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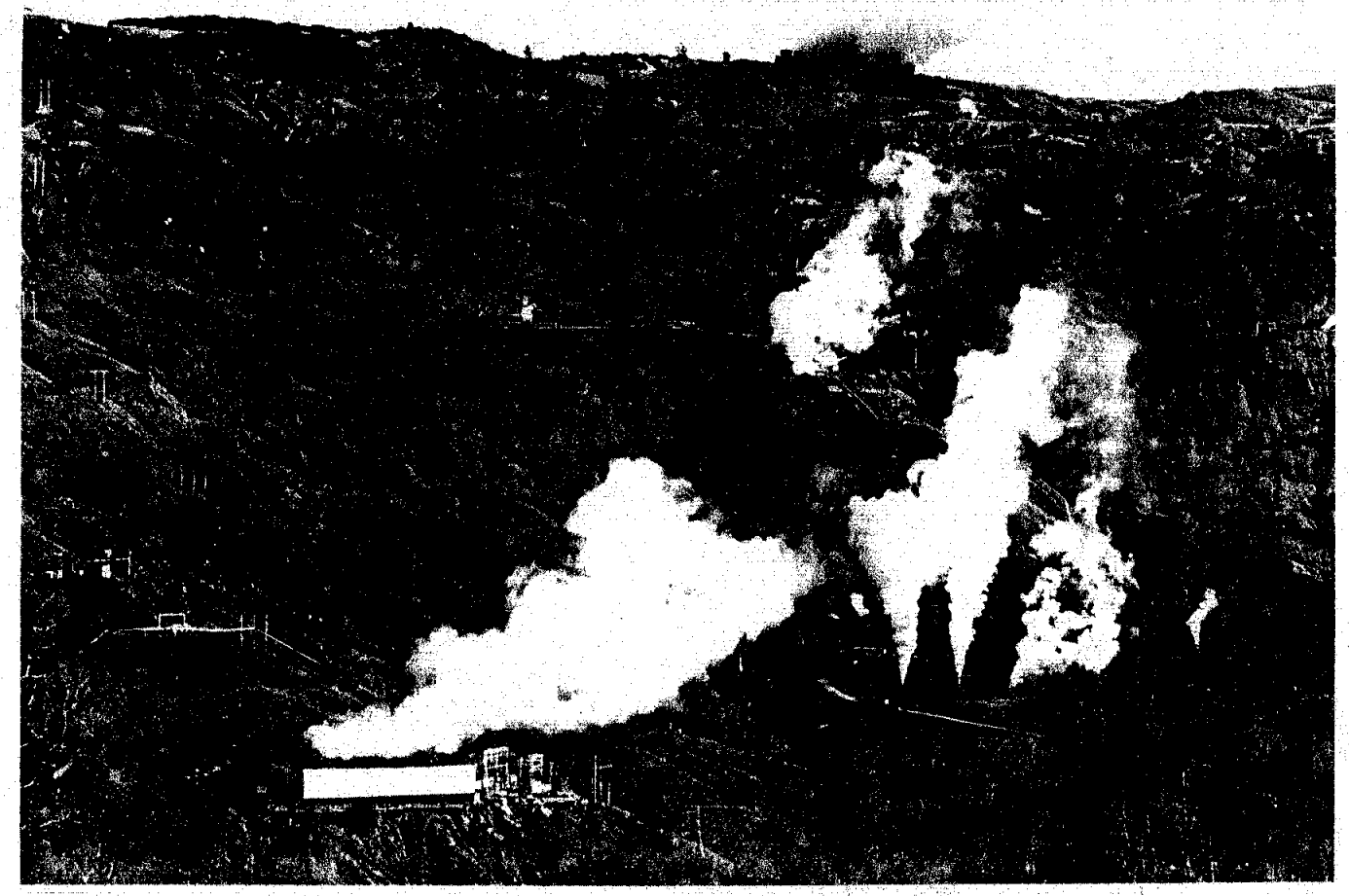


GEOTHERMAL HOT LINE

A Publication of the California Division of Oil & Gas

MAY 1979 Vol. 9 No. 2

UPDATE: THE GEYSERS

The world's largest geothermal steam-generating plant, Pacific Gas and Electric Company power plant Unit 13, is under construction at The Geysers Geothermal field. Unit 13, scheduled to be completed by the end of 1979, is expected to begin commercial operation early in 1980. Aminoil USA wells will supply 2.7 million pounds of steam per hour to the 135 MWe plant.

Presently, 608 MWe are produced from The Geysers field. The new total of 743 MWe will provide the electrical needs of more than 700,000 residential customers.

Pacific Gas and Electric Company has filed an application with the California Energy Commission to build power plant Unit 18 in The Geysers Geothermal field in Sonoma County, California.

The unit will have a 110 MWe generator, capable of supplying the electrical needs of 100,000 residential customers. It will be powered with dry steam from 15 wells drilled by Union Oil Company

Continued on page 3.

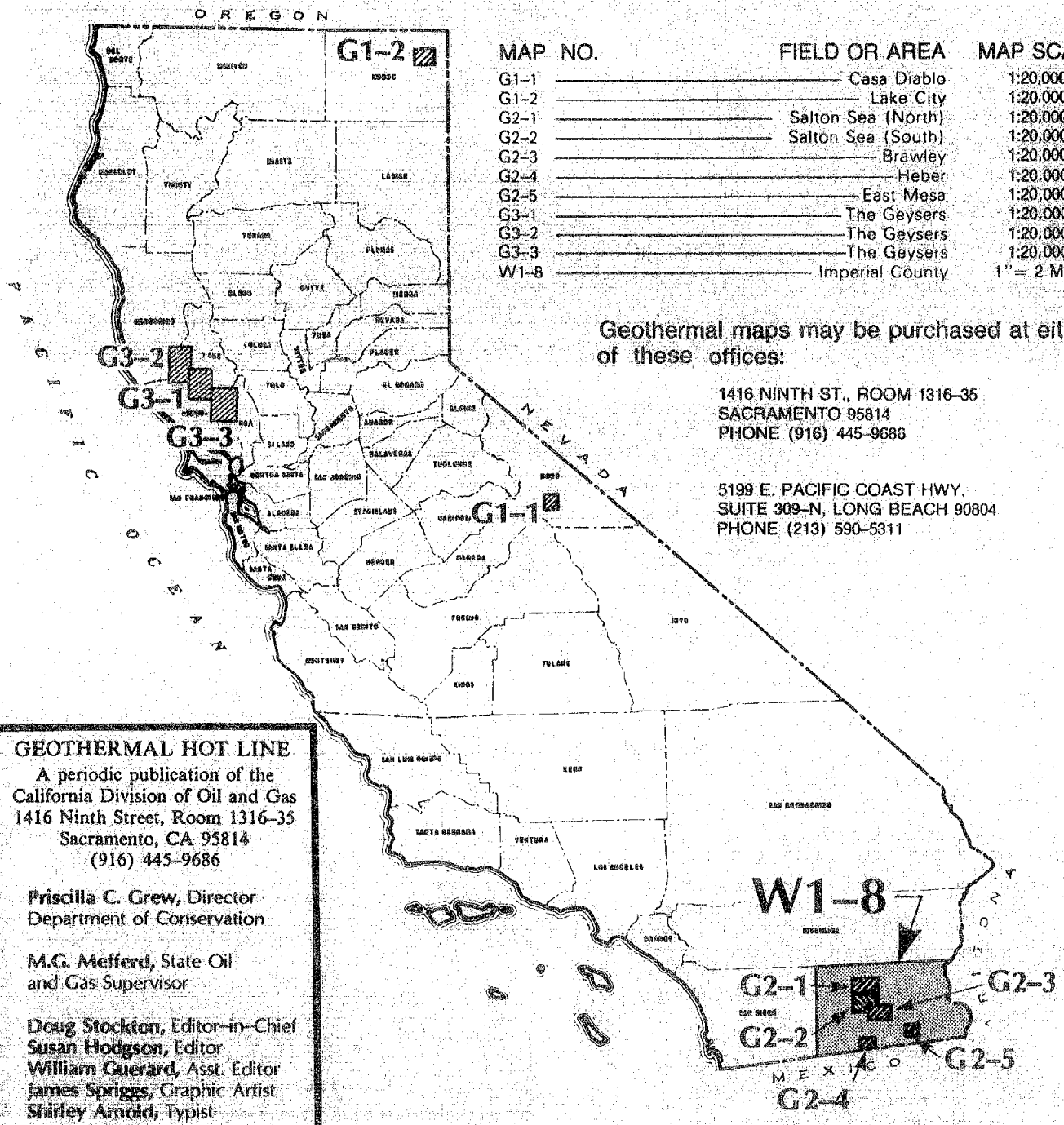
FRONT COVER

The Geysers Geothermal field. Pacific Gas and Electric (PG&E) power plant Units 7 and 8 are at the top of the hill, photo right. The units began operating in 1972. PG&E power plants Units 3 and 4 are at the bottom of the photo, to the left. They began operating in 1967 and 1968, respectively. Steam in the photo not emitted by the power plants comes from producing wells. Pipelines and power lines are also shown. Photo courtesy of Pacific Gas and Electric Company.

California Division of Oil and Gas

GEOTHERMAL MAPS

ALL MAPS ARE AVAILABLE AT A COST OF $3.00 PER COPY.



MAP NO.	FIELD OR AREA	MAP SCALE
G1-1	Casa Diablo	1:20,000
G1-2	Lake City	1:20,000
G2-1	Salton Sea (North)	1:20,000
G2-2	Salton Sea (South)	1:20,000
G2-3	Brawley	1:20,000
G2-4	Heber	1:20,000
G2-5	East Mesa	1:20,000
G3-1	The Geysers	1:20,000
G3-2	The Geysers	1:20,000
G3-3	The Geysers	1:20,000
W1-8	Imperial County	1" = 2 Mi.

Geothermal maps may be purchased at either of these offices:

1416 NINTH ST., ROOM 1316-35
SACRAMENTO 95814
PHONE (916) 445-9686

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

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of California. The depths of completed wells will vary from 1372m (4,500 feet) to 3048m (10,000 feet).

The energy potential of The Geysers Geothermal field is discussed by V. E. Suter of Union Oil Company of California in "The Application of Petroleum Engineering to Geothermal Development" (SPE 7987), a paper published by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (see page 9).

Suter says enough power plants are either under construction or in the permitting process at The Geysers to raise the generating capacity of the field to 1,300 MWe. He adds that The Geysers' field boundaries are not known; the field could be large enough to supply 2,000 to 3,000 MWe, or the electrical needs of 2-to 3-million residential customers.

Southwestern U.S. & Mexico

Transmission Line Planned: Arizona to Southern California

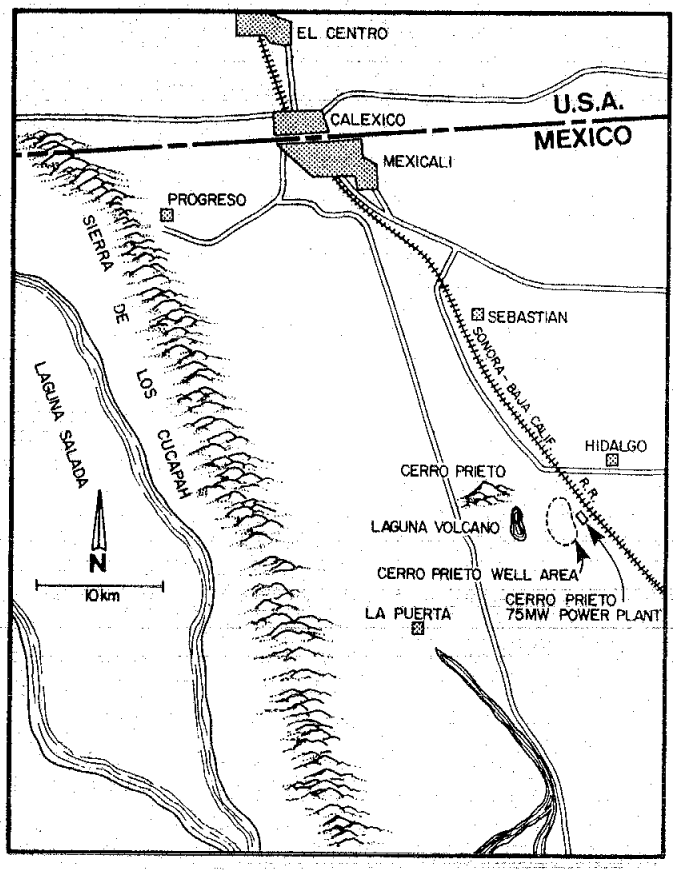
According to San Diego Gas and Electric Company (SDG&E), a 500 kilovolt transmission line will be built between the Palo Verde Nuclear Generating System, west of Phoenix, Arizona, and a SDG&E substation in the Imperial Valley, with a proposed connection into San Diego. The transmission line could be used to transmit electrical energy generated in the Imperial Valley as well as energy from Mexican power sources. The line may help to accelerate the development of geothermal resources in the Imperial Valley.

Cerro Prieto Development

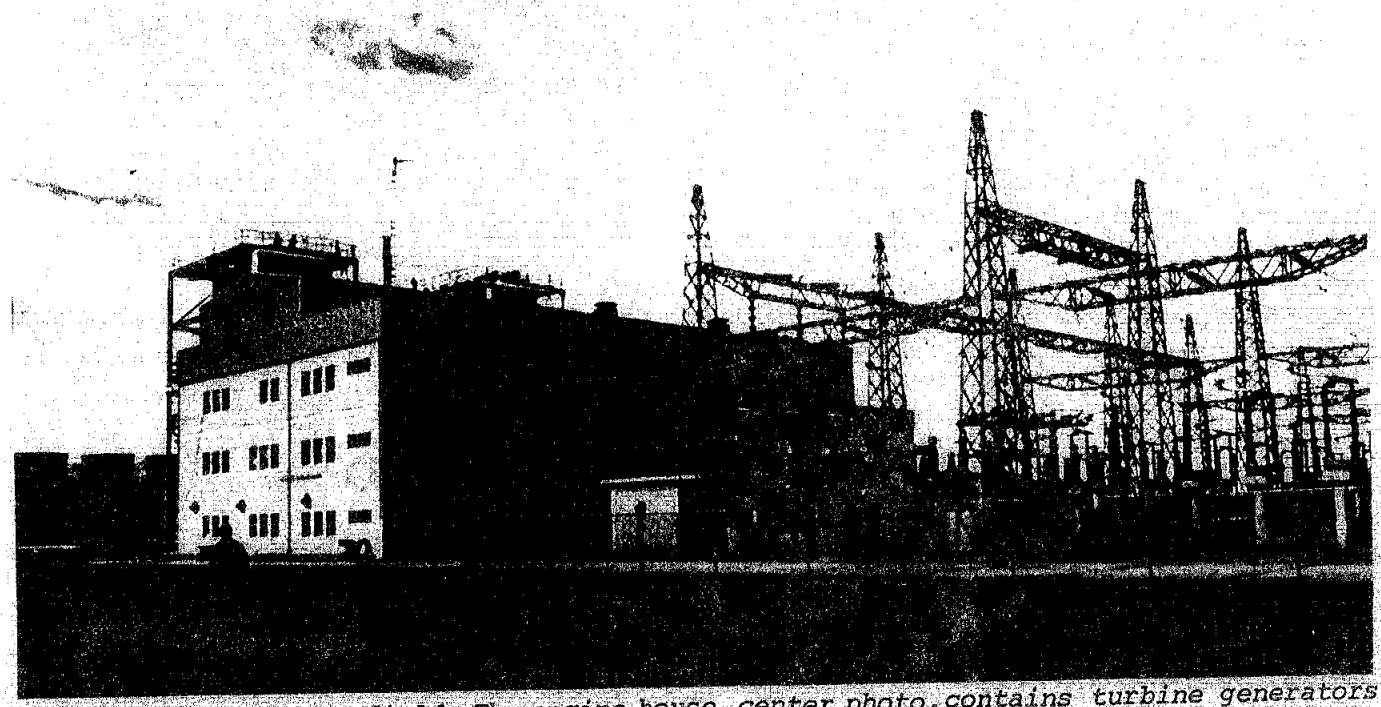
Units 3 and 4 of the Cerro Prieto Geothermal Power Plant were officially inaugurated on April 24, 1979 by the President of Mexico, José Lopez Portillo. The field is about 20 miles south of Mexicali in Baja California. The new units will raise the field's electrical power output to 150 MWe from 75 MWe.

The University of California's Lawrence Berkeley Laboratory is coordinating all U.S. technical activities at Cerro Prieto under a 5-year agreement between the Mexican Comisión Federal de Electricidad and the U.S. Department of Energy.

According to a report by Paul Jacobs printed in the Los Angeles Times, San Diego Gas and Electric Company (SDG&E) announced that it has been working with Southern California Edison Company to arrange the purchase of up to 600 MWe generated from Mexican geothermal fields south of Mexicali. Under an accord reached with Mexico's federal power agency, SDG&E would purchase 300 MWe from the Mexican fields in increments of 150 MWe, beginning in 1983. Southern California Edison would do likewise, beginning in 1985. The project awaits U.S. governmental approval. A joint application has



Cerro Prieto Geothermal field, location map.



Cerro Prieto Geothermal field. The engine house, center photo, contains turbine generators, oil and hydrogen systems, an instruments laboratory, the control room, and some offices. The electrical substation is at photo right, and the cooling towers at photo left. Photo by Don Lande, CDOG.

been filed by the two companies with the DOE Economic Regulatory Administration.

Current Cerro Prieto drilling and production information is included in an article titled "Drilling and Producing Wet Steam Wells at Cerro Prieto, Mexico," published in the April 1979 issue of Petroleum Engineer International.

Heber Power Plant Contracted

Chevron Resources Company signed a contract with Southern California Edison Company to provide geothermal water for a 50 MWe plant near Heber, California. The plant will supply the electrical needs for the community of about 45,000 people.

The plant will use a double-flash generating system, separating steam from water in two successive stages as pressure is reduced. The steam will drive the turbines and the water will be pumped back into the formation for reheating and recycling. The plant is scheduled for completion in 1982.

Maryland

Crisfield Geothermal Project

The East Coast's first deep geothermal well will be drilled at Crisfield, Maryland on the Delmarva Peninsula. The Department of Energy (DOE) has awarded Gruy Federal Inc. of Houston a contract to drill the well to a depth of around 1524 m (5,000 feet). At this depth, an effort will be made to produce the underground water for residential and industrial heating uses and for agricultural applications.

Before the casing is perforated and production activities begun, the well will be deepened by 214 m (700 feet) into basement rock. The basement rock will be fractured hydraulically to evaluate the hot dry rock potential of the area. Once this investigation, funded by the Los Alamos Scientific Laboratory, is concluded, the hole will be plugged back to the top of the basement rock and work in the aforementioned geothermal zones undertaken.

Underground temperatures at the Crisfield location were found to increase 2.5°F per 100-foot interval, and well temperatures at the proposed total depth are expected to be around 185°F. The site is on a geophysical anomaly that, hopefully, will be an important geothermal discovery.

Low-Temperature Resources

Geothermal Success Story

The Presbyterian Intercommunity Hospital in Klamath Falls, Oregon opened in 1965. No geothermal energy was used by the hospital then, although the hospital had been purposefully located at a site with geothermal potential.

In 1974, hospital officials decided to install a geothermal system that would utilize 88°C (191°F) water for space heating, domestic hot water, and snow melting. The system was completed in 1976. The total cost of the geothermal changeover, including a new mechanical building, reached $351,500.00 for the 98,000 square foot hospital. In the first full year of operation, natural gas costs were reduced by $31,200.00.

After the changeover, a nursing home was built next to the hospital and the geothermal system was expanded to serve an area totaling 207,000 square feet.

Projects Funded by DOE in 8 Western States

In fiscal year 1979, a wide range of low-temperature geothermal projects, using both hot water and steam, are slated to receive a total of $4½ million from the DOE. The projects are in 8 western states and were selected from 40 proposals submitted to the DOE.

CALIFORNIA

1. City of El Centro. Geothermal space heating and cooling and domestic water heating in the city system; space heating and cooling for commercial buildings and residences; and process heating for industry and agriculture.

2. TRW, Inc., Redondo Beach. Designing, building, and operating a geothermal energy system for the Holly Sugar factory in Brawley, California. The geothermal system will supply the make-up steam and all energy required for pulp drying at the plant.

3. City of Susanville. Geothermal space heating and agricultural process heat in a livestock feed production system and feedlot operation at Kelley Hot Springs, California.

4. Aquafarms, International, Inc., Mecca. Raise prawns with geothermal fluids in the Coachella Valley.

COLORADO

5. Town of Pagosa Springs. A district geothermal heating system, providing hot water to public buildings, schools, businesses, and homes.

IDAHO

6. Madison County Energy Commission and Rogers Foods, Inc., Rexburg. Municipal space heating and industrial food processing with geothermal fluids.

7. City of Boise. Large-scale space heating program for several downtown commercial buildings and for homes in the Warm Springs Water District.

MONTANA

8. Montana Energy and MHD Research and Development Institute, Inc., Butte. Designing, constructing, and operating a geothermal conversion system for space heating in the Warm Springs State Hospital.

NEVADA

9. Chulton Engineering Co., Elko. Space and water heating in three commercial buildings in Elko.

10. Hydrothermal Energy Corp., Reno. Geothermal space and water heating system for a Reno apartment complex.

OREGON

11. Klamath County YMCA, Klamath Falls. Geothermal space and water heating.

TEXAS

12. Navarro College, Corsicana. Geothermal space and water heating system for a college building and the County Memorial Hospital.

UTAH

13. Utah Roses, Inc., Sandy. Converting six acres of greenhouses to geothermal heating.

14. Utah Energy Office, Salt Lake City. Space and water heating for the minimum security building at the Utah State Prison using the geothermal resources at Crystal Hot Springs.

Geothermal Systems Use Conventional Equipment

Conventional, mass-produced types of heating equipment, like baseboard radiation, may be used safely with low-temperature geothermal fluid systems when the design is right, according to E. Wehlage. Mr. Wehlage discussed the topic during a seminar for applied geothermal equipment sponsored by the International Society for Geothermal Engineering.

For seminar information, write SAGE IV, c/o ISGE, P.O. Drawer 4743, Whittier, California 90607.

Well Logs

Simultaneous Drilling and Logging Studied

Sperry Research Center of Boston is investigating the use of a tool with surface readout that makes sonic signatures of drill bit action while drilling with a turbodrill. Researchers believe that all fracture zones and formations have discrete, identifiable signatures; thus, a lithologic log can be obtained as the formations are penetrated. First tests were in April at the Terra Tech Drilling Research Laboratory in Salt Lake City, Utah.

Report Available

The Midterm Report on Geothermal Well Log Interpretation by Scientific Software Corporation (SSC) is available from Los Alamos Scientific Laboratory, University of California, P.O. Box 1663, MS 983, Los Alamos, NM 87545.

Research

Methane in Geopressured Aquifers

An on-going study of methane in geopressured brines beneath the south Texas Gulf Coast is discussed in the April 9, 1979 issue of The Oil and Gas Journal. In an article entitled "Methane from Geopressured Aquifers Studied," by T. M. Doscher et al, USC, the authors describe how the predicted performance of a geopressured brine reservoir is analyzed by simple fluid expansion.

The reservoir parameters used to solve the pseudo-steady-state flow equations to estimate the sustained flow by physical expansion in 10-to 20-year periods are: permeability to brine; porosity; compressibility; area; thickness; reservoir pressure; and reservoir depth.

"Sloshing" Goes on Record

Gunnar Bodvarsson, a professor at Oregon State University, is measuring

natural reservoirs of hot water. He does this by finding earth fractures that carry hot water or molten deposits of material. When earthquakes or tidal strains occur, the hot or molten materials move enough that the sloshing, or oscillations, can be measured with finely calibrated instruments. Dr. Bodvarsson calls these movements hydroelactic oscillations. He hopes data from the oscillations will yield information on the dimensions of subsurface geothermal systems.

Courses & Meetings

Geothermal Resources Board Workshops Part II by Suzanne Butterfield

In February and March 1979, the Geothermal Resources Board held workshops on the Transmission of Geothermally Generated Electricity from Remote Areas, and on the Potential for Direct Geothermal Heat Utilization in California.

Topics of discussion at the Transmission workshop included wheeling, transmission corridors, wilderness areas, and the role of environmental and cultural factors in transmission corridor selection. Workshop participants, including representatives from utilities and local, state, and federal agencies, identified a number of issues that need further attention. Among these issues is the need for a Statewide Plan for Transmission Corridors that would include transmission of geothermally generated electricity. The recommendation will be presented to the Geothermal Resources Board and other governmental entities.

The Direct Geothermal Heat Utilization workshop was held in Sacramento and was attended by representatives from companies and small businesses interested in low-temperature resources. Topics of discussion included an overview of world-wide, low-and medium-temperature resources; commercial projects underway in California and surrounding states; technical and financial assistance; a comparison of California regulatory procedures with procedures used in Oregon and Idaho; and ways the state can provide a more supportive developmental environment, (e.g., enacting district heating legislation).

A final report on all four workshops, held by the Geothermal Resources Board between December 1978 and March 1979, will be available in May from the Director's Office, Department of Conservation, 1416 Ninth Street, Room 1320, Sacramento, California 95814.

Geothermal Resources Council Events

June 4-6, 1979

A technical training course, "Geophysical exploration methods for geothermal resources", will be held at Asilomar in Pacific Grove, California.

September 24-27, 1979

The annual meeting of the Geothermal Resources Council will be held at the MGM Grand Hotel in Reno, Nevada. The theme of the meeting is "Expanding the Geothermal Frontier." Although the Basin and Range Area will be highlighted, the program will include sessions covering all aspects of geothermal exploration, development, and utilization.

For additional information on either event, contact Beverly Hall or Sheila Roberts at the Geothermal Resources Council, P.O. Box 98, Davis, California 95616.

Lease Sales

Lease Sale Schedule as of 2/13/79

Lease sale dates are provided by the state directors of the U.S. Bureau of Land Management (BLM). Lease sale dates are tentative until public notice is issued 30 days prior to sale. Lease sale notices may be obtained by contacting the appropriate BLM state office.

Location of KGRA	Tentative Date	Final Date
East Mesa, CA	5/10/79	
Marysville & Boulder Hot Springs, MT	5/15/79	5/31/79
Mono-Long Valley, CA	6/ /79	
New Mexico Reoffers	6/ /79	
Nevada Reoffers	6/26/79	
Indian Heaven & St. Helen, WA	7/ /79	
Belknap-Foley Hot Springs, OR	7/ /79	
Gillard Hot Springs and Clifton, AZ	8/ /79	
Island Park (ID & MT)	10/ /79	
Alvord, OR	1/ /80	

Publications

USGS Circular 790-Errata

"Assessment of Geothermal Resources of the United States-1978" USGS Circular 790, contains the following errors. L. J. Muffler of the USGS has requested that the Hot Line publish this list:

1. p. 23, Col. 2: "Recovery of Thermal Energy from Hydrothermal Convection Systems" should be a first-rank heading, and "Resource Determination" should be a second-rank heading.

2. p. 25, equation (10): T_o instead of t_o

3. p. 25, symbols for equation (11): $\lambda = 9.8$ m/s^2 instead of 0.098 m/s^2

4. p. 26, Figure 6 caption: Equation (13) instead of Equation (9)

5. p. 27, column 1, last line: 1640×10^{18} instead of 1650×10^{18}

6. p. 38, figure 13: $t + 92.92$ instead of $t \pm 92.92$

7. p. 44: The mean reservoir volume of The Geysers should be 166.7 km^3 instead of 1167 km^3.

8. p. 141, Table 15, Column 7 (Volume of dissolved methane): Units should be 10^{12} ft^3 instead of 10^2 ft^3.

Baca Data Available

Information is available about the demonstration power plant on the Baca location in the Valles Caldera, New Mexico. To examine the data, contact Arthur C. Wilbur, Manager, Geothermal Demonstration Power Plant, 600 - 2nd Street, NW, Room 712, Albuquerque, New Mexico, 87102, telephone (505) 766-3822.

Recent SPE of AIME Papers

The development of geothermal resources was the subject of several papers presented at the Ventura April 18-20 meeting of the Society of Petroleum Engineers of the American Institute of Mining,

Metallurgical, and Petroleum Engineers, Inc. (SPE of AIME). Copies at $2.00 each are available from the AIME, 6200 N. Central Expressway, Dallas, Texas 75206.

SPE 7959 Radial steam flow in two-phase geothermal reservoirs - comparison of analytical and finite - difference solutions for transient pressure drawdown, by Allen F. Moench.

SPE 7960 Radioactive tracer adsorption chromatography in geothermal reservoirs, by O. J. Vetter and H. B. Crichlow.

SPE 7963 Well test analysis of HGP-A, by B. H. Chen, D. H. Kihara, A. Seki, and P. C. Yuen.

SPE 7966 A comprehensive wellbore steam-water flow model for steam injection and geothermal applications, by T. Sugiura and S. M. Farouq Ali.

SPE 7878 Electrical resistivity of geothermal brines, by Hikmet Ucok, Iraj Ershaghi, and Gary R. Olhoeft.

SPE 7987 The application of petroleum engineering to geothermal development, by V. E. Suter.

☆

1979 KGRA special in Bulletin, vol. 8, No. 3, March 1979, 27p., $2.50 (Calif. residents add 6 percent sales tax). Published by and available from the Geothermal Resources Council, P.O. Box 98, Davis, California 95616.

This issue of the Bulletin lists the lease sales held from January 1974 through December 15, 1978 within KGRA's in the United States. Tabulated material includes the state, date of lease sale, acreage, number of bids, range of bidding, highest bidder, and the lessee.

☆

Final Report: The geothermal advisory committee to California State Energy Resources Development and Conservation Commission. January 1979. 65p. Free. Available from the Energy Resources Conservation and Development Commission, 1111 Howe Avenue, Sacramento, California 95825, Attention: Publications.

Open meetings were held by the Geothermal Advisory Committee from April through December 1978 to discuss California's geothermal resources. The substance of these meetings and the committee's recommendation are in this report.

☆

Geothermal loan guaranty program and its impact on exploration and development. By Louise H. Nasr, 1979, 221 pages, $10.00. Available from Publications Department, Colorado School of Mines, Golden, Colorado 80401.

The impact of the geothermal loan guaranty program on U.S. geothermal development is evaluated in this book. In addition, an assessment of the program's impact on private and public decision making for investment in geothermal resources development is examined.

☆

Energy from geothermal resources, publication No. 4809, 1978, 165p., $2.75 a copy. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The United States Government has published an extensive revision of a 1974 report covering most aspects of geothermal energy. Geology, technology, global distribution, utilization, economics, environmental considerations, and legislation are included.

☆

Geothermal energy, recent developments 1978. Edited by M. J. Collie. Energy Technology Review No. 32., 445p., $40.00. Available from: NOYES Data Corporation, Mill Road at Grand Avenue, Park Ridge, New Jersey 07656.

The 12 chapters in this geothermal energy review are based on studies funded by governmental agencies. A survey of the recent patent literature is also included. One of the chapters is devoted to California geothermal

resources and another to comparison studies among Heber, Valles Caldera, and Raft River projects and between binary and hybrid plants.

☆

Geothermal energy. By H. Christopher H. Armstead, 1978, 357 pages. Available from John Wiley and Sons, Inc., One Wiley Drive, Somerset, New Jersey 08873.

This book summarizes the nature, occurrence, exploration, drilling, collection, and transmittal of geothermal fluids. Uses and economics of geothermal energy are included as well.

☆

Three reports describing geothermal research at the Roosevelt Hot Springs area in Utah are available from the Earth Science Laboratory, Univ. of Utah Research Institute, 391-A Chipeta Way, Salt Lake City, Utah 84108. They are:

"Geology of Roosevelt Hot Springs KGRA, Beaver County, Utah," by Dennis L. Nielson, et al.

"Radon Emanometry as a Geothermal Exploration Technique; Theory and an Example from Roosevelt Hot Springs," by Dennis L. Nielson.

"Initial Investigation of Soil Mercury Geochemistry as an Aid to Drill Site Selection in Geothermal Systems," by Regina M. Capuano and Robert W. Bamford.

Also available from the Institute, but at 420 Chipeta Way, Suite 120, Salt Lake City, Utah 84108 are:

"Hydrothermal Alteration at the Roosevelt Hot Springs Thermal Area, Utah," by W. T. Parry, Univ. of Utah, work performed under DOE/DGE Contract No. EG-78-C-07-1701, May 1978.

"Hydrothermal Alteration at the Roosevelt Hot Springs Thermal Area, Utah: Characterization of Rock Types and Alteration in Getty Oil Company Well Utah State 52-21," Geoffrey H. Ballantyne, Univ. of Utah, work performed under DOE/DGE Contract EG-78-C-07-1701, November 1978.

Three additional reports of research at the Roosevelt Hot Springs area are available from the Univ. of Utah. Direct inquiries concerning these reports to Dr. Stanley H. Ward, Chairman, Dept. of Geology and Geophysics, The Univ. of Utah, 717 Browning Bldg., Salt Lake City, Utah 84112. The reports are:

"Self potential survey, Roosevelt Hot Springs, Utah" (a large-scale potential survey showing a broad area of negative self potential centered over the thermal region.)

"Stable water-rock interaction in the Roosevelt Hot Springs thermal area, Utah" (Carbon, hydrogen, and oxygen isotope analyses on hydrothermal calcite, geothermal fluids, and regional spring waters.)

"Interpretation of a seismic profile across the Roosevelt Hot Springs, Utah and vicinity" (78-1701.a.3) (A seismic profile recorded across the Milford Valley, the Roosevelt Hot Springs KGRA, and the Northern Mineral Mountains in southwestern Utah.)

☆

Studies of a geothermal system in northwestern Nevada, Parts 1 and 2. By G. V. Keller and L. T. Grose, eds. CSM Quarterly, v. 73, Nos. 3 and 4, 1978, $7.50 each or $15.00 a set. Available from Publications Department, Colorado School of Mines, Golden, Colorado 80401.

The object of the study described in these two issues of the CSM Quarterly was to demonstrate that geothermal energy suitable for producing electrical energy can be explored for in areas throughout much of the western United States where the heat flow is only moderately higher than average. The studies of the Black Rock Desert - Hualapai Flat area in northwestern Nevada demonstrate the high probability that useful temperatures can be found beneath thermally resistant alluvial rock in the intermontane valleys of the western United States.

☆

Methodology of determining the uncertainty in the accessible geothermal resources of identified hydrothermal convection systems. By Manuel Nathenson, 1978, 51p.,

Open File Report No. 78-1003, Microfiche $3.50, paper copy $7.50. Available from Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

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Petroleum Information Service has begun publication of a weekly report entitled National Geothermal Service and a monthly well completion card program. Subscriptions to the report are $420.00 a year and to the completion card program $120.00. Address inquiries to Petroleum Information Corporation, P.O. Box 2612, Denver, Colorado 80201.

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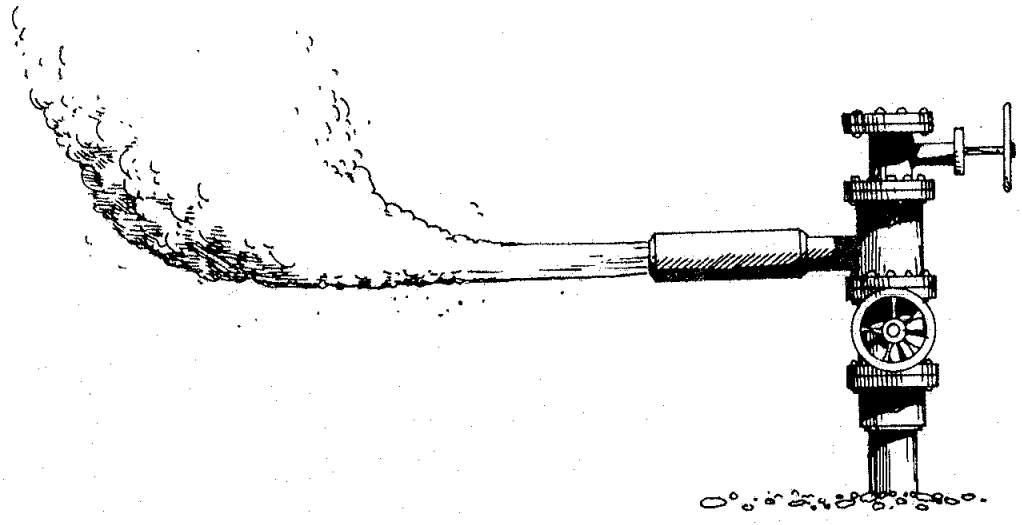
The Hot Line is published quarterly, and the subscriptions are free. To become a subscriber, send your name and address to the California Division of Oil and Gas, 1416 Ninth Street, Room 1316-35, Sacramento, California 95814.



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