GEOTHERMAL

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HOT LINE

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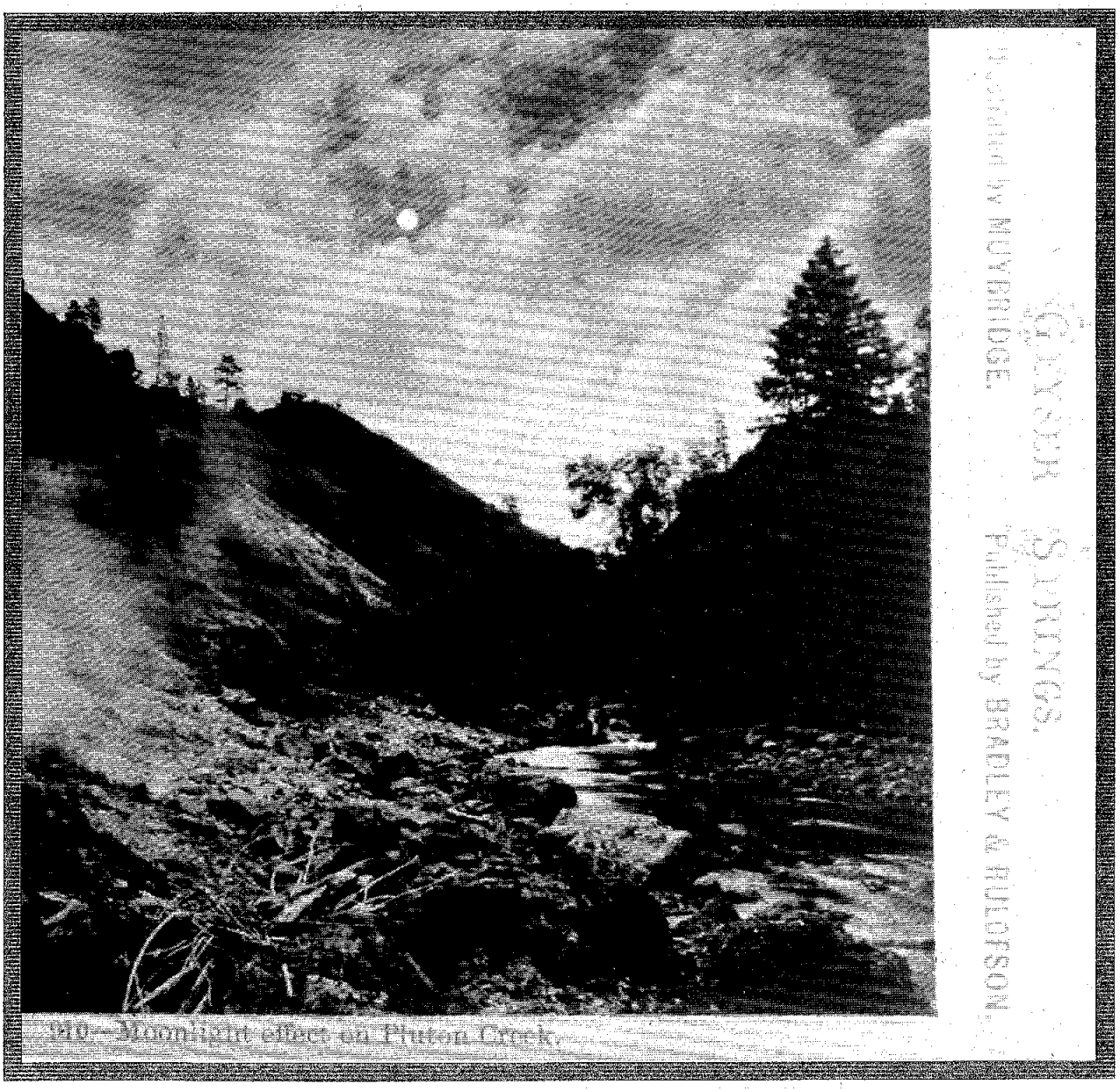

Fig. 1—Moonlight effect on Putah Creek

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GEOTHERMAL
HOT LINE

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ISSN 0735 0503

From the Editor...

IMAGING THE GEYSERS

Photographs by Eadweard Muybridge from 1870 and drawings by Thomas Moran from 1873 may be our oldest images of The Geysers. Both men record a bygone age with great skill and artistry. Their images are reprinted frequently, but without credit. The attributions were lost with time, although both would become world famous.

This issue highlights images from The Geysers by Eadweard Muybridge and Thomas Moran and summarizes their careers.

An early motion study by Muybridge of a horse changing gait has been reprinted, beginning at the lower right-hand corner of the next page. Fan quickly through the pages to see movement.

I hope you enjoy the photographs and drawings by these two masters.

Susan

On the Cover: *"Moonlight Effect on Pluton Creek (Big Sulphur Creek),"* from a stereograph by Eadweard Muybridge, 1870. *Courtesy, The Bancroft Library.*

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CALIFORNIA

Commercial Use of Low-temperature Geothermal Resources in the Imperial Valley

Introduction

One of the hottest places in the world can be found in California's Imperial Valley, not at the surface on the asphalt streets in summer, but in the subsurface, where vast deep reservoirs of superheated water reside. The water in the reservoirs, at temperatures between 360° and 600° F, is hot enough to use for generating electricity at large power plants. In fact, the energy potential of the waters is considerable and has elicited much attention for the past 20 years. As a result, 15 geothermal power plants now are producing over 500 megawatts of electricity in the Imperial Valley.

The story does not stop there. Commercial operations using low-temperature geothermal water have been established in the Imperial Valley during the past 10 years. (The term *low-temperature geothermal* refers to those waters produced at the surface with temperatures in the range of 86° to 210° F.)

Low-temperature geothermal water can be found in relatively shallow reservoirs throughout the Imperial Valley. This is because the entire Imperial Valley, including the Coachella Valley to the north and the Mexicali Valley to the south, is an area with high crustal heat flow. Figure 1 shows the low-temperature areas mentioned in the article.

Dos Palmas Spring

The Dos Palmas Spring area is in Riverside County, about five miles east of the Salton Sea and five miles north of the Imperial County border. It lies at the base of the Orocopia Mountains, near the San Andreas fault zone. Some records from the late 1800s refer to the original site as a single spring marked by a pair of fan palms. Other writers suggest the water comes from a well drilled to supply stagecoach travelers. Still other accounts suggest Dos Palmas is a natural spring discovered in 1911.

Today, the original Dos Palmas "spring" is on land owned by the U.S. Department of the Interior, Bureau of Land Management (BLM). The "spring" provides water to numerous artificially constructed ponds. A small wetland, grown up around the ponds, is the focus of conservation efforts managed by The Nature Conservancy, in cooperation with the BLM.

Adjacent to Dos Palmas Spring, about a dozen low-temperature wells have been drilled for commercial aquaculture on privately owned land. The wells are 600 feet to 800 feet deep and water temperatures range from 75° to 102° F. All are operated by Aquafarms International, which raises tilapia and other freshwater fish.

Hot Mineral Spa Area

The Hot Mineral Spa area is located south of Dos Palmas Spring, northeast of Hot Mineral Spa Road. About 22 low-temperature artesian wells are drilled in the area. The majority are used for commercial fish farming, and 5 supply hot water to spas in trailer parks.

Each well produces 200 gallons to 400 gallons per minute of water from about 500 feet. The total dissolved solids in the water range from 2,000 to 3,000 parts per million. Each year, between 3,000 and 4,000 acre-feet of water is used from this thermal aquifer.

by Christy Craig Hunter
Geothermal Engineer

Change of Gait. Recovery after a leap of eight and three-quarter yards in length over a bar one and a half yards high. Photographed at Palo Alto, 1879, by Eadweard Muybridge.

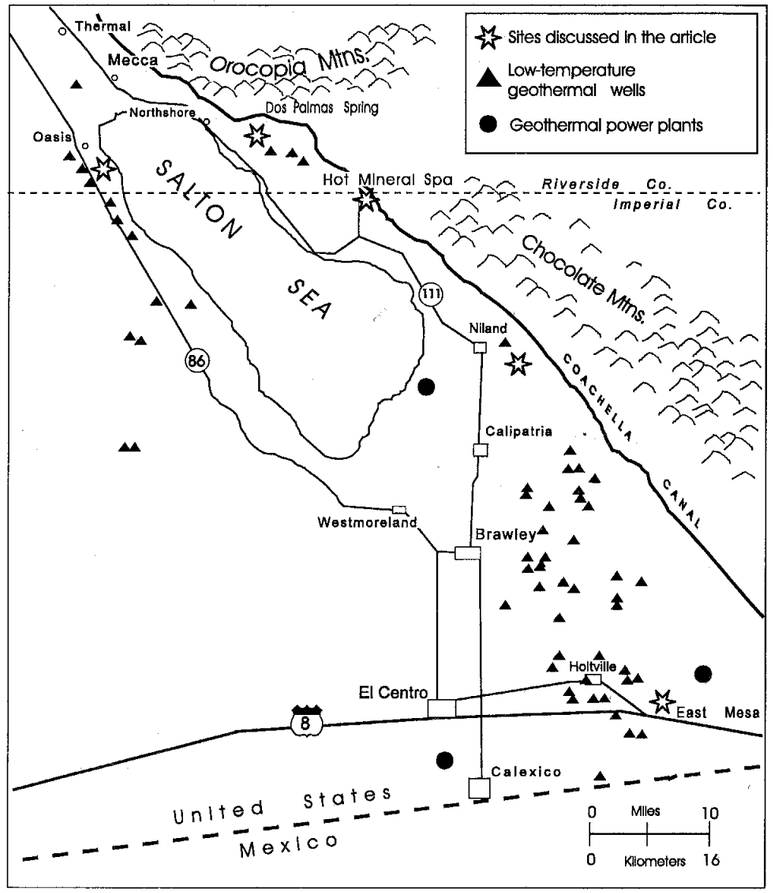


Figure 1. Locations in the Imperial Valley with low-temperature geothermal resources used commercially and discussed in the article. Low-temperature geothermal wells and geothermal power plants are shown.

About six commercial fish farms operate in the area. The primary crop is tilapia. Pacific Aquafarms, one of the largest fish producers here, ships about three-quarters of a million pounds of live fish per year to the Asian food market. The company has begun raising saltwater shrimp to sell as brood stock to saltwater fish farms.

Three commercial trailer parks located in the Hot Mineral Spa area provide geothermal water for their residents. The water is used in small baths and swimming pools. Although the parks are operated throughout the year, the peak visiting season is in the winter months.

Niland

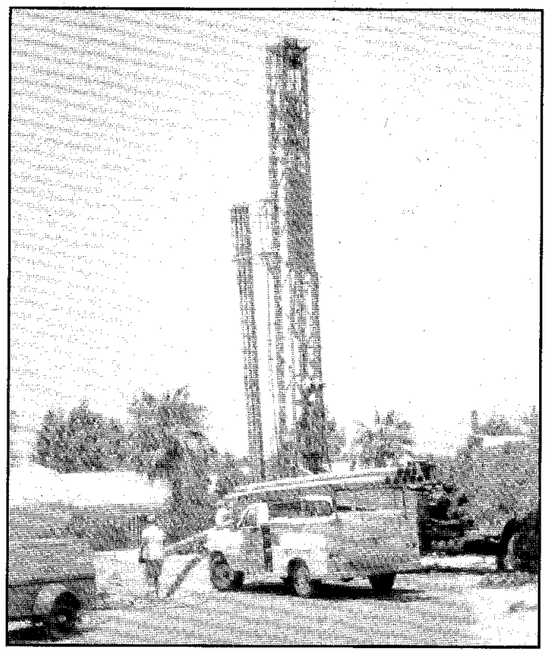
Niland is about 12 miles southeast of Hot Mineral Spa Road, on Highway 111. Fish Producers, a fish farm operating about four miles southeast of Niland, produces geothermal water from three wells to supplement the water supply. Well flow rates average about 100 gallons per minute at a temperature of about 115° F.

The company uses the low-temperature water to provide additional heat during the fish hatching process, help accelerate winter growth in the present catfish crop, and warm brood ponds. The primary fish crop is catfish; however, tilapia is raised, as well.

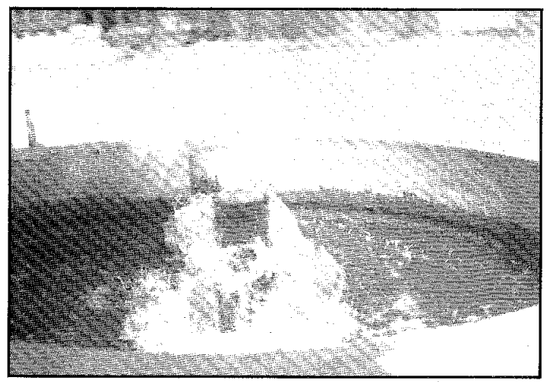
East Mesa Public Lands

The Hot Spring Long Term Visitor Area, known as the LTVA, is located on public lands in southeastern Imperial Valley. The BLM manages the LTVA as a recreational area for campers. Visitors come here to enjoy the mild winter climate and to soak in an open-air, concrete-lined pool filled with water from an adjacent artesian geothermal well. The well produces water at a temperature of about 120° F. It was drilled in the 1920s as a water supply for county sand and gravel operations.

Each year, about 2,000 people camp at the LTVA and about 800 local residents visit the pool. The site is within view of several geothermal power plants in the nearby East Mesa Geothermal field.

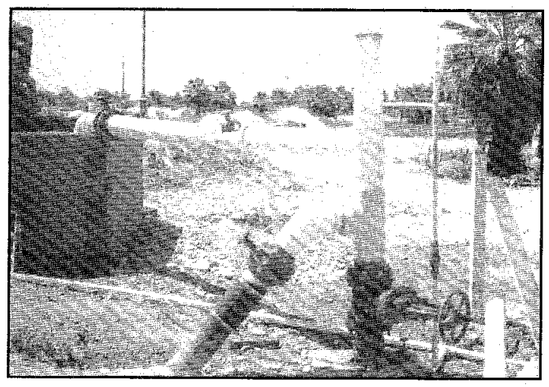


Most low-temperature geothermal wells are drilled with the same truck-mounted equipment that is used for drilling water wells. Since the wells are drilled no deeper than 600 feet and the rigs occupy small sites, they are ideal for use by trailer parks. One such rig is shown. *Photos by C. Craig Hunter.*

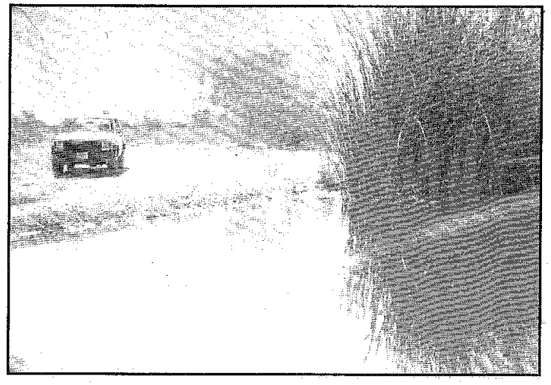


Geothermal water is pumped from a well that supplies hot water to spas. Although many wells in the Hot Mineral Spa area are artesian, their production rates are increased with down-hole, air-lift pumps installed in the wells.

One of many fish farms in the Hot Mineral Spa area. The fish are raised in large, concrete-lined ponds aerated with floating paddle machines.



The oldest well in the Hot Mineral Spa area is "USBR" No. 1. Drilled in 1939, the well still supplies water to a commercial trailer park. The wellhead is connected to pipes that run to a large tank. Here the geothermal water is cooled slightly before being passed to soaking tubs and swimming pools.



This small warm-water pond, named Frink spring, is in the southern part of the Hot Mineral Spa area. Pond water may come from an artesian well, now buried.

Oasis Area

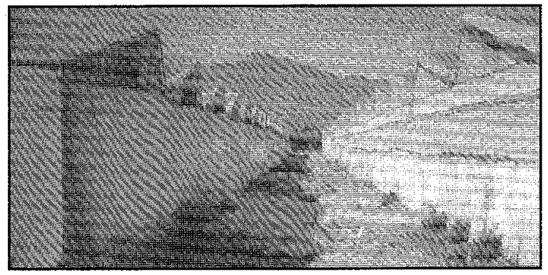
Oasis is a small rural community located in Riverside County, about three miles north of the Imperial County border and northwest of the Salton Sea. The geothermal wells in the area range in depth from 300 feet to 1,000 feet and produce water at temperatures from 95° to 120° F. Most of the wells are used to supply water for domestic use, agricultural irrigation, and sand and gravel mining.

A few wells are used by four commercial nurseries, which pipe low-temperature geothermal water to large greenhouses to increase plant growth in the winter months.

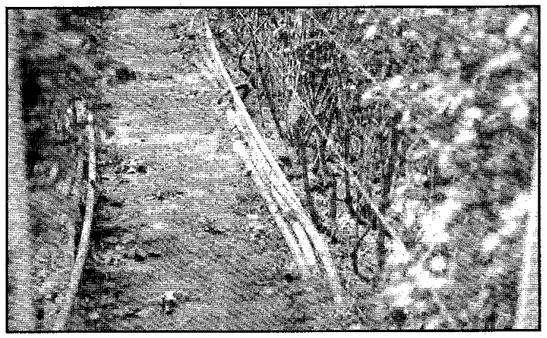
One such nursery, Nakashima Nursery Company, was the first in California to use geothermal water. The nursery was built in 1980 with the intent of growing roses for sale to florists. Roses, still its only crop, are harvested in the winter and spring months.

Located at the foot of the Santa Rosa Mountains, Nakashima Nursery is hidden among the citrus groves in Riverside County. A sandy road off Highway 86 winds its way beside a canal to the nursery entrance. The following pictures are from the nursery.

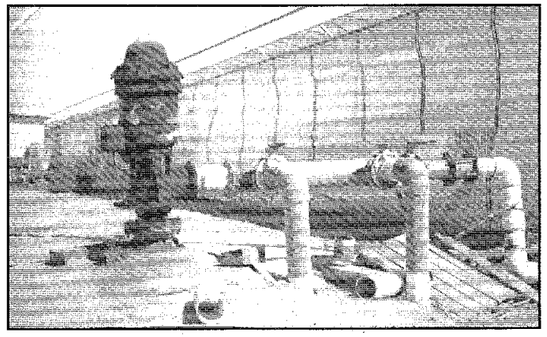
Geothermal water at Nakashima is pumped from two wells at temperatures of 108° F and 118° F. The water flows through one-inch-diameter plastic pipes, which are run along the bases of the plant beds. Heat radiating from the pipes keeps the root systems warm. The spent geothermal water is diverted into drainage ditches.



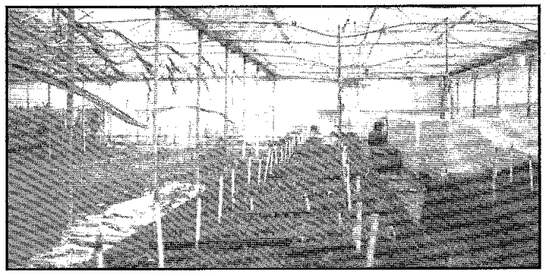
Looking down a row of plastic-enclosed greenhouses at the nursery.



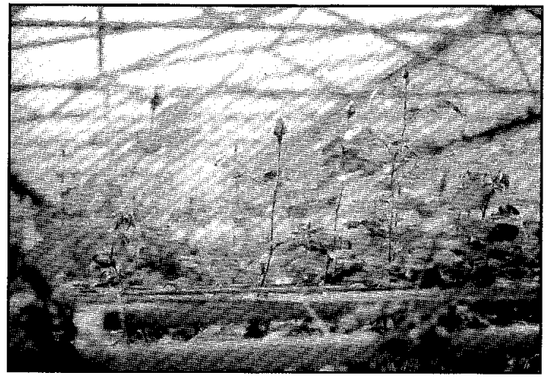
In the greenhouses, geothermal water passes through plastic pipe laid around plant beds. Heat radiates into the soil, warming the root systems.



A pumping unit is installed on one of Nakashima's two geothermal wells and geothermal water is piped to a manifold connected to the greenhouse heating systems.



Rose seedlings started in these beds will replace aging and diseased bushes.



After the morning harvest, a few rosebuds remain on the bushes, ready for collection in the afternoon. Roses must be picked at just the right time. Those cut too soon never open, and those cut too late wilt before reaching the florist.

In a large room, workers group roses by size and color, and wrap them for delivery in bunches of two dozen.

Desert Hot Springs Well Cased with CPVC

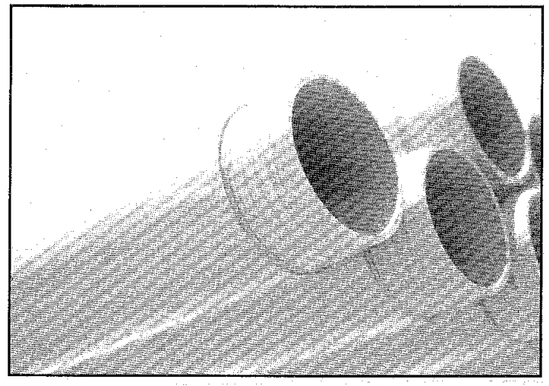
Desert Hot Springs is a small desert resort town near Palm Springs, California. Visitors come mostly in the winter to enjoy bathing and swimming in warm geothermal water. Most of the water is pumped from low-temperature geothermal wells that are used by a number of hotels and trailer parks, including Tamarisk Trailer Park.

Recently, the owners of Tamarisk replaced their geothermal well with a new one. Their first well was installed with steel casing. For the second well, "Tamarisk" No. 2, they chose casing made from a more corrosion-resistant material, a high-temperature plastic pipe called *CPVC, schedule 80.* The well is noteworthy because this is the first reported use of plastic pipe in a geothermal well in Desert Hot Springs.

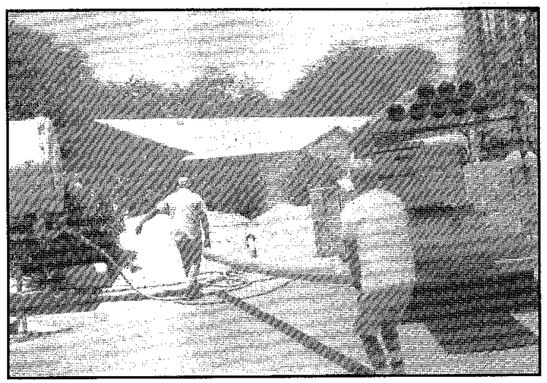
On June 27, 1996, "Tamarisk" No. 2 was drilled to a depth of 231 feet. Casing was run to total depth and the top 82 feet was cemented. Prior to installation, the drillers perforated the lower 56 feet of the casing, hand-drilling 10 rows of 1/8-inch holes.

The 30-foot casing sections were joined with threaded connections precut at the factory. Threaded connections were chosen because the threaded joint is considered superior to the cement-solvent joint typically used with plastic pipe.

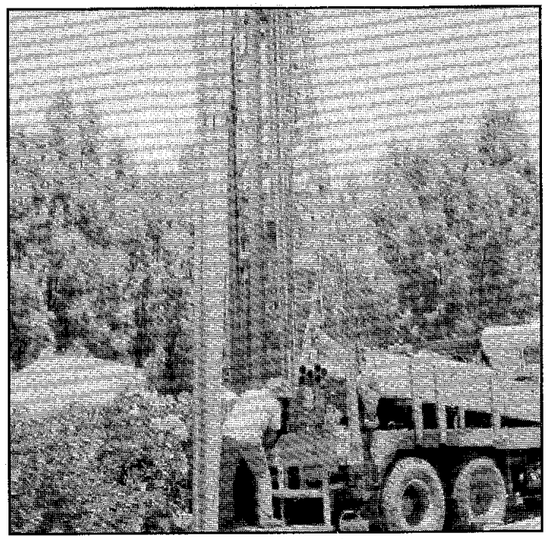
by Christy Craig Hunter
Geothermal Engineer



CPVC pipe with cut threads. *Photos by C. Craig Hunter.*



Lengths of CPVC pipe are light enough to be carried to the well.



A truck-mounted rotary drilling rig was used to drill the well and run in the casing.

The well is in a part of Desert Hot Springs where reservoir water temperatures range from 150° to 160° F. Because CPVC pipe is rated to withstand temperatures up to 210° F, its use was approved for the well by both the Department of Conservation's Division of Oil, Gas, and Geothermal Resources and the Riverside County Department of Health.

Initially, the cost per foot for CPVC casing is much higher than for steel casing. However, owners may consider the expense worthwhile if a well, such as "Tamarisk" No. 2, has a longer, corrosion-free life with less downhole maintenance.

EAST MESA TEST SITE RESTORED

Site restoration is completed at nonpond areas of the Geothermal Test Facility, operated by the U.S. Department of Energy (DOE) at East Mesa, 20 miles east of El Centro, California. The areas where two ponds were located will be restored by the DOE in 1997.

The DOE built the Geothermal Test Facility in the 1970s to help commercialize geothermal energy. Geothermal fluid and support services at the facility were used by many companies and institutions to experiment with heat extraction and to test energy-conversion equipment and materials.

During site restoration, many materials from the facility were recycled, such as concrete, asphalt, scrap metal, two buildings, fencing, copper wire, a water tank, and a septic tank. Recycling played a significant role in lowering facility restoration costs, which were 22 percent below budget.

Geysers Pipeline Project Update

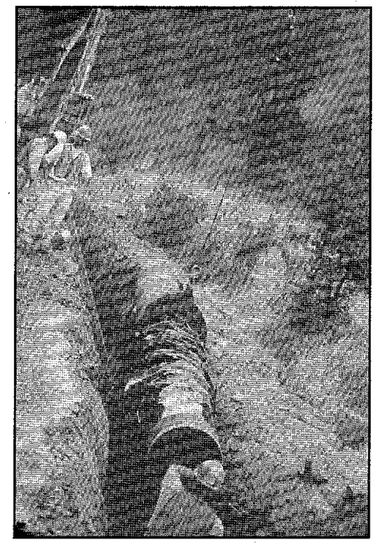
The Southeast Geysers Effluent Pipeline Project is underway. By August 19, 82,300 feet of pipeline had been laid and about 60,000 feet were left to put in place. Installing the final pipeline sections will take longer, as welded steel joints are needed and three large pumping stations must be constructed.

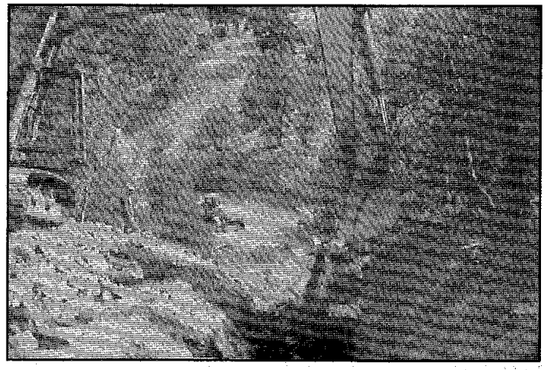
Mark Dellinger, of Lake County Special Districts, says that the pipeline project is on schedule and completion is expected by May 1997, when some testing will occur. Full operation is set for August 1997. It is hoped injecting treated wastewater effluent and lake make-up water into The Geysers Geothermal field will increase electrical generation by 50 to 70 megawatts.

The Clear Lake Make-up Water Intake area is a block away from this pipeline construction site. Trench shields, photo left, and hydraulic expanders keep unstable ground from caving in as the pipeline is laid.

About 7.8 million gallons a day of treated wastewater effluent and lake make-up water will flow from Lake County Sanitation District treatment plants at Clearlake and Middletown to leases at The Geysers Geothermal field. *Photos by M. Ali Khan.*

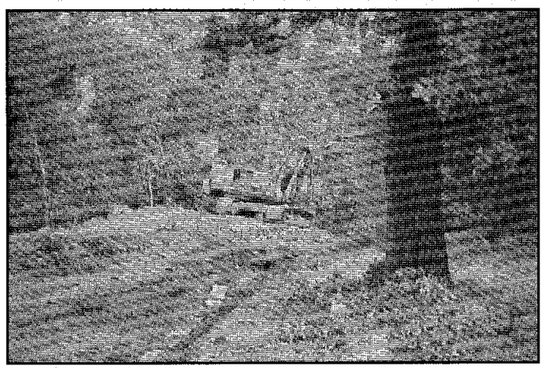
A pipe section being lowered into a trench north of Middletown. Each section is pressure fitted to the next with a rubber gasket, attached to electrical conductors to inhibit corrosion, checked for leaks, and wrapped in a plastic sleeve.



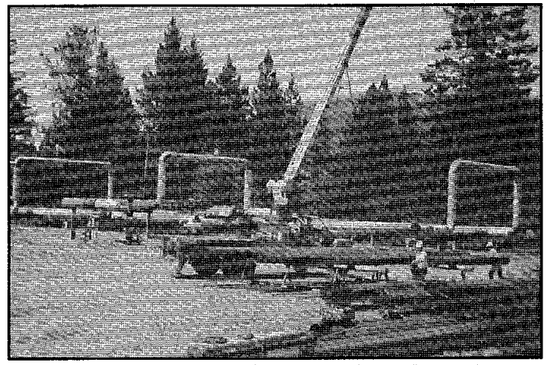


Gravel packed around the pipeline keeps it in place, protects it from rock damage, and drains away rain water.

Leaks are detected with a sonic tester.



The half-buried strip of purple plastic liner, photo foreground, is the international symbol for a treated wastewater pipeline.



Operators at The Geysers will spend an additional $7 million on secondary distribution and injection facilities. Here a Unocal crew is at work.

CCPA Power Plant Closed

On June 27, 1996, commissioners of the Central California Power Agency (CCPA) voted unanimously to shut down the Coldwater Creek Geothermal Power Plant, which is located in The Geysers Geothermal field in Sonoma County, California. CCPA continues to pursue a potential power plant sale.

The 132-megawatt plant, co-owned by the Sacramento Municipal Utility District (SMUD), the Modesto Irrigation District, and the City of Santa Clara, has suffered from a steady decline in geothermal steam supplies since operation began in 1988. It has been operated at less than half its rated capacity.

Project closure and dismantling is expected to cost CCPA members an estimated $10 million to $20 million. However, due to a power surplus available on the market, the members expect to save $7 million to $8 million a year in power costs.

A closure plan will be filed with the California Energy Commission (CEC). Meanwhile, the CCPA will continue to pursue selling the plant. If this is unsuccessful, plant closure could include dismantling the facility, salvaging some equipment, and restoring the site. Plant closure is expected to take two years.

Under the CCPA agreement, SMUD owns 50 percent of the project and operates the plant. The other two partners, Modesto Irrigation District and the City of Santa Clara, own 40 percent and 10 percent, respectively.

Glass Mountain EIS Underway

In April 1996, an environmental impact study (EIS) was begun at the Glass Mountain Known Geothermal Resource Area in Northern California, about 50 miles south of Klamath Falls, Oregon. The EIS was started under an accord reached in March 1996 by Calpine Corporation, in partnership with Trans-Pacific Geothermal Corporation, and their mutual agreement with the Bonneville Power Administration (BPA).

The Glass Mountain EIS will consider impacts from a 45-megawatt, net, geothermal power generation facility, a 24-mile transmission line, and the power-purchase agreements.

Calpine and Trans-Pacific Geothermal entered an agreement in August 1994 with the BPA and the City of Springfield, Oregon, to develop a 30-megawatt geothermal facility at Glass Mountain. The BPA and Springfield hold options to purchase an additional 100 megawatts of power.

In March 1996, Calpine acquired about 25,000 acres of federal geothermal leases at Glass Mountain from Freeport-McMoRan Resource Partners, L.P. The potential capacity of the leases is estimated at 400 megawatts of electrical power generation.

Calpine plans to begin construction on the initial phase of the project in 1997 and begin commercial operations in 1999.

Pacific Northwest Office Opens

In July 1996, Calpine opened a regional office in Portland, Oregon, to serve the Pacific Northwest energy market. The director is Barrett C. Stambler, who will work to expand the base of Pacific Northwest and California customers for the Glass Mountain project. Mr. Stambler will work closely with BPA officials to complete the 30-megawatt pilot project.

The new office is at 400 S.W. Sixth Avenue, Suite 600, Portland, Oregon 97204. The telephone number is (503) 224-3363.

Mammoth Mountain is Restless

Carbon dioxide gas (CO_2) is venting from the sides of Mammoth Mountain, a geologically young volcano in the eastern Sierra Nevada, near the Town of Mammoth Lakes, California. Scientists from the U.S. Geological Survey (USGS) estimate that about 1,200 metric tons of CO_2 are released daily.

According to the USGS, the CO_2 probably comes from deep, multiple intrusions of basaltic magma that are beneath the volcano. The gas could be produced directly from the cooling magma or it could be produced from carbonate rocks that have been heated. The large quantity of released CO_2 suggests that the gas might have been confined in a zone recently breached, allowing it to escape to the surface.

Unfortunately, the CO_2 is killing trees. The first areas of dying forest were observed in 1990. Since then, six tree-kill areas have been identified, each ranging from a few hectares to about 12, and totaling 30 hectares in all.

Trees die when CO_2 inhibits their root function. (Typical forest soils contain about 0.1 percent to 1.5 percent CO_2 ; soils at Mammoth Mountain contain from 30 percent to 96 percent CO_2 .) Some of the dead trees are

by Elizabeth A. Johnson
District Engineer

Area with trees killed by CO_2 gas at Mammoth Mountain. *Photos by E. Johnson.*

This campsite lavatory at Horseshoe Lake was closed after CO_2 was measured in high levels. Note dead trees in the background.

about 250 years old, indicating that the area has been free of such tree kills for at least that period of time.

In addition, the CO_2 is settling into confined spaces in the area, such as subterranean utility vaults and a snow survey cabin. Elevated levels of CO_2 have been measured in campsite lavatories and small tents in a campground at nearby Horseshoe Lake, which was closed as a safety precaution during the 1995 camping season.

Whether the CO_2 discharge presages an eruption at Mammoth Mountain is not known, but the area continues to be monitored and studied.

Long Valley Well Focus of USGS Study

Well *Long Valley Federal 51-20*, drilled in two phases under the U.S. Department of Energy (DOE) Geothermal Program, is a deep geothermal exploration-research well in the Long Valley caldera, near Mammoth Lakes, California.

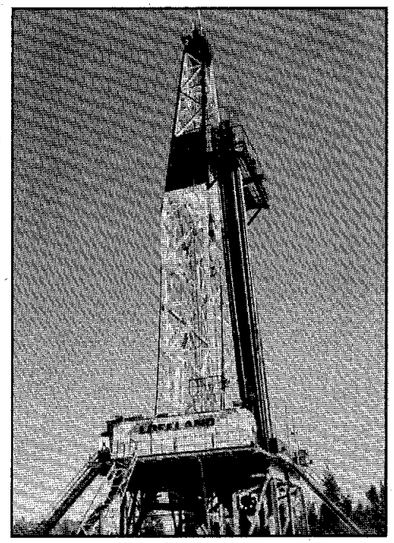
"The well is located at the point of maximum uplift on the caldera's resurgent dome, said John Finger, well program manager and principal investigator for Sandia National Laboratories, under auspices of the DOE. "It is above a widespread aseismic zone possibly associated with the brittle-ductile transition for basement rock, which indicates a temperature above 350^0 C."

Phase I drilling began in August 1989. After the well was drilled to a total depth of 2,568 feet, an additional 185 feet of continuous core was extracted.

During Phase II in the summer of 1991, the well was deepened to 7,130 feet and plugged back to 6,826 feet. Then a 3.85-inch core hole was cut to a total depth of 7,578 feet. Phase II drilling costs of about $2.3 million were shared almost equally by the California Energy Commission (CEC) and the DOE.

In the summer of 1992, scientific research activities were undertaken at the well.

Phase III was designed to deepen the well to a total depth of about 14,000 feet. In the summer of 1993, preliminary work was undertaken by Sandia, which completed remedial cementing, ran a tie-back casing string to the surface, straightened the hole, and installed a high-pressure wellhead.



Well *Long Valley Federal 51-20. Photo by E. Johnson.*

Phase III was never completed. In fiscal year 1995, some well site maintenance occurred and scientific measurements were made. Although the DOE had planned to plug and abandon the well in early 1996, it instead has agreed to give the well to the U.S. Geological Survey (USGS) as an observation well for scientific study.

The USGS wants to drill the well deep enough to find a fairly stable temperature gradient to verify the presence of a heat source under the caldera. To date, the temperatures measured in the well are cool for the depth, perhaps because of the lateral flow of cool groundwater. The USGS also wishes to study how young silicic calderas are formed and change over time.

The USGS program will answer questions of interest to the CEC, Sandia, and the DOE. These include defining the caldera's hydrothermal resource to expand commercial development; learning whether crustal magma exists closer than 25,000 feet to the surface in this area; testing new drilling technology; and furthering scientific understanding of caldera formation and evolution.

Dr. David Hill from the USGS will be chief scientist for the project and Dr. John Sass will be science manager.

Long Valley Hydrologic Advisory Committee Celebrates 10 Years

The Long Valley Hydrologic Advisory Committee started in Mono County, California, as the Long Valley Technical Advisory Committee. It soon became obvious that monitoring deer herds, visual resources, and noise levels was beyond its scope and expertise. The focus was narrowed to hydrologic issues and the committee became the Long Valley Hydrologic Advisory Committee.

The first hurdle was to create the bylaws, which took more than a year and a half. Committee membership was opened to all governmental agencies with geothermal or hydrologic activities in the Long Valley caldera, including permitting, regulatory, and operational. Membership was offered to parties proposing activities that might affect caldera hydrology.

On November 4, 1986, the Mono County Board of Supervisors recognized the need for a local, multiagency technical advisory committee to provide hydrologic monitoring data and suggestions for remediation to permitting agencies within the Long Valley caldera. Today, almost 10 years later, the Long Valley Hydrologic Advisory Committee approaches its second decade as an effective governing tool.

Dan Lyster, director of the Mono County Energy Management Department, is the committee chair. A subcommittee to study proprietary geothermal data includes representatives from Mono County; the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources; and the U.S. Bureau of Land Management. Hydrologic monitoring is performed by scientists from the U.S. Geological Survey.

With a fourth geothermal power plant proposed in Mono County and increased development in the Town of Mammoth Lakes, the need still exists for the committee. The past 10 years have shown that wise decisions come through consensus and open discussions of scientific and technical issues.

Cheryl Seath, on behalf of the Bureau of Land Management, presents a plaque to Dan Lyster, honoring his 10 years of service chairing the Long Valley Hydrologic Advisory Committee. *Photo by E. Johnson.*

by Elizabeth A. Johnson

The Status of Electric Utility Restructuring, with Emphasis on Geothermal and Other Renewables

From an address on April 9, 1996, by James Hendry, advisor on energy and water issues to P. Gregory Conlon, president of the California Public Utilities Commission

Plan Highlights

The California Public Utilities Commission (PUC) first considered restructuring California's electric utilities in April 1994. The goal was to reduce high electricity rates in the state. The rates resulted, in part, from the high costs of nuclear power plants, and from the long-term, electrical-power generation contracts over market rates held by utilities.

The PUC considered many restructuring plans. In December 1995, it decided to distribute electricity to a market driven by customer choice among diverse sources of power generation. The power-generation market will be open to competition and unregulated by the PUC, which wants utilities to divest themselves of 50 percent of their fossil fuel assets.

However, the PUC will regulate the power-exchange marketplace. Direct access by contract will be allowed. The PUC hopes to implement the plan by January 1, 1998.

Electrical transmission will be regulated by the federal government under the Federal Energy Regulatory Commission. The PUC hopes there will be open access to transmission lines -- that they will become common carriers with nondiscriminatory treatment for all power-generation users.

Although the PUC believes utilities should honor existing long-term contracts, it gives them an incentive to renegotiate these contracts while moving into the marketplace. Under the PUC plan, customer surcharges will reimburse utilities for transition costs incurred by prior contractual obligations. The PUC hopes the costs will be met by the year 2003. (Pacific Gas & Electric Company filed a proposal in April 1996 under which it will try to recover its transition costs in five years.)

Energy Diversity and Renewables

The PUC wants to maintain and expand the state's current energy-generation diversity. Though it finds research in renewable energy generation to the public good, it knows the marketplace has problems funding such efforts. The PUC believes improved technology will eventually lower the cost of power generation from renewables, making them competitive. It believes that the California Legislature may have to decide the state's renewable energy policy.

The PUC has established a Renewable Energy Working Group to study effects of restructuring on renewable energy sources and to make recommendations. The group will issue a report to the PUC in the summer of 1996.

In the new marketplace, customer choice will rule. Producers generating electricity from renewable resources at costs above conventional sources must communicate to end users the benefits of "green power" purchases. The system will not allow renewable power producers to rely on long-term utility contracts arbitrated by the PUC.

Some customers will be willing to pay a premium for "green projects," and they offer a new marketing opportunity. End-user choices will decide if renewable resources are used in California to generate electrical power. Under restructuring, all power sellers -- including geothermal operators -- will have the guarantee of the general marketplace instead of specific contracts. This will change the financial market and probably encourage development of a futures energy market and hedging strategies.

By January 1, 1998, the PUC will place a percentage of each California customer group under the restructuring plan. Perhaps a year later, but -- it hopes -- at least by five, the entire marketplace will be restructured. The PUC is working to spur new power contracts, lower electricity costs, and increase customer choices of electrical vendors.

FERC Opens Transmission Lines

On April 24, 1996, the nation's public electric utilities were told to open their transmission lines to competitors by the Federal Energy Regulatory Commission (FERC). This is a major change in the way electricity is sold at wholesale levels in the United States.

FERC chair Elizabeth A. Moler said, "Today's actions by the commission will benefit the industry and consumers to the tune of billions of dollars every year. They will give us an electric industry ready to enter the 21st century. These rules will accelerate competition and bring lower prices and more choices to energy customers."

She was referring to two closely related final rules, Order Nos. 888 and 889, and one Notice of Proposed Rulemaking.

Order No. 888 addresses both open access and stranded cost issues. It opens wholesale power sales to competition. It requires public utilities owning, controlling, or operating transmission lines to file nondiscriminatory open-access tariffs that offer others the same transmission service they provide to themselves. This will lower power costs for electric consumers, ensure continued reliability of the electric-power industry, and provide for open and fair electric-transmission services by public utilities.

The order also provides for the full recovery of stranded costs. These are costs (1) that were prudently incurred to serve power customers and (2) that could go unrecovered if the customers use open access to move to another supplier.

Order No. 889 is now known as the *Open Access Same-time Information System* rule or the *OASIS* rule. It also covers standards of conduct. It works to ensure transmission owners and their affiliates do not have an unfair competitive advantage by using transmission to sell power.

The rule requires public utilities to obtain information about their transmission system for their own wholesale power transactions, such as available capacity, in the same way their competitors do -- via OASIS on the Internet; and to completely separate their wholesale power marketing and transmission operation functions.

Order Nos. 888 and 889 go into effect 60 days after being published in the *Federal Register*. They will affect all public utilities subject to FERC's *Federal Power Act* jurisdiction and their customers. Reciprocity is required for those receiving service under the new tariff. This will affect municipals, electric cooperatives, and federal power marketers.

Under the Notice of Proposed Rulemaking -- the "*CRT*" *Capacity Reservation Open Access Transmission Tariffs* (RM96-11-000) -- FERC proposes to establish a new system for utilities to use in reserving capacity on their own and others' transmission lines. Under the proposed capacity-reservation tariff, utilities and all other power-market participants would reserve firm rights to transfer power between designated receipt and delivery points. FERC proposes that each public utility would replace the Open Access Rule pro forma tariff with a CRT by December 31, 1997.

A time frame for the Notice of Proposed Rulemaking is available from FERC.

CPUC Approves Loan Guarantees

California's three largest power producers requested permission from the California Public Utilities Commission (CPUC) to guarantee loans so that an industry collaborative group could begin developing the underlying computer system for the restructured electrical marketplace. Pacific Gas & Electric Company and Southern California Edison each asked for $112.5 million, and San Diego Gas & Electric asked for $25 million in loan guarantee authority.

In August 1996, loan guarantees for up to $250 million were approved by the CPUC for developing the computer hardware and software that will help industry prepare key components of the new electricity market: the independent system operator (ISO) and the power exchange (PX).

The ISO will control and operate the state's electrical transmission system to provide fair and efficient access. The PX will be a voluntary wholesaler, pooling power from electrical producers and issuing prices periodically to consumers, investors, and power marketers.

Approval to develop the systems now is important, because only 17 months remain until January 1998, the date for initiating a new way of marketing electrical power in California. The Federal Energy Regulatory Commission (FERC) and the CPUC will consider various ISO and PX proposals in that period.

Along with approval, the CPUC pointed out risks to proceeding with the work. Decisions by the California legislature, federal or state courts, FERC, or by the CPUC, itself, could cause the ISO or PX to fail to develop or to evolve in ways that might cause some of the start-up costs to be excluded from federal rates. However, the hardware and software designs chosen should minimize the potential for unrecoverable costs while allowing for a flexible approach to changes required in the ISO or PX.

In the event of exclusion from federal rates, one option the utilities have is to seek recovery of development costs through rates paid by California customers.

A separate trust will be created to oversee development of the ISO and the PX computer systems. Both will include setting up business and engineering computer systems, cable linkups for computers, facilities to house hardware, project management, trust administration, and start-up costs.

The governing boards for the trusts will differ slightly. The ISO board will include independent electricity utilities, governmental and municipal officials, sellers, customers, and nonstakeholders; the PX will include nonutility power producers, customers, buyers/sellers, and distribution companies. A commissioner will be assigned to implement the August order and to ensure the trusts develop as rapidly as possible.

Both the ISO and PX will be regulated by FERC, which will also set rates, practices, and service standards. The CPUC will continue its role of advocating on behalf of California consumers.

The BLM Is 50

This year, the U.S. Bureau of Land Management (BLM) is 50 years old. It was created on July 16, 1946, with the merger of the Grazing Service and the General Land Office in the U.S. Department of the Interior.

According to the BLM, "Originally public lands were regarded primarily as a source of livestock forage, timber, and energy and mineral resources. The passage of the Taylor Grazing Act in 1934 established the U.S. Grazing Service to provide range management on lands under public domain. Today, those traditional uses continue to be important, but the public lands are valued more and more for their environmental resources, the recreational opportunities they offer, the cultural resource they contain, and in an increasingly urban world, their vast open spaces." From the first, we have "...struggled to find a balance between our conservation and land-disposal mandates....and have continued to face challenges to meet the changing uses of public lands."

In 1812, Congress established the General Land Office to administer the 1.8 billion-acre public domain. The lands stretched from the Appalachian Mountains to the Pacific Ocean. Of the original 1.8 billion acres, two-thirds went to citizens, corporations, and the states. Many of the remaining lands were set aside for national forests, wildlife refuges, parks, and national monuments.

Today the BLM manages 270 million acres, about one-eighth of the total land surface in the United States and 41 percent of the lands under federal ownership.

The BLM manages more than 400 geothermal leases nationally and more than 100 geothermal leases in California.

In July 1996, the Sacramento BLM office moved to 2135 Butano Drive, Sacramento, California 95825-0451. The telephone number is (916) 979-2800; and the fax is (916) 979-2867.

Biphase Turbine Installed

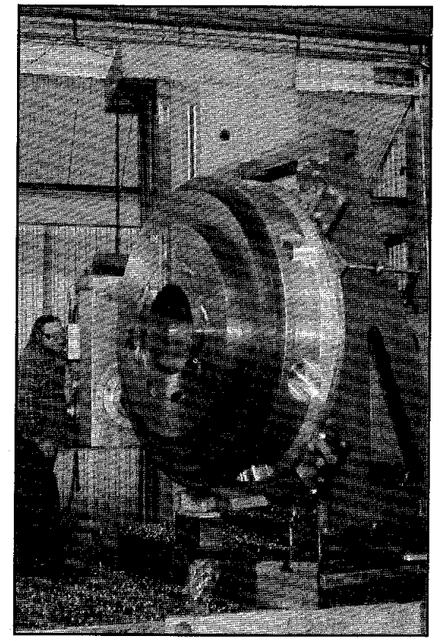
In July 1996, a Biphase turbine was delivered to Cerro Prieto Geothermal field south of Mexicali, Mexico, and installed on well 103. The Biphase wellhead system is expected to raise the well's electrical output by 45 percent. The test is under the auspices of Mexico's Comisión Federal de Electricidad.

"A Biphase turbine, affixed to a wellhead, generates electricity at the well before the steam and hot water are piped to the power plant," said Walter Studhalter, program manager for Douglas Energy Company. "Biphase turbines are designed for wells with wellhead pressures above power-plant needs. Such extra pressures have to be dissipated in any case, and a Biphase turbine uses them to generate electricity.

According to Mr. Studhalter, "The fluids flow at high pressures directly from the well into the Biphase turbine system, where they are separated into vapor and hot-water phases. After electricity is generated from both, the fluids are piped to the main power plant at lower temperatures and pressures, where more electricity is generated. Biphase turbine costs range from $500 to $750 per kilowatt."

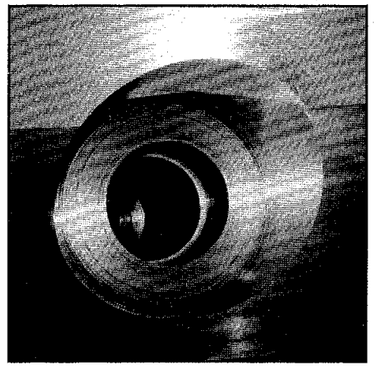
Today's Biphase turbine design is improved from one used in 1985 at Roosevelt Hot Springs, Utah, when it accepted full flow from a geothermal well in a 4,000-hour demonstration test. The Biphase unit generated 1600 kilowatts of electricity and increased power output by

by Susan F. Hodgson

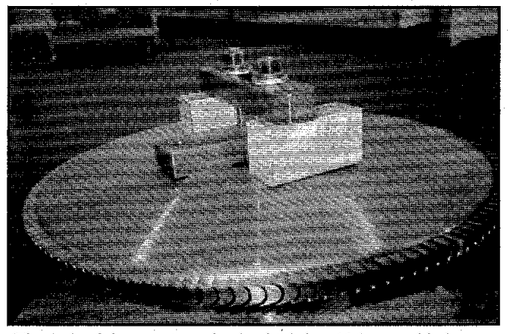


Rob Miller, Allied Engineering & Production Corporation, machines the manifold where the vapor and hot water phases are separated in the Biphase turbine. The internal porting system distributes flow to eight nozzles designed for pressure levels up to 1,000 psi. *Photo by S. Hodgson.*

20 percent from a single-flash power plant system. The project was sponsored by the U.S. Department of Energy (DOE).

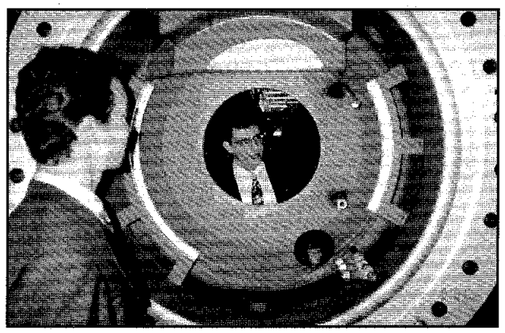


The internal passage for a nozzle insert. *Photo by S. Hodgson.*



The web of the rotating wheel, which has 136 steam blades on its circumference. *Photo by S. Hodgson.*

The 1985 unit had three rotors running at different speeds, a complexity that raised costs and maintenance requirements to economically marginal levels. The 1985 unit used kinetic energy from the liquid phase, but not from the steam phase. (In both designs, fluids are forced to flow under high acceleration through nozzles to convert pressure energy to kinetic energy.)



Case for the Biphase turbine. The manifold plate is bolted to the open side. Nozzles from the hydroblast system use high-pressured water to dislodge scale (upper and lower right). Jeff Hahn of the DOE looks through the mounting hole for the rear bearing. *Photo by W. Studhalter.*

In the new model, only a single rotor is used and impulse steam blades capture kinetic energy from the steam phase. A new hydroblast system removes scale, and a computerized control system allows for automatic control from a remote location.

The new design was built at sub-scale size and tested at a geothermal production well in Coso Geothermal field, in the high desert of Southern California. Three 250-hour tests were made on slip-stream flows at low, medium, and high enthalpy.

Under a grant from the California Energy Commission and with support from the DOE, a full-sized Biphase turbine was manufactured at Allied Engineering & Production Corporation in Alameda, California (*see* photos).

Heat-pump Training Funded

Geothermal heat pumps, often called ground-source heat pumps, are energy-saving devices relatively unknown in California. Few people in the state either own or install geothermal heat pumps.

A strong educational training program is needed to bring this technology into the California marketplace. To this end, public utilities, public agencies, a nonprofit consortium, and a geothermal trade association have pooled funds and efforts to base a heat-pump training center in Davis, California.

The center will be funded with an award of $157,337 to the Geothermal Energy Association (GEA) from the California Energy Commission (CEC), and with matching funds of $402,000 from Pacific Gas & Electric Company, the Sacramento Municipal Utility District, the Truckee-Donner Public Utility District, the Plumas-Sierra Rural Electric Cooperative, and the Geothermal Heat-pump Consortium.

The Geothermal Heat-pump Consortium was founded as a nonprofit corporation by the Edison Electric Institute. The U.S. Department of Energy has pledged six years of support for the consortium's program to have 400,000 geothermal heat pumps installed each year in the United States by the year 2001.

The CEC funds will be used for two mobile field laboratories, instructional equipment, materials development, program management, and training.

Trainers in mobile laboratories will cross the state, offering heat-pump basics to California designers, architects, and engineers; city, county, and state officials; environmental planners and inspectors; and construction and utility workers. Major utility companies will participate, as peak power loads could fall significantly with widespread use of heat-pump technology.

Certified and uncertified courses will cover designing, installing, and operating geothermal heat-pump systems. The students will become an infrastructure for heat-pump development in California.

Geothermal heat pumps can heat and cool buildings efficiently with relatively simple technology. Basically, heat is transferred from the ground to the building in the winter, and from the building to the ground in the summer using pumps, a heat exchanger, and a large network of plastic tubing filled with water.

Geothermal Awards by CEC

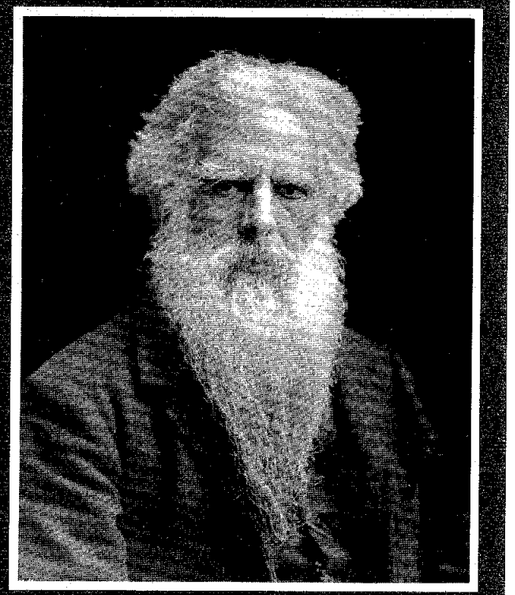
The California Energy Commission (CEC) awarded over $3.5 million to four projects through its Geothermal Program during fiscal year 1995-96. About $4.1 million is available for funding in fiscal year 1996-97.

Recipient	Project
Calpine Corporation	Drill and test a production well to evaluate the potential of the Glass Mountain geothermal reservoir.
Truckee-Donner Public Utility District	Establish and coordinate training for geothermal heat-pump technicians, who will serve the geothermal heat-pump market in California.
Pacific Gas & Electric Company	Identify and resolve the major technical and market barriers limiting market penetration of geothermal heat pumps in California.
Douglas Energy Company	Add a back-pressure steam turbine to a commercial-scale demonstration of the Biphase turbine at Cerro Prieto Geothermal field, Mexico.

The CEC funds partnerships with private and public entities to promote the development of new geothermal resources and technologies. A project must relate directly to geothermal energy and be located in California or sponsored by a California-based company. There are no predetermined funding limits, but the applicant must provide a matched contribution of cash, equipment, and/or in-kind services. Contact the CEC Geothermal Program, at (916) 654-5129.

by Elizabeth Johnson
District Engineer

EADWEARD MUYBRIDGE, EARLY GEOTHERMAL PHOTOGRAPHER



"We've all seen his pictures of The Geysers. We just didn't know they were his."

Who Was Muybridge?

Eadweard Muybridge (pronounced *Edward Mybridge*) (1830-1904) made three outstanding contributions to photography, writes Robert Bartlett Haas in *Muybridge, Man in Motion*.

Muybridge photographed the American West from Alaska to Central America, but especially California (including The Geysers) with pictures Haas calls "...superior to that of any photographer working as his contemporary."

He was first "...to develop a practical system for taking a series of instantaneous photographs of an object in rapid motion."

Finally, he was first to invent motion pictures, projecting "...images derived from his sequential, instantaneous photographs upon a screen, commercially, for the instruction and enjoyment of large audiences."

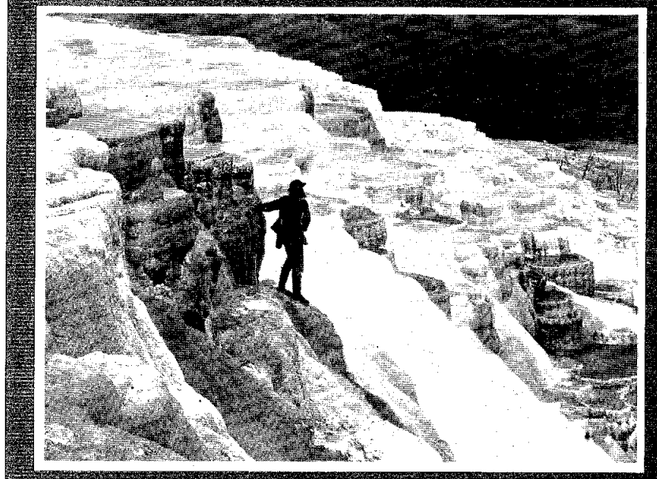
Early Geothermal Photographer

Perhaps Eadweard Muybridge was first to photograph The Geysers Geothermal field. We've all seen the pictures he took of The Geysers in 1870 -- views of the white clapboard hotel and guests posed along the piazza; and many shots of Geyser Canyon -- some with men in waistcoats and women in long gowns standing by hot springs and fumaroles, and some of the heavy canyon walls laced by delicate, steamy wafts. We just didn't know they were his.

I found out by chance, while reading an article about The Geysers in the October 1873 issue of *Scribner's Monthly*. Called "The Geysers of California," by Benjamin P. Avery, it included many familiar drawings of The Geysers that have been published time and again, including the

Continued on page 22

by Susan F. Hodgson



Thomas Moran at Mammoth Hot Springs, Yellowstone, 1871. Photograph by William Henry Jackson; courtesy National Park Service, Yellowstone National Park.

EADWEARD MUYBRIDGE TO THOMAS MORAN

"Not only had a world-famous photographer taken the pictures and gone unnoted for it, but a world-famous artist had drawn them and was equally unrecognized."

Thomas Moran, Geothermal Artist

Learning that a *Scribner's Monthly* artist used Eadweard Muybridge photographs to illustrate an article about The Geysers published in 1873, I searched the magazine for other geothermal articles with Muybridge's work. I found none.

Instead, I came across several articles about Yellowstone, now Yellowstone National Park, published in the same era. As is well known, these articles were beautifully illustrated by Thomas Moran (1837-1926), world-renowned artist of majestic landscapes, widely remembered for his gorgeous vistas of Yellowstone and the Grand Canyon. (Two Moran canvases depicting these areas were purchased by the U.S. Government and hung in the Capitol Building in Washington, D.C.)

Moran biographers note that he signed his work in various ways. Sometimes he wrote his name as *T. Moran*; sometimes he used the initials TYM, superimposing the T and Y over the M -- the Y stood for *Yellowstone*.

Now wondering who had illustrated Muybridge's photographs of The Geysers for *Scribner's*, I looked at the works more closely. There in the corners, the artist had placed three superimposed initials, *TYM*.

Not only had a world-famous photographer taken the pictures and gone unnoted for it, but a world-famous artist had drawn them and was equally unrecognized.

Artist of the West

About three years before his illustrations of The Geysers, Thomas Moran started his Yellowstone series at *Scribner's Monthly* in New York City. It all began when *Scribner's*

Continued on page 23

Eadweard Muybridge, continued from page 20

famous "View from the Witches' Cauldron." I knew that illustrations like these often were drawn from photographs.

About the Witches' Cauldron, Avery wrote, "A clever photographer, Mr. Muybridge, conceived the idea of grouping three lady visitors about this cauldron, with hands linked, and alpenstocks held like magic wands, in which position he photographed them amid the vaporous scene with telling effect."

Reading this I thought, there couldn't be two *Muybridges*. And, if Eadweard Muybridge took this photo, where would it be? I called the nearby Bancroft Library, which houses a wonderful collection of California history on the UC Berkeley campus. The curator of photography listened to the description of the Witches' Cauldron and said yes, the photo was in their Eadweard Muybridge collection. The mystery was solved.

That photo and a few others by Muybridge are in this *Hot Line* issue. You may recognize them, for they are reprinted often, but without attribution. Other well known -- and probably some less well known -- photos of The Geysers by Muybridge are also archived at the Bancroft Library and in collections of his work throughout the United States and Great Britain.

A final puzzle was solved as I sat and looked at Muybridge's photos. At last I realized why many historical pictures of The Geysers hold a curious similarity, a singular aesthetic. They were taken by the same person.

A Look at his Career

Eadweard Muybridge was first to photograph animal and human locomotion. His rapid sequence, still photos of moving animals and people are world-famous. Most people recall his first sequence from 1872, that of a galloping horse photographed for Leland Stanford, former governor of California. Stanford had wagered that at some point the horse's hooves would all be off the ground at once. Muybridge's photos proved this was true, at the moment when the legs bend toward each other under the horse's belly. After Stanford won the bet, he helped Muybridge customize photographic equipment for the locomotion studies that would follow.

Such studies progressed well in many directions. In 1879, Muybridge invented motion pictures with a device he called a *zoopraxiscope*, which he never patented. He put his sequential, still-motion photos on glass discs that were mounted on a spindle turned with gears. As the discs were spun, "moving" pictures, such as an athlete turning a somersault on horseback, were projected on screens before audiences. The first public showing was in 1880 at the California School of Fine Arts in San Francisco.

"By every definition of cinematography, Muybridge's instantaneous photographic, magic lantern zoetrope was the fist motion picture presentation in the world," writes Beaumont Newhall, photographic historian. George Nitzsche, another historian, notes that Muybridge talked with Thomas Edison in 1888 about combining the zoopraxiscope and the phonograph -- picture and sound. "Edison made his first continuous movie on strip film using Muybridge's motion photographs of running horses."

Muybridge was born Edward James Muggeridge on April 9, 1830 in Kingston-on-Thames, near London. He changed his name himself, in a way he said was closer to the original Anglo-Saxon, and came to the United States at age 21. He studied photography in New York, moved to San Francisco, and by 1869 had made photography a career.

An early project was to photograph panoramas of natural wonders in California and throughout the West. He printed and sold these as stereographs -- stereoscopes were very fashionable. His shots of The Geysers from 1870 were part of this work. His photos of Yosemite from this project brought him world fame.

Muybridge compiled and published pictures from the western trips in a sample book titled, *Catalogue of Photographic Views, Illustrating the Yosemite Valley, Mammoth Trees, Geyser Springs, and Other Remarkable and Interesting Scenery of the Far West.*

Soon Muybridge began working with Stanford on motion photography, which he continued to study and write about for the rest of his life.

But the pictures of The Geysers remain, a legacy from the early days of Eadweard Muybridge's photographic career. He has left us a past to wonder at and reflect upon, without receiving -- oddly enough -- the credit he deserves.

Selected References

Haas, Robert Bartlett, *Muybridge, Man in Motion.* University of California Press, Berkeley, Los Angeles, London. 1976.

Muybridge to Moran, continued from page 21

asked Moran to illustrate a Yellowstone article submitted by Nathaniel Langford, member of the 1870 Washburn-Doane expedition. Moran based his 14 black and white washes on rough sketches by two explorers from the expedition and Langford's descriptions.

The article was part of a public relations campaign by the Washburn-Doane explorers. Every way they could, they spread word of Yellowstone's beauty. They wrote newspaper articles, a congressional report, and Langford lectured in several cities. He was paid by Jay Cooke, financial agent for the Northern Pacific Railroad, which wanted to promote tourism in the American West.

On seeing Moran's work, officials of the Northern Pacific asked the U.S. Government to include him in the upcoming 1871 expedition to Yellowstone. They wrote, "...Mr. Moran is an artist (landscape painter) of much genius, who desires to take sketches of the upper Yellowstone regions, from which to paint some fine pictures on his return." The expedition would be led by Dr. Ferdinand V. Hayden, chief of the Department of the Interior's U.S. Geological Survey of the Territories.

The government agreed and Moran met the Hayden expedition in Virginia City, Montana Territory. He had never ridden a horse but he soon adjusted, helped by a pillow tied to his saddle. Once at Yellowstone, Moran was inspired. The exquisite line, color, and composition in his many sketches and paintings capture great beauty.

The expedition returned east in 1872 and Moran painted many Yellowstone pictures and illustrated yet another Yellowstone article for *Scribner's*, this one written by Dr. Hayden. Moran's Yellowstone paintings not only shaped his own career, but helped Hayden convince Congress and President Ulysses S. Grant to designate Yellowstone as the first national park in 1872.

In late 1872, Moran left on another western expedition. He accompanied Major General John Wesley Powell to the canyons of the Colorado River. Powell thought Moran's work brilliant, capturing both the depth and breadth of the Grand Canyon.

Scribner's Monthly wrote about Moran, "Here you behold almost equal mastership with pencil, brush, and etching needle -- ink, watercolor, oil; unsurpassed brilliancy in effect; seldom-equaled intelligence and delicacy in detail. He knows the language of the rocks, the curving pathway of the branch out toward the light, the sky's every trick of cloud and color."

Moran Point, Mount Moran, and Moran Canyon, famed western sites -- all are named after Thomas Moran. Many Thomas Moran paintings can be seen at the Thomas Gilcrease Institute of American History and Art in Tulsa, Oklahoma.

IMAGING THE GEYSERS
Witches' Cauldron -- Macbeth, Act V, Scene I

"Eye of newt and toe of frog,
Wool of bat and tongue of dog...
Double, double, toil and trouble;
Fire burn and cauldron bubble."

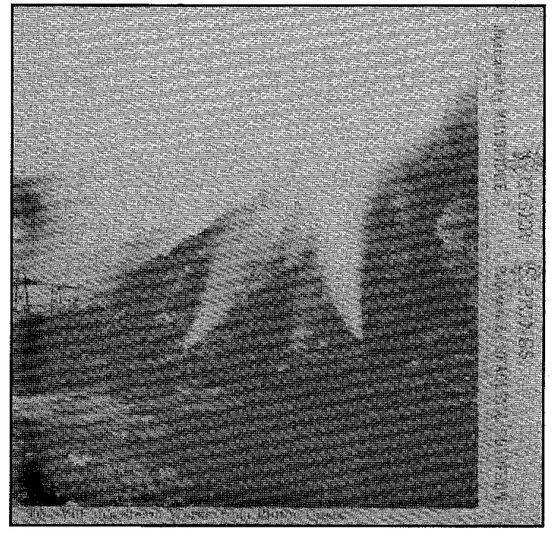
"The Witches' Cauldron is a black cavernous opening in the solid rock, about seven feet across, and of unknown depth, filled with a thick inky liquid, boiling hot, that tumbles and roars under the pressure of escaping steam....that seems to proceed from some Plutonic reservoir. One irresistibly thinks of the hellbroth in *Macbeth*.

"A clever photographer, Mr. Muybridge, conceived the idea of grouping three lady visitors about this cauldron, with hands linked, and alpenstocks held like magic wands, in which position he photographed them." Benjamin P. Avery, *Scribner's Monthly,* October 1873.

From a stereograph by Eadweard Muybridge, 1870. *Courtesy, The Bancroft Library.*

Drawing by Thomas Moran of the Muybridge photograph. Note the initials in the lower right-hand corner. Published by *Scribner's Monthly,* October 1873.

IMAGING THE GEYSERS
Vulcan's Steam-works, from Pluton Creek (Big Sulphur Creek)



From a stereograph by Eadweard Muybridge, 1870. *Courtesy, The Bancroft Library.*

Drawing by Thomas Moran of the Muybridge photograph. Published by *Scribner's Monthly,* October 1873.

IMAGING THE GEYSERS
From stereographs by Eadweard Muybridge, 1870.
Courtesy, The Bancroft Library.

View up the Canyon, from the Witches' Cauldron.

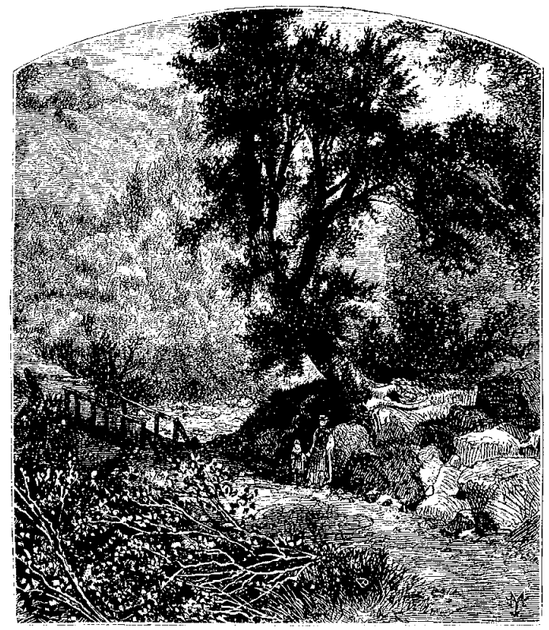
Cooking eggs at the Witches' Cauldron.

View up the Canyon, from the Witches' Cauldron.

Trout fishing on Pluton Creek.

IMAGING THE GEYSERS
Drawings by Thomas Moran
Published by Scribner's Monthly, October 1873

The Devil's Canyon. View looking up.



Bridge over Pluton Creek.

Devil's Tea-kettle.

CONFERENCES

International Conference on Mathematical Models in Renewable Energy, September 17-20, 1996, Makhachkala, Daghestan, Russia. Organized by the Russian Academy of Sciences (RAS) -- the Department of Physical and Technical Problems of Power Engineering, the Russian Foundation of Fundamental Investigations, the Administration of the Republic of Daghestan, the Daghestan Scientific Centre of the RAS; the Centre of Small Power Engineering of Daghestan, and the Geothermal Research Institute.

The conference will focus on using calculation mechanics and mathematics to solve problems of renewable energy, including calculation mechanics, heat physics of geothermal systems, calculation methods for renewable energy, and geophysical simulation. The official languages are Russian and English.

Contact Dr. Rasul M. Aliyev, Geothermal Research Institute, Kalinin Ave. 39a, Makhachkala 367030, Russia. Fax 7(8722)629357.

1996 Annual Meeting of the Geothermal Resources Council, September 30-October 2, 1996, Portland, Oregon. Sponsored by the Geothermal Resources Council. Four field trips are planned.

Simultaneous translations in Spanish and Japanese. For information, contact the GRC at PO Box 1350, Davis, CA 95617-1350. Telephone (916) 758-2360.

4th Congress of the Mexican Geothermal Association, November 6-9, 1996, Guadalajara, Jalisco, México. Sponsored by the Mexican Geothermal Association.

Technical presentations at the congress are from the scientific, academic, and industrial communities. They help promote geothermal exploitation, development, and research activities in Mexico and abroad.

The congress will be held in Zapopán, 10 minutes from Guadalajara, at the Villa Primavera Hotel in the forest of La Primavera, part of the University of Guadalajara.

Contact Dr. M. César Suárez A. Fax: 52 43 14 4735; e-mail: msuarez@zeus.ccu.umich.mx

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The 18th New Zealand Geothermal Workshop, November 6-8, 1996, Auckland, New Zealand. Organized by the Geothermal Institute and the New Zealand Geothermal Association in conjunction with the Centre for Continuing Education, The University of Auckland. The meeting is a forum for exchanging information on all aspects of geothermal exploration, development, and use, including materials, standards, and environmental and legal issues. Case studies are included.

Contact Professional Courses, Centre for Continuing Education, The University of Auckland, Private Bag 92019, Auckland, N.Z. Telephone 64-9-373 7599, extension 7050; fax 64-9-373 7419.

22nd Stanford Workshop on Geothermal Reservoir Engineering, January 27-29, 1997, Holiday Inn, Palo Alto, California.

A short course, *Reservoir Engineering of Two-phase Reservoirs*, is planned on January 30 and 31; and a trip to The Geysers Geothermal field on February 1. Workshop, $260 ($300 in 1997); proceedings, $50; short course, $150 ($175 in 1997); field trip $20 ($50 in 1997).

The workshop on recent developments in geothermal reservoir engineering should interest those involved in the commercial exploitation of geothermal energy, such as reservoir engineers and scientists, plus project operators and developers.

Contact Dr. Shaun D. Fitzgerald, Geothermal Program Manager, Department of Petroleum Engineering, Stanford University, Stanford, CA 94305-2220. Telephone (415) 725-2728; fax (415) 725-2099.

Terrane Dynamics 97, February 10-14, 1997, Christchurch, New Zealand. Sponsored by the Department of Geological Sciences, University of Canterbury; Royal Society of New Zealand; and Institute of Geological and Nuclear Sciences.

The conference will highlight terrane place of origin, the dynamics of terrane displacement, identifying terranes in old orogenic belts, and developing a general theory of terrane geology, which often includes geothermal areas.

For information, contact Dr. J.D. Bradshaw, Dept. of Geological Sciences, Univ. of Canterbury, Private Bay 4800, Christchurch, New Zealand.

PUBLICATIONS

Geology and Ore Deposits of the American Cordillera. $125. Proceedings from the April 1995 Symposium. ***Field Trip Compendiums*** are $65.00. Order from the Geological Society of Nevada, P.O. Box 12021, Reno, Nevada 89510-2021.

Geology of the Mexican Republic. By Dante Morán-Zenteno. $67; $45, AAPG members; call for mailing costs. Translated from the Spanish, and with an additional annotated bibliography by James Lee Wilson and Luis A. Sánchez-Barreda. Available from the AAPG Bookstore, P.O. Box 979, Tulsa, OK 74101-0979. Telephone 1-800-364-2274.

The book offers the best and most complete summary of Mexico's structurally complex and economically important regional geology. The original references have been augmented with hundreds of annotated references from Mexican geological literature between 1983 and 1993. The original maps and diagrams are redrafted.

Geologic and Natural History Tours in the Reno Area. By Becky Weimer Purkey and Larry J. Garside. Paperback, 212 p., illustrations and photos, ***and***

Geologic Tours in the Las Vegas Area. By Becky Weimer Purkey, Ernest M. Duebendorfer, Eugene I. Smith, Jonathan G. Price, and Stephen B. Castor. Paperback, 156 p., illustrations and photos.

The books are $10.95 each, plus shipping: UPS is $4.50 for the first book and $.50 for each additional book; U.S. Postal Service book rate is $3.00 for the first book and $.50 for each additional book. Published by and available from the University of Nevada Press, Mail Stop 166, Reno, NV 89557-0076. Telephone (702) 784-6573.

In the volumes, the authors bring to life two spectacular geologic histories, those of the Reno - Lake Tahoe area and the Las Vegas area. Interesting geothermal elements are in each. The books are organized into a series of fascinating tours, and mileage and driving conditions are noted.

Every tour is replete with photos and illustrations, including many geologic diagrams. Plants, animals, and cultural history are described and amply illustrated. A glossary and bibliography are included.

Geothermal Energy, Current Abstracts, DOE/GET-95/6 (PB95-914700). By the U.S. Department of Energy's Office of Scientific and Technical Information for the Office of Energy Efficiency and Renewable Energy. Paperback; 18 pages for the Nov.-Dec. 1995 issue. Bimonthly, available by subscription from the National Technical Information Service (NTIS). Each issue costs

about $20.00 and the cost will vary. There are two ways to subscribe. You may give NTIS a credit card number or you may set up a prepaid account. Call NTIS subscriptions at (703) 487-4630.

The publication is one of a series organized by energy type, called current awareness publications. Facts of publication and abstracts are cited for literature published worldwide.

Selected Cost Considerations for Geothermal District Heating in Existing Single-family Residential Areas. 1996. By Kevin Rafferty, Geo-heat Center. Free. Available from the Geo-heat Center, Oregon Institute of Technology, Klamath Falls, Oregon 97601. Telephone (541) 885-1750.

For OIT publications, copies of the *Bulletin*, and studies of California geothermal sites, visit OIT on the world-wide web, at http://www.oit.osshe.edu/~geoheat

Mr. Rafferty writes that district heating has not been used widely in single-family homes because of low heat-load density. His report studies characteristics of residential areas that enhance the economics of district heating.

NEW ADDRESSES

FOR: Dennis Trexler, Thomas Flynn, Paul Buchanan, and Susan Wehrkamp

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PHONE AND FAX: Unchanged

FOR: The Earth Sciences Division
Lawrence Berkeley National Laboratory

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B90-1116
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NEVADA WELL DATA SOUGHT

Data from Nevada geothermal temperature-gradient wells and slim holes are being collected for a database by the Nevada Bureau of Mines and Geology (NBMG).

The database will preserve geothermal data gathered by industry in the 1970s and early 1980s, minimizing the need for re-collection. The effort is funded by the U.S. Department of Energy.

The NBMG is interested in geothermal well files, maps, and temperature logs, including partial information on proprietary data, for which the owner will be listed.

Location information for temperature-gradient holes is especially important. The locations will be added to a database used for interactive search in a Geographic Information System, such as ArcView.

Contact Larry Garside or Daphne D. La Pointe at the NBMG, Mail Stop 178, Reno, Nevada 89557-0088. Telephone (702) 784-6691.

CALIFORNIA WELLS

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 Department of Conservation, Division of Oil, Gas, and Geothermal Resources. All data are in metric units. The file may be purchased at cost from the division in Sacramento.

Drilling Permits for Geothermal Wells Approved December 1995 to July 1996 by the Department of Conservation

Date Notice Received	Operator Well Name & No.	API Number	Sec.T.R.	Location & Elevation
	 **DISTRICT G1**			
None to Report				
	 **DISTRICT G2**			
	Imperial County			
	MAGMA OPERATING COMPANY			
12/05/95	"Vonderahe" 2	025-91252	5 12S 13E	Fr SE cor 747m N, 359m W, el -69m gr
02/13/96	"Elmore" 101	025-91253	5 12S 13E	Fr SW cor 39m N, 74m E, el -69, gr
03/14/96	"Elmore" 16	025-91254	27 11S 13 E	Fr SW cor 759m N, 883m E, el -69m gr
05/01/96	"IID" 17	025-91256	5 12S 13E	Fr SW cor 131m N, 73m E, el -68m gr
	Riverside County			
	GOLDEN LANTERN MOBILE HOME PARK			
01/31/96	"Spa" 1	065-90189	11 3S 5E	NW ¼, SW ¼, Sec. 11
	MIRACLE MANOR			
02/25/96	"Miracle Manor" 1	065-90187	32 2S 5E	SW ¼, NE ¼, Sec. 32, el 229m gr
	DESERT CREST COUNTRY CLUB			
04/09/96	"Desert Crest" 4-96	065-90188	10 3S 5E	SW ¼, NE ¼, Sec. 10, el 215 gr
	TAMARISK MOBILE HOME PARK			
06/11/96	"Tamarisk" 2	065-90190	14 3S 5E	NE ¼, SW ¼, Sec. 14, el 366 gr

Date Notice Received	Operator Well Name & No.	API Number	Sec.T.R.	Location & Elevation
	**DISTRICT G3**			
	Lake County			
	CALPINE CORPORATION			
7/19/96	"Davies State 5206" 5	033-90741	36 11N 8W	Fr NW cor 1067m S, 472m E, el 585m gr

TR02(9-96-DWRR-2M) Printing by DWRReprographics

Department of Conservation
Division of Oil, Gas, and
Geothermal Resources
801 K Street, MS 20-20
Sacramento, CA 95814-3530

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