approved in October by the Nevada Public Service Commission.

"We are encouraging parties to submit creative proposals that would be of mutual advantage to both the bidder and to Sierra Pacific," said Noreen Leary, manager of power and fuel contracts. The proposals must be submitted by January 15, 1990.

This is the second time Sierra Pacific has issued an RFP to fulfill its long-term additional capacity needs. The utility’s first RFP was issued in the spring of 1989 and yielded 94 responses from 34 different bidders. As a result of the first RFP, Sierra Pacific successfully negotiated long-term contracts for about 163 megawatts, divided between Idaho Power Co., PacifiCorp, and Ormat Energy Services.

For more information or a copy of the RFP, contact: Noreen Leary, manager of power and fuel contracts, Sierra Pacific Power Co., P.O. Box 10101, Reno, NV 89520, or call (702) 689-4889.

PG&E Undertakes Study

Pacific Gas and Electric Company is participating in a 3-year, $10 million study to improve efficiency in the use of electricity, according to an article in the San Francisco Chronicle. Also participating are the Natural Resources Defense Council, the Rocky Mountain Institute, and Lawrence Berkeley Laboratory.

LEGISLATION

Federal Legislation

The following material is a federal legislative report, with information on the status of geothermal and thermal power legislation from the 101st Congress, current as of November 15, 1989. The report was compiled by LECI-SLATE.

Abstracts and excerpts from abstract summaries are included for some bills and resolutions on this list.

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GEOThERMAL HOT LINE

H.R.1761 BY ROSTENKOWSKI (D-IL) -- Internal Revenue Code of 1986, Amendment

H.R.2566 BY YOUNG (R-AK) -- Nevada Wilderness Act of 1989

H.R.2377 BY YOUNG (R-AK) -- Transfer of Real Property to the City of North Las Vegas, Nevada, Provision

H.R.2304 BY VEDN (D-OR) -- Renewable Energy Trade Equity and Promotion Act of 1989

H.R.2272 BY BYRON (D-MT) -- California Military Lands Withdrawal Act of 1989

H.R.2393 BY THOMAS, WILLIAM (R-CA) -- Internal Revenue Code of 1986, Amendment


H.R.2535 BY OWENS, WAYNE (D-UT) -- Addition of Lands to the Galiatin National Forest, Provision


H.R.2719 BY CLINGER (R-PA) -- Surface Mining Control and Reclamation Act of 1977, Amendment


H.R.2959 BY SORRE (D-WI) -- Foreign Operations, Export Financing, and Related Programs Appropriations Act, 1990


H.R.3402 BY FASSELL (D-IL) -- Polish and Hungarian Democracy Initiative of 1989

H.R.3448 BY SMITH, ROBERT F. (R-OK) -- Conveyance of Railroad Grant Lands in Oregon and California, Provision

H.R.3460 BY LEWIS, JERRY (R-GA) -- California Desert Conservation Act of 1989

S.11 BY CRAMERON (D-CA) -- California Desert Protection Act of 1989

S.234 BY BROWN (R-OK) -- Energy Security Incentive Act of 1989


S.469 BY BROWN (D-OK) -- Domestic Energy Security Act of 1989

S.452 BY WILSON, PAUL (D-CA) -- California Military Lands Withdrawal Act

S.468 BY REID (D-WV) -- Real Property to the City of North Las Vegas, Nevada, Conveyance

S.488 BY FOULIER (D-CA) -- Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989

S.507 BY SIMON (D-IL) -- Anti-Apartheid Act Amendments of 1989

S.693 BY SCHMITZ (R-NE) -- Global Warming Response Act of 1989

S.626 BY REID (D-WV) -- Apex Project, Nevada Land Transfer and Authorization Act of 1989

S.817 BY GORE (D-CT) -- Ozone Layer Conservation Act of 1989

S.914 BY MATSUMAG (D-HI) -- Internal Revenue Code of 1986, Amendment

S.966 BY FORD, WENDELL (D-CT) -- Civilian Energy Programs Authorization for Fiscal Years 1990 and 1991

S.1059 BY HAYFIELD (R-OR) -- Renewable Energy Trade Equity and Promotion Act of 1989

S.1113 BY BACUS (D-OR) -- Waste Minimization and Control Act of 1990


S.1569 BY RIEGEL (D-NY) -- Establishment of the Grand Island National Recreation Area in Michigan, Provision

S.1582 BY SIMON (D-IL) -- Support for East European Democracy (SEED) Act of 1989

S.1611 BY LEARY (D-VT) -- International Climate Change Prevention Act of 1989

S.1739 BY HAYFIELD (R-OR) -- Certain Lands in Oregon to the Rogue Community College District, Conveyance

H.R.26 BY GIBBON (R-MT) -- Geothermal Energy Control Act of 1989

Abstract

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

S.914 BY MATSUMAG (D-HI) -- Internal Revenue Code of 1986, Amendment

Abstract

Amends the Internal Revenue Code to extend the investment tax credit in connection with certain energy property.

S.4658 BY ANDREWS (D-CA) -- Energy Security Incentive Act of 1989

Abstract

Amends the Internal Revenue Code to establish tax incentives, including tax credits, for domestic oil and gas exploration and production.

Repeals provisions that tax executive income any gains from dispositions of oil, gas, or geothermal wells.

S.2395 BY THOMAS, WILLIAM (R-CA) -- Internal Revenue Code of 1986, Amendment

Abstract

Amends the Internal Revenue Code with respect to the investment tax credit in connection with certain energy property.

Digests

Amends the Internal Revenue Code to: (1) extend for three years, through 1992, the investment tax credit in connection with depreciable solar energy property and geothermal property; and (2) permit this credit against the taxpayer's entire regular tax liability and minimum tax liability.


Abstract

Establishes a comprehensive national energy policy to reduce global warming and promote energy conservation and efficiency, including measures for international energy cooperation and world population reduction.

Digests

National Energy Policy Act of 1989 -- Establishes national goals: (1) that the amount of carbon dioxide in the atmosphere be reduced from 1988 levels by at least 20 percent by the year 2000 through a mix of federal and state energy policies; and (2) the establishment of an international global agreement on the atmosphere by 1992.

Title I: National Energy Plan

Requires the Secretary of Energy (the Secretary) to transmit to the Congress a "least cost national energy plan" with forecasts, priorities, inventories, and targets for meeting such national goals, sets forth the
Title II: Office of Climate Protection

Establishes the Office of Climate Protection which shall be responsible for: (1) participation by the Department of Energy in various domestic and international agencies involved in global climate change analysis; and (2) the monitoring of U.S. energy policies for atmospheric and global warming effects, with annual reports on such effects.


Abstract

Sets forth national goals and priorities for renewable energy and alternative energy resources programs.


Requires the President's budget requests for FY 1991 to contain the recommendations of the Secretary of Energy for specified Department of Energy research and development programs for 1993, including biofuels energy systems, solar buildings energy systems, ocean energy systems, and geothermal energy.

S.458 by FOWLER (D-CA) -- Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989

Abstract

Sets forth national goals and priorities for renewable energy and alternative energy resources programs.

Digest

05/09/89 (Reported to Senate from the Committee on Energy and Natural Resources with amendment, S. Reppt. 101-107)

Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989 - Confers general authority upon the Secretary of Energy (the Secretary) to pursue joint ventures with the private sector in energy renewal and energy efficiency technologies. Specifies national goals for the wind, photovoltaics, and solar thermal energy programs.

Requires the Secretary to report to the Congress on goals for other specified renewable energy technologies at the time the President's budget request is submitted for FY 1992.

Authorizes appropriations for FY 1991 through 1995 for: (1) the wind energy research program; (2) the photovoltaics energy systems program; (3) the biofuels energy systems program; (4) the solar buildings energy systems program; (5) the ocean energy systems program; and (6) the geothermal energy programs.

S.964 by FORD, MENDELL (D-KT) -- Civilian Energy Programs Authorization for Fiscal Years 1990 and 1991

Abstract

Authorizes appropriations to the Department of Energy for various civilian energy programs for FY 1990 and 1991.

Digest

Civilian Energy Programs Authorization for Fiscal Years 1990 and 1991

Title I: Research and Development

Authorizes appropriations for FY 1990 for Department of Energy civilian research and development programs relating to: (1) general science and research activities; (2) energy supply research and development; (3) the Geothermal Resources Development Fund; (4) fossil energy research and development; (5) energy conservation; (6) the Strategic Petroleum Reserve; and (7) the Strategic Petroleum Reserve Petroleum Account.


Abstract

Establishes a comprehensive national energy policy to reduce global warming, including measures for international energy cooperation and world population reduction.

Directs the Secretary of State to convene an international meeting in the United States by the end of 1992 to adopt a global climate protection agreement with measures at least as stringent as those in this Act. Sets forth a percentage reduction schedule for emissions of specified gases.

S.603 by BOSENFITZ (R-MN) -- Global Warming Response Act of 1989

Abstract

Establishes the Office of Global Warming.

Amends the Foreign Assistance Act of 1961 to provide assistance to specified agencies for environmental assessment and assistance, forestry programs, and energy projects.

Sets forth global warming response requirements for specified agencies and departments.

Digest

Title I: Establishment of a Single Coordinating Body on Global Warming

Provides for the establishment of a single coordinating body for global warming within the Department of State to serve as the single coordinating point for the United States on all global warming policy and response matters. Provides that the Office shall be headed by a Deputy Assistant Secretary for Global Warming to be appointed by the President. Requires the Office to establish an interagency team for ongoing formulation of policy and response mechanisms to global warming to be coordinated with the Intergovernmental Panel on Climate Change. Directs the Office to develop, annually update, and transmit to the President and the Congress a Global Warming Strategy Plan to coordinate policy, research, and response efforts.

LEASING

BLM Issues Amendments to Geothermal Leasing Regulations

On April 10, 1989, the Department of the Interior’s Bureau of Land Management (BLM) issued an interim rule implementing the Geothermal Steam Act Amendments of 1988, which were enacted September 22, 1988, to amend the Geothermal Steam Act of 1970. The rulemaking was published in the April 6, 1989, issue of the Federal Register.

The new regulations will allow extension of geothermal leases under certain conditions, and include a list of specific lands named in the legislation to be excluded from geological exploration, development, and utilization.

Geothermal development can be a very expensive initiative because the remote locations of many geothermal sources may force a developer to plan for construction of not only the geothermal steam production facilities, but also the means to convert the steam to electricity. Geothermal sources may also be limited geographically, with temperatures that are too low for steam generation. Some geothermal sources may be economically viable only in a specific part of the country. As a result, certain geothermal sources in the United States may never become economically viable.

Geothermal country: Palm Canyon, on the reservation of the Agua Caliente Band of Cahuilla Indians, near Palm Springs, California. Photo by Susan Hodgeson.
to electricity and then transport it to market. Even a small project may well take longer than the 10-year lease term.

Prior to the passage of the Geothermal Steam Act Amendments, geothermal leases could be extended only under two conditions – if geothermal energy was being produced at the end of the 10-year term, or if there was a well capable of production and a contract to sell that production within 5 years from the end of the 10-year term.

Many developers have been unable to meet those criteria. For example of significant expenditures include funds spent on actual drilling operations, geotechnical or geophysical surveys for exploratory or development wells, road or generating facility construction on the lease, and environmental studies required by state or federal law.

The interim rule also specifies that geothermal leases shall not be issued or extended if geothermal development would result in a significant adverse effect on a significant thermal feature within a unit of the National Park System.

The rulemaking is being published on an interim basis so that leases scheduled for expiration may be extended if they meet the qualification requirements of the Geothermal Steam Act Amendments. For those leases in effect upon commencement of utilization within a specific period of time. The new regulations will allow lease extensions of up to 10 years, in two 5-year blocks. In order to qualify for an extension, a lease must show bona fide efforts to produce geothermal resources in commercial quantities given the current economic conditions for marketing geothermal steam.

The lessee must also choose either to make “payments in lieu of commercial quantities,” or to make “significant expenditures” toward development of the lease.

Federal Geothermal Leasing Operations in California, 1989

These data are from the Bureau of Land Management, California.

Geothermal energy development on federal lands in California produced 918 megawatts of electrical power in 1989, the equivalent of 695,454 barrels of oil per month, or enough to supply the power needs of almost 920,000 people.

This alternative energy source also earned $13.56 million in rents and royalties for the federal, state, and county treasuries from federal leases covering 314,225.7 acres.

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<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of leases</td>
<td>365</td>
<td>293</td>
<td>268</td>
<td>241</td>
</tr>
<tr>
<td>Competitive leases issued</td>
<td>3</td>
<td>0</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Noncompetitive leases issued</td>
<td>39</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Federal production (megawatts)</td>
<td>735</td>
<td>754</td>
<td>795</td>
<td>918</td>
</tr>
<tr>
<td>Producing leases</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Producing wells</td>
<td>132</td>
<td>167</td>
<td>186</td>
<td>222</td>
</tr>
<tr>
<td>Plans of operation approved</td>
<td>11</td>
<td>14</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Drilling permits issued</td>
<td>50</td>
<td>64</td>
<td>93</td>
<td>39</td>
</tr>
</tbody>
</table>

* No leases were issued, due to a Congressional moratorium.

Leases on California Federal Lands, 10/1/88 to 9/30/89

| Number of existing, noncompetitive geothermal leases | 111 | (158,366.855 acres) |
| Number of existing, competitive geothermal leases | 130 | (215,838.85 acres) |
| Number of geothermal leases in actual production | 19 | (21,479.4 acres) |
| Number of noncompetitive leases issued | 9 | (8,334.63 acres) |
| Number of competitive leases issued | 2 | (1,676.19 acres) |

Seven Parcels Leased in Nevada Geothermal Sale

Seven parcels of public land totaling about 15,078 acres of land attracted the interest of bidders on April 20, 1989, as the Nevada Bureau of Land Management (BLM) held a geothermal competitive lease sale in Reno, Nevada.

A total of $175,808.71 was offered in “bonus bids” (one-time bid to gain the opportunity to lease an area). In addition, successful bidders will now pay $2 an acre for the first year's lease on the parcels they hope to develop.

Ed Spang, Nevada State Director for the BLM, says the April 20 sale was offered pursuant to the Geothermal Steam Act of December 1970 and regulations issued since the Act. A total of 61 parcels totaling about 121,733 acres was offered at the geothermal competitive lease sale. Twelve bids were received, with seven being successful. The successful bidders will have an opportunity to lease their parcels for ten years.

All parcels are on public lands that have been declared to be Known Geothermal Resource Areas (KGRA's). The parcel location, successful bidder, and high bonus bid are:

Parcel 33 of the Gerlach KGRA, Washoe County: Michael B. Stewart, Yerington. $7.13/acre.

Parcel 34 of the Gerlach KGRA, Washoe County: Michael B. Stewart, Yerington. $15.13/acre.

Parcel 35 of the Gerlach KGRA, Washoe County: Michael B. Stewart, Yerington. $4.13/acre.

Parcel 48 of the New York Canyon KGRA, Pershing County: Union Oil Co. of Calif. $20.35/acre.

Parcel 49 of the New York Canyon KGRA, Pershing County: Union Oil Co. of Calif. $20.35/acre.

Parcel 50 of the New York Canyon KGRA, Pershing County: Union Oil Co. of Calif. $7.65/acre.

Parcel 53 of the San Emidio Desert KGRA, Washoe County: Omint Energy, Sparks. $7.00/acre.

In accordance with federal regulations, royalties will be paid to the United States should any of the parcels go into production for heat or energy. The State of Nevada receives half of all royalties on public lands and will also receive half of the revenue from the bonus bids and rental.
Prudential Power Funding Completes Financing for Four Geothermal Power Plants

Prudential Power Funding Associates has provided $287 million in debt financing for four geothermal power plants in Nevada and California—representing the first time The Prudential has invested in geothermal power production.

Of the total, $180 million consisted of permanent financing for the recently completed Oxbow Geothermal Power Plant in Dixie Valley, Nevada. The 55-megawatt plant, developed by Oxbow Geothermal Corporation, is expected to produce 392 million kilowatt-hours of electricity per year, which will be sold to Southern California Edison Company under a 30-year sales contract. The financing also covers a 210-mile transmission line developed by Oxbow.

Another $81 million was provided for the Ormesa Geothermal I and Ormesa IE plants in Imperial Valley, California. Ormesa Geothermal I, a 29.5-megawatt facility, has been operating since October 1987; the 10-megawatt Ormesa IE was completed in February 1989. Both were developed by Ormat Energy Systems, Inc. and have contracted to sell a total expected annual output of 260 million kilowatt-hours of electricity to Southern California Edison.

The remaining $26 million was allocated to finance a 13.5-megawatt plant called Stillwater Geothermal I, that is scheduled to be completed in the spring of 1989 in west-central Nevada. This project, also developed by Ormat Energy Systems, is expected to produce 91 million kilowatt-hours of electricity annually, which will be sold to Sierra Pacific Power Company.

“We have been closely following the development of geothermal power production for some time, and believe it presents a viable and increasingly attractive way to supplement existing energy resources,” said Martha Clark Briley, President and Chief Executive Officer of Prudential Power Funding.

Prudential Power Funding Associates was formed in January to consolidate all of Prudential’s private placement management. Projects Begin ..................... As early as July 1990

The inexistence of energy resources, said Martha Clark Briley, President and Chief Executive Officer of Prudential Power Funding.

Prudential Power Funding Associates was formed in January to consolidate all of Prudential’s private placement investments and financing activities in the electrical power industry. The unit’s portfolio includes financing for more than 40 electric utilities and 60 alternative energy projects, making it one of the largest providers of capital to this industry.

The The ETAP Program

In September 1989, the California Energy Commission (CEC) released separate Requests for Proposals for the Fourth Local Jurisdiction Solicitation and the Fifth-Round General Solicitation of the Energy Technologies Advancement Program (ETAP). The Fourth Local Jurisdiction Solicitation is open only to local jurisdictions. The Fifth-Round General Solicitation is open to both the private and public sectors.

Through ETAP, the CEC co-funds advanced energy projects that will increase the energy efficiency or cost-effectiveness of energy technologies, or help to develop new, cost-effective alternative sources of energy. Projects must include hardware development. Nearly any type of advanced technology is eligible for ETAP funding, including those based on energy production, energy conservation (including advancements in recycling technology), and load management.

About $5.2 million is anticipated to be available in fiscal year 1989-90 to co-fund qualifying proposals for both solicitations. Projects submitted under both the Fourth Local Jurisdiction Solicitation and the Fifth-Round General Solicitation will compete for this funding. At least $520,000 and up to $5.2 million will be available to qualifying projects through the Fourth Local Jurisdiction Solicitation.

Individual projects for either of these solicitations may request up to 25 percent of the total funding available (i.e., up to $1.3 million) for co-funding.

Projects can qualify for one of two types of ETAP funding: loans or repayable research contracts. The CEC will allocate for loans between 50 to 70 percent of the available funds. The remainder will be allocated for repayable research contracts. In prior fiscal years, the competition for loans has been much less than for research contracts. Up to 80 percent of the total project cost can be funded by an ETAP loan. For research contracts, ETAP can co-fund up to 50 percent of the total project cost. Loans are repayable at an 8 percent interest rate. Research contracts are also repayable under certain conditions, and also accrue interest at about 8 percent.

The CEC has completed four General Round Solicitations and three Local Jurisdiction Solicitations, resulting in 35 projects that total about $10.6 million dollars in ETAP funding. Among the list of ETAP projects approved as of June 30, 1989, is the following project:

TECHNOLOGY TRANSFER

CONFERENCES

II Reunión Nacional sobre la Energía y el Confort, Universidad Autónoma de Baja California, Instituto de Ingeniería, Mexicali, B.C., May 23-25, 1990.

An efficient use of electricity is the subtitle for this national conference on Energy at the Autonomous University of Baja California. All papers will be presented in Spanish.

Conference organizers would welcome papers on geothermal topics.

For further information, contact the Universidad Autónoma de Baja California, II Reunión Nacional sobre la Energía y el Confort, Instituto de Ingeniería, Quím. Maricela de la Paz Carpio, Tel. 91 (65) 66-41-50 o bien a, Lupita Ortega, Telex No. 508988, Fax: S29761.


The conference theme is Circum-Pacific Region: Resources for an Expanding Economy. Emphasis will be placed on newly identified, significant energy and mineral resources of the Pacific and new technological and methodological developments. Geothermal energy will be included.

For a brochure, contact the AAPG Convention Department, P.O. Box 979, Tulsa, Oklahoma 74101-0979. Phone: (918) 584-2555.


This symposium will provide a forum for exchange of new and significant information on all aspects of the exploration and use of geothermal resources. Country updates and international R & D will be featured.

There will be four special sessions:

1. Geothermal Development in Hawaii,
2. Groundwater Problems Associated with Geothermal Development,
3. Geothermal Energy and the Global Environment,

The tentative schedule for the Fourth Local Jurisdiction Solicitation is:

Request for Proposals Released — August 31, 1989
Proposals Due — October 20, 1989
Commission Funding Decision — May - June 1990
Projects Begin — As early as July 1990

The tentative schedule for the Fifth-Round General Solicitation is:

Request for Proposals Released — August 31, 1989
Proposals Due — October 20, 1989
Commission Funding Decision — May - June 1990
Projects Begin — As early as July 1990

For further information, contact the ETAP staff at (916) 324-3490.
The National Geophysical Data Center (NGDC) has a variety of publications and data sets which provide information on the location, magnitude, and potential uses of geothermal resources.

Regional Geothermal Maps
In 1979, NGDC produced three maps for U.S. Geological Survey Circular 790, Assessment of Geothermal Resources of the United States, 1978. These maps are available from NGDC,

- Geothermal Energy in the Western United States (scale 1:2,500,000) (Product number: 641-B01-001).
- Geothermal Energy in Alaska and Hawai'i (scale: 1:5,000,000 for Alaska and 1:2,500,000 for Hawai'i) (641-B01-002).

These two maps show identified hydrothermal convection systems, igneous systems, low-temperature geothermal waters, regional heat flow, and known Geothermal Resource Areas (KGRA's).

- Geopressurized-Geothermal Energy in Reservoir Fluids of the Northern Gulf of Mexico Basin (scale 1:1,000,000). This map includes contours showing depth to top of geopressured zone, and thermal energy in sand beds; concentrations of methane energy in sand beds; areas with higher potential for energy use; and temperatures at 15,000 feet in selected wells (641-B01-003).

The correlate U.S. Geological Survey Circular 790, which includes 163 pages plus maps, is available from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Box 25425, Denver, CO 80225. An additional report, U.S. Geological Survey Circular 892, Assessment of Low-Temperature Geothermal Resources of the United States, 1982, may also be obtained from the same address.

State Geothermal Resources Maps
Between 1980 and 1984, NGDC produced geothermal maps for eighteen western states as part of the State Geothermal Resource Assessment Program, funded and managed by the U.S. Department of Energy:

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Title</th>
<th>Date</th>
<th>Scale (ft)</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>641-A01-001</td>
<td>Geothermal Resources of Alaska</td>
<td>1982</td>
<td>1,500,000</td>
<td>35 x 56</td>
</tr>
<tr>
<td>641-A01-002</td>
<td>Geothermal Resources of Arizona</td>
<td>1982</td>
<td>1,500,000</td>
<td>47 x 63</td>
</tr>
<tr>
<td>641-A01-003</td>
<td>Geothermal Resources of California</td>
<td>1980</td>
<td>1,500,000</td>
<td>49 x 60</td>
</tr>
<tr>
<td>641-A01-004</td>
<td>Geothermal Resources of Colorado</td>
<td>1980</td>
<td>1,500,000</td>
<td>41 x 52</td>
</tr>
<tr>
<td>641-A01-005</td>
<td>Geothermal Resources of Hawaii</td>
<td>1983</td>
<td>1,500,000</td>
<td>35 x 50</td>
</tr>
<tr>
<td>(out of print)</td>
<td>Geothermal Resources of Idaho</td>
<td>1980</td>
<td>1,500,000</td>
<td>42 x 65</td>
</tr>
</tbody>
</table>

The maps are designed to be of use to land planners, legislators, environmentalists, and entrepreneurs, as well as the geothermal community. Included on the maps are locations of thermal springs, thermal wells, areas with high potential for discovery of additional geothermal resources, and land-status items such as urban areas, national forests, wilderness areas, and other state and federal reservations.

A digital data base containing more than 6,000 records of thermal springs and wells has been compiled from this state map series and is available on magnetic tape (902-A07-001). Each record provides location of spring or well, temperature, flow, total dissolved solids, depth, and other significant data.

Technical Map Series
During the course of the State Geothermal Resource Assessment Program, technical geothermal maps were prepared for California and New Mexico:

- Technical Map of the Geothermal Resources of California (1983, scale 1:750,000). Presents tectonics, volcanism, and thermal spring and well data including temperature, location, geochemistry, and total dissolved solids (641-C01-001).

- Geothermal Resources in New Mexico: Scientific Map Series (1983, scale 1:500,000). This map series includes a paper base map and three plastic overlays. The series may be ordered as a set (651-A01-001), or in its separate parts:
  - Late Tertiary and Quaternary Tectonics and Volcanism (paper). Shows tectonics, volcanism, thermal spring and well locations, heat flow, areas favorable for the discovery of low-temperature geothermal waters, and Known Geothermal Resources Areas (651-A01-002).
  - Bouguer Gravity Anomaly Map of New Mexico (plastic overlay). Depicts computer-contoured data at a 2-mgal contour interval and shows locations used for control (895-A01-001).
  - Composite Residual Total Intensity Aeronautical Map of New Mexico (plastic overlay). Computer-contoured, geology-related local variations in Earth's magnetic field (891-A01-001).

- Hydrology and Geochemistry (plastic overlay). Shows temperature gradient contours, ground-water barriers and constrictions, sedimentary basins, and geochemistry (651-A01-003).

Thermal Springs List
NGDC compiled a list of 1,700 thermal spring locations in 23 states while producing maps for the U.S. Geological Survey and the State Geothermal Resource Assessment Program. This list was published in 1980 as NOAA Key to Geophysical Records Documentation No. 12, Thermal Springs List for the United States (640-A12-001).

Thermal springs are arranged alphabetically by state, and are organized by degrees of latitude and longitude within the state. Included are spring name and location, surface temperature, and topographic-map coverage (either 7.5- or 15-min. quadrangle). Two index maps (one for Alaska and Hawaii, and one for the conterminous United States) are included with the list. The thermal springs list is also available in digital format (902-E07-001).
Geothermal Gradients

NGDC and Los Alamos National Laboratory co-produced the Geothermal Gradient Map of the United States, Exclusive of Alaska and Hawaii (1982; scale 1:2,500,000) (852-A01-001). This map presents a compilation of more than 1,700 wells for which temperature has been measured at depths greater than 50 m. Temperature-depth profiles are linear, or composed of linear segments which reflect changes in the thermal conductivity of the rocks, rather than hydrology.

The data are displayed on two sheets (eastern and western United States) in a format that shows the location, depth, and gradient of each well in a single color-coded symbol. Each well has a number that is keyed to a table giving latitude, longitude, well depth, gradient, heat flow and thermal conductivity (where available), and a reference. The map data are also available in digital format (902-B07-001).

World Heat Flow

In 1976, NGDC published a map, Terrestrial Heat Flow Data, depicting world heat flow data compiled by the International Heat Flow Commission (of the International Union of Geodesy and Geophysics) (901-A07-001). Digital data used to create the map are also available (901-A07-001). Each of the 6,500 heat flow measurements includes location information, height of the temperature-measuring elements in relation to sea surface, temperature gradient, thermal conductivity, and heat flow value. In addition, each heat flow measurement is referenced to the source where it was first reported.


An updated digital world heat flow data set is being compiled at this time. The revised data will be available in late 1986; please contact NGDC for details.

Thermal Aspects Data for North America

As part of the Geological Society of America's Decade of North American Geology (DNAg), a continental scale Thermal Aspects Map (scale 1:500,000) was produced. The data were compiled and mapped by John L. Steele and David D. Blackwell, Department of Geological Sciences, Southern Methodist University. The original sources for the data are the United States and Central America Geothermal Database (Southern Methodist University), the Canada Geothermal Database (Geothermal Survey of Canada), and the Canadian Cordillera Geothermal Database (Geological Survey of Canada). Professional papers about these data sources are included in Neotectonics of North America, edited by D.B. Stennons, E.R. Engdahl, M.D. Zoback, D.D. Blackwell, and D. Schwartz, Geological Society of America Centennial Special Map Volume I, in press, 1989.

The actual map and written reports (both in press), as well as companion maps (i.e., neotectonics, crustal stress, geology, earthquake seismology, gravity, and magnetics) are available from the Geological Society of America. Inquiries can be addressed to GSA Publication Sales, P.O. Box 9140, Boulder, CO 80301; telephone 1-800-GSA-1989.

The digital data used to produce the map are available from NGDC on magnetic tape (980-C07-001) or floppy diskette (980-C28-001). These data include hole location, minimum and maximum values, gradient and heat flow results per depth interval, lithologic information, and general comments. The digital data are also available on compact disc (975-B07-001), as is part of NGDC's Geophysics of North America data set. This data set also contains gravity, magnetics, seismology, topography, crustal stress, and satellite imagery data.

86 DIVISION OF OIL AND GAS

Volcanoes

Publications

Catalog of Submarine Volcanoes and Hydrological Phenomena Associated with Volcanic Events (by P. Hedervari, Georgiana Observatory, Budapest, Hungary) is in two volumes and covers the time span of 1500 B.C. through 1959 A.D. The information presented includes submarine eruptions, new volcanic islands, seiches, and base surges related to volcanic activity (900-B12-001 and 900-B12-002).

Slide Sets

Two special sets of 35-mm slides provide a unique tool for presentation to both technical and nontechnical audiences. Each set includes 20 slides and a list of captions that provide date and location of the event, and description of damage or other effects.

- Volcanoes in Eruption (B&W/Color). Depicts explosive eruptions, rues and domes, lava fountains and flows, steam eruptions, and fissure eruptions from 20 worldwide volcanoes. Volcano types include calderas, cinder cones, complex, fissure vents, lava dome, shield, and island-forming (739-A11-001).
- Volcanic Rocks and Features (Color). Illustrates eruption products and features resulting from volcanism in Australia, the Canary Islands, New Zealand, Scotland, and the United States. Pictured are examples of a lava flow, ash, cinders, bombs, necks, dikes, and sills (739-A11-002).

Data and Publications Price List

Note: All maps priced at $5 are folded maps. Rolled maps are available for $10 each. Due to mailing restrictions, rolled maps are not available outside the U.S.A. Digital data prices are for standard magnetic tape copies: 9-track, ASCII, 1600 bpi. Floppy diskettes are high density, 5.25" IBM-PC compatible.

<table>
<thead>
<tr>
<th>Product #</th>
<th>Price</th>
<th>Description</th>
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<tbody>
<tr>
<td>641-A01-001</td>
<td>$ 5</td>
<td>Geothermal Energy in the Western United States</td>
</tr>
<tr>
<td>641-A01-002</td>
<td>$ 5</td>
<td>Geothermal Energy in Alaska and Hawaii</td>
</tr>
<tr>
<td>641-A01-003</td>
<td>$ 5</td>
<td>Geopressured Geothermal Energy in Reservoir Fluids of the Gulf of Mexico Basin</td>
</tr>
<tr>
<td>641-A01-004</td>
<td>$ 5</td>
<td>Geothermal Resources of Alaska</td>
</tr>
<tr>
<td>641-A01-005</td>
<td>$ 5</td>
<td>Geothermal Resources of Arizona</td>
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<td>641-A01-006</td>
<td>$ 5</td>
<td>Geothermal Resources of California</td>
</tr>
<tr>
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<td>$ 5</td>
<td>Geothermal Resources of Montana</td>
</tr>
<tr>
<td>641-A01-011</td>
<td>$ 5</td>
<td>Geothermal Resources of Nevada (folded map only)</td>
</tr>
<tr>
<td>641-A01-012</td>
<td>$ 5</td>
<td>Geothermal Resources of New Mexico</td>
</tr>
<tr>
<td>641-A01-013</td>
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<td>Geothermal Resources of North Dakota</td>
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<tr>
<td>641-A01-014</td>
<td>$ 5</td>
<td>Geothermal Resources and Temperature Gradients of Oklahoma</td>
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<td>641-A01-015</td>
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<td>641-A01-017</td>
<td>$ 5</td>
<td>Geothermal Resources of Washington</td>
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<tr>
<td>641-A01-018</td>
<td>$ 5</td>
<td>Geothermal Resources of Wisconsin</td>
</tr>
</tbody>
</table>

GEOTHERMAL HOT LINE
641-C01-001 $ 5 Technical Map of the Geothermal Resources of California
651-A01-001 $ 55 Geothermal Resources in New Mexico: Scientific Map Series (complete set: 1 paper map and 3 plastic overlays)
651-A01-002 $ 5 Late Tertiary and Quaternary Tectonics and Volcanism (paper)
895-A01-001 $ 15 Bouguer Gravity Anomaly Map of New Mexico (plastic overlay)
891-A01-001 $ 15 Composite Residual Total Intensity Aeromagnetic Map of New Mexico (plastic overlay)
651-A01-003 $ 15 Hydrology and Geochemistry (plastic overlay)
640-A12-001 $ 5 Thermal Springs List for the United States
902-E07-001 $ 91 Digital thermal springs data.
652-A01-001 $ 10 Geothermal Gradient Map of the United States, Exclusive of Alaska and Hawaii (map set, folded; rolled set is $20)
902-B07-001 $ 91 Digital geothermal gradient data
901-A01-001 $ 10 Terrestrial Heat Flow Data (rolled map only)
901-A07-001 $ 91 Digital world heat flow data
980-C07-001 $141 Thermal aspects data for North America (magnetic tape)
980-C25-001 $ 80 Thermal aspects data for North America (flippy diskette)
975-B07-001 $580 Geophysics of North America compact disc
900-B12-001 $ 5 SE-36, Catalog of Submarine Volcanoes and Hydrological Phenomena Associated with Volcanic Events, 1500 B.C. to December 31, 1989
900-B12-002 $ 5 SE-42, Catalog of Submarine Volcanoes and Hydrological Phenomena Associated with Volcanic Events, January 1, 1900 to December 31, 1959
739-A11-001 $ 20 Volcanoes in Eruption slide set
739-A11-002 $ 20 Volcanic Rocks and Features slide set

Please refer to the product number when ordering.

The prices quoted here are valid through September 30, 1995. Prices applicable after that date may be obtained by calling 303 497-6419.

How to Order

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A ten-dollar ($10) handling fee is required on all orders; an additional ten-dollar ($10) charge is required for non-U.S.A. orders. If you elect to use RUSH service at an additional cost of sixteen dollars ($16), your order will receive priority processing and will be mailed First Class, Overnight delivery is available at an additional cost; please call for details.

Please direct telephone inquiries to (303) 497-6419 (Telex: 592811 NOAA MARC BDR). Inquiries, orders, and payment should be addressed to:

National Geophysical Data Center
NOAA, Code E/GC1
325 Broadway

For a complete listing of NGDC data services, request the free brochure: Publications, Maps, and Data Services

This Dynamic Planet

A World Map of Volcanoes, Earthquakes, and Plate Tectonics


The Earth's physiographic features overlay its volcanoes, earthquake epicenters, and the movement of its major tectonic plates are shown in this map.

This computer-generated map of the world provides a base that shows the topography of the land surface and the sea floor; the additions of color and shaded relief help to distinguish the important features. From the Volcano Reference File of the Smithsonian Institution, nearly 1,450 volcanoes active during the past 10,000 yr are plotted on the map in four categories. From the files of the National Earthquake Information Center (U.S. Geological Survey), epicenters selected from 1,300 large events (magnitude ≥7.0) from 1897 onward and from 140,000 instrumentally recorded earthquakes (magnitude ≥4.0) from 1960 to the present are plotted on the map according to two magnitude categories and two depth categories.

This special map is intended as a teaching aid for classroom use and as a general reference for research. It is designed to show prominent global features when viewed from a distance; more detailed features are visible on closer inspection. The authors of this map encourage your comments and suggestions for improvement.

Copies of this map may be bought from the following distribution centers:

By Mail ($3 + $1 handling) Prepayment is required.

U.S. Geological Survey Map Distribution Federal Center, Box 25286 Denver, CO 80225

The Smithsonian Institution Shop National Museum of Natural History 10th and Constitution Avenue Washington, DC 20560

USGS Earth Science Information Centers in Washington, DC: Reston, VA; Denver, CO; Spokane, WA; Menlo Park, CA; Salt Lake City, UT; Anchorage, AK; Los Angeles, CA; and San Francisco, CA.

Schematic cross section illustrating plate tectonics processes

DIVISION OF OIL AND GAS

GEOTHERMAL HOT LINE

88

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Before the Drilling Begins

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

The videotape, titled "Before the Drilling Begins," may be purchased for $25 in 1/2" VHS format.

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

PUBLICATIONS

14th Annual Report of the State Oil and Gas Supervisor, 1988. Free. Published by and available from the Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, California 95814.

Statistical and verbal summaries of 1988 California geothermal activity.

Injection wells, an introduction to their use, operation, and regulation. $5.00. 12 pages. Published by and available from the Underground Injection Practices Council, 525 Central Park Drive, Suite 304, Oklahoma City, Oklahoma 73105. Phone (405) 525-6146.

This useful and well-presented booklet is published by the UIPC in cooperation with the EPA. It summarizes EPA injection well clauses, and gives useful information about each class.


Volume I is a summary of the FY88 geothermal R & D program. It includes a description and status report of hydrothermal, geopressured, hot dry rock, and magma geothermal resources.

Volume II contains technical descriptions of each division-funded R & D activity. It is designed to maximize technology transfer of division activities.


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DIVISION OF OIL AND GAS
PURPA lines, Independent energy business news. Published every other week. Six-month trial subscription $127.50. Published by and available from HEC Publications, 410 Archibald St., Kansas City, Missouri 64111-9924.


Electricity, 1988, the final electricity report seven. June 1989. P106-88-001. First copy free; subsequent copies $5.95. Published by and available from the California Energy Commission, Publications Unit, MS-13, 1516 Ninth Street, Sacramento, California 95814.


National energy resource issues. B 1850. By Bryant and Martin. 79 pages. $6.00. Published by and available from the USGS, Books and Open-File Reports, Federal Center, Box 25425, Denver, Colorado 80225.

The publication offers a geologic perspective and gives the role of geologic information in energy resource matters.

Energy... in demand. Published quarterly. $300 a year. Write to Energy... in Demand, 4281 Evergreen Avenue, West Vancouver, British Columbia, Canada V7V 1H2.

State of the world, by L.R. Brown and A.B. Durning, et al. 1989. $18.95, hard cover; $9.95, paper. Published by and available from the Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036.


The atlas illustrates a wide range of social indicators for 185 countries and territories. Text in English, French, and Spanish.

PURPA lines, Independent energy business news. Published every other week. Six-month trial subscription $127.50. Published by and available from HEC Publications, 410 Archibald St., Kansas City, Missouri 64111-9924.


Electricity, 1988, the final electricity report seven. June 1989. P106-88-001. First copy free; subsequent copies $5.95. Published by and available from the California Energy Commission, Publications Unit, MS-13, 1516 Ninth Street, Sacramento, California 95814.


National energy resource issues. B 1850. By Bryant and Martin. 79 pages. $6.00. Published by and available from the USGS, Books and Open-File Reports, Federal Center, Box 25425, Denver, Colorado 80225.

The publication offers a geologic perspective and gives the role of geologic information in energy resource matters.

Energy... in demand. Published quarterly. $300 a year. Write to Energy... in Demand, 4281 Evergreen Avenue, West Vancouver, British Columbia, Canada V7V 1H2.

State of the world, by L.R. Brown and A.B. Durning, et al. 1989. $18.95, hard cover; $9.95, paper. Published by and available from the Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036.


The atlas illustrates a wide range of social indicators for 185 countries and territories. Text in English, French, and Spanish.

Valuation of federal geothermal resources--electrical generation, June 1988. Free. Published by the U.S. Dept. of the Interior, MMS. For a copy, contact Dennis C. Whitcomb, Chief, Rules and Procedures Branch, Box 25165, MS662, Denver, Colorado 80225; phone (303) 231-3432.

The report describes the policies, guidelines, and methods used by the MMS to value federal geothermal resources used to generate electricity.

Nevada geothermal electric power production, 1984-88. Pamphlet. Free. Published by and available from the Deps. of Minerals, 400 W. King Street, Suite 106, Carson City, Nevada 89710.

The pamphlet offers a quick summary of Nevada geothermal development. Nevada stands seventh in the world for geothermal power generation, and second in the United States, behind California.

Power surge, the status and near-term potential of renewable energy technologies. By N. Rader. 1989. 100 pages. $50.00 paper. Published by and available from HEP Unit, Pub-:i Whitcomb, Chief, Rules and Procedures Branch, Box 25165, Spring


These volumes contain the main parts of 15 of the Camborne School of Mines Project's major reports from October 1983 to September 1986.


Geothermal direct-use engineering and design guidebook. Prepared through cooperative efforts of the Oregon Institute of Technology, Idaho National Engineering Laboratory, University of Utah Research Institute, Battelle Pacific Northwest Laboratories, Radian Corporation, and the Washington State Energy Office. 401 pages. $20 domestic orders; $27 foreign orders. Distributed by the Geo-Heat Center, OIT, 3201 Campus Drive, Klamath Falls, Oregon 97601.

Proceedings: symposium in the field of geothermal energy, San Diego, California, April 1989. Ing. Miguel Ramirez (CPE) and Dr. John E. Mock, principal coordinators. 289 pages. $28.95. Microfiche, $5.95. Available from the NTIS, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

On April 7, 1986, a three-year agreement for geothermal research was signed by the U.S. Department of Energy and the Comisión Federal de Electricidad of the Mexican Federal Government. The major objectives of the agreement were to achieve a thorough understanding of the nature of geothermal reservoirs in sedimentary and fractured igneous rocks, and to investigate how geothermal resources can best be explored and utilized. To achieve these objectives, mutually agreed upon tasks were defined, encompassing a broad range of cooperative research activities. The scientific results of this highly successful research program are reported in this document.
The publication contains comprehensive technical data on space-heating and cooling buildings, district-heating systems, greenhouse-heating systems, and agriculture- and industrial-processing using low-to-moderate temperature geothermal resources. It covers geology, exploration, well drilling, reservoir engineering, materials selection, well pumps, piping, heat exchangers, space-heating equipment, heat pumps, absorption refrigeration, applications, engineering cost analysis, regulatory codes, and environmental aspects.

Striking a balance, the environmental challenge of development, No. 11271. 52 pages. $4.95. Published by and available from World Bank Publications, 1811 H Street, NW, Washington, D.C. 20433.

The report describes how developmental strategies can give more attention to the environment, and how the World Bank integrates environmental considerations in its work, including pollution control.

Development of mineral, energy, and water resources and mitigation of geologic hazards in Central America. USGS Circular 1006. 272 pages. In English and Spanish. Free. Published by and available from the Books and Open-File Section, USGS, Federal Center, Box 25425, Denver, Colorado 80225.

The publication is the result of a workshop held in 1985 in Guatemala on the Development of Mineral, Energy, and Water Resources and Mitigation of Geologic Hazards in Central America.


Over 500 volcanic vents have been identified in California. At least 76 have erupted in the last 10,000 years. The nature and probable distribution of potentially hazardous volcanic phenomena and their threats to people and property are described.

Discovery, location, recordation, and assessment work for mining claims and sites in California - 1989. $4.00. Published by and available from the BLM, 2800 Cottage Way, Room E-2845, Sacramento, California 95825. Phone (916) 978-4754.

Evaluation of a hydrothermal anomaly near Ennis, Montana, P1844-K. By R.B. Leonard and W.A. Wood. 1988. $3.50. Published by and available from the USGS, Books and Open-File Reports, Federal Center, P.O. Box 25425, Denver, Colorado 80225.

Maps and diagrams illustrate the results of test drilling and geophysical and geochemical studies near Ennis Hot Spring in southwestern Montana. The spring has a temperature of about 89°C.


A wide variety of British publications are included in this list.

Entech, newsletter of the E.C. Joule Energy R & D Programme. Two issues a year. Published by and available from the Commission of the European Communities, Directorate-General XII, Attn: ENTECH Editor, Rue de la Loi, 200, B-1049 Brussels, Belgium.


Geoscience resources, 1989-90 catalog. Free. Published by and available from Geoscience Resources, 290 Anthony Road, Burlington, North Carolina 27215. Phone (800) 342-2677.

Minutes pass effortlessly while you read through this wonderful catalog. There are hundreds of descriptions for books on geology--books about geologic hazards, physical processes, space, weather, nature guides, the complete Roadside Geology series, atlases, a Time-Life series on The Planet Earth--I've never seen so many listed in one place.

Another equally good feature is the section on Geoscience Maps. Many maps (and geologic books) are listed for countries all around the globe, and for many U.S. states. Here is the place to go for geologic, topographic, mineralogical, geophysical, geostatellite image, city, and travel maps. From Afghanistan to Zimbabwe, they're all here.

Imprints of time, the art of geology. By B.B. Van Diver. 1988. 151 pages. $19.95, paper. Published by and available from Mountain Press Publishing Company, P.O. Box 2399, Missoula, Montana 59806-9987.

Geology is based on calendars, and rocks are the imprints of time, with their millions of shapes, colors, textures, sizes, and varieties--from the saw-toothed grandeur of mountain ranges to the surreal smoothness of hot spring terraces and Oregon geology. Vol. 51, No. 51, September 1989. $2.00.


Alaska is a mosaic, a collage of continental scraps swept in from the Pacific and added one by one onto the far northwestern corner of the continent. Although the authors state that "...unraveling Alaska’s complex and fragmented geologic history would have baffled Sherlock Holmes," this roadside geology is a good first stop for clues.

Both armchair and traveling detectives will be well satisfied with the extensive descriptions of volcanoes and other geothermal surface manifestations, and with information about the geology of this beautiful state.


The ancient sedimentary formations of northern Idaho, the Idaho batholith in the central part of the state, the continental hot spot track, the just-discovered meteorite impact crater of the volcanic Snake River Plain, and the active faults of the Basin and Range province are all chapters in Idaho's exciting geologic story, recounted in this roadside geology.

The authors write that the Snake River Plain and Columbia Plateau formed after an enormous meteorite exploded in southeastern Oregon 17 million years ago. The impact formed a crater that probably extended into southwestern Idaho. The crater, perhaps 200 miles wide, filled with molten basalt and turned into a lava lake. The lake overflowed in a series of enormous flood basaltic flows, building the Columbia Plateau of Oregon, Washington, and westernmost Idaho. The same explosion started a column of hot rock rising deep within the Earth, which generated the long row of volcanoes that became the Snake River Plain and, now, the Yellowstone volcano. Basin and range faulting, too, began with the meteoritic impact.

Oregon geology. Vol. 51, No. 51, September 1989. $2.00 an issue, or $6 per year. Published by and available from DOGAMI, 910 State Office Bldg., 1400 SW Fifth Ave., Portland, Oregon 97201.

This issue includes an excellent summary article, "Geothermal exploration in Oregon, 1988."


Geological mechanisms behind subsidence, except slope failure, are covered, and the worldwide extent and frequency for each type are assessed. For each type of subsidence, site investigation methods are reviewed and evaluated, and remedial actions are summarized. Included are illustrative photos and line drawings.


The book is written for a beginning geology student and divided into three sections: morphology, deformation, and geotectonics. Discussions are included on extensional set-

The book focuses on the processes of glacial erosion and sedimentation, with emphasis on physical quantities and relationships. Erosion is treated from the viewpoint of applied rock mechanics, tribology, and fluid mechanics.


Major ore deposit types are covered in this book, as well as mining districts—mostly those in North America, Australia, Africa, and Western Europe. The most effective exploration methods are described. Emphasis is on assessing the relative importance of genetic models in determining exploration strategy.

Geophysics of North America, a compact disc with access software. #975-B27-001 data set: $580; #975-B27-002 additional compact disc: $235; #975-B13-001 additional software. #975-B27-001 data set: $580; #975-B27-002 additional compact disc: $235; #975-B13-001 additional software.

Drilling Permits for Geothermal Wells Approved in 1989 by the Division of Oil and Gas

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**District G3**

Lake County

FGRC

02/05/89 "Davies Estate" 8 033-90708 | 36 11N 8W Fr NW cor 813m S, 778m E, el 529m kb

Sonoma County

GEOTHERMAL ENERGY PARTNERS, LTD.

01/26/89 "Aidlin" 4 097-90804 | 32 11N 9W Fr SE cor 46m N, 210m W, el 617m kb

COUNTY OF SONOMA

09/07/89 "Sonoma Valley Geo" 1 097-90809 | 35 6N 6W Fr SE cor 838.2m N, 548.6m W, el 61m RT

UNION OIL CO.

08/18/89 "S" 1 097-90810 | 34 11N 8W Fr SW cor 275m N, 170m E, el 870m kb

**DIVISION OF OIL AND GAS**

**GEOTHERMAL OFFICES AND MAPS**

**OFFICES**

Headquarters & District G1: Sacramento 95814 Phone (916) 323-1788

District G2: 485 Broadway Suite E El Centro 92243 Phone (619) 353-9900

District G3: 50 D St, Room 300 Santa Rosa 95404 Phone (707) 576-2385

**MAPS**

(All maps are $3.00 each)

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**MAPS**

(All maps are $3.00 each)
**The Languages:** The English, Spanish, Italian, and Japanese languages were chosen for this dictionary because they are spoken in countries producing the most megawatts of electricity from geothermal resources. The Philippines, which is among this group, uses English for scientific and technical matters; thus, no separate entry was created.

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