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GEOTHERMAL HOT LINE

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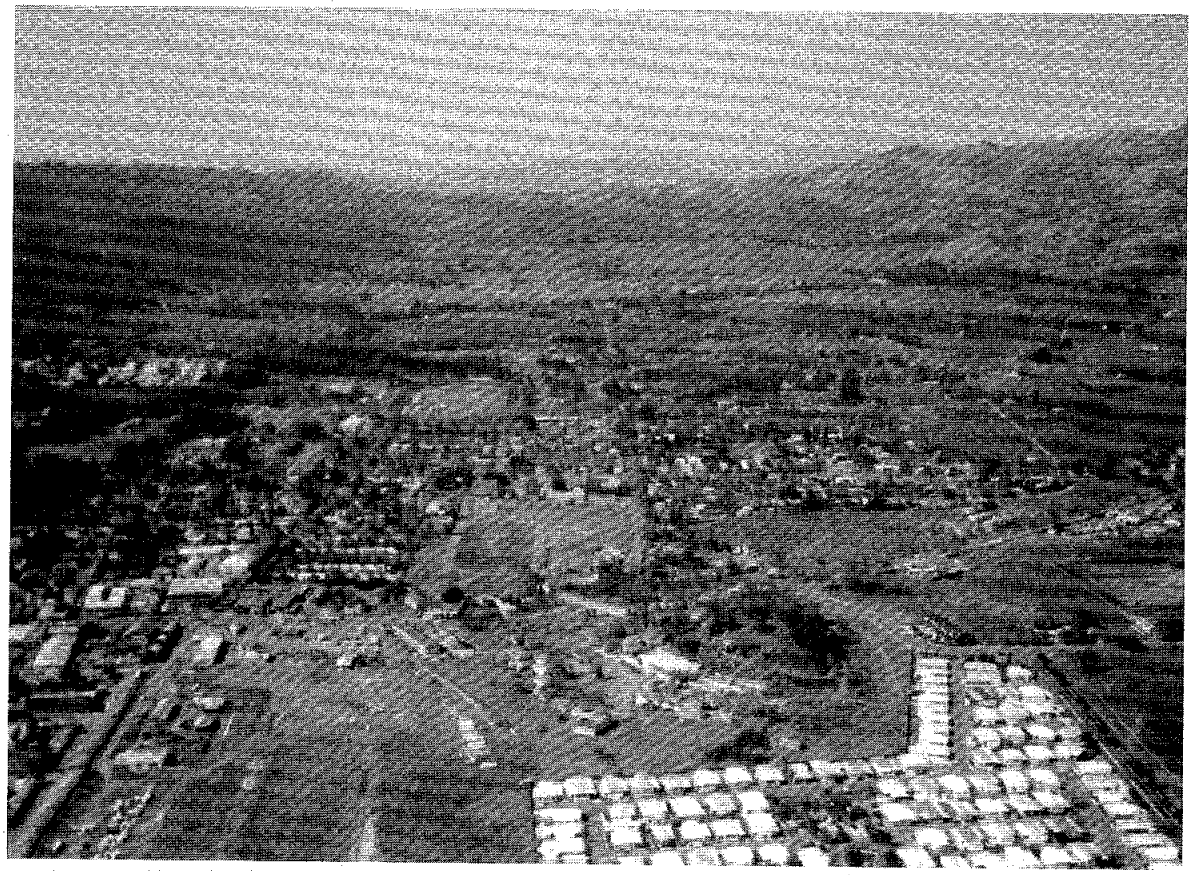

View of Calistoga, about 15 miles southeast of The Geysers Geothermal field in Northern California. A district-heating system is the latest geothermal project underway in this city, famous for its low-temperature, geothermal resources. Story inside. *Photo by Susan Hodgson.*

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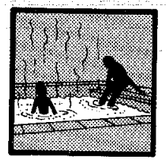
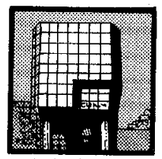
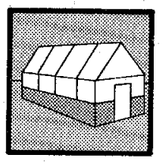
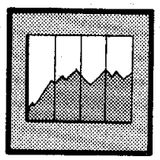
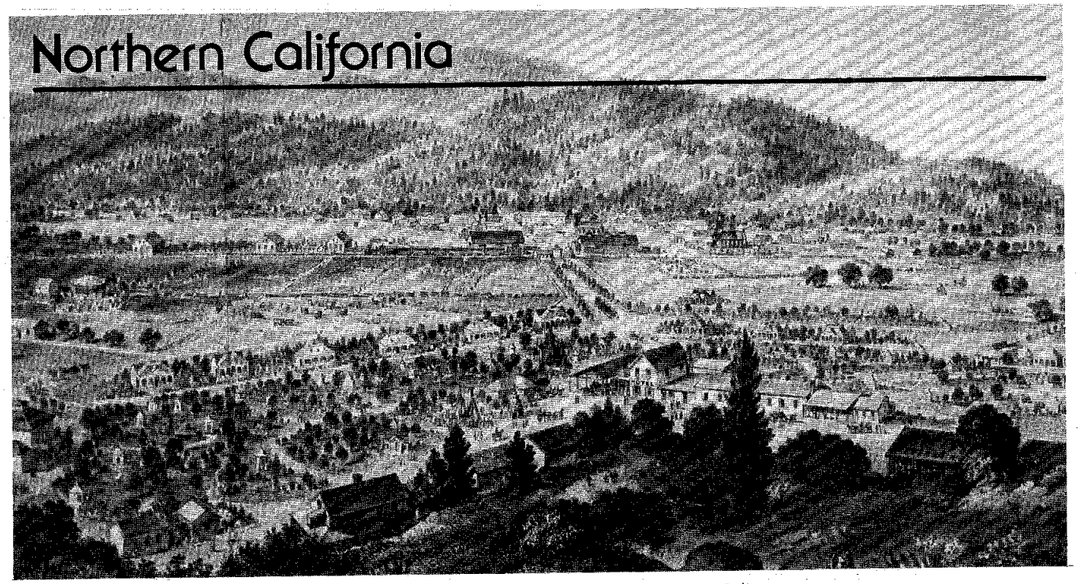








Northern California



View of Calistoga, California, c.1871. Photo by C. Handly, The Sharpsteen Museum, Calistoga.

MODERATE-TEMPERATURE GEOTHERMAL RESOURCE

Calistoga: A Historical Perspective

by

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and

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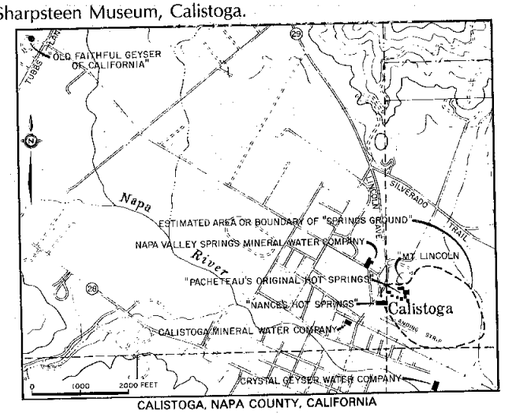
California Department of Conservation
Division of Mines and Geology

Adapted from an article published in the April 1981 issue of California Geology. Reprinted with permission.

THE INDIAN-SPANISH PERIOD OF USE

According to all historical sources and local lore, the Indians residing in the upper Napa Valley were the first to utilize the hot springs and steaming mud at the site of present day Calistoga. In a fanciful drawing, labeled "Calistoga in primitive times", found in the 1871 "Handbook of the Calistoga Springs", several Indians are shown relaxing about the hot springs. Two or three are apparently partaking of a natural steam bath.

How long the Indians had been coming to the springs to "bathe away aches and pains" is not clear. Beard (1979) reports that the Napa Valley has been continuously inhabited by man for 4,000 years and probably longer.



CALISTOGA, NAPA COUNTY, CALIFORNIA

Studies of two nearby Lake County archaeological sites have placed ancient man there about 10,000 - 12,000 years ago.

When Spanish explorers and friars entered the upper Napa Valley in 1823, probably several thousand Indians were encamped throughout the valley and foothills, mostly along streams and rivers.

The Spanish "discovered" a small, isolated volcanic tuff knoll with many hot springs and probably some small geysers at its base several hundred feet to the south and east. They called the place "Agua Caliente". In a succession of names, the surrounding area was called the Agua Caliente District, Hot Springs, Calistoga Springs, and, eventually, Calistoga. The meadow containing the hot springs was often called the Springs Ground.

ARRIVAL OF THE AMERICAN SETTLERS

George C. Yount, an American, settled in the upper Napa Valley in 1831 and was endowed with a Spanish grant of land in 1836 from General Mariano Guadalupe Vallejo. Dr. Edward Turner Bale was awarded a land grant from General Vallejo in 1841. Dr. Bale's grant included present day St. Helena and extended northwestward to encompass the present day Calistoga City limits and all the valley lands out to the foothills that enclose the upper Napa Valley.

Ownership of two large tracts of land by Americans was attractive to early American immigrants who wanted their own small farms. Likewise, the prospect of selling portions of Yount's and Bale's grants to the immigrants for profit was attractive to those two gentlemen. Hence, in the late 1830's and early 1840's, the upper Napa Valley began to acquire new settlers.

"THE SARATOGA OF CALIFORNIA"

In 1857, Samuel Brannan, reportedly California's first millionaire, began buying up portions of the Springs Ground. By 1859, he had acquired nearly 2,000 acres of upper valley property including all the Springs Ground. He set out to build a health resort to rival the famed Saratoga Hot Springs of New York State.

A popular story of the times related how the resort became known as Calistoga. It seems Sam Brannan, while slightly "under the influence" meant to say that he was going to build the Saratoga of California, but instead said "Calistoga of Sarafornia". The name had appeal and was adopted.

In the fall of 1862, Brannan declared his fabulous resort open at a gala party for some 3,000 guests. The grounds included a large hotel, stables, racetrack, 25 neat little cottages for guests, dance pavilion, store, bath houses, steam rooms, mud baths, laundry, swimming pool, an observatory placed atop the volcanic tuff knoll (dubbed Mount Lincoln by Brannan), and even an aviary. It was a grand place by any standards.

I.C. Adams (1946) reports how the bath houses were built at the hot springs and makes a very interesting observation about the consequences of drilling wells at a later date in the area:

> Before there were any geysers here, there were many individual springs and streams of hot water from which on cool days, steam could be seen rising; but since the drilling of the geysers this is practically a thing of the past as it seems the surface pressure has been taken off and this has done away with the smaller emanations. Over some of the little individual springs lattice houses were built which were approximately eight by ten feet in size, with seats running lengthwise on the inside upon which patrons could sit while partaking of the water if they so desired.

Writing in 1881, an anonymous author ("History of Napa and Lake Counties, 1881") records some temperatures at the famed Calistoga Springs:

> Several years ago a well was bored directly in front of the hotel, and at the depth of seventy feet rock was struck which prevented further progress, and water stood in this well at the uniform temperature of 185°. There was a Russian steam bath formed by having the bath-room erected immediately over a spring which had a temperature of 195°, with apparatus for letting steam come up into the room. There are a host of springs there, each differing from the others in some peculiarity.

From the "Handbook of the Calistoga Springs" (1871) comes this quantitative record of temperatures at the Calistoga Springs:

> There are baths of all temperatures, dozens of them, from cold to scalding hot, by which last, eggs are boiled and combining medicinal virtures applicable to every ill that flesh is heir to.

The famed Robert Louis Stevenson writes of Calistoga Springs' temperatures circa 1883:

> ...and Calistoga itself seems to repose on a mere film above a boiling, subterranean lake. At one end of the hotel enclosure are the springs from which it takes its name, hot enough to scald a child seriously while I was there. At the other end, the tenant of a cottage sank a well, and there also the water came up boiling. It keeps this end of the valley as warm as a toast.

And still another record of early temperatures at the springs comes from Waring (1915):

> The observed temperatures of the principal springs range from 126° to 173° and their flows from about one-fourth gallon to 5 gallons per minute. The hottest spring which yields about 1 gallon a minute, appears to be the most strongly mineralized, though its mineralization is only slightly perceptible to the taste.

At Brannan's resort one could spend the day strolling the grounds and partaking of mud bath or steam bath, then prepare lunch in special cooking houses utilizing the natural steaming waters from the springs. The bathing towels were sterilized in the waters of the hottest springs, thus providing a "natural boiling laundry".

Brannan lavishly landscaped his resort with palms, hardwoods, flowers, and cactii. Some of these plants and trees are still growing today in Calistoga. However, Brannan had to bring in "fresh" soil for some of his gardens because the soil around the springs had high "toxic" concentrations of minerals. This may be the earliest record of the high concentrations of boron evident in some of the geothermal waters at Calistoga today.

THE DECAY AND REVIVAL OF CALISTOGA AS A RESORT

Sam Brannan was going broke by 1873. Resorts closer to the San Francisco area were becoming more popular. He leased the once magnificent resort to George Schonewald, but the economics worsened. In 1875, The Sacramento Savings Bank ordered all of Brannan's property in Calistoga sold. Leland Stanford, who once considered siting his university at Calistoga, but instead chose Palo Alto closer to the Bay Area, retained the main resort and several of the guest cottages. Thus began a long succession of managers of the resort and a gradual decline and decay of the facilities. Several fires at the resort destroyed some of the buildings at about the time of diminishing popularity.

Mr. A.C. Tichenor became manager of the property in 1880 ("History of Napa and Lake Counties", 1881). He erected a steam whistle and had "...some machinery in motion, operated by the steam of one of the springs". He also placed some sort of gas collecting device over one of the springs and attached a lighted burner. The burning gas was called "carburetted hydrogen" (methane?). Mr. Tichenor also claimed the waters of the springs were laden with gold. Through a "secret process" he added some gold to the water and was supposed to be able to recover six times the original amount of gold.

In 1911, Jacques Pacheteau became proprietor of the resort and bought all of Leland Stanford's interest in 1919. The Pacheteau family built up the grounds and improved the resort. Although the Pacheteau family no longer owns the resort, the resort thrives today as Pacheteau's Original Hot Springs, Inc.

Around 1922, Charley Nance bought a lot on the southern edge of the original Springs Ground and started the second mud bath spa in Calistoga (Adams, 1946). The operation continues today as Nance's Hot Springs, located on Lincoln Avenue.

Other motels/spas have been built through the years in Calistoga. Some have remained operational through the present, some closed and became apartment complexes. Today, facilities available in Calistoga include four mud-bath spas, hot mineral water baths, jacuzzi baths, and heated swimming pools. Today, Calistoga offers more types of hot mineral water "treatments" and more facilities than any other "hot springs" resort area in California.

HISTORY OF WELL-DRILLING AND GEYSER WELLS

The first geysering hot water well at Calistoga was drilled on Sam Brannan's resort ground (now Pacheteau's Original Hot Springs) probably in the late 1860's. Bancroft's "Tourists" Guide (1871) provides the following account of the drilling:

> "...A well was bored at this place preparatory to the erection of a bath-house, to the depth of sixty-five feet, when the boring instruments were blown out with tremendous force high into the air, as if some unseen power beneath was resenting intrusion of mortals upon his domain. The workmen ran for their lives and could not be induced to resume operations on any terms. An attempt was made to pump water from this well, and after a few strokes a violent stream was blown out of the well ten or fifteen feet high. If the pumping were stopped the blowing would stop also, but was renewed afresh as often as the pumping was resumed. The water being cold at the top, seemed to hold in abeyance the steam and intensely hot water below; the action of the pump relieved the superincumbent pressure when the hot water below rushed out."

Adams (1946) surmises that "...this well was left to its own devices as it were, as nothing was ever done with it. The probabilities are that it was filled with debris at the time and forgotten."

The date when the second and third geysering wells were drilled is uncertain, but they were in existence before 1916. A resident of Calistoga related that, in 1916, when she moved to Calistoga as a young lady of eight years, there were two geysering wells: one at the Ephriam Light winery and one on Tubbs Lane owned by Mr. Bhegnasco. She recalled being under the impression that the Light well was drilled about two years prior to her arrival and that the Bhegnasco well was drilled perhaps only one year or less before her move to Calistoga.

Ephriam Light bought the stable building from Sam Brannan's decayed resort and turned it into a winery. Adams (1946) relates the circumstances of drilling a well on the property:

> Mr. Ephriam Light, knowing that his property was situated on the edge of the hot-water land, thought that by boring a well he could get hot water which would be available at all times and with which he could wash the barrels and tanks as they needed it without having to build a fire each time, so he hired a local well-driller — Mr. Strubel—to drill a well for him.
>
> At a depth of one hundred fifty feet hot water was struck and the drilling was stopped. Shortly after this his son Edward who lived close by, heard a loud swishing noise one night and running out saw hot water and steam being shot high into the air. It would seem that the drilling had been stopped just before the area of hot water was struck and that the plug between where the drilling stopped and where the lake of boiling water is, had been blown out which allowed the hot water and steam to shoot out. For a time one could set one's watch by the intervals at which the spouting occurred but it changed quite frequently. At first it would shoot every day or so and finally got down to about an hour or so.

The geyser caused a terrific stir about the area. Benches were set up for the people who came to sit and wait for the eruption. A few years later the well was capped.

The stable-converted-to-winery still stands in Calistoga today on Grant Street, but it is no longer used for a winery. The present occupant is the Napa Valley Springs Mineral Water Company. The company commercially bottles mineral water from a "hot water" well on the property (not the original geysering well).

By 1924, thirteen geyser wells had been drilled in Calistoga and all but three were capped so that the water could be utilized (Allen and Day, 1927). Other wells that didn't geyser also have been drilled into the geothermal zone. An unpublished map (Koenig and Anderson, 1970) shows the location of 76 "hot water" wells in Calistoga.

Many of the "hot water" wells drilled in Calistoga were flowing or artesian wells. Today, about 10 wells are openly discharging at the surface. Many of the artesian wells have been capped. Three spectacular, flowing wells are on the Pacheteau's Original Hot Springs property. These wells flow at a pressure of 80 psi. The resort manager reported that two of them flowing together can discharge 250,000 gallons of 100°C water in about 8 hours. These wells are approximately 160-180 feet deep and were drilled around 1920. Apparently these wells have flowed at the same volume since they were drilled.

The three wells are controlled by gate valves at the well heads. The water is directed into holding tanks for cooling before it is used in the swimming pool, mineral baths, and mud baths. In addition the resort has put their geothermal resource to a clever practical use: to dry bath towels and linens after washing, two large commercial clothes dryers are employed. The heat is supplied by geothermal well water circulating about the large drying drums.

The geothermal wells at Pacheteau's have provided some "hair-raising" moments throughout the years. Adams (1946) provides the following account:

> In 1928 the boiling water geyser on the Springs Ground next to the Pacheteau's Bath-house ran amuck and was finally brought under control by the Calistoga Fire Department after it had "shot" for several days continuously. It not only damaged the nearby bath-house but drained other wells in the vicinity. This incident had its start when A.H. Word, a local well-driller reached a depth of one hundred fifty feet while boring a well for Mrs. Pacheteau. Suddenly tools and equipment went hurtling through the air propelled by a force which was estimated to be about one thousand pounds to the square foot. For days the frantic efforts of the people failed, as they attempted to "cap" the geyser. After much publicity in bay-area papers, the Springs Ground was the goal of thousands of motorists for several days. Finally it was the Fire Department that solved the problem. They pumped cold water into the well fast enough to cool it off thus allowing workmen to cap the pipe and to put a concrete packing around it.

About 8 years ago a similar incident occurred. There was an old abandoned open well in the driveway in front of the bath house at Pacheteau's. Some of the waste water from the mineral baths had been allowed to drain into this well for years. Apparently over the years some debris had been dropped down the well, also. One night, this well erupted with a vengeance belching forth cans, bottles, and sundry debris. The local Fire Department was prevailed upon again to quench the eruption, and the well was capped and buried.

"OLD FAITHFUL GEYSER OF CALIFORNIA"

There remains only one uncapped geysering water well in Calistoga today. That one is the old Bhegnasco well at the corner of Tubbs Lane and Myrtledale Road which apparently has always remained open since it was drilled circa 1915. The well erupts on a somewhat regular basis on the average of every 40 minutes (Rinehart, 1972) and has long been both a point of interest and a tourist attraction. It is now called the "Old Faithful Geyser of California". The grounds around the geyser have been moderately well maintained, and provide a small park-like setting for tourists awaiting the eruption. An eruption sometimes lasts as long as three minutes. It has been reported by the owners that the discharge during an eruption is as much as 4,000 gal/min, sometimes shooting to a height of sixty feet or higher.

A local resident related how he had been baptized at the geyser in 1942. Apparently others had been baptized there also. He remembered that in the 1940's, weddings were occasionally performed at the geyser site.

DISAPPEARANCE OF THE SPRINGS

In the "Handbook of Calistoga and the Geysers" (1871), the author describes the abundance of hot springs on the old Springs Ground:

> "...there are upwards of a hundred within an area of about sixty acres...in winter when a slight frost tips the glades with silver, the boiling springs send up clouds of vapor as from a hundred steam engines...".

Waring in 1915 writes:

> Four main springs rise at the base of a knoll of buff-colored tuffaceous material at the northern border of the meadow land, and a few pools and seepages of hot water appear in the meadow itself...about 400 yards west from the springs, a dug well supplies warm water for tub baths...Warm water is also obtained in several other wells near by and there is one strongly flowing artesian well".

If both authors are to be believed, the old Springs Ground was beginning to dry up by 1915. The meadow lands were apparently completely dry by 1924 as Allen and Day (1927) state:

> Until recent years there was a small group of hot springs near a knoll of tuff at the eastern edge of the town... Small mounds of characteristic siliceous sinter, doubtless deposited by the waters, were found here in 1924 by one of the authors. ...the flow of these springs ceased when a few years ago, a number of wells were drilled in the vicinity for the purpose of developing a water supply."

The old grounds remain completely dry at the surface today, except for some discharge flowing from the artesian wells at Pacheteau's. A mobile home park and a glider airport are situated on a large portion of the original hot spring-laden meadow land.

BOTTLED MINERAL WATER

Guests at Sam Brannan's Calistoga Hot Springs would not only bathe and steam themselves, but also drink the spring waters in hopes of improving their constitutions or effecting a cure of some malady or another. Today, bottling the mineral water at Calistoga is a thriving business; there are three commercial mineral water bottling companies operating in town. It is reported that a fourth bottling company, with its works located in Santa Rosa, obtains some of its water from the Pacheteau's wells.

The largest in sales volume and the longest in business is the Calistoga Mineral Water Company on First Street. A well was drilled on this site in 1920, and the temperature of the water was reported to be 100°C. In 1924 the first bottles of mineral water were produced, and the company has remained in business ever since.

Prior to 1975, the Napa Valley Springs Mineral Water Company was only a small weekend business. After that year the company stepped up to full time production and now puts out its product in gallon plastic jugs. Their production well was probably drilled about 1920.

The Crystal Geyser Water Company, located on Washington Avenue drilled their production well in 1978. After testing the water and ensuring the presence of a large enough supply, a bottling plant was erected at the site. According to the company, they now rank third in total mineral water sales in California. First in sales in California is the French import "Perrier". Second is the Calistoga Mineral Water Company.

The volume of water pumped from the moderate-temperature geothermal resource for mineral water bottling purposes is unknown. Because of the competitive nature of the mineral water business, the bottling companies guard their production figures. However, it may be assumed, since the popularity of Calistoga's mineral waters is great, that a relatively large volume of "hot water" is removed from the resource annually.

RECENT USE OF THE GEOTHERMAL RESOURCE

Through the years a few enterprising individuals attempted to utilize the geothermal resource at Calistoga for home heating. According to a long time resident of Calistoga, these heating systems generally had to be abandoned after a few years when the water pipes would become choked with mineral deposits.

In recent years there have been successes though. There are at least two private residences totally heated by utilizing hot water from a well. One house built in the late 1950's to early 1960's simply has copper pipes built into the concrete foundation through which the geothermal waters circulate, heating the whole house from the floor up. The other house has an elaborate custom-made heat exchanger system whereby the heat from mineral laden waters is transferred to a system containing fresh water. This eliminates the mineral deposit problem that plagued early heating systems.

There is one motel/spa in Calistoga that heats its entire complex from a geothermal well. The hot waters circulate through a space-heating system in each of the units.

There may be as many as 20-25 residences that are using water from a "hot well" directly as a domestic hot water supply in Calistoga. Approximately 10-12 residences are utilizing their "hot wells" for heating swimming pools, private mineral water baths, and jacuzzi-type spas.

In the mid 1950's a moderate size greenhouse was built and heated with water from two geothermal wells. This business is still operating today on Tubbs Lane. Another greenhouse complex was started in the early 1960s in the same general area. Waters from two geothermal wells were used as heat sources. However, the economics of the plant business apparently forced the abandonment of this operation in the late 1960's.

EFFECT OF RESOURCE DEVELOPMENT ON THE "HOT WATER" TABLE

It is obvious that the "hot water" table has lowered in the area of the original Springs Ground since the development of the geothermal resource there. The history suggests that the springs dried up sometime between 1910-1920, probably at least in part due to the drilling of the first deeper (150-190 feet) water wells in Calistoga. It is now generally believed by townspeople and local well drillers that a well must be drilled over 100 feet to reach the resource in this area.

Even though the "hot water" table has deepened around Pacheteau's, it may not have lowered very much in nearby areas. It was reported that shallow excavations (dug in the early 1960's to 8-10 feet deep) in the vicinity of Tubbs Lane and Bennett Lane became so hot that the soil was nearly "too hot to touch", even when no water flowed into the excavations.

Despite moderately heavy commercial and domestic development of the resource over the years, some geysering and flowing wells drilled around 1920 are still producing at what appears to be nearly their original volume.

Although geothermal wells have been drilled elsewhere in Calistoga, none seem to have been able to produce as much hot water as the wells at Pacheteau's. Therefore, the largest volume of the resource may be in this area, although exploratory drilling has yet to prove this conclusion to be correct.

The literature suggests that the temperature of the resource may not have changed much in at least the last 120 years (that is, boiling water is still available from the resource).

Getting the Dirt on Calistoga

by Steve Rubenstein

It is a pleasure to include a favorite San Francisco writer in the *Hot Line*. The *San Francisco Chronicle* ran this column by Steve Rubenstein on July 14, 1986, and it is reprinted with the Chronicle's permission.

Calistoga, Napa County

You don't have to clean the tub after taking a mudbath. There isn't much point.

In Calistoga, a town that has made its mark in the world by slinging dirt, they never even empty the tub. It's not necessary to scrub the porcelain or polish the tile after a mudbath.

What a great arrangement.

It was opening day at the remodeled Calistoga Spa mudbath, a $1.5 million palace of mud just off the main street. The joint was brand new and spanking clean and dirty. I was in Tub No. 2.

A mudbath is what you do in Calistoga after running out of patience with winery tours. This usually happens after one winery tour. At that point, it's either mudbaths, glider rides or hot-air balloons. Mudbaths stay put, so it was no contest.

In Calistoga, people have been paying money to have mud thrown on them for 100 years, but never like this. This place was paradise for mud. Deep, thick carpets. Sparkling chrome. Fancy chairs. They do this mud thing right.

The remodeled spa has eight tubs of mud, instead of the old four. That means that twice as many people can bathe in mud as the old days.

"We're very excited," said manager Brad Barrett. "It's hard to envision mud as clean but, if there is such a thing as clean mud, this is it."

Well, there isn't such a thing as clean mud. That's my report from Tub No. 2.

A mudbath lasts 10 minutes. At first, it is all warm and squishy and feels like lying in oatmeal, although it doesn't smell like it. That sensation lasts a few seconds. For the rest of the time, lying there is hard work. You sweat. You catch fire. You blow fuses and trip circuit breakers. A lumpy black monster that resembles something from a Vincent Price movie is lying beside you, and it's your right leg.

The mud man comes around to tell you how much time you have left. "Only three more minutes!" says the mud man. "Two more minutes! One more minute!"

There you are, paying $19 for the mudbath and you can't wait to get out. Not only that, but the guy who's giving you the mudbath knows you can't wait to get out and provides a countdown as part of the service.

After you pull yourself somehow from the mud and are ready to drop dead, they toss you in a mineral bath and then a steam room, until you hand over the microfilm and confess.

Why, exactly, do people take mudbaths? The first time, you do it to say you took a mudbath. What about the next time? The fellow in Tub No. 3 said he takes a mudbath once a week.

"Gets the toxins out," he explained.

I asked the mud man. He said the same thing. Gets the toxins out. So did Barrett. Gets the toxins out. It's the municipal chant of Calistoga.

But by lying in the mud, which is not changed from customer to customer, aren't you merely lying in the toxins left by the fellow who went before?

"I hadn't thought of that," said the mud man. "You have a point."

Well, I hate to spoil opening day at the Calistoga Spa mudbath, but I do feel sorry for the guy who had to climb into Tub No. 2 after I climbed out. Poor guy. He probably never knew what hit him.

A photo reproduction after a drawing in the 1871 "Handbook of the Calistoga Springs", page 4.

You Are What You Drink

The demand for bottled water is the fastest growing segment of the beverage industry, according to an article by Lawrence Fisher in the New York Times, reprinted in the San Francisco Chronicle. In the past decade, per capita consumption of bottled water has more than tripled to 5.2 gallons. Sales have risen to about $1.5 billion in 1985 from $275 million in 1975, according to Fisher.

A new book reflecting the trend is titled The Best Bottled Waters in the World, the 150 purest, most delicious, and healthful waters from Ain Sofat to Zurich. The authors, Maureen and Timothy Green, describe how to evaluate bottled waters (look for salinity and stillness); what is and is not real mineral water; and which are the major labels. Among these brands are Laoshan water (low sodium) from Shandong Province in China and Baraka water from Egypt. The book is available for $8.95 from Simon and Schuster.

Calistoga District-Heating Systems

Calistoga, California, with a $450,000 award from the California Energy Commission (CEC), is starting development on a geothermal district-heating system for 36 structures. The district-heating system will include many downtown businesses and three city buildings.

An economic feasibility study for the project was completed by Gene Culver of the Oregon Institute of Technology. The system will include one or more production wells and, initially, a single injection well.

210°F geothermal water is expected to be pumped from the production well(s), located near Pacheteau's spa, and pass through a plate heat exchanger nearby. At the heat exchanger, fresh water in a separate, closed loop will be heated and circulated through the system. The geothermal water will be injected back into the reservoir through an injection well drilled at the southern end of town.

Monies borrowed from the CEC will be repaid by the city with the revenues collected from system users. The city, not the building owners, will pay retrofitting costs.

Estimates are that the geothermal district-heating system will be less costly to operate than the oil and gas heating systems presently in use.

As an additional note, the Calistoga Unified School District is finalizing plans for the construction of a new high school and Olympic-sized pool. Both will be heated by geothermal water in a space-heating project separate from the city project (and separately funded).

Calistoga's Geothermal Reservoir

"Over 200 freshwater and geothermal wells have been drilled in Calistoga, California," said Kent Murray, a geologist with California State University, Sacramento and the California Energy Commission. "The wells are between 25 and 2,000 feet deep. The sampled water temperatures in the wells reach a maximum of 135°C, although reservoir temperatures may exceed 150°C based on geothermometry investigations. Sometimes, geothermal waters mix with shallow, cool groundwaters. This is inferred from the results of several chemical tests. Reservoir extraction and flow appear to be in near equilibrium, today. The current average well withdrawal is 40 gallons a minute," Murray added.

The geothermal resource is discussed further in papers by Murray and others (1985) in Part 1 of the International Symposium on Geothermal Energy, and Murray and Jonas (1986), both published by the Geothermal Resources Council. In the former, the authors write, "The source of the geothermal component of waters in the upper Napa Valley may be related to one of two possible shallow plutonic bodies both north and south of the City of Calistoga. Geophysical and geochemical evidence suggest the presence of a subsurface fracture zone approximately coincident with the geographic axis

of the valley. The fracture zone appears to act as a conduit for the upward migration of meteoric water coming from the south. The hotter wells in the Calistoga area are distributed along the geographic axis of the valley, have similar chloride to boron ratios, and are high in chloride, boron, fluoride, and sodium. These wells also indicate higher temperatures by geothermometry, implying a deeper aquifer source.

"As the geothermal water seeps upward along the fracture zone, it migrates laterally towards the margins of the valley, and gradually becomes enriched in Fe, SO_4, and HCO_3 by mixing with the cool, near-surface groundwater. A comparison of these geochemical indicators on trilinear diagrams suggests various degrees of mixing between the geothermal waters and shallow fresh groundwater at different locations throughout the greater Calistoga area, and can thus be used to trace and map the geothermal waters."

Murray believes the main body of the geothermal aquifer is only about 100 feet thick, and dips 9 degrees to the southwest. Although a transfer of heat by conduction could occur for several hundred feet above and below the reservoir, a temperature reversal could be encountered by a well drilled through the aquifer.

Dr. Murray and his students from California State University, Sacramento, have been monitoring a network of wells to pinpoint the geothermal reservoir's upflow zone. The reservoir consists of brecciated flow surfaces and interbedded clayey sands at depths of 150 to 250 feet below the surface.

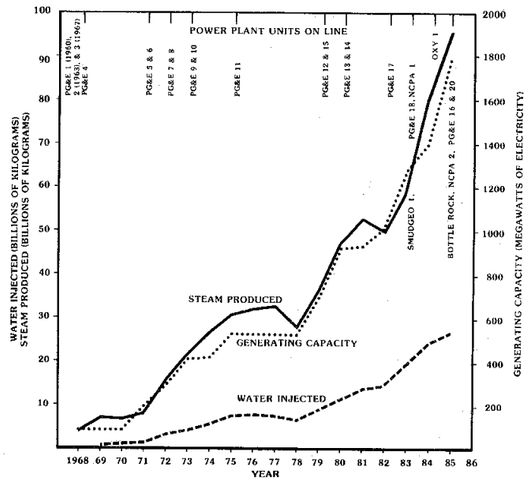
"We'll be looking to learn the fundamental nature of this resource system," said Sally Benson, a scientist from Lawrence Berkeley Laboratory who will be assisting Murray in the testing of possible production wells near Pacheteau's spa. "We're not telling anyone where to drill. Instead, we will provide a data base so local community members can make intelligent decisions about managing the resource."

The Geysers Unit 21 Update

A spokesman for Pacific Gas and Electric Company said discussions are underway between the California Public Utilities Commission and Pacific Gas and Electric Company over the rate treatment for PG&E's power plant Unit 21 at The Geysers Geothermal field. Construction on the facility may be delayed until May 1987, and possibly beyond that time.

The Geysers Geothermal Field, 1985

The following information is reprinted from the Seventy-First Annual Report of the State Oil and Gas Supervisor, published by the California Department of Conservation, Division of Oil and Gas. The report is available from the Division of Oil and Gas, free of charge, at 1416 Ninth Street, Room 1310, Sacramento, California 95814.



History of steam production, water injection, and power-plant capacity at The Geysers Geothermal field.

Power plant NCPA 2, The Geysers Geothermal field. Photo by Susan Hodgson.

Steam production in The Geysers Geothermal field totaled 95.8 billion kilograms in 1985, a 19.8 percent increase from 80.0 billion kilograms produced in 1984.

Injection of condensed steam and water from Big Sulphur Creek increased from 24.6 billion kilograms in 1984 to 26.7 billion kilograms in 1985.

In 1985, four power plants were brought on line at The Geysers Geothermal field: Pacific Gas and Electric Company Units 16 and 20 (each generating 113 megawatts, net); the California Department of Water Resources Bottle Rock power plant (generating 52 megawatts, net); and Northern California Power Agency power plant NCPA 2* (Unit 3, generating 55 megawatts, net, as will Unit 4, scheduled to go on line in April 1986). The four power plants raised the total electrical generating capacity at The Geysers to 1,718 megawatts, net, as of December 31, 1985.

* (NOTE: Name change. The current plant NCPA 2 was initially called NCPA 3; the first NCPA power plant, initially called NCPA 2, is now known as NCPA 1).

Low-Temperature Resources Studied in Clearlake

Clearlake, California, is about 15 miles northeast of The Geysers Geothermal field. The Clearlake City Council has accepted grants totaling $150,000 from the California Energy Commission and Lake County to assess the nature and the extent of its low-temperature geothermal resource. The firm of S.S. Papadopulos and Associates was hired to conduct the geophysical studies for the project.

Initially, the studies consisted of a radon soil survey and a 3-meter temperature survey of the western half of the city. The purpose of these tests was to identify those areas of the city most likely to overlie a low-temperature geothermal resource.

The survey results have indicated an area with high potential where S.S. Papadopulos proposes to drill 4 temperature-gradient holes to a depth not to exceed 500 feet. The temperature-gradient holes will be drilled on Pearl Street, Mullen Drive, Ridge Road, and Laddell Street.

The City of Clearlake has indicated that no rare plants or rare and endangered wildlife species are in the immediate vicinity of the site.

The State Water Quality Control Board has stated that it has no objection to the proposed project. No water quality impacts are anticipated since none of the sites are adjacent to water bodies.

Coldwater Creek Power Plant Underway

The Coldwater Creek Geothermal Power Plant (CCPA No. 1) is under construction at The Geysers Geothermal field, Sonoma County, California. The plant is being built by the Central California Power Agency, composed of the Sacramento Municipal Utility District, the Modesto Irrigation District, and the City of Santa Clara.

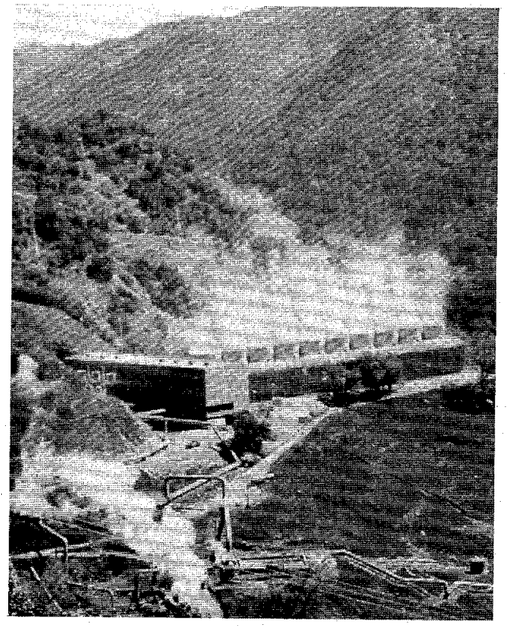
The firm of Stone and Webster is providing licensing, environmental, engineering, design, construction management, and startup services for this two-unit, 130-megawatt geothermal power plant.

The plant includes two 65-megawatt, gross, turbine generators, centrifugal compressors for noncondensible gas removal, a distributed control system, a Stretford system for hydrogen sulfide removal from noncondensible gases, and a 13.2 lb/kwh, gross, steam rate at design conditions.

Commercial operation of the power plant is scheduled for 1988, with Unit 1 beginning in May and Unit 2 in October of that year.

Elemental Accumulation Studied in Biological Species

"You can begin an environmental study at any time, but, of course, it's preferable to begin before development starts," said Mike Smith, Grant and Loan Program Manager of the California Energy Commission (CEC). "At The Geysers, relatively little environmental baseline data were collected during the early years of development. In early 1983, the CEC awarded Sonoma County a geothermal grant for $37,655 to analyze the biological accumulation of trace elements in The Geysers Geothermal region. The CEC funds were provided through the Geothermal Grant and Loan Program for Local Jurisdictions. Sonoma County provided matching funds of $8,575.



Power plant at The Geysers Geothermal field. Photo courtesy of the California Energy Commission.

"Although The Geysers region of Northern California has the largest concentration of geothermal power plants in the world, it still remains a very rural area with diverse flora and fauna. Prior studies in The Geysers region have established data for 27 different chemical elements, and suggest that chemicals are accumulating near power plants.

"Using this grant, the Sonoma County Planning Department contracted with the Institute of Chemical Biology to conduct an analysis of elemental accumulation in biological species. The study examined selected species of rodents, fish, and lichen. Elevated amounts of chemical elements were found in their tissues. It is not clear if this accumulation is the result of geothermal development or due to naturally high backgrounds of these elements in the region. However, today these element loads serve as reference points for both developers and regulators.

"The CEC awarded a second grant of $54,910 in July 1985. The study funded by this grant will provide a more complete analysis of elemental loads by examining species such as western fence lizards and deer. Results and conclusions from these two studies will be assimilated into a final report for the Phase Two study. This can be used by regulatory agencies planning for future geothermal development in The Geysers region."

For further information, contact Mike Smith at (916) 324-3502.

Mono County Geothermal Activity

by Daniel L. Lyster
Director, Energy Management Department
Mono County, California
P.O. Box 8060
Mammoth Lakes, CA 93546
(619) 934-6704, Ext. 403

The following geothermal projects have been proposed or are under way in Mono County, California.

Mammoth/Chance Geothermal Development Project

Bonneville Pacific Corporation, as project developer, has applied to the Mono County Energy Management Department for a use permit to construct and operate a 10-megawatt geothermal binary power plant. The proposed location of the plant, about 5 miles southeast of Mammoth Lakes, comprises about 400 acres owned by the City of Los Angeles (Department of Water and Power). The geothermal mineral rights are owned by Magma Power Co. The developer holds a lease interest in both the land and the geothermal mineral rights.

Pursuant to the requirements of the California Environmental Quality Act (CEQA), an Environmental Impact Report (EIR) is currently under preparation by a third-party consultant, WESTEC Services, Inc. As the lead agency under CEQA, the Mono County Energy Management Department is responsible for the contents of the EIR and for processing the use-permit application for subsequent issuance or denial by the Mono County Planning Commission.

The areas of specific focus within the EIR include potential impacts to shallow aquifers and surface streams; potential impacts to geothermal aquifers associated with the Hot Creek Fish Hatchery (California Fish and Game) and the Hot Creek Gorge Recreation Area; visual impacts; impacts on wildlife; the placement of access roads and power transmission lines; and the economic impacts and benefits to Mono County by the project.

The project proposes to include 8 production wells and 3 injection wells to operate in conjunction with the binary power plant. The working fluid to be used at the power plant will be isopentane heated by geothermal water maintained under pressure and at an approximate temperature of 260°F. The geothermal fluid is to be extracted from wells drilled into a geothermal reservoir 400 to 700 feet below the surface.

Pacific Lighting Energy Systems

Pacific Lighting Energy Systems (PLES) has submitted to the Bureau of Land Management (BLM), a "Plan of Operation" for development, injection, and utilization for electrical power generation of geothermal resources on federal lands in Mono County. The proposed project area is on Inyo National Forest lands adjacent to the existing Mammoth-Pacific Power Plant. The area is on federal geothermal lease number CA-11667 (within Sec. 32, T. 3S., R. 27E. M.D. B.&M.).

The proposed project (PLES I) includes the construction, drilling, and operation of geothermal production and injection well S-2, the related production and injection pipeline systems, control and maintenance facilities, and a 10 MWe (net) binary power plant. The project would use geothermal fluids produced from up to 5 geothermal wells, which would be located within 1,000 feet of the power plant. The geothermal fluid would be directed by surface pipelines to the binary power plant, where heat from the fluid would be extracted and used to drive a turbine generator. After heat extraction, the cooled geothermal fluid would be directed from the power plant by surface pipeline to up to 4 geothermal injection wells.

During production operations, about 5,000 gallons per minute of geothermal fluids would be extracted from the production wells. At no time during the power production cycle would the geothermal fluids be flashed to steam or

exposed to the atmosphere. The electrical power generated would be transported from the generating facility to the Southern California Edison substation at Casa Diablo and be incorporated into its power grid.

Geothermal Research Drilling Near Mammoth Lakes

On May 7, 1986, a geothermal research well was spudded near the Shady Rest campground near Mammoth Lakes. The well was funded by the U.S. Department of Energy, the California Energy Commission (CEC), and Mono County. The primary purpose of the well is to provide a way to periodically measure the thermal gradient, pressure, and chemistry of the thermal aquifer in the caldera's southwestern moat. The secondary purpose of the well is to investigate the geothermal energy and space-heating potential of the area in the vicinity of Mammoth Lakes.

The well was rotary drilled to 303 feet, and a 5-inch surface casing installed. The well was then cored by HQ (3.8 inches) wireline to a total depth of 2,346 feet. Core recovery exceeded 90 percent, and volcanic lithologic units were well represented.

The well was completed and cased by mid-June. Difficulties were encountered in completing the well. Sloughing, squeezing, and lost circulation prevented the installation of casing over the full 2,346 feet. Attempts to redrill and recover the portion of the well below 804 feet resulted in drilling a new well, which deviated from the original well at about 790 feet. The new well was cored to a depth of 1,398 feet. Then, 2 3/8 inch tubing was cemented in and filled with water.

Temperature-gradient surveys will be run to determine an equilibrium profile. Then, a portion of the cased zone will be perforated within the identified high-temperature zone to provide access for fluid sampling from the hot aquifer.

Long Valley Magma Energy Extraction Project

By Bill Rintoul
(Reprinted with permission of the Bakersfield Californian)

The U.S. Department of Energy Magma Energy Extraction Project has as its goal the extraction of geothermal energy from magma. To this end, the DOE is planning to drill close to or into magma from an as-yet-unchosen site in the Long Valley caldera in northeastern California. Presently, researchers at Lawrence Berkeley Laboratory, under DOE funding, are reviewing all data concerning magma in Long Valley.

One site under consideration is in the West Moat area of the Long Valley caldera. The second is the site of what was originally to be the Occidental Geothermal well LVF No. 51-20 on Sec. 20, 3S-28E, Inyo County, on the northwestern quarter of the northeastern quarter of the section. The pad was built, and 30-inch conductor pipe was cemented at 80 feet. Before Occidental could drill the well, the parent company sold the geothermal operation to Santa Fe International Corp., and it became a part of Santa Fe Geothermal. The final site will be chosen in the spring of 1987 for the 18,000-foot well.

Sandia's Geothermal Technical Development Division is spearheading the scientific project, which reportedly will be funded by a grant of $6.7 million from the Department of Energy over a 4-year period.

It's theorized that magma consisting primarily of obsidian, molten at 900°C, lies at a depth of 15,000 to 20,000 feet beneath the proposed drill site. The deepest well in the area has gone only to about 8,000 feet.

Scientific emphasis will be on the technology required to drill the hole under high temperatures and on the development of informaticn on the geology.

The drilling work is to be carried out in three stages. The first stage, with drilling tentatively slated to start in October 1987, will take the hole to about 3,000 feet. The second stage, starting around September 1989, will take the well to 7,500 feet. The third stage, starting in September 1990, will take the hole to 18,000 feet or 500°C.

The casing program calls for 16-inch at 3,000 feet, 11 3/4-inch at 7,500 feet, 8 5/8-inch at 14,000 feet and 7 3/8-inch to 18,000 feet. Plans call for using insulated pipe to cool drilling fluids.

Basic tests planned for the well include temperature profile, seismic, fluid sampling, pressure, stress, and core sampling tests. It's anticipated that the temperature at about 14,000 feet will be around 325°C, or 617°F.

Southern California

Geochemistry and Geothermometry of the Desert Hot Springs GRA

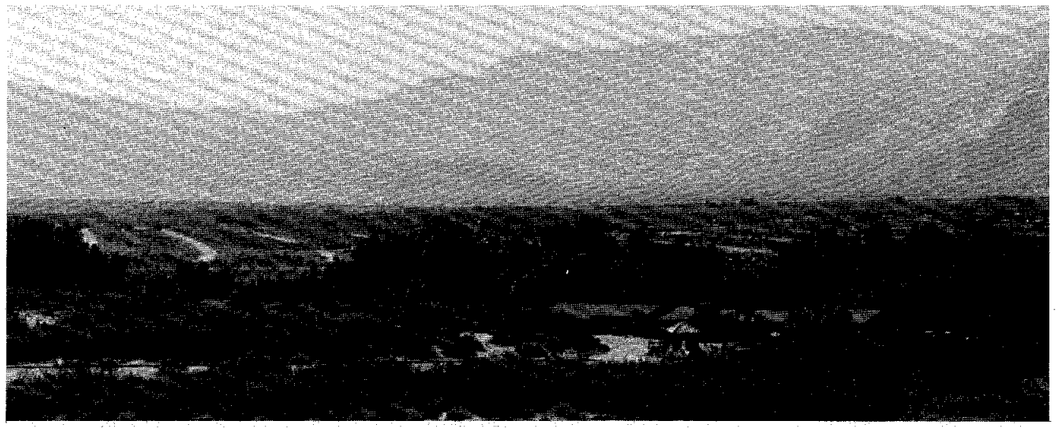
by Richard E. Corbaley and Ramiro Oquita
California Department of Conservation
Division of Oil and Gas

(This material, a portion of a longer article, is reprinted with permission of the Geothermal Resources Council from the Geothermal Resources Council Transactions, 1986.)

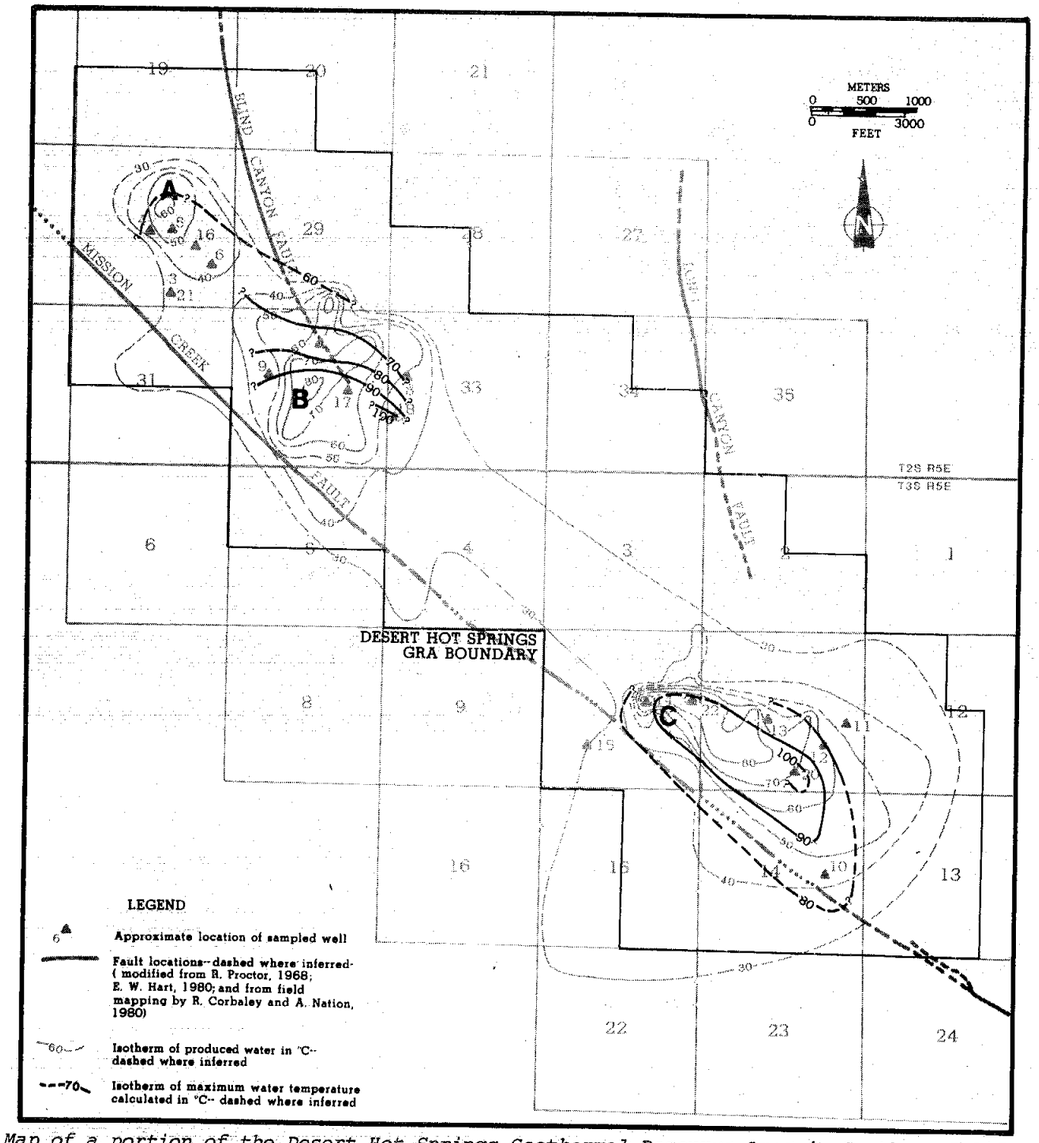
Desert Hot Springs, California, "The Spa City", is about 14.5 km north of the City of Palm Springs, California, and partially within the Desert Hot Springs Geothermal Resource Area (GRA). Since 1941, about 200 low-temperature geothermal wells (below 100°C) have been drilled in the GRA. Today, about 50 of the wells are used commercially for pools and spas. Water produced from some of the wells reaches temperatures of about 90°C.

The northwesterly-trending Mission Creek fault borders the GRA on the southwest. Geothermal water is produced from the alluvial deposits underlying the GRA.

Chemical analyses of water from 22 wells throughout the GRA indicate the geothermally heated water north of the Mission Creek fault is high in sodium and sulfate, differing from the water sampled south of the fault, which is high in calcium and bicarbonate.

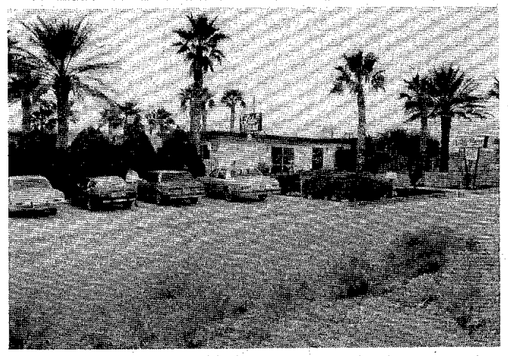


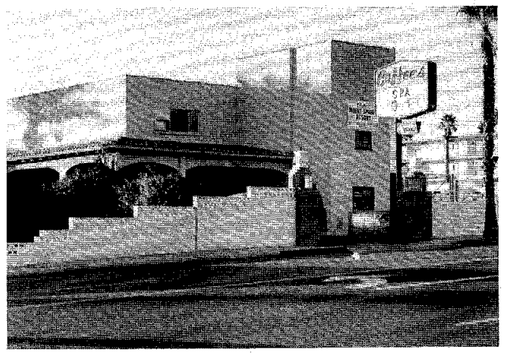
Two Bunch Palms, location of the only natural spring that is associated with the Desert Hot Springs anomaly.



Map of a portion of the Desert Hot Springs Geothermal Resource Area in Southern California, with locations of sampled wells, traces of major faults, isotherms of produced-water temperatures, and isotherms of maximum-water temperatures. Maximum-water temperatures were calculated by averaging two chemical geothermometer equations for SiO_2 and Na-K-Ca.

The results of the study indicate that meteoric water, originating in the San Bernardino Mountains, flows southeasterly toward the GRA along the Mission Creek fault. Geothermometry indicates that the water is heated to temperatures as high as 110°C at depths between 2.7 km and 3.0 km. The geothermal water ascends along fractures near the intersections of the subsidiary Blind Canyon and Long Canyon faults. After cresting in the shallow alluvial rock, some geothermal water flows northeasterly and southwesterly. All of the water, however, eventually flows southeasterly along the direction of the regional hydraulic gradient.



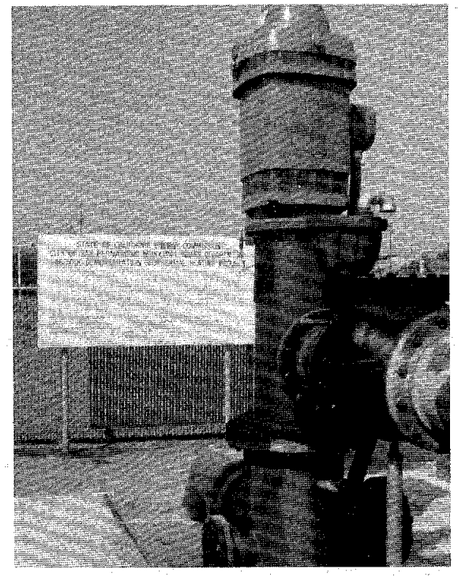


Some spas in Desert Hot Springs, California.

San Bernardino Geothermal District-Heating System

On May 30, 1986, one of the largest geothermal district-heating systems in the United States was dedicated in San Bernardino, California. The system, owned and operated by the San Bernardino Municipal Water Department, demonstrates the use of low-temperature geothermal energy as an alternative to fossil fuels for space- and water-heating in the City of San Bernardino.

Currently, 12 facilities are hooked up to the system, including City Hall, the St. Bernardines Retirement Plaza, the sewage treatment plant, the blood bank, the city library, and the 13-story Ramada Inn. Fifteen more facilities are scheduled for hook-up by early 1987, including the nine-building County Government Complex and the four-building East County Complex.



Well "Meeks and Daley" 66, one of two low-temperature geothermal production wells in the City of San Bernardino.

The geothermal, district-heating system reduces natural gas bills by 50 percent, and, in the initial phase, will save its users about $389,000 annually by 1985 fuel prices. When completed, the system will provide economical space - and water-heating to about 120 customers.

Project funding has come largely from the state through the Energy Commission's Geothermal Grant and Loan Program. To date, the City and County of San Bernardino have received $4.65 million from the state to assist in geothermal resource development and project construction. Of this amount, $3.6 million are low-interest loans.

San Bernardino Demonstration Geothermal District Heating System

Purpose

The district heating system will demonstrate the use of low-temperature geothermal energy as an alternative to fossil fuels for space and water heating in the City of San Bernardino.

Funding

The system is owned and operated by the San Bernardino Municipal Water Department. Funding for the initial phase of the system is being provided by:

California Energy Commission	
Grants to the City of San Bernardino	$ 944,450
Loans to the City of San Bernardino	2,750,000
Grants to the County of San Bernardino	146,840
Loans to the County of San Bernardino	811,245
	$4,652,535
City of San Bernardino	$1,646,118
County of San Bernardino	451,312
	$2,097,430
TOTAL	**$6,749,965**

System Design

The initial phase of the system will include two production wells and 35,000 feet of insulated pipe connecting 27 facilities.

These 12 facilities are presently part of the system: Wastewater Treatment Plant (2 Digesters and 3 Buildings); City Animal Control Center; San Bernardino Blood Bank; City Hall; City Convention Center; Central City Library; the 12-story Saint Bernardines Retirement Plaza; and 13-story Ramada Inn.

The following facilities are scheduled for inclusion in the system during 1986 and early 1987: California Department of Transportation Building and a separate state office building; County Government Complex including nine buildings; and East County Complex including four buildings.

Geothermal Resource

The two production wells can produce an artesian flow rate of 4,000 gallons per minute (GPM) of 130-140°F resource. The initial phase of the system is designed to use 2,800 GPM. When pumped, each well can produce up to 5,000 GPM. The Water Department will deliver geothermal fluid at 130-134°F at a system pressure not less than 50 pounds per square inch. The exceptionally clean fluid is discharged into a surface channel.

Potential Future Users

The system will eventually service an additional 60 private buildings in the Central City and Hospitality Lane areas. Norton Air Force Base is also a potential user.

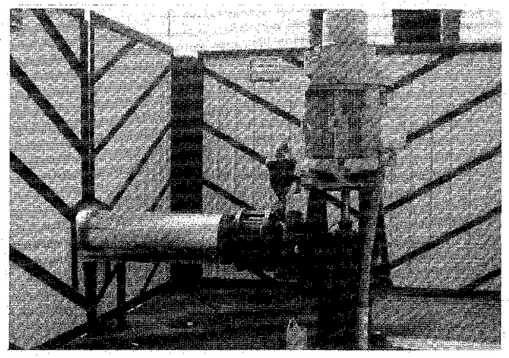
Payback Period

Typical public or private users will recoup investments in system hardware and installation costs in periods ranging from 18 months to 6 years.

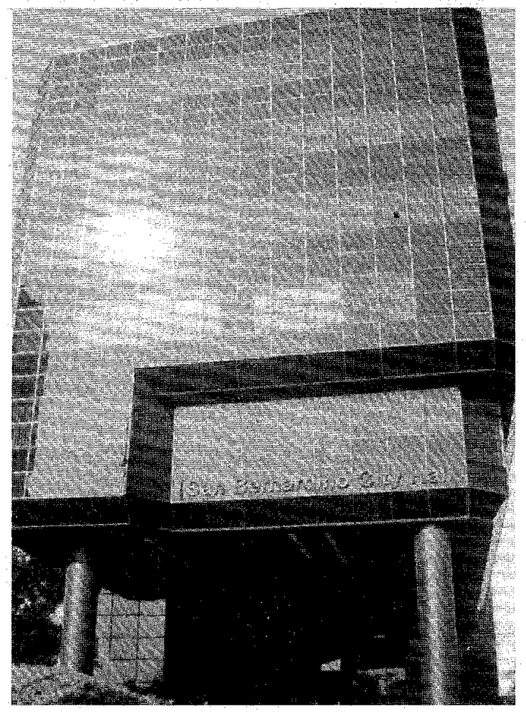
Savings

The initial facilities will realize a total annual savings of approximately $389,000 based on 1985 fuel prices.

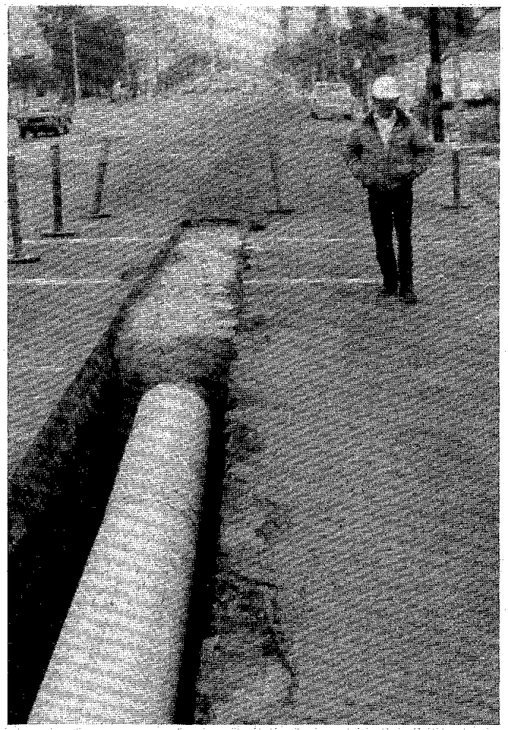
When the planned system is complete, including city and county buildings and private facilities in the downtown and Hospitality Lane areas, system users will save an estimated $876,000 per year based on 1985 fuel prices.



Well "Mill and D Street", one of two low-temperature geothermal production wells in the City of San Bernardino.



San Bernardino City Hall, included in the city's low-temperature geothermal district heating system.



35,000 feet of insulated pipeline will initially connect 27 facilities (and ultimately, as many as 120 facilities) in the district heating system, City of San Bernardino.

St. Bernardines Retirement Plaza, a 12-story structure included in the city's low-temperature geothermal district heating system.

Coso KGRA Update

California Energy Company, Inc. of Santa Rosa, California, has drilled 10 wells in the Coso Known Geothermal Resource Area (KGRA) at the Naval Weapons Center near China Lake, California (see July 1984 Hot Line). All 10 wells are successful geothermal wells. One of the wells, drilled to a depth of about 6,500 ft. with a bottom-hole temperature above 640°F, is among the hottest geothermal wells in California.

Nine of the wells are on land leased from the Navy and 1 well is on land leased from the Bureau of Land Management (BLM).

Three, 80 megawatt power plants will be built by California Energy Company in the KGRA at about 1.2 mile intervals. Each plant will consist of three, Mitsubishi turbine-generator sets. Construction on the first plant (on Navy land) has begun, and electrical generation is scheduled to begin in the spring of 1987. The second plant will be built on BLM land, and the third on Navy land.

How large is the reservoir at the KGRA? "We know the field has a pretty good wing spread," said Bill Tipton, Vice President and General Manager of California Energy, "but we don't know where the field starts and stops. Our hottest well is about 2½ miles south of the other wells."

In a letter submitted to California Energy Company, Dr. Henry J. Ramey, Jr., Mr. C. Russell James, and Dr. Jon S. Gudmundsson, independent reservoir engineers, wrote, "Inspection of location of wells drilled at Coso Geothermal field, indicates a proven production area of at least 3 square miles. Assuming that 15 pounds of hot fluid may be used to produce one kilowatt-hour of electricity, this amount of hot fluid is equivalent to 7,850 MW-years. This is equal to 260 MW for 30 years."

California Energy Company has three power-sales contracts to supply electricity generated at the Coso KGRA to Southern California Edison Company (SCE), with firm escalating prices for each plant for 10 years. The power sales or PURPA contracts pertain to an aggregate net capacity of 240 megawatts. These contracts have been earmarked, two-thirds (160 MWe) to the Coso Navy lands and one-third (80 MWe) to the Coso BLM lands. The company will build 28.5 miles of 115 kv transmission lines from the power plant sites to a SCE substation at Inyokern.

Ultrasystems, Inc. Plant Proposal Withdrawn

The proposed plant by Ultrasystems, Inc. in Imperial County, California, that would have incorporated geothermal energy to produce high-fructose syrup from corn will not be built, according to an article in the Imperial Valley Press. Russel L. Greengard, senior vice president of Ultrasystems, Inc., is quoted as saying that while plant plans are not completely dead, the company has effectively withdrawn its proposal for a plant in Imperial County.

Health Advisory on Salton Sea Fish

On May 6, 1986, the California Department of Health Services announced results of a study of croaker, orangemouth corvina, sargo, and tilapia from the Salton Sea in California's Imperial Valley. Analyses of edible flesh from these fish, caught in 1985, indicate the presence of selenium at levels sufficiently high to warrant issuance of a health advisory for people who consume these fish.

Nevada

Stillwater Development Planned

Trans-Pacific Geothermal Corporation (TGC) of Oakland, California, has recently acquired all Union Oil Company geothermal leases in the Stillwater area, 15 miles northeast of Fallon, Nevada. The Stillwater geothermal system has been fully explored by Union Oil Company from 1976 to 1981. Six deep exploratory wells were drilled in the area, defining a large geothermal reservoir, with fluid temperatures ranging from 320-335°F. Maximum fluid temperatures have been encountered at depths as shallow as 900 feet.

Tsvi Meidav, president of TGC, described Trans-Pacific's plans as consisting of a two stage development: a 1-2 megawatt power plant to be installed and operating by the end of the first quarter of 1987, and an additional 8-9 megawatts of capacity to be brought on line by the end of 1987. The 1-2 megawatt plant would utilize geothermal fluid from existing production wells. Sierra Pacific Power Company (SPPC) in cooperation with TGC, is currently conducting a study of transmission line routes from the project site to the SPPC sub-station at Fallon.

For further information, contact TGC, 1330 Broadway, Suite 1525, Oakland, CA 94612, (415) 763-7812.

Beowawe Geothermal Power Plant Operating

On August 30, 1986, a geothermal power plant was dedicated in the Whirlwind Valley near Beowawe, Nevada, about 55 miles west of Elko. The plant was constructed by the Beowawe Geothermal Power Company, a partnership between Chevron Geothermal Company of California and Crescent Valley Energy Company (an affiliate of Southern California Edison Company). Chevron is project operator and supervises both the power plant and reservoir operations in the water-dominated geothermal field.

The 16.6 megawatt, gross, dual-flash power plant began operating in December 1985. The project is designed to produce a net electrical output of 15 megawatts.

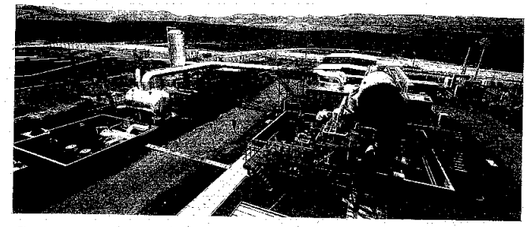
In the 1960's, surface geothermal manifestations in the Whirlwind Valley drew geologists to the area from several energy companies, including Chevron. Several test wells were drilled to define the resource. Chevron concluded the resource could support several hundred megawatts of electrical generating capacity, which it hopes to develop. The pace of development will depend on market conditions.

Today, the two production wells connected to the Beowawe power plant, the power plant, the injection pipeline, and the one injection well cover less than 5 acres. The generator's turbine is driven by steam flashed from 420°F, low-salinity (1,200 ppm total dissolved solids) geothermal fluids delivered to the plant at a rate of 1.25 million pounds per hour or 100,000 barrels a day. The production wells draw geothermal fluid from a fault zone that is 7,000 to 10,000 feet below the surface.

Spent geothermal fluid is pumped through a 2-mile long, 10-inch diameter, insulated, above-ground pipeline to an injection well.

Associated Southern Engineering Company, a wholly-owned subsidiary of Southern California Edison Company, provided the design and construction management of the electrical generating facilities. The facilities were constructed by Dravo Constructors, Inc.

Most equipment for the electrical generating facilities, including the turbine-generator, condenser, geothermal fluid handling facilities, and the



Beowawe geothermal power plant. Photo courtesy of Chevron Geothermal Company.

substation, was supplied by Mitsubishi International Corporation. The cooling tower was furnished and erected by the Marley Cooling Tower Company.

Swinerton and Walberg, under Chevron's supervision, constructed the geothermal fluid-gathering facilities and injection pipeline.

Electricity generated at the project is sold to Southern California Edison Company and Sierra Pacific Power Company under terms of avoided-cost, power-purchase contracts. Sierra Pacific Power Company provides the service required to transmit the electrical output of the project to Southern California Edison Company.

Several other geothermal wells capable of production have been drilled in the field. Preliminary planning is underway for construction of a second power plant.

Hawaii

Geothermal-Development Attitudes Surveyed

The State of Hawaii has conducted several surveys on public opinion towards the development of geothermal energy. The latest poll was taken in August 1986 as inter-island, cable development planning proceeds. The survey was designed to:

- Measure public opinion in the County of Hawaii relevant to geothermal development for electrical power supplied to Island of Hawaii residents only;
- Measure public opinion in the County of Hawaii relevant to geothermal development of electricity to be exported for use on Oahu; and
- Identify barriers to, and opportunities for energy conservation programs, including geothermal development.

Poll Results

In general, the residents of the County of Hawaii favor some form of geothermal development. Those in favor of development outnumber those who oppose it by more than a 3 to 1 margin. Support for developing geothermal energy resources was stronger in the Puna District than in the rest of the county. This level of support represents an increase in popular support for geothermal development since the 1982 study undertaken by the State of Hawaii.

However, support for large-scale development (100 megawatts vs 25 megawatts), drops to a 2 to 1 margin over those opposed. Support was strong in all areas, but decreased significantly in the Puna District.

A proposal for a very large scale development (500 megawatts) for producing power for export to Oahu drew much less support. Although a small plurality favored the idea, the number of those opposed increased, especially in the Puna area.

Issues on geothermal development of concern to the public were similar to those mentioned in the 1982 study. Basically, the issues amount to a

trade-off between the economic advantages and the environmental problems of geothermal development. The strong points in favor of development include a perceived need for more energy, a strong preference for alternate energy forms over petroleum, perceived benefits for the local economy and the employment rates, and the possibility that development may reduce or contain utility bills. On the other hand, it appears that geothermal development will cause health problems for those who live near the wells, be hazardous to flora and fauna in the Puna area, and create noise and odor above tolerable levels. These are oversimplified statements of the reasons behind both support and opposition for geothermal development.

When residents consider very large scale development on the Island of Hawaii to generate electricity for export to Oahu, their opinions reflect their willingness to share resources with others. Supporters of the plan feel that the ability to share with others is important, and are glad for the opportunity to be of assistance. Opponents feel it is best for Big Island resources to be used on the island itself, and Oahu must find its own solutions. In this case, the often expressed "not in my back yard" syndrome seems to have given way to a "let's keep it home" philosophy. We note that there were a few people in the Puna area who felt that power generated from geothermal wells should be used in Puna and not shared with those in other areas of the Big Island.

For a free copy of a survey abstract, contact Gerald Lesperance, Hawaii Dept. of Planning and Economic Development, P. O. Box 2359, Honolulu, Hawaii 96804.

New Owner for HGP-A

On November 13, 1986, the U.S. Department of Energy formally transferred ownership to the State of Hawaii of Hawaii's only geothermal plant, the 3 megawatt geothermal wellhead generator designated HGP-A. The power plant, located in the Puna District on the Island of Hawaii, began providing electricity to the local utility in March 1982. The plant has had an availability exceeding 95 percent. It is the intent of the State of Hawaii to continue to operate the plant until a commercial power plant comes on line in Hawaii. Puna Geothermal Venture, a venture of Thermal Power Company and AMFAC Energy, intends to have a 12½ megawatt plant in operation near HGP-A in 1989.

New Geothermal Project in Hawaii

"True-Mid-Pacific Geothermal Venture has received a permit to explore for and develop geothermal resources on James Campbell Estate land on the Island of Hawaii," said Rod Moss, vice president of Mid-Pacific Geothermal, Inc. The development area lies within a 27,000 acre parcel of Campbell land.

Moss said the permit was granted in a ruling on April 11, 1986 by the Hawaii State Board of Land and Natural Resources. The ruling granted Mid-Pacific Geothermal, Inc. and True Geothermal Energy Company the right to explore for and develop up to 100 megawatts of geothermally generated electricity in the Kiluea Middle-East Rift Zone, within the state-designated Geothermal Resources Subzone. The company lease within this subzone is about 8 miles up the east Rift Zone from the Hawaii Geothermal Project, site of well HGP-A and the 3.0 megawatt power plant (Hot Line, December 1985).

"We plan to proceed with exploration activities as soon as possible," said Moss. "However, an appeal to the board's ruling has been made. It could take 8-10 months for the appeal to be acted upon."

Thermal Power Company Signs Contract For Geothermal Energy In Hawaii

Thermal Power Company, a subsidiary of Diamond Shamrock Corporation, has signed an agreement with the Hawaii Electric Light Company (HELCO) to develop the first commercial geothermal power plant in Hawaii.

The electricity sales contract calls for the development of 25 megawatts of geothermal power by 1993. Puna Geothermal Venture, of which Thermal Power is the operator with a 75 percent interest, would develop the wells and build the power plant. Under the terms of the contract, Puna Geothermal Venture plans to supply 12.5 megawatts on line before 1993, to meet the scheduled needs of the utility.

The Puna Geothermal Venture is comprised of Thermal Power Company (75 percent), and Amfac Energy, Inc., a subsidiary of Amfac Company (25 percent). (On September 8, 1986, Diamond Shamrock Corporation announced that Thermal Power Company had purchased the 25 percent interest of Dillingham Geothermal, Inc. in the Puna Geothermal Venture. Purchase terms were not disclosed.)

Purchase of the electricity by HELCO was approved by the State Public Utilities Commission under rules implementing state and federal laws passed to encourage development of alternative energy.

The State of Hawaii is over 90 percent dependent upon imported oil for electrical generation; in the past few years, Hawaii has been pursuing a policy of reducing that dependency. This agreement marks an important step toward that goal.

"We are continuing negotiations with HELCO for an expanded contract which would provide an additional payment for generation capacity supplied by the geothermal plant," said Richard Pittenger, Vice President of Thermal Power Company. "Instead of bearing the costs of building new generating facilities, the utility would pay us for supplying new capacity."

Earlier this year, Thermal Power Company announced the successful completion of a third exploratory well at the Puu Honuaula site in the Puna District on the Island of Hawaii. The wells are adjacent to the Hawaii Geothermal Plant and geothermal well HGP-A. (This 3-megawatt plant was constructed with major support from the U.S. Dept. of Energy and a development group consisting of the State of Hawaii Dept. of Planning and Economic Development, the County of Hawaii, and the University of Hawaii's College of Engineering.)

The third Thermal Power well tested at an average rate of 65,000 pounds of steam per hour. "The three wells have confirmed the existence of a commercial steam reservoir that is one of the hottest geothermal resources in the world," said Pittenger.

Five to 7 wells will be drilled at the site, and the average well depth will be 7,000 feet. In September 1986, the company was in the process of submitting applications to drill the fourth well.

Geothermal Research in Hawaii

Dr. Harry J. Olson has been named the 1986 Spark Matsunaga Fellow in Renewable Energy Engineering (FREE) and, as of April 1986, assumed the position of Hawaiian Electric Industries' geothermal researcher in the FREE program.

Hawaiian Electric Industries is providing $250,000 over five years to fund the FREE program, which has been established as a partnership of the Pacific International Center for High Technology Research, University of Hawaii; the College of Engineering, University of Hawaii; the Hawaii Natural Energy Institute, University of Hawaii; and the Renewable Energy Institute of Washington, D.C.

The program matches a professor's salary (provided by the University of Hawaii) with additional funding increments from sponsors, such as Hawaiian Electric Industries, to attract well qualified energy faculty

to work on critical renewable energy engineering problems in Hawaii.

The FREE researcher's duties will include coordinating the geothermal research program for the Hawaii Natural Energy Institute and the Pacific International Center for High Technology Research; interacting with University of Hawaii researchers, the Natural Energy Laboratory of Hawaii Board, the Energy Division of the Department of Planning and Economic Development, the private sector; and with the University of Hawaii College of Engineering, Hawaii Electric Industries, Inc., and the Puna Research Center.

Olson will chair meetings with his Technical Advisory Committee and the Council of FREE Scholars for Geothermal Energy. These bodies will assist the researcher, as will a graduate student.

The Technical Advisory Committee is made up of: Dr. Bill Chen (UH-Hilo), Dr. Ping Cheng, Dr. Donald Thomas and Dr. Deane Kihara (UH-Manoa), Dr. W.L. D'Olier (Thermal Power Company), and Dr. Chin-Fu Tsang (University of California at Berkeley).

Serving on the Council for FREE Scholars for Geothermal Energy are: Dr. Henry J. Ramey (Stanford University), Dr. Robert Rex (Republic Geothermal), and Dr. T.W. Fraser Russell (University of Delaware).

A distinguished Board of Advisors, chaired by Senator Matsunaga, guides the FREE program.

The program involves corporate and foundation support of teaching and research positions to advance the development of renewable energy technologies. A sum of $250,000 over five years is required for each Fellow, and a target funding goal to support up to six Fellows has been established.

Oregon

Reservoir Engineering Case History and Problems Klamath Falls, Oregon

By William E. Nork
WILLIAM E. NORK, INC.
1026 West First Street
Reno, Nevada 89503

Geothermal resources from the Klamath Falls, Oregon KGRA are used primarily for space heating. Over 500 wells drilled into the KGRA use the geothermal resource daily. Heat from the geothermal water penetrated by these wells is extracted with downhole heat exchangers or with systems that either pump the fluids to a direct-use application or to an above-ground heat exchanger with a closed-loop system. It is estimated that peak-flow discharge exceeds 3,000 gallons per minute (gpm).

During the initial heating season (1984-1985), using the City of Klamath Falls pump and inject geothermal system, an investigation was conducted by William E. Nork, Inc. (WEN) for the purposes of determining:

1. The effect on the geothermal aquifer directly related to use of the city system;

2. The accuracy and dependability of water level fluctuations predicted by the VARFLOW model, developed by Lawrence Berkeley Laboratory, with comparison to observed measurements;

3. The causes of problems observed in privately owned geothermal wells; and

4. Additional understanding of the hydrology of the geothermal aquifer underlying Klamath Falls, from that which was reported by the U.S. Geological Survey and Lawrence Berkeley Laboratory.

The investigation encompassed the period November 1984 through August 1985, and included: a thorough review of all existing reports, maps, and files dealing with the Klamath geothermal reservoir; weekly evaluations of water levels and temperature data taken in 21 monitoring wells, seven of which were measured with continuous recording devices, the others being measured daily or weekly; monitoring the pumping rate, drawdown, and injection in the city geothermal system; use of the model VARFLOW to predict drawdown effects that were compared with observed data; use of "inverse" VARFLOW (written by WEN) to estimate the amount of pumping from private wells that were pumping but not injecting that could conceivably account for the drawdown effects; addressing individual well owners' concerns/complaints experienced during the heating season; and an assessment of the effects brought about by fluctuations in recharge, changes in temperature, and other external causes, e.g., pumpage from the cold water system.

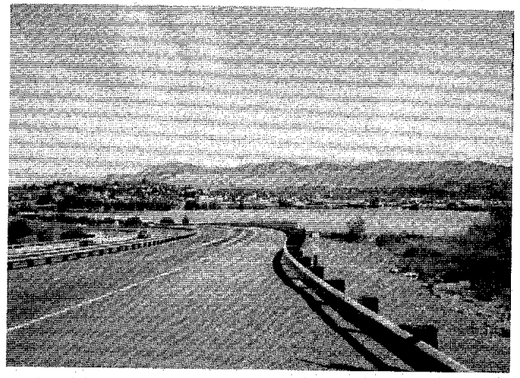
Among the more significant discoveries made during the investigation were:

In addition to the city's pump and inject system, seven other pump and inject systems were in operation. Unlike the city's system, each of these seven other systems experienced a measured thermal breakthrough, but, like the city's system, still provide viable geothermal heating.

Approximately 90 privately owned geothermal wells throughout the city pumped geothermal waters for heating purposes, at a peak rate of about 3,100 gpm, and an annual average of 1,250 gpm, the heat-spent water being discharged to waste, and not injected.

There was no evidence to suggest a direct coupling between the city's cold water-supply wells and discharge from the cold-water aquifer to the geothermal aquifer system.

U.S. Bureau of Reclamation activity south of Klamath Falls in the early part of the century was eliminated as a causal factor in water level declines in the geothermal aquifer.



View of the City of Klamath Falls, Oregon.

Recharge to the geothermal aquifer is primarily from snow melt in the Cascades to the west. It is derived from two distinct elevations, the lower elevation providing snow melt in the spring and the higher elevation in the early summer. Average annual recharge to the geothermal reservoir is estimated at about 650 gpm.

Super-heated water in the extensive geothermal aquifer is slow moving; a carbon-14 age of 11,400 years was calculated by the U.S. Geological Survey.

Water level declines in the geothermal aquifer most likely began in the early 1970's, when average combined pumpage to waste from privately owned wells exceeded the average recharge rate.

Although steadily increasing annual declines in water levels have been noted in the few wells with long-term records, the regional decrease in temperature within the geothermal aquifer is apparently very small to negligible.

The principal conclusions drawn from the study were:

At current discharge rates, the contribution of the city's pump and in-

ject system to the annual fluctuations in water level within the geothermal aquifer is very small and locally contained.

The major causes of changes in water level throughout a heating season appear to be pumpage-to-waste and recharge. Since about 1973, average pumpage-to-waste has exceeded average annual recharge, and the results of modeling with "inverse" VARFLOW suggest that 50 percent or more of the long-term declines in water levels since that date are due to excessive pumpage-to-waste.

There is a high level of correlation between changes in water level due to pumping and average ambient temperature, at least on a daily basis. Over an entire heating season, the relationship is less certain and water level fluctuations must be influenced by something else -- presumably uneven recharge rates during the colder winter months.

During heating seasons when ambient air temperatures are lower than average, pumpage-to-waste increases, thereby exacerbating the rate of decline.

Injection of heat-spent fluids currently being discharged to waste will mitigate the annual rate of decline in water levels. If injection of heat-spent fluids reaches a point wherein net pumpage-to-waste approximates the average annual recharge (i.e., the amount of waste pumpage without injection is about 650 gpm, as in the early 1970's), the decline in water levels will be essentially arrested. When net pumpage-to-waste is less than average annual recharge, a rebound effect will occur and water levels in the geothermal reservoir will begin to rise annually. Seasonal fluctuations can be expected to persist, although perhaps at a reduced amplitude than those experienced presently.

Problems experienced by private well owners reported during the 1984-1985 heating season appear to be related mainly to well construction, water level declines, or both.

Cascades Geothermal Program

The U.S. Department of Energy (DOE), Division of Geothermal and Hydropower Technologies, as part of its mandate to support research for the identification, evaluation, and utilization of geothermal energy, has initiated a program to support industry efforts in the Cascades volcanic region. The Cascades region is an area with high geothermal potential but few surface manifestations and limited subsurface data. To stimulate further development of hydrothermal resources, DOE-Idaho Operations Office issued Solicitation Number DE-SC07-85IDI2580. The reason for this solicitation was to secure cost sharing agreements with industry to drill gradient holes that would penetrate the "rain curtain" and obtain deep thermal, lithologic, and structural data. The data obtained and studies conducted under this program are to be released to the public for the benefit of the geothermal industry and the scientific community.

The first thermal gradient hole to be drilled under this program was finished November 1985 by GEO-Newberry Crater, Inc. on the south flank of Newberry volcano. GEO-Newberry is a wholly-owned subsidiary of GEO Operator Corporation. The hole, Corehole GEO N-1, is located 3,500 ft. west and 2,450 ft. north of the southeast corner of Sec. 25, T. 22S., R. 12E., in Deshutes County, Oregon. The hole was rotary drilled to a depth of 487 ft., and was then cored at HQ size (3.8 in.) to a depth greater than 4,000 ft. Core recovery was about 95 percent.

The UURI Earth Science Laboratory will open file data for the hole and make available a split of the core for inspection in Salt Lake City on February 24, 1986. The data that will be available include:

1. GEO N-1 Well Data to 4,000'
   a) Drillers log
   b) Well summary including casing schematic
   c) Temperatures measured during drilling
   d) Temperature log (detailed), November 9, 1985
   e) Table of measured thermal conductivity

2. GEO N-1 Core Hole Lithologic Log

3. GEO N-1 Geophysical logs (Dresser Atlas) to 4,000', November 2, 1985
   a) Gamma ray
   b) BHC acoustic fraclog
   c) 4-Arm caliper log
   d) BHC acoustilog
   e) Geothermal temperature log
   f) Induction electrolog

4. Core Hole GEO N-1, Photographs 487' - 4,003'

Data for additional wells drilled under the Cascades Geothermal Drilling Program will be released as they become available.

A detailed lithologic log made from observation on the core by Michael Johnson of GEO-Newberry will be available. Rock names are tentative at the present time because no chemical or microscopic work has been done on the core. Basalt and basaltic andesite flows dominate the sections. There are a number of interspersed units of basaltic ash, pyroclastic deposits, and basalt dikes. Below about 3,100 ft., the section apparently becomes somewhat more felsic, as indicated by an increased gamma ray response. Flows or dikes tentatively classified as dacitic occur frequently below 3,200 ft. A number of clay-altered basaltic ash and latitic tuff units were found.

Copies of the Dresser Logs can be obtained from Rocky Mountain Well Log Service, P.O. Box 3150, Denver, CO 80201. Copies of all other data can be obtained from UURI by contacting Joan Pingree (UURI; 391 Chipeta Way, Suite C; Salt Lake City, UT 84108). A split of the core can be inspected at the UURI Sample Library by prior appointment arranged through Joan Pingree. Prices for data released from UURI are as follows:

1. GEO N-1 Well Data to 4,000'
   a) Drillers log - $ 9.50
   b) Well summary including casing schematic - $ 1.00
   c) Temperatures measured during drilling - $ .50
   d) Temperature log (detailed) - $2.50
   e) Table of measured thermal conductivity - $ .50

2. GEO N-1 Core Hole Lithologic Log - $ 8.50

3. Core Hole GEO N-1, Photographs 487' - 4,003' at $.50/print - about $200.00

Young Volcanic Reservoir Research

From the Five-Year Research Plan of the U.S. Geothermal Energy Program, 1986-1990, published by the U.S. Dept. of Energy.

Tests are underway to evaluate techniques for characterizing the hydrothermal reservoirs associated with young volcanic areas in the Cascades Range of California, Oregon, and Washington. This region is believed to contain a vast quantity of high-temperature fluids, possibly the largest identified liquid-dominated geothermal fields in the United States. However, these hot aquifers are overlain and masked by shallower, cooler aquifers. Calderas occur in many other areas besides the Cascades, and are responsible for some of the largest geothermal systems known (e.g., Yellowstone, Valles Caldera, and Long Valley).

Two 4,000-foot boreholes, cost-shared with industry, have been drilled outside the Newberry Crater in Oregon, where heat flow studies and other research are underway. Other bore-

holes are expected to be completed in 1986 in the Clackamas area and in the Santian Pass area, also in Oregon. This program is continuing with two more boreholes in FY 1987. Fluid samples, cores, and well logs will be analyzed by the group of investigators involved, and the research will be completed in FY 1988. The data obtained will be integrated into topical reports and case studies on each well. A detailed final report will be issued, workshops will be conducted, and proceedings published.

New Mexico

New Valles Caldera Project Underway

In September 1986, well VC-2A was completed at a depth of 1,737 meters in the Sulphur Springs area of Valles caldera in New Mexico. Sulphur Springs is the site of the caldera's most vigorous surface thermal activity (including H_2S emissions) and strongest surficial alteration, according to a report by Hulen and Nielson in the Transactions of the Geothermal Resources Council, vol. 10, Sept. 1986. It is also one of two areas of highest heat flow in the caldera (Swanberg, Tectonophysics, vol. 94).

As part of the VC-2A project, a special rotating head was developed for the drilling rig to control the emissions of H_2S. The head was co-developed by UURI, Los Alamos National Laboratory, Sandia National Laboratory, and a drilling company.

After the results from well VC-2A are evaluated, well VC-2B will be drilled. The project is funded by the U.S. Department of Energy Office of Basic Energy Sciences.

For further information, contact Dennis Nielson at (801) 524-3438.

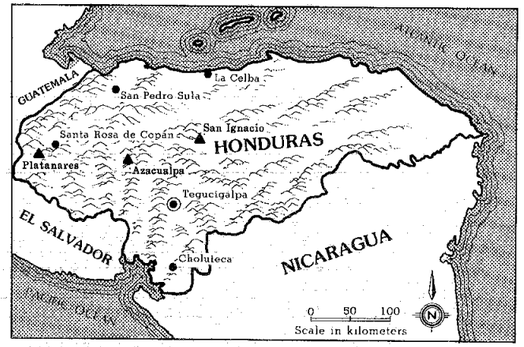
Central America

Geothermal Resources Assessed in Honduras

The following material is excerpted from a bilingual publication, "Geology of the Platanares Geothermal Site, Departamento de Copan, Honduras, Central America, Field Report," LA-10634-MS. Both English and Spanish translations of the report are included in this volume. The report was prepared by the Platanares Site Geology Team of G. Heiken, D. Eppler, K. Wohletz, W. Flores, N. Ramos, and A. Ritchie. The work was supported by the U.S. Agency for International Development. Copies of the report are available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA 22161. $11.95.

The investigation of the Platanares geothermal site is part of a joint Honduras (Empresa Nacional de Energia Electrica)/United States of America (Los Alamos National Laboratory and U.S. Geological Survey) assessment of the nationwide geothermal resource potential of Honduras. Geothermal resource evaluation is part of the Central American Energy Resources Project being sponsored by the U.S. Agency for International Development (see Hot Line, July 1985).

Platanares was selected as one of the initial sites for detailed study on the basis of previous geothermal reconnaissance work. The purpose of this study was to make a preliminary evaluation of the geothermal system to determine if further investigations using geochemical and geophysical



Map of Honduras. Promising geothermal sites are marked with triangles.

techniques were needed to site an exploration well. Once the well has been tested, Honduras will have the information it needs to make decisions on the use of this geothermal resource for electric power generation.

Platanares is a small mining village located about 16 km west of Santa Rosa de Copan in western Honduras. The geothermal site, which is situated on the west side of the Quebrada del Agua Caliente, has many hot springs flowing from numerous faults that cross the area.

All hot springs in this area lie along fractures that represent upward extensions of faults in the older rocks at depth, which provide the main conduit for thermal waters to rise to the bottom of the Quebrada del Agua Caliente. The total area over which these springs emanate is about 0.2 km^2. Many of the springs in the area were found to be boiling. From the estimated flow rates of boiling water, the thermal output is calculated to be between 0.7 and 1.0 megawatts. This conclusion was checked by measuring and comparing stream temperatures above and below the hot spring area. From this 16°C temperature difference, it was concluded that there is a significant contribution to the thermal energy increase in the stream from submerged springs that emerge in the stream bed. Therefore, it appears that the thermal energy input to the stream is several megawatts.

The results of the geologic studies indicate that Platanares' potential for development as an electrical power source is extremely good. This preliminary conclusion must be substantiated and refined through additional studies. Geophysical investigations are needed to further define the subsurface geology and fracture system. Several wells should be drilled to a depth of several hundred meters to measure thermal gradients. This will allow the calculation of the geothermal potential of the Platanares site and will indicate whether further development of the site is warranted.

Central American Energy Resources Project, Year Two

by Susan F. Hodgson

"Presently, most electricity in Central American countries comes from hydroelectrical generation," said Bob Hanold,* a Program Manager for Los Alamos National Laboratory. "Hydroelectrical projects are very expensive to build and can't be augmented in increments small enough to match small changes in a country's electrical needs.

"On the other hand," Hanold added, "geothermal energy is less expensive to develop and can be increased in a much more flexible manner. The Central American countries have large, untapped, high- and low-temperature geothermal resources. Thus, geothermal energy could become a significant contributor to future electrical generation in Central America."

* NOTE: Hanold was in San Salvador during the October 1986 earthquake. He says that damage from the quake was very great, but quite localized. The geothermal power plant at Ahuachapan was not harmed. The plant continues to supply about 20-25 percent of San Salvador's electrical needs.

The Central American Energy Resources Project is designed to help the countries of Honduras, Costa Rica, El Salvador, Guatemala, and Panama develop their geothermal resources. Auxiliary project goals are to increase economic development and employment in Central America; to provide a scientific basis for the private sector to develop natural resources; and to provide scientific training to in-country scientists, engineers, and technicians. The energy resources project began in March 1985 (see the July 1985 edition of the Geothermal Hot Line).

Honduras is the focus of many project activities. "Geothermal features in Honduras are not as evident as those in El Salvador and Costa Rica," said Hanold. Honduran geothermal resources resemble the basin and range geothermal systems in Nevada."

"In fact," said Lisa Shevenell of Los Alamos, "the total dissolved solids, pH range, and major element chemistry of Platanares and Beowawe are very similar."

"Preliminary investigations have been made of six sites in Honduras in conjunction with the United States Geological Survey and the Honduran electrical authority," said Hanold. "We believe that the sites at Platanares, Azacualpa, and San Ignacio have potential for the generation of electricity from geothermal brines."

"The thermal system at Platanares appears to be liquid-dominated," he added. Numerous geochemical samples have been collected from hot and boiling springs along the Quebrada del Agua Caliente at Platanares, and geothermometer temperature estimates are in the 225°C range. Los Alamos will drill a 500-meter temperature-gradient well at Platanares by the end of November 1986.

The resources in Honduras are being investigated cooperatively by scientists from the United States and Italy.

Platanares Geothermal field is seen on the hillside in the foreground of the photo. The lighter, diagonal line through the trees (foreground, photo center to photo right) is the Quebrada del Agua Caliente. Steam is rising along the Quebrada. Photo by R. Hanold.

The Italians will drill temperature-gradient wells at San Ignacio by the first of 1987.

"Central America looks to California as a model of how to develop high-temperature geothermal resources while protecting the environment," Hanold concluded. "Today, all of us at Los Alamos are impressed with the mutual cooperation we receive from our Central American counterparts. We are comfortable working together."

Funds for the Central American Energy Resources Project are issued to Los Alamos National Laboratory by the United States Agency for International Development. Los Alamos is assisted in parts of the project by staff from the U.S. Geological Survey.

For further information, contact Robert J. Hanold, Program Manager, Earth and Space Sciences Division, Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545. Phone (505) 667-1698.

Geothermal Power Plant for Costa Rica

Reprinted from the September 19, 1986 issue of the Central America Report, Inforpress Centroamericana, Guatemala City, Guatemala.

Costa Rican President Oscar Arias' government presented a loan proposal to the legislature that would require Costa Rica to guarantee two loans: one for US $74 million (over 20 years with a 6-year grace period and variable interest rates - currently at 8.75 percent yearly) from the International Development Bank; and the other from Japan's Overseas Economic Corporation Fund in the amount of 13,547 million yen (25 years, 7 years' grace, 4.75 percent annual interest). The money would go to construct the power plants at Miravalles Geothermal field.

The bill is currently awaiting its third reading in the assembly, easily passing the first two readings by simple majority; however, a two-thirds vote is needed for final passage (38 of the 57 members).

Mexico

Mexican Update

During his talk at the 1986 meeting of the Geothermal Resources Council, Dr. Paul Kruger provided the following information on Mexican geothermal development. He said that the purchase by Mexico of the 55 megawatt Baca power plant in New Mexico has been finalized. The power plant will go to Los Azufres Geothermal field.

The five, 5-megawatt wellhead generators at Los Azufres Geothermal field are successful, and Mexico has ordered 10 more. Five of the wellhead generators will go to Los Azufres, 3 to Los Humeros, and 2 to La Primavera Geothermal fields.

CFE-EPRI* Survey of Mexico's Geothermal Electric Power Capacity**

1986 Survey Data

	Megawatts of Electricity in Year				
	1985 Actual	1986 Firm	1990 Est.	1995 Est.	2000 Est.
***Announced	425	645	745	1000	1000
Probable Additions	--	--	--	155	320
Total Possible	425	645	745	1155	1320

* Comision Federal de Electricidad and the Electrical Power Research Institute

** This table is reprinted from a report by Paul Kruger and Vasel Roberts, presented at EPRI's Tenth Annual Geothermal Conference and Workshop, June 1986.

***Announced: Stated publicly or through Public Utilities Commission-type reports.

Probable: Based on successful demonstration of technology for cost-effective use of liquid-dominated resources.

Possible: Based additionally on anticipated growth of electricity demand and favorable regulatory treatment.

Mexico and PG&E Discuss Energy Issues

The impact of the September 1985 earthquake on Mexico's public utility systems was one of the topics of an information and technology symposium that Pacific Gas and Electric Company co-sponsored with five Mexican agencies.

PG&E's co-sponsorship of the May 1986 meeting in Cuernavaca, Mexico, with Mexican electrical, petroleum, and other energy agencies marked a first for a U.S. corporation.

The Symposium on Development in Energy Systems included sessions on new gas and electric technologies and operations, research, and resource planning. Daniel E. Gibson, PG&E vice president - fuel resources, said, "The meetings promoted research and information exchanges between our company and appropriate Mexican agencies and businesses that will help foster greater understanding between both countries."

"More importantly, the symposium helped establish contacts with key Mexican officials, agencies, and business executives that could facilitate negotiations for the purchase of natural gas, oil, and electricity from Mexico should that need arise."

PG&E does not currently buy energy from Mexico, but has had information-exchange agreements with key govern-

ment agencies for some time. The utility also cooperated with Mexican agencies after the 1985 earthquake and provided five computers to the relief efforts in Mexico City.

The symposium's Mexican co-sponsors were the Mexican Petroleum Institute, the Electrical Research Institute of Mexico, Pemex (the nationally owned petroleum company), the Federal Electricity Commission (operator of Mexico's electric system), and the Office of the Secretary of Energy, Mines, and State-Owned Industries.

Gibson said he hoped this would be the first of a series of symposiums co-hosted by U.S. and Mexican energy agencies.

Geoscience Information in Mexico

by Nelly Benveniste

Reprinted from Blueline, published by the Association of Earth Science Editors

Distributing Information

In general terms, there is not enough dissemination of Mexican publications, and one of the main reasons is that they are usually written in Spanish. Papers sometimes have English abstracts that can be included in foreign data bases. In other cases, the authors prefer to publish in foreign periodicals, especially in the United States, where the papers have a much wider dissemination.

Foreign publications constitute 95 percent of the books, periodicals, indexes, and other bibliographic materials in Mexican libraries. Most are from the United States, and other come from England, France, Germany, and other countries.

The National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología, CONACYT) offers the Consulting Services to Data Bases (Servicios de Consulta a Bancos de Información, SECOBI), which acts as a liaison to multidisciplinary foreign data bases. Through this service, all the institutions with terminals are connected, thus saving considerable time and money.

With regard to the geosciences, we have access to the Tulsa data base and GeoRef through the ORBIT system; to GeoRef and Geoarchives through DIALOG; and to Geode, in France, through QUESTEL. This allows for historical bibliographic research, retrieval of references, and selective dissemination of information profiles. Selective dissemination of information is offered to institutions, universities, government agencies, and libraries that deal with the geosciences but do not have terminals.

Technical Literature

Some Mexican institutions that do research and development also consult for and manage geoscience libraries for industry and government. For example, the Institute of Electrical Research (Instituto de Investigaciones Eléctricas, IIE) operates the Federal Commission of Electricity (Comisión Federal de Electricidad, CFE); and the Mexican Petroleum Institute (Instituto Mexicano del Petroleo, IMP) operates the National Petroleum Company (Petroleos Mexicanos, PEMEX).

The Institute of Electrical Research has an in-house network, with seven terminals that handle the centers where the Federal Commission of Electricity technicians do operational work, mainly on geology, geothermal energy, and power plants. The Mexican Petroleum Institute has a geophysical data processing center for field information supplied by PEMEX. The researchers in this center are designing programs that will gradually replace imported software.

Computer Data Bases

The National University of Mexico and the Mexican Petroleum Institute have computerized their libraries' collections to speed bibliographic retrieval. This information can be consulted on paper printouts or through terminals connected to the library. The Mexican Petroleum Institute also has a statistical data base of the world's oil industry, based on analyses of both foreign and domestic publications. These data can be consulted on paper or through computer terminals. Besides these services, there are inter-institutional cooperation programs, such as the Collective Catalogue of Periodicals of Mexico, which is multidisciplinary.

The Geological Institute (Instituto de Geología) of the National University of Mexico and the Council of Mineral Resources (Consejo de Recursos Minerales) are compiling geological information on Mexico. The Geological Institute has already started to computerize this information, using its own software programs. The Council of Mineral Resources is still compiling information included in unpublished technical reports. The ultimate purpose is to establish an electronic information center of geoscience data.

The current trend is to integrate all the geological information on Mexico so that there will eventually be a domestic computerized information network. This network will allow communication between data bases so that results of current research may be shared.

Mexican Geothermal Services Available From IIE

The Instituto de Investigaciones Electricas (IIE), a decentralized organization of the Mexican Government, was founded by the Mexican Government in 1975 as a public scientific research center. Its goals are to enhance the scientific and technological development of Mexican electrical energy industries, which include geothermal energy. IIE is funded by the Mexican Government and the Comisión Federal de Electricidad. Today, IIE offers its services and technological expertise to the geothermal community at large.

IIE personnel are available for aid in collecting samples and analysing geothermal and geological materials, measuring petrophysical properties of drill cores under simulated reservoir conditions, and performing reservoir engineering tasks. Process and equipment testing and plant engineering assistance are also offered.

For further information, contact Daniel Walls, International Technological Promotion Dept., Apdo. Postal 47-5, 62000 Cuernavaca, Morelos, Mexico. Telex (No. 173380 INIEME).

Spain

Spain and the U.S. Sign Bilateral Agreements for Energy Research and Development

On June 6, 1986, two Spanish Governmental agencies and the U.S. Department of Energy (DOE) signed a Memorandum of Understanding for cooperation in energy research and development. One memorandum was signed by the DOE and the Spanish Junta de Energia Nuclear, and the other with the Spanish Instituto Geologico y Minero.

The agreements are the first bilateral arrangements between the two nations in the area of energy R&D.

The memoranda continue a series of bilateral agreements which, along with R&D agreements under International Energy Agency (IEA) auspices, are part of the DOE's effort to stimulate and expand international collaboration in energy research and development.

The fields of cooperation covered by the Memoranda of Understanding include:

- Nuclear energy, including nuclear safety technology,
- Radioactive waste management,
- High energy physics,
- Renewable energy, including biomass and geothermal,
- Coal and gas technologies,
- Environmental impact of energy technologies, and
- Energy conservation.

Cooperative mechanisms may include exchanges of scientists, engineers, and other specialists for participation in research, development, analysis, design, and experimental activities conducted in research centers, laboratories, and engineering offices.

Exchanges also may be conducted in such areas as samples, materials, instruments, and testing components. Exchange of information will be conducted through seminars or other meetings held alternately in the United States and Spain. Joint projects in which each nation agrees to share the work and/or costs will be the subject of separate agreements.

For further information about the DOE program, contact Constance Stuart, DOE-HQ, Washington, D.C.; (202) 252-4750.

As a further note, according to the June 16 issue of the Oil and Gas Journal, the Spanish government will spend $400 million for alternative fuels research and development between 1986 - 1992. By investing in such research, including geothermal research, Spain is hoping to lessen its dependence on oil by about 3 percent by 1992. About $300 million will be spent by governmental institutions directly. The rest will be used to assist projects in the private sector.

Japan

Japanese Geothermal Project

In a joint venture, Magma Power Company, Geothermal Resources Inc., Nippon Steel Corporation, and Mitsui and Company will work together to explore and develop the geothermal potential at Mt. Komogatake on Hokkaido in Northern Japan.

According to the Magma Power Company 1985 Annual Report, the New Energy Development Organization of the Japanese government has investigated the area's geothermal potential.

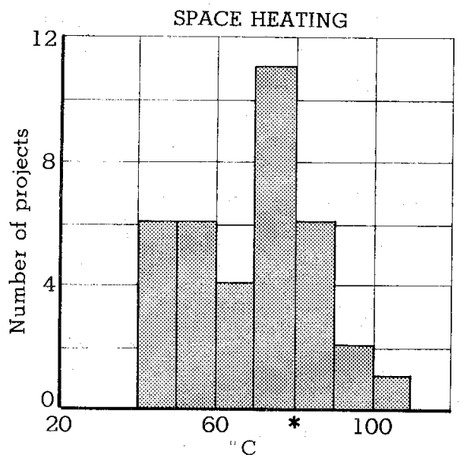
An Analysis of Direct Uses of Geothermal Energy in Japan

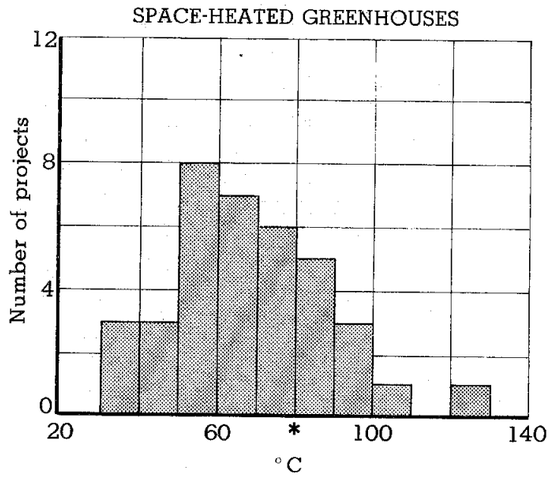
by Dr. Mitsuru Sekioka
Professor of Geoscience
Institute of Geosciences and Astronomy
The National Defense Academy
Hashirimizu, Yokosuka
Kanagawa 239, Japan

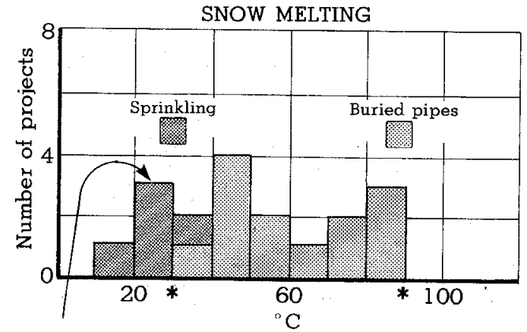
Three basic parameters in low-temperature geothermal production were analysed: inlet water temperatures, flow rates, and load factor. The study was undertaken with data collected through December 1985. As of that date, the total low-temperature, geothermal heat load in Japan is estimated at 84.39 megawatts, thermal.

Dr. Sekioka arranged material in this article in a poster display at the 1986 Geothermal Resources Council Annual Meeting. He has kindly allowed the Geothermal Hot Line to publish the information.

Inlet Temperature

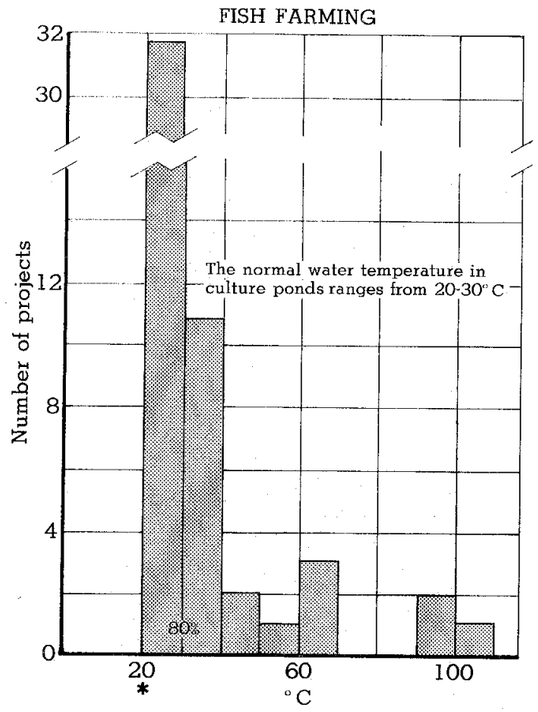




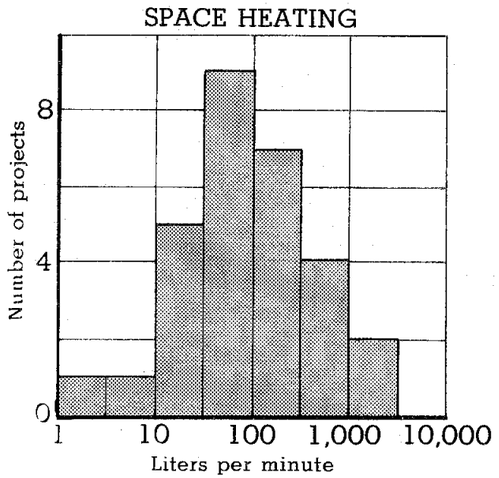


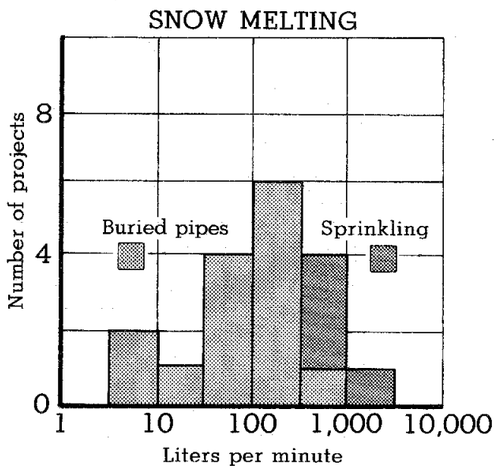
(Fog may form when water heated to this temperature is sprinkled on the roads. Such fog makes driving difficult.)

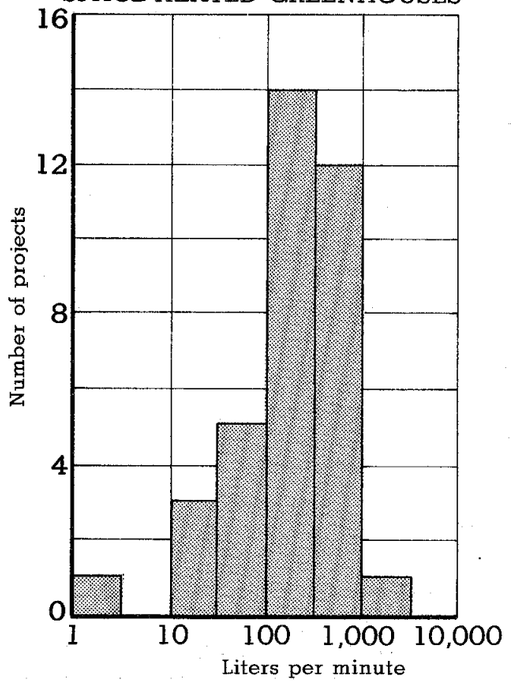
*The asterisk indicates the Lindal temperature. A Lindal diagram is at the end of the article.

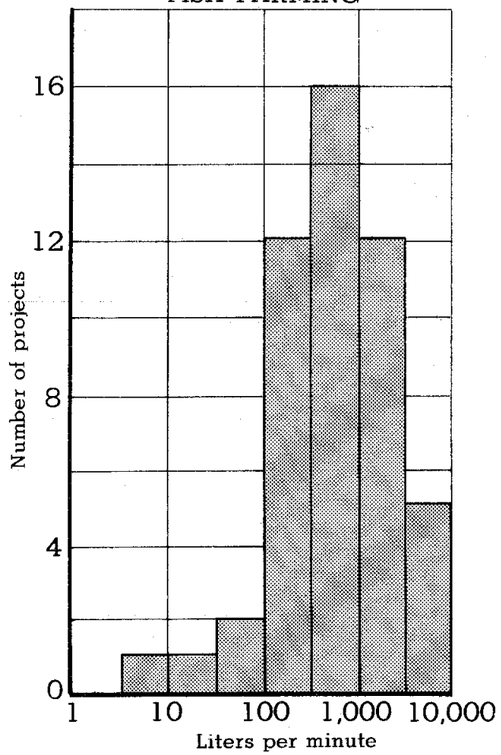


Flow Rate

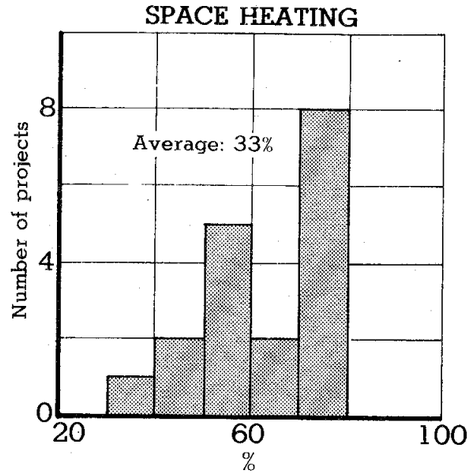


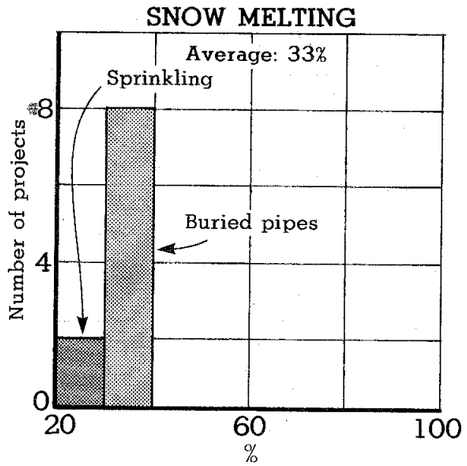


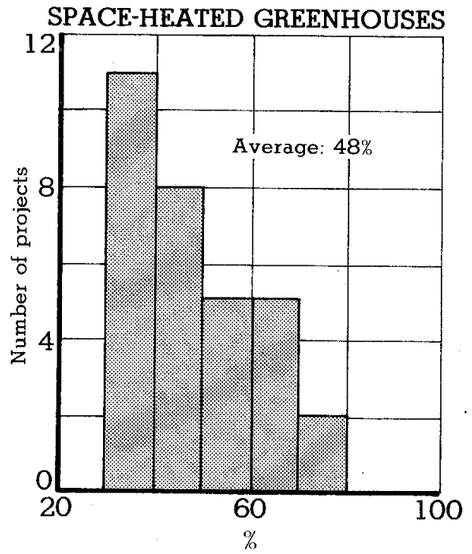




Load Factor







FISH FARMING
Average-100%
(Note: Almost all fish farms operated the entire year.)

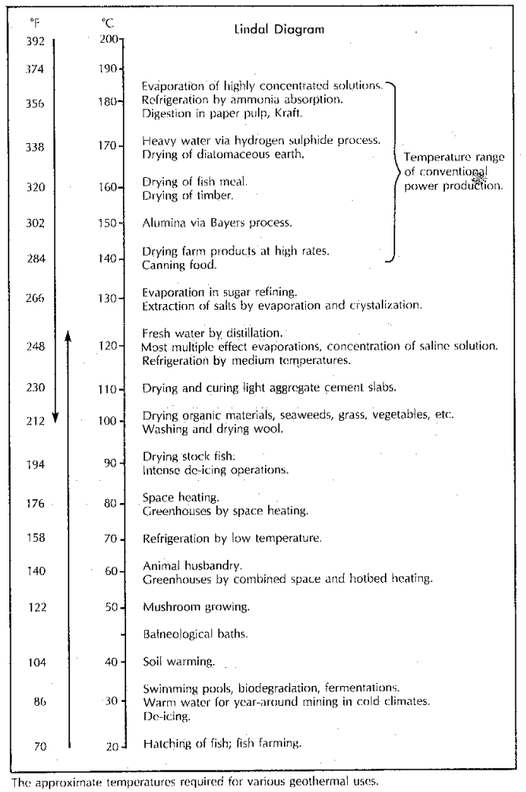
SUMMARY

	Temperature	Flow rate	Load factor
Space heating	H	L	M-H
Greenhouses	M	M	L
Snow melting (b.p.)	M-H	M	L
Snow melting (s.)	L	H	L
Fish farming	L	H	H

H:high M:moderate L:low

AN ESTIMATE FOR GEOTHERMAL ENERGY FOR DIRECT USES IN JAPAN, ANNUAL MEAN VALUE (MWt).

As of December 1985	N. Japan	C. Japan	W. Japan	Total
Space heating	10.28	9.49	4.23	24.00
Greenhouses	7.81	0.34	19.34	27.49
Snow melting	1.73	0.59	0.09	2.41
Fish farming	7.87	6.20	13.42	27.49
Process heating	0.62		0	0.62
Leisure facilities	1.56	0.69	0.08	2.33
Stock breeding		0.04	0.01	0.05
Total	29.87	17.35	37.17	84.39



The approximate temperatures required for various geothermal uses.

For further information on low-temperature uses in Japan of geothermal energy, see Dr. Sekioka's article in the December 1984 issue of the Hot Line, and his article in volume 10 of the Geothermal Resources Council Transactions, published in 1986.

Statistics

1985 Geothermal Well Statistics*

During 1985, the Geothermal Section of the Division of Oil and Gas issued 309 reports on proposals to drill, rework, and abandon geothermal wells in the state, an increase of 42 reports from 1984. New wells accounted for 108,299 meters drilled in 1985, a decrease from the 166,222 meters drilled in 1984.

The number of wells that were completed as production wells decreased to 43 wells, from 55 drilled in 1984. The number of inspections increased to 1,886 in 1985, from 1,191 in 1984.

* Federal geothermal activity not included.

BLM Geothermal Activities

From the BLM, 1985 Annual Report

California leads the world in geothermal energy production. About one-third of that production comes from federal lands leased by the Bureau of Land Management (BLM).

In 1985, these lands produced 430 megawatts of power. The 12 producing, federal geothermal leases in California, encompassing 69 producing wells, generated $13 million in royalties in 1985. In addition, $7.6 million was collected from geothermal bonuses and rents during the year. Half of these revenues went to the State of California.

There are currently 310 federal geothermal leases in California covering some 547,216 acres. Most of the potential or attractive federal geothermal resources are already under lease, which explains the lower number of new leases issued during 1985. The industry's emphasis is now shifting to exploration and development.

The BLM geothermal program is conducted under the Geothermal Steam Act of 1970. Lands with known geothermal resources are designated as Known Geothermal Resource Areas (KGRA's) and are leased competitively. Areas not within KGRA's may be leased to the first qualified applicant on a first-come, first-served basis. All leases are for 10-year terms. Diligent exploration of leases is required.

The BLM issued 59 geothermal drilling permits during 1985, more than double the amount issued in 1984. The BLM approved 17 geothermal plans of operation, up from 4 in 1984, along with four geothermal unit agreements. Other program efforts focused on inspecting operations to ensure compliance with laws, regulations, and lease terms; and monitoring production so proper royalty payments can be assessed.

During 1985, about 9,376 acres were leased within KGRA's, and high bonus bids of $323,851 were received. An additional 57,321 acres were leased noncompetitively.

The 1986 outlook for geothermal production on federal lands in California

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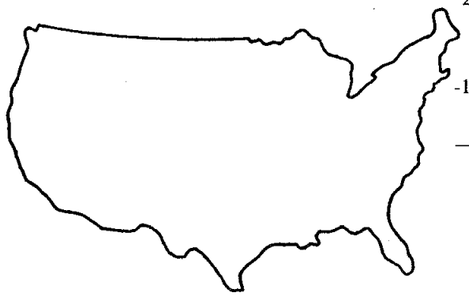
Public Land Statistics
Prepared by the BLM

PUBLIC LAND STATISTICS

—NATIONAL STATISTICS—



2.3	billion acres in the United States:
	1.934 billion in continental United States
	378 million in Alaska
	4 million in Hawaii
-1.568	billion acres to states as they joined the Union (for schools, railroads, etc.)
732	million acres (32%) remain under nationwide Federal jurisdiction:
	192 million managed by Dept. of Agriculture (26%)
	29 million managed by military bases & facilities (3%)
	506.6 million managed by Dept. of Interior (70%), including:
	72.2 million (11%) by National Park Service
	84.6 million (12%) by Fish & Wildlife Service
	342.0 million (46%) by Bureau of Land Management (including 160 million—22%—in Alaska)
	7.8 million (1%) by other Interior agencies
	4.4 million managed by other Federal agencies

—CALIFORNIA STATISTICS—

101.5	million acres in California, including inland water:
-45.8	million under Federal management:
	17.1 million surface, 47 million subsurface acres—BLM
	20.4 million—U.S. Forest Service
	8.3 million—other Federal agencies
- 3.8	million managed by State Government in California
51.9	million California acres in private ownership, etc.

*1984 statistics

looks bright. Four new power plants are scheduled to come on line during the year on federal leases in The Geysers Geothermal field and Imperial Valley. These plants will generate an additional 296 megawatts of electricity from federal geothermal resources. Development of proven geothermal resources at Coso Hot Springs in the Mohave Desert will increase steadily. Exploration activity in northeastern California is expected to rise, as well.

BLM Geothermal Leases Issued

	1983	1984	1985
Competitive Leases	17	9	1
Noncompetitive Leases	15	52	33

For further information, contact the BLM, California State Office, 2800 Cottage Way, Room E 2841, Sacramento, California 95825.

1986 EPRI Utility Geothermal Survey

At the Electric Power Research Institute's (EPRI) Tenth Annual Geothermal Conference and Workshop in June 1986, Paul Kruger and Vasel Roberts presented the results of a survey of North American Electric Reliability Council utilities. The survey was undertaken to provide a basis for forecasting the growth in geothermal capacity through the year 2005.

The survey results follow. The data for Hawaiian utilities are grouped with those for California. The Gulf States are comprised of the states with the potential resources of geopressured thermal and natural-gas deposits. The northwestern states include data from British Columbia and Alberta in Canada. Mexican electrical production in Northern Baja California (including Cerro Prieto Geothermal field) are included.

For the second year, the installed capacity in the western states showed a marked increase in additional geothermal power plants coming on-line. The significant increase from 21 megawatts outside of the California-Hawaiian region to 67 megawatts firm for 1986 indicates an acceleration in the commercial development of liquid-dominated geothermal resources in the United States. Although individual utility data are not given in the survey, it is noted that several of the new plants are designed to operate with rotary separator turbines or binery cycles, which should accelerate the development of the more numerous moderate-temperature geothermal resources in the western states.

Capacity (megawatts of electricity) by Year

	1985 Actual	1986 Firm	1990 Est.	1995 Est.	2000 Est.	2005 Est.
Southwest						
*Announced	51	67	131	159	159	159
Probable			181	247	530	730
Possible			284	597	1180	1845
Northwest						
Announced	0	0	0	0	0	0
Probable			0	20	40	60
Possible			0	35	65	145
California-Hawaii						
Announced	1899	2048	3319	3509	3509	3509
Probable			3655	4439	5403	6003
Possible			4189	5434	7108	8058
Gulf States						
Announced	0	0	0	0	0	0
Probable			0	0	0	0
Possible			1	5	10	20
Total Forecast						
Announced	1950	2115	3450	3668	3668	3668
Probable			3836	4706	5973	6793
Possible			4474	6071	8353	10068

*Announced: Either publicly or through Public Utilities Commission-type reports.

Probable: Based on successful demonstration of technology for cost-effective use of liquid-dominated resources.

Possible: Based additionally on anticipated growth of electricity demand and favorable regulatory treatment.

Electrical Transmission

Fourteen Utility Companies Form New Electric Power Pool

Southern California Edison Company has joined with at least 13 other utilities extending from Oregon to West Texas to form a new power pool to achieve further economies of power production and electric service.

The new Western Systems Power Pool (WSPP), which could be in effect as early as January 1987, should benefit more than 10 million customers served in an area of far western states comprising some 30 million people, according to Edison's Executive Vice President David J. Fogarty.

"The WSPP should provide more efficient use of existing generation and transmission facilities through better coordination of operations and power exchanges," Fogarty explained.

By this agreement and through use of a central computer network, enhanced power exchanges can occur between electrical systems from three geographic regions, including the Northwest, California, and the Southwest--each with a different customer load and different types of generation resources.

"Using this diversity of resource and customer need provides a natural opportunity to better coordinate the marketing of power," Fogarty said. "The anticipated benefit of WSPP is that the aggregate cost of supplying electricity to millions of Western customers will be reduced."

Participants expected to ratify the WSPP Agreement include eight investor-owned utilities: Arizona Public Service Company, El Paso Electric Company, Pacific Power & Light Company, San Diego Gas & Electric Company, SCE, Pacific Gas and Electric Company, Portland General Electric Company, and Public Service Company of New Mexico.

The remaining utilities are public entities, including the Sacramento Municipal Utility District, Northern California Power Agency, Arizona Electric Power Cooperative, Salt River Project, California Department of Water Resources, and the federal power marketing agency, the Bonneville Power Administration.

Membership will continue to be open to any interconnected electric utility that owns or has entitlement to generation facilities.

The WSPP Agreement is subject to regulatory approval by the Federal Energy Regulatory Commission.

Small Power Producers

PURPA Analyzed in a DOE Report

According to the Department of Energy (DOE) publication, Information News Summary, the authors of a DOE-released report concluded that the Public Utility Regulatory Policies Act (PURPA) has met the Congressional objective of promoting cogeneration and small power production, but has caused some economic inefficiencies and raised consumer rates.

The report, "Emerging Policy Issues in PURPA Implementation," was intended to focus debate on several important provisions of PURPA that have given rise to economic inefficiency.

Such a debate could lead to suggestions for improved implementation. For instance, one of the report's recommendations is that utilities be allowed to seek bids from PURPA generators and sign contracts with such generators based on market pricing.

The study was commissioned as part of the DOE's continuing interest in ensuring an adequate and efficient electrical infrastructure for the United States.

In addition to the implementation problems, the study found other problems with the Act itself, including size limitations on small power producers, fuel limitations on qualifying facilities, and the prohibition on utility ownership of qualifying facilities.

The study lists a range of possible changes in FERC regulations or in the law itself that would achieve greater economic efficiency while continuing to encourage economic development of qualifying facilities.

Copies of the report are on file at the DOE Public Reading Room in Washington, D.C., and at the Energy Information Center of the DOE San Francisco Operations Office, 1333 Broadway, Oakland, CA 94612, (415) 273-4428.

For further information, call David Devane, DOE-HQ, Washington, D.C., (202) 252-8325.

PUC Suspends Standard Offer No. 2

On March 19, 1986, the California Public Utilities Commission temporarily suspended Standard Offer No. 2, which, unlike Standard Offers 1 and 3, contains fixed and levelized payments for electricity that utilities purchase from small power producers and cogenerators, called Qualifying Facilities (QF's). Under PUC orders, Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas and Electric Company are required to execute standard offer, electrical sales contracts with QF's. The requirement comes from the Public Utilities Regulatory Policy Act and the PUC's alternative generation program (OIR 2).

Since the inception of the alternative generation program in 1982, more than 13,000 megawatts of QF capacity have been placed under Standard Offer No. 4 contracts and Standard Offer No. 2 contracts with firm capacity payments. The PUC has already suspended Standard Offer No. 4, because a recent PUC investigation revealed a risk that payments to QF's under that standard offer may be too high.

In a sworn affidavit, the Public Staff Division* member responsible for monitoring the OIR 2 program for the PUC recommended that the PUC immediately suspend Standard Offer No. 2 for a number of months until the capacity payments are revised by the PUC. "Should the capacity payments remain unrevised," he said, "ratepayers are at risk of substantial overpayments in future years."

The PUC took emergency action because "...Any time the Commission indicates its interest in adjusting prices or otherwise modifying standard offers, a disproportionate number of QF's request to sign the standard offer under scrutiny. This increases the ratepayers' exposure to higher capacity costs, and, based on past experience, disrupts the development of final standard offers."

The PUC is expected to hold a hearing as soon as possible to allow all parties to comment on whether the suspension should be continued until the PUC decides on the appropriate capacity price adjustment for all standard offers.

* The Public Staff Division is part of the PUC staff. It is comprised of economists, engineers, financial examiners, researchers, and other analysts who represent the long term interests of all the utility customers.

The CEC Evaluates QF Electrical Generation

The following information is from the California Energy Commission (CEC).

As demand for electrical energy grows and old existing plants are retired, new supply resources must be developed. These resources may consist of additional conservation programs, new utility power plants, utility contracts for resources located outside California, and supplies from independent (nonutility) power developers, often termed Qualifying Facilities (QF's).

The independent power industry is a growing and important part of California's electricity resource base. Not all QF projects are required to come before the CEC for siting approval, since the Commission's regulatory authority extends only to thermal-electric projects greater than 50 MWe. Consequently, the CEC must estimate electricity supply likely to be available from projects not subject to its jurisdiction before it can decide whether or not projects that do come before it for licensing are needed.

The California Energy Commission staff has prepared papers on the following topics:

- Staff Paper on Utility-Owned Projects or Imports from other Utilities Likely to be Available
- Staff Paper on Criteria for Determining Utility-Owned Resources and Interutility Transactions Likely to be Available
- Staff Report on Nongeneration Resources Likely to be Available: Anticipated Building and Appliance Standards
- Draft Final Contractor Report on Projections of Qualifying Facilities Likely to be Available, 1986-1997
- LTBA Data Base Structure and Definitions (for Nonutility Power Projects)
- LTBA Data Base (85-ER-6)

These documents have been docketed and are available for public inspection at the California Energy Commission's Docket Unit, 1516 Ninth Street, Sacramento, California, 95814, or copies may be obtained by calling the Assessments Division at (916) 324-3167.

Research & Development

Geothermal Research Group Formed

A geothermal research group has been formed under the auspices of the geothermal industry and the U.S. Department of Energy (DOE). The group will select and sponsor geothermal research projects with a high probability of yielding short-term benefits to the geothermal industry in the areas of reservoir performance and energy conversion technology. The DOE has allocated $250,000 in FY 86-87 for sharing the costs of projects selected by the group.

Presently, legal representatives for industry and the government are looking over the organization's charter. Once this step is completed, the group will solicit and review proposals for projects. Companies will be awarded contracts to undertake the projects that are selected. The research group will set up a committee to monitor project progress and to disburse funds.

Chairman for the group's first meeting, held in September 1986 at the Palm Springs GRC conference, was Chandler Swanberg of GEO Operator Corporation, (415) 349-3232.

High-Temperature Acoustic Televiewer Developed

The Geothermal Drilling Organization (GDO) was formed in 1985 at the request of the geothermal industry. Through the GDO, the industry and the U.S. Department of Energy (DOE) share the costs of geothermal wellbore research and development projects.

In FY 1986, under a contract awarded by the GDO, Squire-Whitehorse Inc., a logging-tool manufacturer in San Diego, built and tested two acoustic televiewers reliable in temperatures up to 275°C. Field testing and use are planned for FY 1987. Half of the televiewer cost was borne by the DOE, 25 percent by UNOCAL, and 25 percent by GEO Operator Corporation. These two companies will have exclusive use of the tool for 2 years.

Studies will be begun by the GDO on a downhole air turbine and a downhole foam lost circulation control system in FY 1986, with evaluations completed in 1987.

Patents for products developed under GDO contracts are issued to contractors for commercial use. GDO members receive royalty-free licenses for patented equipment.

A paper about the televiewer, "Determination of Borehole Shape by Inversion of Televiewer Data," has been published by Peter Lysne in The Log Analyst, vol. 27, p. 64-71 (1986). The abstract follows:

"Recently the acoustic borehole televiewer has emerged as a logging tool for the determination of the in-situ stress state of deformable geologic formations. This determination is contingent upon an accurate evaluation of the shape and spatial orientation of a deformed borehole. Such information can be obtained from televiewer caliper data if the associated inversion process is mathematically and experimentally justifiable. Considered herein is the inversion problem for an off-centered tool in an elliptical borehole. This nonlinear problem is solved using Marquardt's Algorithm, and a singular value decomposition of the sensitivity matrix is used to evaluate its justifiability. The inversion problem was found to be justifiable for elliptical boreholes with aspect ratios greater than 1.02. Furthermore, when experimental difficulties are considered, it may be advantageous to purposely off-center applicable to the understanding and design of logging tools in general."

California Well Sample Repository

Rock samples from California wells are available for study at the California Well Sample Repository, California State College, Bakersfield. Presently, repository personnel are finishing the fourth edition of the catalog describing cores and cuttings available for study at the facility. The catalogues are scheduled for release on October 1, and will cost $3.00.

Besides maintaining core samples, the repository tries to gather additional records about the samples, such as well histories, electric logs, mud logs, core descriptions, micropaleo data, core analyses, and publications such as maps and reports.

For further information, contact the curator, Jack Tucker, California State College, Bakersfield, 9001 Stockdale Highway, Bakersfield, CA 93309, phone (805) 833-2324.

DOE Technology Transfer Program

The U.S. Department of Energy's Geothermal Energy Program includes many technology transfer projects. The following list of technology transfer activities is reprinted from the "Geothermal Five-Year Research Plan," published by the DOE.

The DOE Geothermal Energy Program tries to disseminate to the geothermal industry the scientific and engineering advances made by the DOE R&D activities. Some of the main technology transfer methods include:

- Dissemination of Program plans, bulletins, summaries, and high-value technical reports through the DOE Technical Information Center, the DOE CAREIRS energy information program, and the National Technical Information Center, Department of Commerce.
- Dissemination of computer codes through the National Energy Software Center at Argonne National Laboratory.
- The monthly Bulletin, the annual conference, and topical workshops of the Geothermal Resources Council, the major U.S. geothermal energy development association. These technical programs cover the gamut of geosciences and conversion concerns of the geothermal industry.
- Special programs and projects conducted by the geothermal technology program of the Electric Power Research Institute, the R&D association of U.S. public electric utilities. These programs emphasize electric conversion technology.
- Special technical reports on the economics of the Heber binary conversion system verification experiment. These indicate what the costs of a follow-on plant, stripped of its special research and testing features, would be if industry were to construct it without federal involvement.

The Program also supports industry-oriented technical workshops and provides technical information to new users of geothermal technology through:

- Idaho National Engineering Laboratory: heat cycle research and geopressured geothermal resources
- Lawrence Berkeley Laboratory: reservoir technology and brine injection
- Pacific Northwest Laboratory: brine/chemistry treatment and chemical instrumentation
- Stanford University: geothermal reservoir engineering
- Los Alamos National Laboratory: hot dry rock drilling, instrumentation, and heat extraction
- University of Texas at Austin, Center of Energy Studies: geopressured energy technology
- University of Utah Research Institute: geophysics and geothermal well-log interpretation
- Geo-Heat Center, Oregon Institute of Technology: Geothermal direct heat conversion technology

Additionally, the Program provides forums for joint cooperation in geothermal technology such as:

- The Geothermal Drilling Organization, formed at industry's request, provides joint DOE/industry effort for geothermal related R&D.
- Joint industry/DOE funded programs such as Drilling String Dynamics and advanced drilling technology.
- Academic and industrial technical review panels in wellbore technology and reservoir engineering.

R & D Ideas Sought by DOE

The U.S. Department of Energy (DOE) announced in July 1986 that small businesses are invited to submit proposals under the fifth annual solicitation of the Small Business Innovation Research Program (SBIR). The program implements the Small Business Innovation Development Act of 1982.

Every year, under SBIR, federal agencies list topic areas where research and development is needed. This list is distributed to small businesses, who, in turn, propose to the federal government how the projects should be undertaken. The federal government evaluates the proposals, and about 100 businesses are chosen to undertake the work each year. In FY 1987, no geothermal topic areas were included, but these may be part of next year's list.

The objective of SBIR is to encourage small, innovative firms to participate in federally funded research and development projects. In this manner, federal R & D needs are met, small business growth is encouraged, and the economy grows.

SBIR applicants with successful proposals can receive up to $50,000 for initial work, with up to $500,000 awarded in a second phase for the ideas judged to have the highest potential of meeting SBIR program objectives.

The FY 1987 Program Solicitation was due August 15. The closing date for receipt of proposals is November 3. For a copy of the 1987 topic areas or to place your name on the mailing list for future years, write the SBIR Program Manager, U.S. Dept. of Energy, Washington, D.C. 20545. For further information, contact Jeff Sherwood, (202) 252-5806.

DOE Geothermal Research

The following geoscience and conversion research projects are part of the U.S. Department of Energy's Geothermal Energy Program. Research areas, current project status, and five-year R&D objectives are described. The material is reprinted from a draft of the "Geothermal Five Year Research Plan, FY 1986-1990," published by the Department of Energy.

RESEARCH STATUS AND OBJECTIVES

A. GEOTHERMAL GEOSCIENCES RESEARCH

Research Area	Current Status	Five-Year R&D Objectives
Hydrothermal Reservoir Research	Modeling of reservoir characteristics and behavior prediction, including behavior of injected and recharge fluids, has been developed and is used by industry, but improvements	Develop improved understanding of characteristic and prediction methods to provide advanced reservoir management tools and reduce uncertainty in behavior prediction by a factor of

Research Area	Current Status	Five-Year R&D Objectives
	are needed. Some exploration techniques have been developed and tested, but adequate techniques for locating and mapping resources are lacking, as are adequate geologic models of geothermal systems.	five. Develop improved surface and subsurface exploration and mapping techniques and improved geologic models in various geologic environments. Improve the success ratio of drilling by a factor of at least two.
Geopressured Production Research	Geopressured reservoirs shown to be saturated with natural gas. Existence of very large reservoirs proven. Scale control in early stage of development. Reservoir drive mechanisms poorly understood.	Complete the development of predictive model for geopressured reservoir performance based on long-term flow testing to produce better estimates of longevity and recoverability factors. Test scale-control technology. Complete economic analysis of total energy recovery system, including natural gas, electricity, and direct heat applications.
Hot Dry Rock Reservoir Research	Scientific feasibility established. Hydrofracturing of deep, hot crystalline rock shown to be volumetric rather than planar. Microseismic monitoring and delineation in use for fracture detection and reservoir monitoring. High-temperature downhole instrumentation developed.	Complete the development of microseismic technology for locating and characterizing deep hydraulic fractures in stressed crystalline rock. Establish methodology for creation of high surface-area heat exchanger system in deep hot rock geologic environments. Test system at Fenton Hill, N.M., to characterize heat extraction characteristics of the reservoir; complete HDR systems study to evaluate viability and economics.
Magma Energy Extraction Research	Scientific feasibility has been shown for extracting energy from magma bodies. Energy extraction rate is the controlling uncertainty in potential use of magma.	Study target site for magma loop experiment, initiate technology for drilling and heat extraction, test all equipment at interim site, and prepare for major drilling program to start in late 1980's to attempt to access a major magma body.

B. GEOTHERMAL CONVERSION RESEARCH

Hard Rock Penetration Research	Hard, fractured, hot formations result in geothermal well costs up to four times those of petroleum wells. The program has strong industrial interaction and extensive technology transfer of drilling and well completion technologies	Shift program emphasis to highest program priorities including solutions to lost circulation problems, advanced borehole instrumentation for temperatures over 300°C (572°F), new drilling and coring concepts, and continued strong industry interactions. Supplement wellbore research with laboratory studies of two-phase flow in the wellbore.

Research Area	Current Status	Five-Year R&D Objectives
Heat Cycle Research	Advanced heat cycles are under research or pilot scale. Materials, heat exchangers, and condensers are under test and development.	Complete the design and development of components, materials, and systems concepts capable of reducing binary plant costs by 30%.
Binary Conversion Technology Verification	Heber 45 MWe binary plant built in California's Imperial Valley under a DOE/industry cooperative program is now operating.	Perform experimental operation. Test several advanced concepts for in-line control instrumentation. Complete economic evaluation of Heber plant and follow-on improved designs.
Hybrid Geothermal Electric Systems	Third well to serve Honey Lake hybrid plant is being drilled, and work on plant design is underway.	Complete preconstruction activities of Honey Lake hybrid plant, if quality of third well warrants and appropriate cooperative arrangements can be set up.
Materials	Materials developed by previous R&D to withstand the geothermal environment -- e.g. high temperature elastomers and polymer concretes -- are in commercial production.	Continue to address specific material needs that will provide more cost-effective performance of components and systems.
Low-Enthalpy Systems	Twenty-six field projects have been initiated, of which eight were terminated due to technical problems. Sixteen are in operation and one is under construction. Contractual difficulties on the final system are being resolved.	Complete all previous direct heat projects. Publish final reports and economic analyses of direct heat applications of geothermal energy; support expansion of Boise, Idaho, District Heating System.
Geopressured Conversion Research	Wells are ready for tests of electric power production with systems combining methane, thermal, and hydraulic energy. No direct heat use to date.	Complete EPRI experiments on gas-engine plus binary-cycle power plant. Encourage industry use of wells for direct heat tests.
Hot Dry Rock Conversion Research	Reservoir and surface installations are in preparation for heat extraction tests.	Conduct long-term tests. Make site available to industry for larger-scale electric plant.
Magma Conversion Research	Scientific feasibility verified. Long Valley magma body selected and drill site provided by industry.	Complete lab studies evaluating heat transfer mechanisms. Drill into Long Valley magma chamber for extraction research. Provide sufficient information to allow industry-based economic review.

New Owner for Biphase Technology

Transamerica Delaval has liquidated Biphase Energy Systems and sold the biphase energy technology to Mitsui Engineering and Shipbuilding Co., Ltd. Douglas Energy Co. is Mitsui's United States agent for geothermal projects.

With this change in ownership comes a new marketing strategy. Now the company is emphasizing the sale of geothermal power plants utilizing all available steam technologies. Systems benefitting from higher efficiency can include a biphase turbine and a steam turbine in tandem. The biphase turbine will be built by Mitsui under license to Transamerica Delaval. The steam turbine will be built by Mitsui under license to BBC (Brown-Boveri), a Swiss company.

In other cases, Douglas Energy Company will offer double- and single-flash steam turbine systems. A range of plant size from 5 megawatts to 55 megawatts is available, with the smaller plants being factory preassembled.

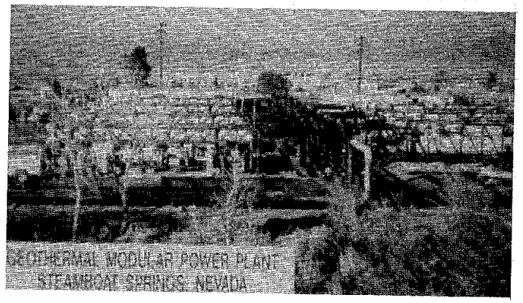
For further information, contact Walter Studhalter, Manager of Geothermal Sales, Douglas Energy Co., 2800 Airport Ave., Santa Monica, Ca. 90405; (213) 398-5647.

Ormat Geothermal Power Plants

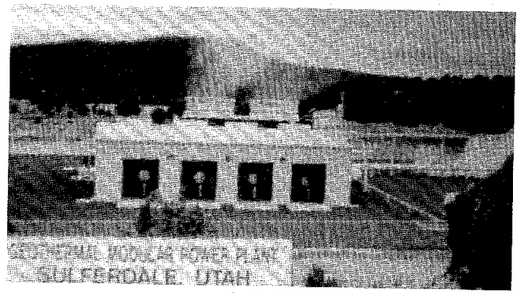
Ormat Geothermal power plants are based on the Rankine power cycle. They are designed to generate up to 1.2 megawatts of electrical power per module from low-temperature, liquid-dominated or low-pressure steam geothermal resources. As many modules as desired may be combined at a geothermal site.

Unlike conventional steam turbines, the Ormat power plant unit uses a low-boiling temperature motive fluid, not water, and operates on a subcritical cycle. The organic Rankine cycle has the advantage that at moderate and low temperatures, it will have efficiencies higher than those of a steam cycle, and will require no superheating.

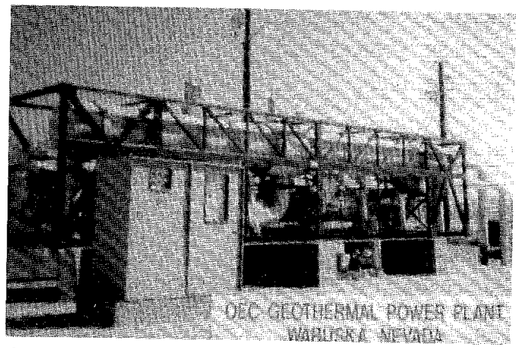
Each power plant module is a self-contained system, including the power and control panels. An Ormat power plant module is designed to operate automatically in an unattended mode.



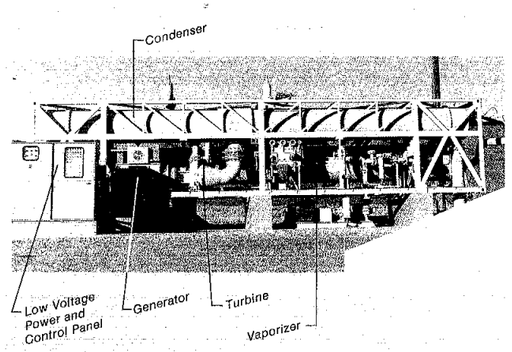
Ormat power plant.



Ormat power plant.



Ormat power plant.



An Ormat power plant module.

Analysis of Power Cycles for Geothermal Wellhead Conversion Systems

(Reprinted from the March 1986 EPRI Journal.)

To help utilities match optimal power cycles to specific geothermal sites, the Electrical Power Research Institute (EPRI) completed a study of different working fluids and power cycles in the range of representative resource and condensing temperatures. Five state-of-the-art flashed and binary power cycles were considered. In all, 240 combinations were analyzed to identify the most efficient cycles and working fluids for each resource temperature range.

Results of the study, reported in Analysis of Power Cycles for Geothermal Wellhead Conversion Systems (AP-4070), reveal the effect of geothermal fluid temperature on power generation. (The publication is available for $47.50 from the EPRI Technical Information Division, P.O. Box 10412, Palo Alto, CA 94303.)

For comparison, at 400°F (204°C), the binary cycle produced 24 Wh/kg of fluid, while at 600°F (316°C), it could produce nearly three times as much electricity. Conversely, at 200°F (93°C), less than one-tenth as much power can be produced. The results clearly show that optimized binary cycles outperformed one- and two-stage flash cycles at all temperatures, and double-flash cycles had an advantage of 30 percent over single-flash systems.

Using the information contained in this study to estimate net power, thermal efficiency, and key state points of specific cycles for specific sites can save utilities time and money in initial engineering studies.

For further information, contact Evan Hughes at (415) 855-2179.

Finance

California Tax Income May Be $123 Million From Geothermal Steam Sales Tax

The California State Board of Equalization announced in late spring 1986 that the board has issued sales tax billings to sellers of geothermal steam amounting to more than $123 million.

The Sonoma County Superior Court ruled recently in the case of the County of Sonoma v. the State Board of Equalization (SCSC No. 122141) that sales of steam produced at geothermal plants at The Geysers generally are subject to sales tax, contrary to earlier opinions by the Board.

Since the city and county portions of the sales tax equal 1¼ percent, local governments could realize more than $25 million in revenue if the superior court decision stands.

Although the board is appealing that decision, it is complying with the court's requirement that it issue Notices of Determination promptly to prevent the statute of limitations from expiring while the decision is appealed.

For further information, contact Glenn Bystrom, Principal Auditor, California State Board of Equalization, Sacramento, California 95814; (916) 445-0387.

Geothermal Grant and Loan Program for Local Jurisdictions

The California Energy Commission (CEC) is into the seventh funding cycle for the Geothermal Grant and Loan Program for Local Jurisdictions. Through this program the CEC distributes funds received by the state from federal geothermal leases to local jurisdictions for projects relating to geothermal development. The CEC has approximately $2.5 million available for this funding cycle.

The CEC will accept applications for any of the following types of projects:

1. Planning projects for large- and small-scale power plants and direct-use development;

2. Projects to assess and develop geothermal resources; and

3. Projects to monitor and/or mitigate impacts of existing geothermal development.

The CEC encourages joint proposals by public and private entities and proposals that will result in direct economic benefits to a community.

The CEC will provide a grant, loan, or a contingent award for projects funded through this program. Grants or loans are awarded to projects that do not directly produce revenue or energy savings. These include planning, impact mitigation, and certain resource development projects such as resource assessment and exploration activities. The decision to receive a grant or loan is entirely up to the applicant.

Contingent awards will be made for resource development projects that produce revenue or energy savings. Once the project is completed and has been sufficiently tested, the contingent award will become a loan. These loans will have a maximum term of six years, an interest rate of four percent, and a principal that cannot exceed 80 percent of the total project cost. Applications for contingent awards must include a detailed feasibility study.

The schedule for the seventh funding cycle is as follows:

Workshops - August 19, 26, and 28, 1986

Preapplication Required Deadline - October 20, 1986

Results of Preapplication Evaluation - November 17, 1986

Final Application Deadline - January 31, 1987

Energy Commission Approval - March 1987

Legislative Approval - July 1987

Important revisions have been made to the Application Manual for this funding cycle. Please obtain a new copy if you have not already done so. Also, all applicants are required to submit a preapplication. Questions regarding this program should be directed to Michael Smith, California Energy Commission, 1516 Ninth Street, MS 43, Sacramento, California 95814, (916) 324-3502.

Nineteen projects were funded in the sixth funding cycle of the Geothermal Grant and Loan Program. A list of the projects follows.

1. Great Basin Air Pollution Control District — $40,250

Develop baseline air quality data for the Long Valley area near Mammoth Lakes and install permanent air quality and meteorological monitoring stations in the Coso Hot Springs and Long Valley KGRAs.

2. Town of Mammoth Lakes (Mono County) — $220,000

Establish a project management position for the City's district heating project and conduct additional feasibility and resource assessment activities begun under a fourth round grant.

3. Lake County Air Pollution Control District — $46,382

Install an air quality monitoring station to develop baseline data for the Kelsey Creek drainage.

4. Lake County (Health Services Department) — $83,900

Install an off-site ground water monitoring network on lands adjacent to the geothermal waste disposal site along Butts Canyon Road.

Lake County (Planning Department) — $10,100

Develop a grass seed mix for use in revegetating serpentine soils exposed during cut and fill operations in The Geysers area.

Lake County (Health Services Department) — $14,000

Computerize the data management for the water quality monitoring system in The Geysers geothermal area.

5. Lake County Flood Control District — $30,000

Conduct a preliminary assessment of ground and surface water supplies and the demand for water by geothermal and non-geothermal users.

6. Napa County — $140,000

Purchase an emergency response vehicle specifically for the geothermal-related traffic through Napa Valley and provide training in hazardous waste materials handling and cleanup.

7. Sonoma County — $12,000

Purchase a four-wheel-drive vehicle to allow efficient access to The Geysers for monitoring and permit compliance at geothermal power plants.

8. Surprise Valley Joint Unified School District — $16,297

Install equipment to monitor the performance and reliability of the space and water heating systems installed in the elementary and high schools with a fourth round grant.

9. San Bernardino County — $171,587

Complete the resource assessment program in the town of Twentynine Palms begun under a fourth round grant by drilling and testing up to three exploratory wells.

10. Indian Springs School (Shasta County) — $8,573

Install equipment to monitor the performance and reliability of the space and water system installed under a fourth round grant.

11. Lassen County — $62,000

Prepare a resource management plan for the Wendel area and conduct a preliminary resource assessment of the Long Valley area.

12. Modoc County — $70,000

Complete the resource assessment program in the town of Alturas begun under a fourth round grant by conducting geophysical surveys, geothermometer analyses, and drilling one exploratory well.

13. City of Susanville (Lassen County) — $42,250

Design and install a space-heating system for the City's shop and extend the distribution line of the City's district heating system to connect the shop and municipal pool.

14. City of Calistoga (Napa County) — $450,000

Design and install a district heating system for the downtown area based on resource data developed under a fourth round grant.

15. San Bernardino County (Facilities Management Department) — $528,306

Design and install a space-heating system for the nine-building County Government Center. This complex will be hooked up to the City of San Bernardino's geothermal district heating system.

San Bernardino County (Facilities Management Department) — $120,443

Design and install a space-heating system for the County Garage building. This is part of a complex including the Jail and Sheriff's buildings, the GSA and EPWA buildings. The latter two are being retrofitted under fourth round grants. The entire complex will be hooked up to the City of San Bernardino's geothermal district heating system.

San Bernardino County (Facilities Management Department) — $162,496

Retrofit the utility plant for the Jail and Sheriff's buildings.

Energy Technologies Advancement Program Underway

The State of California is reducing the risk of developing new, innovative energy technologies under its Energy Technologies Advancement Program (ETAP), which is administered by the California Energy Commission (CEC).

ETAP, established by Assembly Bill 3897 (Naylor-Rosenthal), was sponsored by Governor Deukmejian and the Energy Commission. ETAP's overall goal is to fund energy projects that make energy technologies more efficient and cost-effective and to develop new alternative sources of energy. It offers loans and monies for research contracts to both the private and public sectors. The program's original funding was $6 million. The Governor also proposed an augmentation of $2.2 million, which has been approved by both houses of the Legislature.

ETAP loans are available to cofund existing energy technologies that de-

monstrate increased cost-effectiveness or energy efficiency of the technology. Risk sharing contracts are available only for projects that do not produce net positive cash flows, and that use energy technologies or variations of energy technologies that are not yet commercially available. In the case of projects producing net positive cash flows, loans are required. Loans are offered at an 8 percent annual interest rate, and must be repaid within 90 months. No more than 25 percent of the total available funds can be allocated to an individual project.

As a companion to project funding, technical assistance may be available. The CEC may provide private technical consultants to assist local jurisdictions with their funded projects. These technical consultants would be available to assist with problems encountered to help ensure project success.

In the first funding round, 38 applications were received, and the Energy Commission's Research, Development, and Demonstration Committee has recommended six projects from private companies for initial funding. They are:

- ARCO Solar Inc. - research for $925,000 to develop thin film photovoltaic modules that capture the sun's rays and convert them into electricity. If technological goals are achieved, a large prospective market will develop in California and the primary barrier impeding widespread use of photovoltaics--its high cost--will be directly confronted.

- Alternative Energy Institute - research for $135,000 to collect and concentrate sunlight via a series of tracking parabolic dishes (heliostats), and transfer collected light into the interior of a commercial building. If the demonstration project can be applied to commercial buildings throughout the state, a reduction in energy use and air pollution would result.

- Solar Turbines Inc. - research for $52,500 to test a liquid fuel injection system that results in a reduction of oxides of nitrogen in cogeneration gas turbines. Air quality requirements are one of the major barriers to the use of cogeneration technologies in many areas of the state.

- Pacific Gas and Electric Company - research for $500,000 to establish a program for field testing and evaluating emerging new photovoltaic technologies. The program will include the installation of large utility-scale systems in two different test locations--one near Davis and the other in the Carriso Plains.

- San Diego Gas and Electric Company - research contract to test and evaluate the largest geothermal power plant in the world using an organic rankine cycle steam turbine, which uses a fluid with a lower-than-normal boiling point, thereby potentially generating electricity with lower temperature heat. Located in the Imperial Valley of Southern California, the Heber project will demonstrate the technical and economic feasibility of generating electricity from moderate temperature geothermal resources, which are distributed throughout California.

- Fayette Manufacturing Corporation - loan contract for $1,250,000 to demonstrate the technical and economic feasibility of a new heat cycle process called the Kalina Cycle. It has the potential to increase significantly the efficiency of existing power plants by using an ammonia/water mixture as the steam turbine working fluid, rather than water alone.

The CEC will soon be releasing a Request for Proposals (RFP) for both private and public organizations for the second-round ETAP solicitation. Through ETAP, the CEC will be funding advanced energy projects that will increase the energy efficiency and/or cost-effectiveness of existing energy technologies, or help to develop new, cost-effective alternative sources of energy. Projects must include hardware development. Nearly any type of advanced energy technology, including those based on energy production, energy conservation, load management, energy recycling, etc., is eligible for ETAP funding. A small business preference is given to qualifying bidders. At least $4 million is available in fiscal year 1986-87 to cofund qualifying proposals.

In general, projects can qualify for one of two types of ETAP funding: loan funding or research contract funding. Up to 80 percent of the total project cost can be funded by an ETAP loan. For research contracts, ETAP can fund up to 50 percent of the total project cost.

The tentative schedule for the second-round ETAP solicitation is: Request for Proposals released, November 14, 1986; proposals due, January 19, 1987; and projects begin, June 30, 1987.

To receive ETAP announcements and/or a copy of the Request for Proposals, send your name and address with the request to the California Energy Commission, 1516 Ninth Street, MS 999, Sacramento, California 95814.

Contact Michael Botham or George Simons at the CEC, (916) 324-3472, if you would like to discuss possible energy project ideas or the ETAP program.

DOE Geothermal Resources Development Fund

The U.S. Department of Energy (DOE) Geothermal Loan Guaranty Program was established by Congress in 1974 to encourage and assist the private and public sectors to accelerate the use of geothermal resources by minimizing the lender's financial risk; to develop a financial service infrastructure to ultimately provide financing of geothermal projects without federal assistance; and to promote competition by encouraging new entrants into the marketplace.

The total loan guaranty authority is $500 million. The DOE announced in a March 1, 1982 Federal Register notice that pending applications for guaranties exceeded the remaining loan guaranty authority of the DOE. Therefore, the department suspended the acceptance of applications for new projects and proceeded to process those on hand.

Several of the guaranteed projects have proven to be very successful. The Geothermal Food Processors vegetable dehydration plant at Brady Hot Springs, Nevada, is operating profitably and repaying its loan in a timely manner. The Oregon Trail Mushroom plant at Vale, Oregon, is a semi-automated mushroom-growing facility that will yield about 3.2 million pounds of mushrooms a year.

The Northern California Power Agency, an electric-power agency, represents eleven municipal members and a rural electrification agency. By successfully floating municipal bonds to refinance its first 100 megawatt power plant at The Geysers, it repaid its guaranteed loan 24 years early.

Basic Steps in Researching Foundations

Reprinted from a circular distributed by the California State Library.

1. Develop a broad list of potential funding sources.

   a. What foundations have funded projects similar in some way to yours? Use the FOUNDATION GRANTS INDEX (bimonthly and annual).

   b. What foundations have indicated having a general interest in your subject area? Use the "Fields of Interest Index" in THE FOUNDATION DIRECTORY.

2. Narrow your list by eliminating foundations whose own restrictions rule out funding of your project.

   Use the entries in THE FOUNDATION DIRECTORY. Note if a foundation will give in your geographic area, for the type of support you need, etc.

3. Research in depth the foundations that are left on your list. Consider subject interest, geographic preference, range of giving, type of support, type of recipient, and application deadline dates.

   Identify those foundations whose interests match your needs most closely. The most important information to check is the complete list of each foundation's recent grants. Use the foundation's own published annual report - about 500 foundations provide them.

4. Before getting in touch with a foundation, examine all the information available on its application guidelines and requirements.

Additional aid in assessing foundations may be obtained from the Foundation Center, a national service organization founded and supported by foundations to provide a single, authoritative source of information on foundation grants. For further information, call (800) 424-9836.

Legislation

Legislative Update

1985 California Legislation

AB 899 Hauser
Geothermal resources: leases: reduced royalty.
Approved by the Governor - 7/30/85.
Chapter 434, Effective - 1/1/86.

The Geothermal Resources Act requires prospecting permits and resulting leases for the development of geothermal resources to include, among other things, a royalty of not less than 10% of gross revenue, as specified. However, the act authorizes the State Lands Commission to waive, suspend, or reduce the rental or minimum royalty for lands included in a permit or lease if the commission determines that the action is necessary or beneficial to promote development.

This bill also authorizes the commission to issue leases for direct heat application of geothermal resources for nonelectrical purposes for a royalty of less than 10% of gross revenue if it determines that such a royalty would be in the best interests of the state.

AB 1960 Waters, N.
Geothermal revenues.
Approved by the Governor - 9/19/85.
Chapter 800, Effective - 1/1/86.

Under existing law, geothermal revenues deposited in the Geothermal Resources Development Account in the General Fund are continuously appropriated for specified purposes. The Controller is required to disburse 40% of these geothermal revenues to the county of origin, and the State Energy Resources Conservation and Development Commission is authorized to expend 30% of these geothermal revenues to provide grants or loans to local jurisdictions. Revenues disbursed to counties of origin and grants or loans made to local jurisdictions are required to be expended for specified purposes.

This bill authorizes the revenues disbursed to counties of origin to also be expended for repair and maintenance of capital assets, including roads, bridges, aviation facilities, buildings, and parking areas, thereby making an appropriation.

The bill also makes additional clarifying changes.

Appropriation: yes.

AB 1666 Hauser
Geothermal power plant development.
Approved by the Governor - 9/19/85.
Chapter 807, Effective - 1/1/86.

The Warren-Alquist State Energy Resources Conservation and Development Act provides for site certification of geothermal power plants by the State Energy Resources Conservation and Development Commission.

This bill requires the commission to include, in its written decision approving a geothermal site and related facility, findings on whether there are sufficient commercial quantities of geothermal resources to operate the proposed facility for its planned life. The bill prohibits the commission from certifying a geothermal site and related facility unless it finds that the geothermal field dedicated to the proposed power plant is reasonably capable of providing geothermal resources in sufficient commercial quantities to supply the power plant over its planned life.

1986 California Legislation

SB 1890 Doolittle
Geothermal revenues.
Approved by the Governor - 7/16/86.
Chapter 400, Effective 7/17/86.

Existing law continuously appropriates 40% of the geothermal revenues deposited in the Geothermal Resources Development Account to the Controller for disbursement to counties of origin for expenditure for specified purposes.

This bill authorizes the revenues disbursed to counties of origin, including unencumbered revenues already accumulated, to be expended for construction of jail facilities, thereby making an appropriation.

The bill permits revenues disbursed to counties of origin to be expended for purposes unrelated to geothermal development only in counties where there is no new geothermal development and substantial planning, maintenance, and environmental mitigation of geothermal development has been achieved.

The bill declares that it is to take effect immediately as an urgency statute.

Appropriation: yes.

SB 2315 Deddeh
Sales and use taxes, exemptions, steam and geothermal steam, brines, and heat.
Approved by the Governor - 7/17/86.
Chapter 420, Effective - 7/17/86.

Existing California Sales and Use Tax Law imposes a state sales or use tax on the sale or use of tangible personal property in the state, unless the sale or use is exempted from that tax. It exempts exhaust steam, waste steam, heat, or resultant energy produced in connection with cogeneration technology, as well as water when delivered to consumers through mains, lines, or pipes.

This bill specifies for purposes of that exemption that water includes steam and geothermal steam, brines, and heat.

Under existing law, counties and cities are authorized to impose local sales and use taxes in conformity with state sales and use taxes. Exemptions from state sales and use taxes enacted by the Legislature are automatically incorporated into the local taxes. Section 2230 of the Revenue and Taxation Code provides that the state will reimburse counties and cities for revenue losses caused by the enactment of sales and use tax exemptions.

This bill declares legislative intent that the provisions of the act

do not constitute a change in, but are declaratory of, the existing law.

This bill takes effect immediately as a tax levy.

AB 4268 Waters, N.
Geothermal resources, revenues. Did not reach the Governor's desk for consideration.

This bill would increase the percentage of geothermal revenues dispersed by the Controller to counties of origin with a population of less than 50,000 from 40% to 50%, thereby making an appropriation.

Federal Legislation

The following material is a federal legislative status report, with information on the status of geothermal legislation from the 99th United States Congress, current as of September 10, 1986. It was compiled by Senate LEGIS.

H.R. 418: SPONSOR- Quillen; SHORT TITLE- Geothermal Energy Control Act of 1985; LATEST ACTION- 4/25/85 Executive Comment Requested from Interior.

H.R. 843: SPONSOR- Seiberling; LATEST TITLE- A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes; LATEST ACTION- 1/30/85 Referred to House Committee on Ways and Means.

H.R. 1315: SPONSOR- Latta; LATEST TITLE- A bill to amend the Internal Revenue Code of 1954 to clarify the definition of geothermal energy, and for other purposes. LATEST ACTION- 2/27/85 Referred to House Committee on Ways and Means.

H.R. 2001: SPONSOR- Heftel, et. al; (CROSS REFERENCE BILLS EXIST); SHORT TITLE- Renewable Energy and Conservation Transition Act of 1985; LATEST ACTION- 4/4/85 Referred to House Committee on Ways and Means.

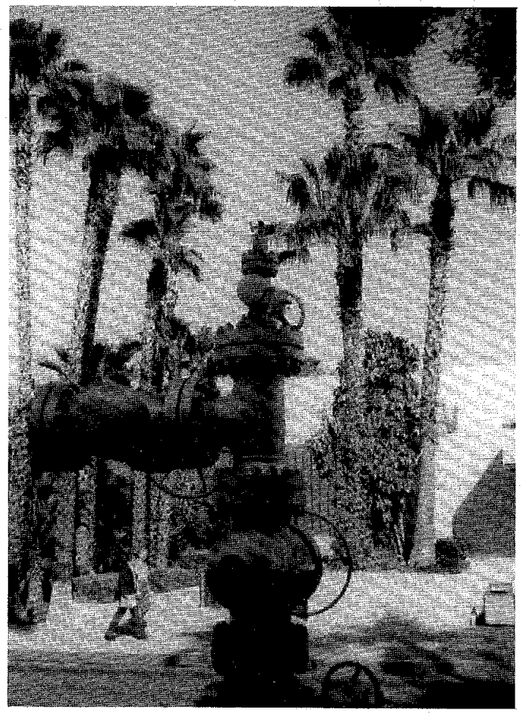
H.R. 2057: SPONSOR- Frank; LATEST TITLE- A bill entitled: "The Energy Tax Reform Act of 1985". LATEST ACTION- 4/16/85 Referred to House Committee on Ways and Means.

H.R. 2498: SPONSOR- Lujan; SHORT TITLE- Alternate Energy Production Tax Act of 1985; LATEST ACTION- 5/14/85 Referred to House Committee on Ways and Means.

H.R. 4101: SPONSOR- Heftel, et. al; LATEST TITLE- A bill to amend the Internal Revenue Code of 1954 to extend the energy investment credit for geothermal property until July 31, 1986. LATEST ACTION- 2/3/86 Referred to House Committee on Ways and Means.

H.R. 1220: SPONSOR- Hatfield, et. al; (CROSS REFERENCE BILLS EXIST); SHORT TITLE- Renewable Energy and Conservation Transition Act of 1985; LATEST ACTION- 5/31/85 Committee on Finance requested executive comment from OMB, Treasury Department, Energy Department.

Geothermal Associations



Outside the 1986 GRC Annual Meeting. Photo by S. Hodgson.

Geothermal Energy - A Milestone Year

"The 1986 Geothermal Resources Council Annual Meeting was our 10th such meeting," said Dave Anderson, GRC Executive Director. "Today, the GRC has 1,200 members, including 108 corporate members. Our membership is still growing at a slow, steady rate."

"Three hundred sixty people attended our 1986 meeting, and there were 85 exhibitors," Dave added. "Keynote speaker for the meeting was Robert E. Daniel, President of Chevron Resources."

Dave explained that the GRC Foundation is a new GRC project. The foundation, now with a $6,000 balance, will be divided into a general fund (called the pioneer fund), a publication fund, and an educational fund.

Hardbound copies of the 1986 Transactions for the meeting are available. These include 80 papers on geothermal energy divided under the following categories: direct use; drilling technology; geochemistry; geology; geophysics; institutional, legal, and environmental; power generation; reservoir engineering; reservoir testing; and Salton Sea Scientific Drilling Project.

Copies of the transactions are available for $44, including postage and handling, from the Geothermal Resources Council, P.O. Box 1350, Davis, California 95617-1350.

Japan Geothermal Energy Association

The Japan Geothermal Energy Association was established in June 1960 as a sole umbrella organization for the private geothermal industries in Japan.

Members of the association include representatives from electric power companies, developers, mining companies, steel industries, contractors, heavy industries, civil engineering companies, and trading firms.

The purpose of the association is to expand the scientific technology used to develop geothermal energy, and to promote the use of geothermal energy.

Association projects include:

1. Surveys and studies of scientific technology relating to the development and utilization of geothermal energy;

2. Collection, introduction, and exchange of data and information, both foreign and domestic, on scientific technology relating to the development and utilization of geothermal energy;

3. Dissemination of an enlightenment on scientific technology relating to the development and utilization of geothermal energy;

4. Publication of "CHINETSU" (the Journal of the JGEA) and of articles relating to geothermal energy; and

5. Other such services as are necessary for accomplishing the objectives of the JGEA.

Motoo Higo is the Executive Managing Director of the JGEA. The association can be reached at 1-7-1, Yuraku-cho, Chiyoda-ku Tokyo, Japan 100. The telephone number is 03-212-7885.

Conferences

The Peace Corps and Geothermal Energy

Is there a place for geothermal specialists in the Peace Corps? Perhaps.

The Peace Corps is interested in recruiting professional people in the fields of mathematics, science, and engineering. Applicants must be United States citizens. There is no upper age limit. Medical and legal requirements must be met.

For further information, contact a local Peace Corps recruiting office or write the Peace Corps, Recruitment Office, 806 Connecticut Avenue, N.W., Washington, D.C. 20526. The toll-free number is (800) 424-8580, ext. 93.

Hawaii Volcano Observatory Diamond Jubilee and Symposium on How Volcanoes Work, Hilo, Hawaii, January 19-23, 1987

A symposium titled "How Volcanoes Work" will be held in celebration of the Diamond Jubilee of the Hawaii Volcano Observatory. The symposium is sponsored by the U.S. Geological Survey, the American Geophysical Union, the Geological Society of America, the International Association of Volcanology and Chemistry of the Earth's Interior, the World Organization of Volcano Observatories, the University of Hawaii, and the Hawaii Institute of Geophysics.

Major symposium topics will include Conceptual Models of How Volcanoes Work, Internal and Deep Structure of Volcanoes, Dynamics of Eruptions, Assessing Volcanic Hazards, and Reducing Volcanic Risk.

Lecture-discussion sessions and poster sessions will be offered. Field trips will be held before, during, and after the symposium, on the islands of Oahu, Hawaii, and Maui.

For further information, write Robert Decker, U.S. Geological Survey, MS 910, 345 Middlefield Road, Menlo Park, California 95025.

Twelfth Annual Workshop on Geothermal Reservoir Engineering. Stanford, California, January 20-22, 1987.

The workshop, sponsored by the Stanford Geothermal Program, brings together researchers, engineers, and managers involved in geothermal reservoir studies and developments. It provides a forum for prompt and open reporting of progress and exchange of ideas. For further information, contact John R. Counsil, Petroleum Engineering Dept., Mitchell Bldg., Room 360, Stanford University, Stanford, California 94305.

Proceedings of past Geothermal Reservoir Engineering workshops may be ordered from the Stanford Department of Petroleum Engineering, Stanford University, Stanford, California 94305. Volumes 1 - 6 and 7 - 10 are sold in set form only. Prepayment must accompany this order.

	USA	Foreign
Vols. 1-6 (1975-1980)	$100.00	$125.00
Vols. 7-10 (1981-1985)	80.00	105.00
Volume 11 (1986)	35.00	45.00

International Symposium on the Use of Isotope Techniques in Water Resources Development, Vienna, Austria, March 30-April 3, 1987.

The symposium is being organized by the International Atomic Energy Agency in cooperation with the United Nations Educational, Scientific, and Cultural Organization. The goal is to undertake a comprehensive review and update of the application of isotope and nuclear techniques to water resources exploration, evaluation, exploitation, and conservation. Included in the list of topics, under "Geothermal", is the study of water movement through a geothermal system; origin of water; isotopic geothermal thermometers; and reinjection of geothermal fluids.

Limited funds are available to help meet the costs of attendees from developing countries with low economic resources.

For further information, write the International Atomic Energy Agency, IAEA-SM-299, Vienna International Centre, P.O. Box 100, A-1400 Vienna, Austria. Telephone (0222)2360 plus extension.

NATO Advanced Study Institute on Geothermal Reservoir Engineering, Antalya, Turkey, July 1-10, 1987.

The organizing committee is composed of Dr. Ender Okandan, Middle East Technical University, Ankara, Turkey; Dr. Roland Horne, Stanford University; and Dr. Jon Gudmundsson, National Energy Authority, England.

For further information and application forms, contact the Director of the NATO ASI, Dr. Ender Okandan, Chairman, Petroleum Engineering Department, Middle East Technical University, Inonu Bulvari, Ankara 06531, Turkey.

1987 Annual Meeting, Geothermal Resources Council, October 12-14, 1987, John Ascuaga's Nugget, Sparks, Nevada. 3 days, $250.00 registration fee (tentative).

The meeting will include technical and poster sessions, exhibits, and field trips. For further information, contact the GRC, P.O. Box 1350, Davis, California 95617. Call (916)758-2360.

9th New Zealand Geothermal Workshop, Geothermal Institute, University of Auckland, New Zealand, November 4-6, 1987.

A Geothermal Energy New Zealand Ltd. Workshop Travel Fellowship will be awarded in conjunction with this workshop. The recipient will be chosen by a panel of judges on the basis of a scientific, engineering, or management paper, 4,000-6,000 words long, on the theme "Reinjection and Waste Disposal Systems." This paper will become the keynote paper for the workshop. Newcomers or experienced scientists and engineers are invited to apply, and the papers should be submitted by June 1, 1987.

For further information, contact the Convenors, 9th Geothermal Workshop, Geothermal Institute, University of Auckland, Private Bag, Auckland, New Zealand.

Symposium on Geothermal Energy, at the Energy-Sources Technology Conference and Exhibition, New Orleans, Louisiana, January 10-14, 1988.

The Symposium is cosponsored by the Geothermal Resources Council and the American Society of Mechanical Engineers (Petroleum and Advanced Energy Systems Divisions). The main emphasis will be on acquainting ASME members with geothermal resources and their development. Technical papers will be presented on aspects of geothermal drilling and production.

If GRC or ASME members are interested in submitting papers, contact Dave Anderson, Executive Director of the GRC, P. O. Box 1350, Davis, Calif. 95617-1350.

International Symposium on Geothermal Energy, Kumamoto and Beppu, Japan, November 10-14, 1988.

The theme of the symposium is the exploration and development of geothermal resources. The symposium is organized by the Geothermal Research Society of Japan. The program will include invited lectures, oral and poster presentations, and excursions. A circular will be sent in December 1986 to all interested persons.

Topics discussed at this symposium will include the geology, geochemistry and geophysics of geothermal fields; exploration techniques; case histories of exploration and development; hydraulic fracturing; drilling techniques; reservoir engineering; power generation; direct use; legal and industrial aspects; economics, financing and marketing; and environmental aspects.

Excursions are planned to geothermal fields in Northern and Southern Japan and to machine works where equipment for geothermal power plants is manufactured.

Address all correspondence to the Geothermal Research Society of Japan, c/o Geological Survey of Japan, Higashi 1-1-3, Yatabe, Tsukuba 305, Japan.

Videotapes

Before the Drilling Begins

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

The videotape, titled "Before the Drilling Begins", may be purchased for $150.00 in ½" (VHS or Beta) or 3/4" formats. It may be rented for $25.00 plus a $25.00 deposit, refundable upon return of the tape.

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

Geothermal Audiovisual Productions from EPRI

Three geothermal audiovisual productions are available from EPRI. One, a general discussion of geothermal energy, is titled "The Primal Furnace." The price for this production in film format is $200 for EPRI members and $350 for nonmembers. In video format, there is no charge to EPRI members. Nonmembers pay $50.

The second and third audiovisual productions are more technical, and the charges for both are the same. One is called "Heber Binary Project," and the second is titled "Rotary Separator Turbine." The film format costs $100 for EPRI members and $160 for nonmembers. The video format is free for EPRI members and $50 for nonmembers.

For further information, contact Carole Wedl, Communications Services, EPRI, P.O. Box 10412, Palo Alto, California 94303. Telephone (415) 855-2000.

Nevada's Geothermal Videotapes

Two videotapes on geothermal energy are available from the University of Nevada. One, Nevada's Geothermal Resources, was written for the general public as an introduction to the topic. The second, Nevada's Geothermal Industry, is oriented towards people quite familiar with geothermal development.

Copies of the videotapes in a VHS or Beta format are $30; tapes in a 3/4" format are $50. Add a $5 postage and handling fee to every order.

Order from the Division of Earth Sciences, Environmental Research Center, University of Nevada, Las Vegas, 255 Bell Street, Suite 200, Reno, Nevada 89503; (702) 784-6151.

Databases

Water Database Available

AQUALINE, a part of Pergamon InfoLine, is an online database containing up-to-date information on water pollution and related topics. The over 85,000 records in AQUALINE are abstracted from over 600 journals and other documents received by the Water Research Centre, the central organization for the UK water industry.

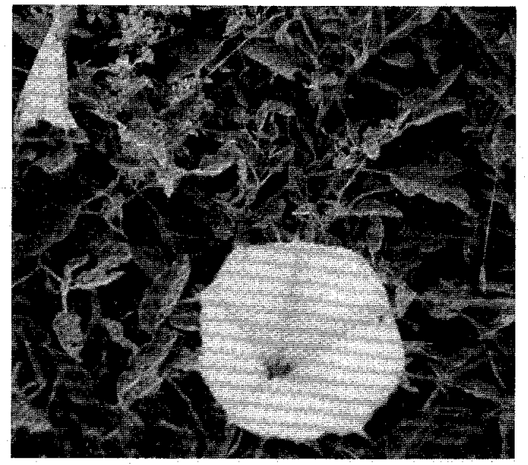
For further information, contact Cally Brown, Pergamon InfoLine, 1340 Old Chain Bridge Rd., McLean, VA 22101; (703) 442-0900.

Computer Data Base Services Available for Nevada

The Nevada Bureau of Mines and Geology (NBMG) has added access to geologic and mineral resource data bases to its services available to the public. At present, seven data base systems can be accessed at cost in the NBMG offices on the University of Nevada-Reno Campus. Four of these are U.S. Geological Survey data bases: Mineral Resource Data System (MRDS), Geothermal Resources (GEOTHERM), Radiometric Age Data Bank (RADB), and Rock Analysis Storage System (RASS). The other three available data bases are the Mineral Inventory Location System (MILS) of the U.S. Bureau of Mines, Nevada Geologic Research-in-Progress (NVGRIP), and Nevada Oil and Gas Wells (NVOILWEL). NVGRIP and NVOILWEL were created and are maintained by NBMG. Contributions of new geologic research project descriptions for inclusion in NVGRIP are welcome.

Hardcopy for each of these seven systems is available for inspection at no charge. For further information, please call Keryl Fleming, Geologic Computer Specialist, at (702) 784-6691, or write the NBMG, University of Nevada-Reno, Reno, Nevada 89557-0088.

Publications



71st Annual Report of the State Oil and Gas Supervisor. 1986. Free. Published by and available from the California Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, California 95814.

Statistical and verbal summaries of 1985 California geothermal activities.

Drilling and operating geothermal wells in California. Free. 1986. Published by and available from the Division of Oil and Gas, 1416 Ninth Street, Room 1310, Sacramento, CA 95814.

California geothermal wells (except for wells on federal leases) are permitted, drilled, operated, and abandoned under requirements and procedures administered by the Geothermal Section of the California Department of Conservation, Division of Oil and Gas. This publication was prepared to familiarize the reader with the basic requirements of the Division of Oil and Gas. It also describes services provided by the division, and includes samples of division geothermal forms.

Chapters cover general information; the environmental review process, with glossary; and the permitting process, with glossary.

Sections are included on a general review of permitting procedures, high-temperature exploratory wells, high-temperature development wells, low-temperature exploratory and development wells, high- and low-temperature injection wells, and temperature observation wells.

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Geothermal systems of the Mono Basin-Long Valley Region, Eastern California and Western Nevada. By Chris T. Higgins, Thomas Flynn, Rodger H. Chapman, Dennis T. Trexler, Gordon W. Chase, C. Forrest Bacon, and George Ghusn, Jr. 1985. Published by the Department of Conservation, Division of Mines and Geology. $17.00 for a photocopy of the report, available from the DMG Information and Publications Office, 1516 Ninth Street, (4th floor), Sacramento, CA 95814. (916) 445-5716.

The report is available for reference at the offices of the Division of Mines and Geology in Sacramento, Pleasant Hill, and Los Angeles, and at the office of the Division of Earth Sciences, 255 Bell Street, Suite 200, Reno, Nevada.

This report presents the results of a cooperative study of geothermal systems in the region from Aurora, Nevada, and Bridgeport, California, south to Long Valley, California, by the Division of Mines and Geology and the Division of Earth Sciences of the University of Nevada, Las Vegas. The U.S. Department of Energy provided most of the funds for this project. The study is the initial reconnaissance phase of a project that was proposed to span several years.

Magmatic and hydrothermal systems have been common in the Mono Basin-Long Valley region for the last 15 million years. The objectives of this study were to begin determination of the properties and interactions of these systems and to develop hypotheses on the locations of undiscovered, active systems in the region. Special emphasis was given to the regional relationships and controls of the systems. This study includes a Bouguer gravity map of the region, several gravity and magnetic profiles, a resistivity profile near Aurora, and a potassium-argon date on Mud Spring volcano, also near Aurora. New interpretations of the data collected are presented and relative ages and distributions of thermal fluids, gravity anomalies, depths to the pre-Cenozoic basement, structural controls of the geothermal systems, and the late Cenozoic tectonic-magmatic evolution of the region are discussed.

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The 1985 California energy plan. 1986. Free. Published by and available from the California Energy Commission, 1516 Ninth Street, Docket Unit - MS-4, Sacramento, CA 95814.

The publication is the CEC's fifth biennial report. It contains many references to geothermal energy.

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Geology of Baja California: a bibliography. By Mary Elizabeth Harris. 1986. Free. Published by and available from the Science Dept. Library, SDSU, San Diego, California 92182-0511. Phone (619) 265-6715.

This excellent, 200-page bibliography includes a Baja, California geology subject index. There are many geothermal citations.

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A limited quantity is available of the following recent publications by the Lawrence Berkeley Laboratory. For copies, contact the authors or write the LBL, Earth Sciences Division, Ref. Room, Bldg. 50-E, Berkeley, CA 94720. Phone (415) 486-7348.

In addition, a complete list of LBL Geothermal Program publications may be obtained from this address.

LBL-14403
Weres, O., 1984. Environmental protection and the chemistry of geothermal wells.

LBL-18232
Goldstein, N.E., and Flexser, S., 1984. Melt zones beneath five volcanic complexes in California: An assessment of shallow magma occurrences.

LBL-18268
Bodvarsson, G.S., Pruess, K., and Lippmann, M.J., 1985. Modeling of geothermal systems.

LBL-18146
Goldstein, N.E., 1984. Fracture detection and mapping for geothermal reservoir definition: An assessment of current technology, research, and research needs.

LBL-18520
Benson, S.M., 1984. Technology transfer report: Feasibility study for the use of geothermal brine in the Ashdod area, Israel.

LBL-17593
Benson, S.M., 1984. Analysis of injection tests in liquid-dominated geothermal reservoirs (M.S. thesis).

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Nevada Publications

The following publications are published by and available from the Nevada Bureau of Mines and Geology, Univ. of Nevada-Reno, Reno, NV 89557-0088, (702) 784-6691.

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The Nevada mineral industry, 1985. Publication number MI-1985. $3.00.

The report describes mining, oil and gas, and geothermal exploration and development in Nevada for 1985.

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Geochemical reconnaissance - Camp Douglas and Moho Mountain Quadrangles - in Mineral County, Nevada, NBMG Report 42. By L.J. Garside. $3.30.

The report includes results of trace element analyses of 69 geochemical rock samples from the study area. The results are related to the regional geology.

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Precious-metal mineralization in hot springs systems, NBMG Report 41. By J.V. Tingley and H.F. Bonham, Jr. $10.00.

Originally prepared as a trip guide for a field conference of the Society of Economic Geologists, this report includes a road log from San Francisco, Ca. to Ely, Nevada, to Reno. Stops along the way include the McLaughlin Mine in California and, in Nevada, the Paradise Peak Mine, the McGinness Hills, the Buckhorn Mine, the Beowawe-White Canyon area, Buckskin Mountain, and the Sleeper gold deposit. Detailed descriptions of the geology of the hot-spring deposits at each of these stops are included.

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Chemistry, scale, and performance of the Hawaii Geothermal Project-A Plant, EPRI AP-4342 Final Report (RP1195-12). $32.50. Contractor: Hawaii Electric Light Co., Inc. Published by and available from the EPRI Technical Information Division, P.O. Box 10412, Palo Alto, CA 94303.

In addition, a complete list of EPRI geothermal reports produced under the Geothermal Power Systems Program is available from this address. For further information, call the EPRI Research Reports Center at (415) 965-4081.

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Geothermal resource subzone designations in Hawaii. 1986. Free. Published by and available from the Hawaiian Department of Planning and Economic Development, 335 Merchant St., Room 110, Honolulu, Hawaii 96813.

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Hawaii and energy. Free. Published by and available from the Hawaii Department of Planning and Economic Development, Information Office, P.O. Box 2359, Honolulu, Hawaii 96804.

The brochure includes descriptions of the national energy picture, Hawaiian energy problems and goals, and Hawaiian alternate energy sources, including geothermal energy.

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The State of Hawaii Data Book 1985: a statistical abstract. 1986. 662 pages. $5.00 if mailed to an address in Hawaii; $15.00 for out-of-state orders. (Postage and handling included.) Published by and available from the Hawaii Department of Planning and Economic Development, P.O. Box 2359, Honolulu, Hawaii 96804.

The document is Hawaii's standard, official summary of statistics on the social, economic, and political organization of the state.

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Geothermal gradient data collected from 1982-1984, open file report 0-86-2. 1986. $5.00. Published by and available from DOGAMI, 910 State Office Building, Portland, Oregon 97201.

The 107-page report contains all temperature-gradient measurements taken by the DOGAMI staff in 42 drill holes in Oregon. For each drill hole, the report contains data tables and temperature-depth plots as graphic summaries.

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Temperature, thermal-conductivity, and heat-flux data; Raft River area, Cassia County, Idaho 1974-1976. OF86-0123. By T.C. Urban et al. 299 p. Microfiche $4.00; paper copy $45.25. Available from the U.S. Geological Survey Books and Open-File Reports Section, Federal Center, Bldg. 41, Box 25425, Denver, Colorado 80225.

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"Geothermal exploration in Oregon, 1985". By Neil Woller, Gerald Black, and George Priest, Oregon Dept. of Geology and Mineral Industries. Article in the July 1986 issue of Oregon Geology, published by DOGAMI, 910 State Office Bldg., 1400 SW Fifth Avenue, Portland, Oregon 97201. $1.00.

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High heat production (HHP) granites, hydrothermal circulation and ore. Presentations from the conference on High Heat Production Granites, Hydrothermal Circulation, and Ore Genesis organized by The Institution of Mining and Metallurgy. 1985. $67.00. 600 pages. Published by and available from the Brookfield Publishing Company, Old Post Road, Brookfield, Vermont 05036.

The 40 technical papers in this volume reflect the diversity of geological problems relating to granites high in heat-producing radioactive elements (HHP granites). These include the petro-chemical classification of ore-bearing granitoids, the nature and sources of ore-forming granites and their mineralization, their content of radioactive elements, and the mechanisms responsible for them. In addition to mineralogical, structural, geological, and geophysical implications of findings, there are also significant implications for economic

geology, nuclear and geothermal energy, and environmental issues.

An article of particular interest is titled "Geothermal implications for the Sierra Nevada Batholith from vertical and horizontal compositional zoning studies in contrasting pluton types," by Swaka and Chappell.

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Copies of the following reports, prepared under DOE contract DE-AC03-84SF-12197, are available free of charge as long as the supply lasts. At that time, Xeroxing costs will be assessed. Write to Dr. Ronald DiPippo, Mechanical Engineering Dept., SMU, North Dartmouth, Mass. 02747. Phone (617) 999-8541.

Similarity Considerations in One-Component Two-Phase Flow. TWOPHASE-1. July 1984. By P.F. Maeder, R. DiPippo, D.A. Dickinson, and D.E. Nikitopoulos.

The Silica Problem in the Design of Geothermal Power Plants. TWOPHASE-2. February 1985. By R. DiPippo.

Single-Substance, Two-Phase Duct Flow: A Unified Theoretical and Experimental Study. TWOPHASE-3. February 1986. By D.E. Nikitopoulos and P.F. Maeder.

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NTIS Publications

The following publications are available from the National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

Proceedings, geothermal program review IV, CONF-8509142. Sponsored by the U.S. Dept. of Energy, Geothermal Technology Division. 1985. $22.95 paper, $5.95 microfiche.

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Geothermal progress monitor. DOE/CE-0156. By the U.S. Dept. of Energy, Geothermal Technology Division. 1985. $16.95 paper, $5.95 microfiche.

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A synthesis of Technology Transfer Methodologies, CONF-8405184. By U.S. Dept. of Energy, Technology Transfer Workshop. 1984. $34.95 paper, $5.95 microfiche.

•

Geothermal injection technology program, annual progress report: FY-85, EGG-2445. By Idaho National Engineering Laboratory and University of Utah Research Institute. 1986. $9.95 paper, $5.95 microfiche.

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Curatorial policy guidelines and procedures for the Continental Scientific Drilling Program, LA-10542-OBES. By Sue Goff. 1986. $9.95 paper, $5.95 microfiche.

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Caldera processes and magma-hydrothermal systems, Continental Scientific Drilling Program - thermal regimes, Valles Caldera research, scientific and management plan, LA-10737-OBES. By the Valles Caldera Scientific Drilling Team. 1986. $16.95 paper, $5.95 microfiche.

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Symposium on high-temperature well-logging instrumentation, LA-10745-C. By B. Dennis. 1986. $16.95 paper, $5.95 microfiche.

•

Characteristics of high-temperature cementitious lost-circulation control materials for geothermal wells, BNL51960. By T. Sugama, L. Kukacka, B. Galen, and N. Milestone. 1986. $9.95 paper, $5.95 microfiche.

•

Active cooling for downhole instrumentation design criteria and conceptual design summary. LA-10723-MS. By G. Bennett. 1986. $9.95 paper, $5.95 microfiche.

•

The physicochemical basis of the Na-K-Ca geothermometer, LA-10806-MS. By D. Janecky, R. Charles, G. Bayhurst, and T. Benjamin. 1986. $9.95 paper, $5.95 microfiche.

•

Exploration for hot dry rock geothermal resources in the Midcontinent USA, LA-10659-HDR, Vol. II. By W. Hinze et al. 1986. $16.95 paper, $5.95 microfiche.

•

The transfer of hot dry rock technology, LA-10601-HDR. By Morton Smith. 1985. $9.95 paper, $5.95 microfiche.

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Renewable energy resources. By John Twidell and Tony Weir. 1986. $65.00 cloth, $29.95 paper. 439 pages. Available from METHUEN, Inc., 29 West 35th Street, New York, New York 10001.

The book, written for college students and energy professionals, stresses the scientific understanding and analysis of renewable energy. The book is written to bridge the gap between descriptive reviews and specialized engineering treatises. It centers on demonstrations of how fundamental physical processes govern renewable energy resources and their applications. A chapter on geothermal energy is included.

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How to write and publish engineering papers and reports. Second edition. By Herbert B. Michaelson. 1986. $21.95, clothbound; $14.95, paperback. Published by and available from the ISI Press, 3501 Market Street, Philadelphia, PA 19104.

A review of the entire publication and public information process, from writing and editing through journal submission and oral report preparation. The final chapter suggests ways to avoid "Strategic Errors in a Manuscript."

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PI's National Geothermal Service Closed

Petroleum Information ceased publication of the National Geothermal Service at the end of September 1986. Along with this change, PI's Geothermal Completion Card product will also be discontinued.

Lowering levels of drilling activity and general uncertainties in the energy industry have made the decision to stop producing these services necessary.

PI will continue to publish geothermal well data in the completion summary section of the West Coast Region Report and the new, weekly, West Coast Report. In addition, general developments on issues pertinent to the geothermal industry will be provided in the newsletter section of these reports. The new weekly West Coast Report is offered at $30/month or $360 annually, which is an annual expense reduction to the Geothermal Report customer of $198. The drilling progress section will, however, only feature oil and gas well activity.

For further information, call 1-800-645-3282.

Maps

Two Oregon Maps

GMS-10 Low- to Intermediate-Temperature Thermal Springs and Wells in Oregon, 1978. $3.00.

Geothermal Resources of Oregon (map produced for the Dept. of Energy), 1982. $3.00.

Both maps are available from DOGAMI, 910 State Office Bldg., 1400 SW Fifth Avenue, Portland, OR 97201. Phone (503) 229-5580.

BLM Maps Available

Bureau of Land Management (BLM) maps show whether a piece of land is privately or publicly owned, who administers it, and what the mineral status is. Called intermediate scale maps, they cover nearly all of California in two versions. The Surface Management edition shows public lands managed by BLM, lands administered by other federal agencies, state lands, and private lands; any use restrictions such as withdrawals are also shown.

The Surface-Minerals Management edition contains the same information, but also shows federally-owned mineral rights. BLM's mapping system divides the state into 104 sections. Maps for 96 sections are complete and available for $3.50 from BLM California District Offices or the BLM, 2800 Cottage Way, Sacramento, CA 95825.

California Wells

Division Well Data Available

A computer-generated file of geothermal production and injection statistics for wells and records open to public inspection is available from the Division of Oil and Gas. All data are in metric units. The file may be purchased for $50.00 from the Division of Oil and Gas in Sacramento.

Drilling Permits for Geothermal Wells Approved January - September 1986 by the Division of Oil and Gas

Date Notice Received	Operator and Well Name & Number	API Number	Sec. T. R.	Location & Elevation
	D I S T R I C T G1			
	Lassen County			
	Trans-Pacific Geothermal Corp.			
7/16/86	"NorCal" 1	035-90076	8 28N 16E	Fr NE cor 186m S 716m W El 1220m gr
7/16/86	"NorCal" 2	035-90075	8 28N 16E	Fr NE cor 495m S 768m W El 1220m gr
	D I S T R I C T G2			
	Imperial County			
4/10/86	Chevron Geothermal Company "GTW" 4	025-90647	4 17S 14E	Fr SE cor 1195m N 47m W El -1.5m gr
4/10/86	"GTW" 6	025-90648	3 17S 14E	Fr SE cor 808m N 760 m W El -1.5m gr
5/21/86	Imperial Magma "SW" 1	025-90649	27 11S 13E	Fr SE cor Sec 33 1690m N 52M E El -69.4m gr
5/28/86	Chevron Geothermal Company "HGU" 58	025-90650	34 16S 14E	Fr NE cor 59m S 304m W El -2m gr

Date Notice Received	Operator and Well Name & Number	API Number	Sec.	T.	R.	Location & Elevation
	Imperial Magma					
6/27/86	"SW" 2	025-90651	22	11S	12E	Fr SE cor Sec 33 4196m N 445m E El -68.2m gr
6/27/86	"SW" 3	025-90652	24	11S	13E	Fr SE cor Sec 33 3984m N 4262m E El -65.8m gr
6/27/86	"SW" 4	025-90653	35	11S	13E	Fr SE cor Sec 33 887m N 2397m E El -69.6m gr
6/27/86	"SW" 5	025-90654	15	12S	13E	Fr SE cor 33 3249m S 80m E El -68.1m gr
6/27/86	"SW" 6	025-90655	8	12S	13E	Fr SE cor Sec 33 1636m S 2388m W El -68.1m gr
	Chevron Geothermal Company					
7/24/86	"HGU" 108	025-90656	33	16S	14E	Fr SW cor 357m N 263m E El -2m gr
7/24/86	"HGU" 156	025-90657	30	16S	14E	Fr SE cor 345m N 131m W El -2m gr
	Imperial Magma					
8/4/86	"Elmore" 4	025-90658	26	11S	13E	Fr SE cor 439m N 752.2m W El -24m gr

D I S T R I C T G3

Lake County

	MCR Geothermal Corp.					
12/24/85	"Francisco" 5-5	033-90520	5	11N	8W	Fr NE cor 350m S 1188m W El 792.8m kb
	Union Oil Company					
3/7/86	"NE Geysers Unit" 17	033-90521	5	11N	8W	Fr SE cor 351m N 526m W El 891.5m kb
	FMRP					
7/1/86	"MLM" 6	033-90528	35	11N	8W	Fr NE cor 753.8m S 624.8m W El 799.5m kb
	GEO Operator Corp.					
9/11/86	"LR" 10	033-90543	6	10N	7W	Fr SW cor 1128m N 457m E El 792m gr
9/11/86	"GR" 41	033-90544	4	10N	6W	Fr SE cor 793m N 366m W El 290m gr
	Union Oil Company					
9/16/86	"DX State 4596" 87	033-90545	8	11N	8W	Fr NW cor 873.4m S 637.1m E El 1028.2m kb

Date Notice Received	Operator and Well Name & Number	API Number	Sec.	T.	R.	Location & Elevation

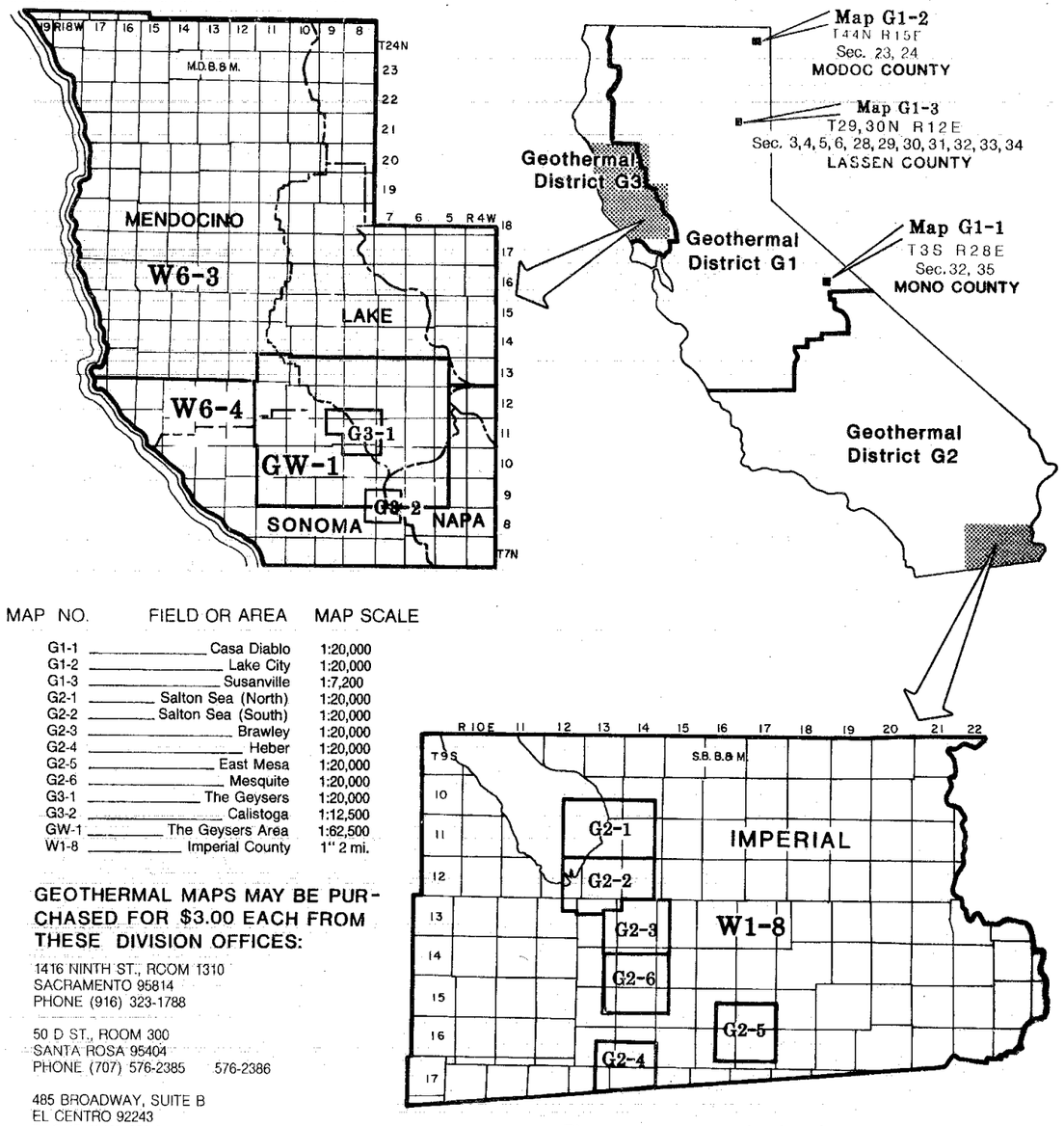
Napa County

	VIP Associates, Inc.					
4/3/86	"Village Inn" 1	055-90083	36	9N	7W	Fr SE cor 850m N 90m W El 112m gr

Sonoma County

	GEO Operator Corp.					
12/27/85	"Prati" 5	097-90684	36	12N	9W	Fr SW cor 384m N 32m E El 793.2m kb
1/21/86	"Prati" 38	097-90687	35	12N	9W	Fr SE cor 34m N 914m W El 579m gr
	Union Oil Company					
2/25/86	"D & V" 9	097-90691	33	11N	8W	Fr NE cor 615m S 662m W El 818m gr
3/7/86	"DX State 4596" 76	097-90696	7	11N	8W	Fr NE cor 305m S 229m W El 1049m gr
	GEO Operator Corp.					
3/17/86	"Prati" 25	097-90695	35	12N	9W	Fr SE cor 673m N 825m W El 715m gr
	Union Oil Company					
5/5/86	"DX State 4596" 77	097-90699	7	11N	8W	Fr NE cor 333m S 247m W El 1057.5m kb
6/11/86	"LF State 4597" 51	097-90700	20	11N	8W	Fr SE cor 448m N 732m W El 936m kb
6/11/86	"DX State 4596" 85	097-90701	7	11N	8W	Fr NE cor 339m S 242m W El 1057.5m kb
7/23/86	"LF State 4597" 48	097-90702	20	11N	8W	Fr SE cor 299m N 600m W El 867m gr
7/30/86	"GDC" 30	097-90704	20	11N	8W	Fr SW cor 101m N 9m E El 619m kb
	GEO Operator Corp.					
8/28/86	"Rorabaugh" A-32	097-90705	14	11N	9W	Fr NW cor 905m S 486m E El 639m kb

California Division of Oil and Gas
GEOTHERMAL MAPS



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

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

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