

Steam

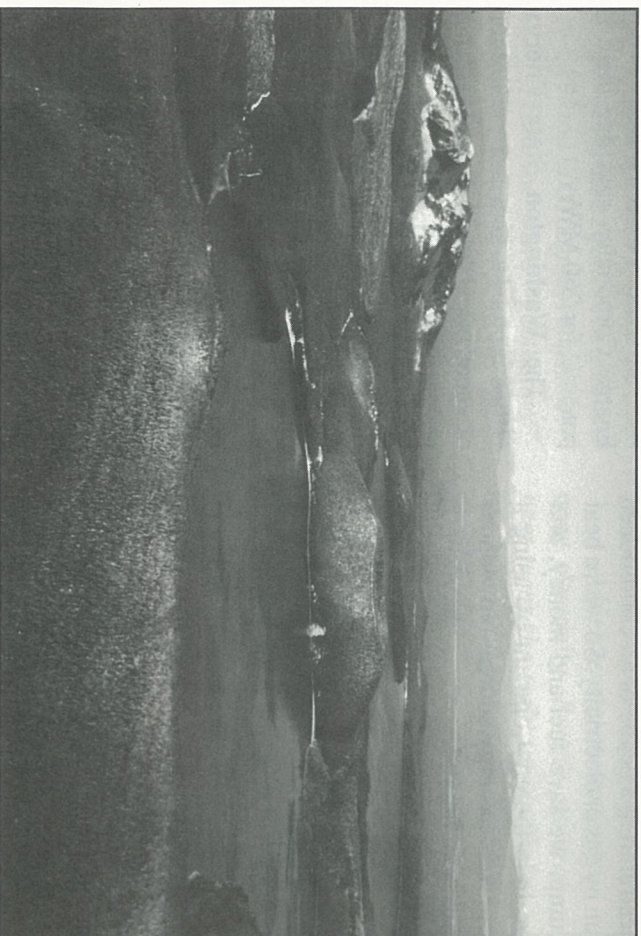
THE JOURNAL OF GEOTHERMAL EDUCATION



Press

SPRING 1992

VOLUME 2, NUMBER 1



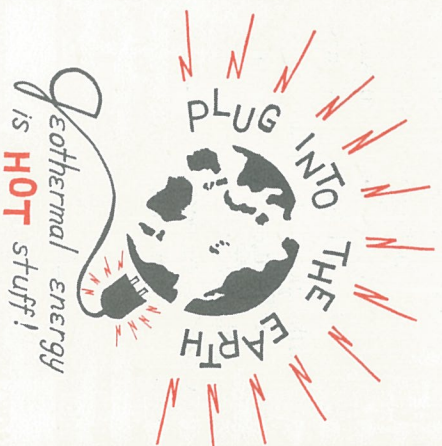
Newberry Crater is a popular recreation area in the Newberry National Volcanic Monument. Geothermal companies helped create the monument. Photo: Sunriver Sun

News from Newberry Collaboration gets results!

Geothermal energy is one of the most desirable renewable energy resources in the Pacific Northwest. So says the Northwest Power Planning Council (NPPC), a board created by Congress in 1980 to set policy on regional energy issues for Oregon, Washington, Idaho and Montana. Renewable energy resources should be pursued as a top priority for the '90s, according to a spokesperson for NPPC, and geothermal heads the list because it is abundant in the Northwest, it is sustainable, and it is kind to the environment.

Our National Energy Strategy

America's 1991-92 National Energy Strategy lays "the foundation for a more efficient, less vulnerable and environmentally sustainable energy future." To meet these goals, our National Energy Strategy endorses the development of geothermal resources. "Geothermal energy systems can already make limited contributions to meeting base and intermediate electrical loads." To expand geothermal's role in our national energy future, U.S. policy recommends "additional investment in R&D to reduce costs and enhance the competitiveness of renewable electric options."



...9

Geothermal in Paradise Energy relief for Hawaii

Hawaii is burdened by an over-dependence on imported fuel. If ever foreign oil supplies were cut off, Hawaii would be the hardest hit state: 90% of its energy is derived from foreign oil! The Hawaiian Electric Light Company has attacked the problem exploring such alternative energy sources as wind, solar, ocean thermal, biomass and geothermal. So far, only geothermal has proven to be reliable.

Remember, the Hawaiian islands are entirely volcanic. Hidden on the Big Island, under the slope of an active volcano, is one of the world's richest sources of geothermal energy. Despite this abundant energy, residents of the island of Hawaii endure regular "rolling blackouts" due to the limited capacity of existing fossil-fuel power plants. The challenge is to tap into the geothermal resource below the surface without endangering Hawaii's rainforest.

There are two major geothermal developers on the Big Island. Their projects have been stalled by environmental concerns.

True/Mid-Pacific Geothermal filed applications in 1982 for development of a 250-megawatt geothermal project in the upper Kilauea East Rift Zone. To develop that project, private and public groups cooperated in 1986 to protect pristine rainforest. Responding to concerns of neighbors and environmentalists, the State Lands Board arranged a land exchange. Private rainforest land originally slated for development was swapped by the James Campbell Estate for less-sensitive, state-owned rainforest at Wao Kele O Puna. The pristine 26,000-acre Campbell property went to the state for preservation, while an initial 25-megawatt plant was permitted at Puna.

Environmental safeguards are a major part of the program. *Less than one percent* of the 60,000-acre Puna rainforest will be used for geothermal wells, roads and generating plants. And the developers will take extensive measures to mitigate potential impacts of the development on the rainforest, including:

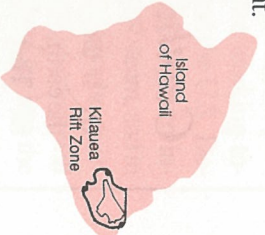
- bird and botanical studies before each area is cleared, so that pristine parts can be left undisturbed;
- botanical monitoring of all drill sites and access roads; and
- an alien species control program to keep out non-native plant species.

The second company, Puna Geothermal Venture (PGV), received authorization in 1989 to drill 14 geothermal wells in the Kilauea Rift Zone and install 10 Ormat generators with a combined capacity of 25 megawatts.

The Big Island's geothermal activity was interrupted in June, 1991, by a drilling incident. A well "vented" (released geothermal materials to the air) for 31 hours. Resumption of drilling has been authorized by a Management Plan adopted in March, 1992. The Plan overhauls drilling and safety requirements and enforcement.

Safety standards in Hawaii are among the world's most stringent. Welfare of workers, as well as control of emissions and noise, are of high priority.

Today, Hawaii's geothermal supporters are more convinced than ever that geothermal energy is good for the state. By combining geothermal development with preservation of pristine rainforest, Hawaii will soon be back on the road to energy independence.



A few words about our publication.

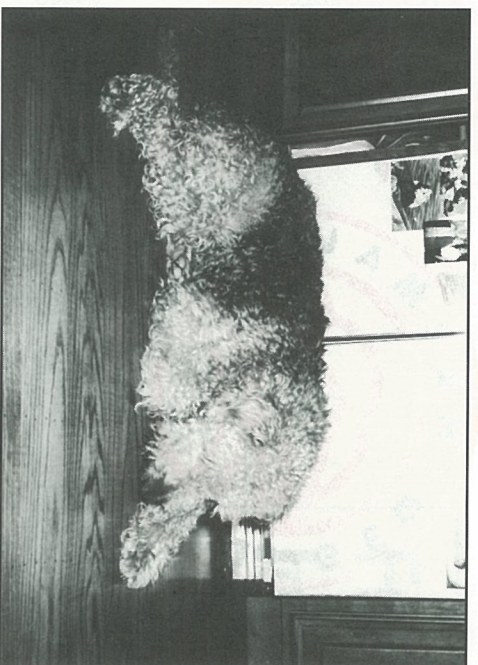
Steam Press is published by the Geothermal Education Office to further educate youth and other interested readers about geothermal energy and its vital role in helping to sustain a healthy and clean world. The staff of *Steam Press* would be

happy to hear from you. Maybe you have suggestions for our next issue (or an article, or even a drawing you would like to submit). Class sets of *Steam Press* and other free materials are available. 1-800-866-4GEO.

Does Your Dog Sleep in Front of the Refrigerator?

If so, your dog is enjoying a heat pump! A heat pump exchanges heat: it moves warmth out of the place you want cold (the fridge) and into the place you want warm (Pup's bed.) With those two sides to the equation, the heat pump has a growing role in bringing comfort--and not just for dogs!

You have just one home, but you want both to warm it (in winter) and cool it (in summer.) You can help do both by using something in contact with all homes: the earth. *The earth changes*



temperature less than the air does, season-to-season. So by exchanging temperature between earth and house, you increase winter warmth and summer coolness.

To exchange temperatures you can install a ground-source heat pump system: long pipes filled with pumped fluid

(which can be water), pipes which snake from the house and loop around in the nearby ground. By pumping the fluid through the loops, the system picks up warmth (in cold weather) or coolness (in warm weather), and brings it into the house.

The temperature difference is not always enough to do the whole job. But the heat-pumped fluid can give a great head start to a heater or air conditioner run by gas or electricity. So with a heat pump, we save fuel and money, *and* we help the environment by using a renewable energy source. No wonder Pup is so happy!

Let Mother Nature Do the Cooking! Geothermal energy sizzles supper

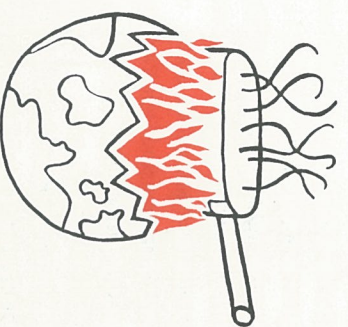
Reprinted by permission from Reuters.

When the villagers of Fumas [in the Azores] bury food in the ground around their local volcano, they know a piping hot meal will be ready in a few hours.

"This is what I call down-to-earth cooking," said Fernando Moniz Cabral, as he and another man heave huge pots of cozido, a spicy stew of chicken, sausages, pork and vegetables, from holes in the earth.

Faces red from the effort and heat, they emerge between billows of steam and pools boiling away in the green landscape of tropical flowers, palm trees and lagoons.

For centuries these villagers on the Azores island of Sao Miguel in the mid-Atlantic have harnessed volcanic energy to bake anything from cod to cabbage. The



Drawing by Nikki Nemer

volcanic island, like others in the nine-island Portuguese archipelago, lies on a thin layer of the earth's crust.

During weekends, the site is filled with picnicking families who drop sacks of meat, yams, potatoes and even corn bread into the three-foot deep holes for a couple of hours while they swim at the nearby crater lake. For those too lazy to

do it themselves, barefoot boys sitting by the roadside sell husks of boiled sweet corn.

With a heat of about 200 degrees Fahrenheit, connoisseurs recommend burying fish for about two hours and meat for up to five. Food is wrapped in paper or cabbage leaves, pots tightly sealed and earth put over the holes to trap the vapor.

Signs spell out the rules: "Cooking corn is not permitted here," "Do not wash clothes," "Using detergent is not allowed." Down the road, rich tourists stay at a nearby 19th century spa where spring water enriched with minerals pours from rocks laced with purple flowers. And, just a few miles away, engineers are trying to tap the volcanic heat to generate electricity and end dependency on imported fuel.

Watt's Up?!

News about our friends in the industry

Canadian Crew Energy Corporation will complete Canada's first geothermal power plant this Spring. The initial electrical output at the Meager Creek plant near Pemberton British Columbia is intended to be 60 MW*. Commonwealth Construction Company plans to build and operate the facility and the power will be sold to British Columbia Hydro and Power Authority. Canadian Crew Energy Corporation says that there is potential for 260 MW.

The **Washington State Energy Office** is proud to announce publication of a geothermal "Guide Book" which is now available from the Bonneville Power Administration (BPA). The **Geothermal Resources Council** in Sacramento, which celebrates its 20th Anniversary this year, has teamed up with BPA on another publication. The first comprehensive environmental document on geothermal development and production will be released in April 1992. Call (916) 758-2360 to reserve your copy.

When the typhoon and Mt. Pinatubo explosion devastated people living in the Philippines, **Unocal Geothermal**, which produces 1380 MW of geothermal electricity worldwide, was there to help in relief efforts.

Design Power, New Zealand Ltd., a subsidiary of Electricity Corporation of New Zealand (the country's national power utility) recently received special commendation from the Institute of Professional Engineers of New Zealand for environmental work associated with design and construction of the new geothermal Ohaki Power Station, a 112 MW facility. Design Power's other geothermal plant at Waitakei was the world's first commercial wetfield geothermal power station when it was built 25 years ago.

The Hot Seat

Geothermal Energy Questions & Answers

Q. If there is geothermal heat in the earth, why don't my feet get hot?
A. They would if you put them in a hot spring, but most places it gets hot slowly as you get deeper. Geothermal energy is everywhere but mostly at a safe depth.

Q. I have heard that geothermal plants emit carbon and sulfur gases that contribute to acid rain and global warming. Is it true?
A. It is true that geothermal steam contains sulfur as hydrogen sulfide (H₂S), but the steam is treated to completely remove H₂S. Carbon dioxide (CO₂) is also in geothermal steam, but in comparatively small amounts. A power plant that burns coal to make electricity produces

1700 times as much CO₂ for the same amount of electricity as a geothermal plant. Geothermal energy doesn't flood valleys, cause air pollution, make miners sick or leave radioactive waste. Environmentally it is the best we have.

Q. If geothermal is so great, why don't we use it to make all our electricity?
A. We would if we could. Making electricity needs high temperature geothermal near the surface to be economical with present day technology. So far, we only find high temperature geothermal in a few places. Some other countries with fewer people and more volcanoes could get all their electricity from geothermal resources.

Kleen Energy, Kleen Air, Keen Awards!

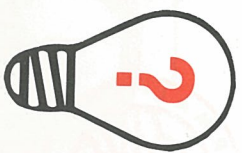
Air comes clean with geothermal

LAKE COUNTY
Well-managed production of energy from geothermal sources in Lake County has resulted in the cleanest air in the state of California and possibly the nation! In 1992, a joint resolution by the California State Senate and Assembly recognized the county's Air Quality Management District for having achieved the lowest air pollutants in the state! Lake County, in cooperation with Pacific Gas and Electric Co., has tapped the energy of the many steam reservoirs in the area to run their power plants. Technology has been developed to harness their power in efficient and clean ways.

PACIFIC GAS & ELECTRIC
Pacific Gas & Electric Company recently won a special award from the California Chamber of Commerce and the California Air Resources Board in recognition of its contribution to the improvement of California's air quality. At the cost of several millions, PG&E improved its systems for handling geothermal power plant emissions, resulting in cleaner-than-ever generation of electricity.

The award was created to recognize an industry for going beyond the call of duty, on its own volition, to improve the air quality of the state. Thank you PG&E!

* (MW) Megawatt: The amount of electrical power needed to service 1,000 households.



Did You Know?

- That geothermal energy can be used to raise fish on a fish farm?
- That citizens of *Boise, Idaho* have been using geothermal energy to heat their homes for 100 years?
- That *Iceland* has the most extensive use of geothermal energy for space heating of any country?
- That the ancient *Romans* used water heated by geothermal energy to warm their homes?
- That scientists estimate the temperature of the earth's core ranges from 5,000 to 11,000 degrees Fahrenheit?
- That the word "geothermal" comes from the Greek words "geo" (earth) and "therme" (heat)?
- That most of the geothermal energy we use today is called *hydrothermal* (hydro = water, thermal = hot)? We access reservoirs of hot water or steam trapped within the earth's crust, and use this naturally-heated water and steam:
 - at *low temperatures* (less than 350 degrees) for home and office heating, food processing, fish and plant cultivation, wood product preparation and bathing; and,
 - at *high temperatures* to generate electricity. *Earth's natural heat turns the turbines, so there are no pollutants from burning fossil fuels.*

Geothermal Through Time

Early History

- **3500 years ago**
Ancient Romans used hot mineral springs for bathing, cooking and heating. Hot springs were also used by the Chinese, Japanese and later by Native Americans.
- **2000 years ago**
Geothermal waters were used to treat eye and skin diseases throughout the Mediterranean.
- **1000 years ago**
Yellow sulphur for salves and gunpowder, disinfectants, and other uses were produced from geothermal salts.

1800s

- **1890** Production of boric acid for medicinal purposes from geothermal springs began.
- **1891** First U.S. district heating from geothermal implemented in Boise, Idaho.

Early-Mid 1900s

- **1900** Geothermally heated water provided to homes in Klamath Falls, Oregon.
- **1904** Electricity generated from Earth's natural steam, Lardarello, Italy.
- **1916** Steam power first attempted for electricity at The Geysers, California.
- **1930's** Geothermal water now commonly used in the U.S., Iceland, Japan, New Zealand, the USSR and other countries for spas, pools and greenhouses.
- **1943** 132 megawatts being produced from Lardarello, Italy. First use in Czechoslovakia for heating of buildings.
- **1958** New Zealand produces first electricity from geothermal.
- **1960** First commercial electricity generated from dry steam at The Geysers, California.
- **1966** First geothermal power plant built in Japan.
- **1969** France begins large district heating projects with geothermal waters.
- **1970** First electrical generation from geothermal in China. Exploration for geothermal resources begins in Greece and Guatemala.
- **1978** First Hot Dry Rock reservoir created and tested by the U.S. Department of Energy in New Mexico. Geothermal crop-drying plant built in Nevada.

Late 1900s

- **1979** First electrical production from geothermal in Indonesia.
- **1980** World's largest geothermal generator (132 MW) built at The Geysers. Electric power from hot dry rock produced in New Mexico.
- **1981** Binary technology demonstrated at Ratt River Idaho. First electrical production from geothermal in state of Hawaii.
- **1982** Total U.S. installed geothermal capacity reaches 1000 MW.
- **1984** First electrical production from geothermal in Utah.
- **1985** U.S. installed geothermal capacity reaches 2000 MW. 2 MW electrical generation begins in Greece.
- **1989** First exploratory well to be sited directly over a suspected magma body by U.S. Department of Energy.
- **1990** Three U.S. geothermal projects win environmental awards. U.S. installed geothermal capacity reaches almost 3000 MW. Iceland has drilled, since about 1928, 110 wells for electrical production and 705 wells for direct use. New Zealand has about 300 MW of geothermal power plants. 700 MW are being produced in Mexico. 558 MW are being produced in The Philippines.
- **1991** Bonneville Power Administration selects three sites in the Pacific Northwest for demonstration geothermal projects.
- **1992** Today, nearly 6,000 MW of electricity are currently being generated from geothermal in 21 countries.

Tomorrow

The amount of electricity being produced from hydrothermal resources will certainly continue to grow. Scientists from the U.S. Department of Energy are working hard to find ways to access and use the Earth's heat at very deep levels--up to 10 miles! This research is focused on magma and hot dry rock (see box to right.)

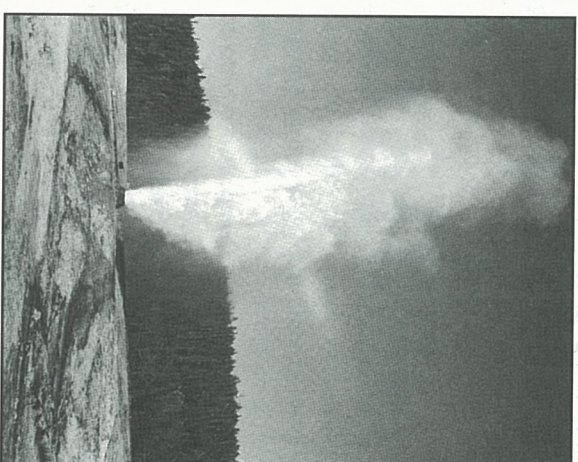
The Department of Energy has stated that in the U.S., "by the year 2030, generation of electricity from geothermal sources will grow to 10,600 MW." That's enough electricity to serve 10.5 million households.

The Thermal Wonders of Yellowstone

Too delicate for power production, but not for Trappers' Tales

Yellowstone National Park contains the world's greatest concentration of geothermal wonders. Hundreds of hot springs and geysers are nestled among grand mountains, beautiful forests, rivers, and lakes and are frequented by wild animals.

We visit the park every summer by the millions. Scientists study it, and Congress enacts laws to protect it. It is far too special and too delicate to develop for power production.



Some geothermal is for show only.

Nearly two hundred years ago, the explorers Lewis and Clark arrived near Yellowstone. They reported in their journal that Indians told of a region close by where "there is frequently heard a loud noise like thunder which makes the earth tremble; and children cannot sleep." They

from the friction of flow down a mountain! We think the real wonders of Yellowstone are more exciting than even the trappers tales.

Tapping Nature's Teakettle *

The hissing fumaroles and boiling sulfur springs of The Geysers were discovered by a bear hunter in 1847. Although there were no geysers, only jets of steam, by 1890 it was a popular spa for visitors from San Francisco seventy-five miles to the south. In the 1920's, scientists and engineers first tried to harness the steam by channeling it through shallow drill holes. Deep drill holes followed and produced abundant steam, but there were no power plants to use it.

A small plant of 25 megawatts (MW) was first opened in 1960, and for the next 25 years Geysers' steam drove an ever-increasing number of power plants. They reached a total capacity of 2000 MW by 1987.

** Clever title courtesy of Department of Conservation, Division of Oil and Gas Publication, "Drilling Through Time."*

This needed more steam than the Geysers reservoir could sustain. Pressure and steam flow started to drop. It had taken thousands of years to create this enormous store of hot rock, steam and boiling water, but with hundreds of wells and dozens of power plants, energy was being removed faster than could be replenished by rainfall.

The Geysers today produce 1300 MW. Even though the steam is diminished, The Geysers still has large amounts of heat in the hot reservoir rocks. The steam producers and the utilities are working together with scientists from the U.S. Department of Energy to find ways to increase efficiency in the use of steam, and to find ways to put back water into the reservoir. With care, The Geysers reservoir will continue to produce electricity far into the future.

Scientists from the Department of Energy are working hard to access Earth's deep heat...

MAGMA RESEARCH

In some areas, mostly the Western Continental U.S., Alaska and Hawaii, hot magma, or molten rock, is close enough to the earth's surface to extract its heat directly. Exciting research is taking place at Mammoth Lakes, California, where there is still lots of geologic activity.

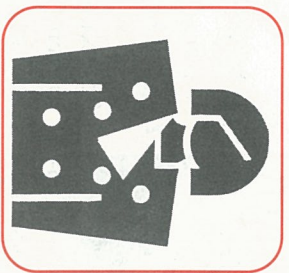
HOT DRY ROCK RESEARCH

A more abundant and widely distributed geothermal energy source is areas in which magma is close enough to the earth's surface to heat rock containing little or no water. Scientists at Los Alamos, New Mexico, are experimenting with ways to use this heat to provide the world with even more clean geothermal energy.

Hot Careers!

Is there a job for you in geothermal?

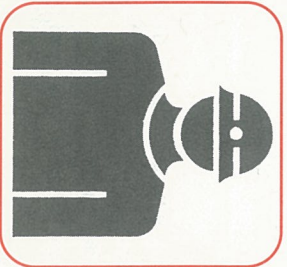
People like to work in the geothermal industry. It gives them satisfaction to produce heat and electricity which improves people's lives without hurting the earth and the air. The search for geothermal resources and the development of geothermal energy is challenging and open to innovation.



workers are needed. Geologists and reservoir engineers plan where to drill for steam and hot water. *Electrical and mechanical engineers and construction workers* design and build power plants to turn steam into electricity. *City planners* and *power line operators* work with utilities and governments to plan how to move the electricity to people.

Geologists search for geothermal heat near the earth's surface. *Geologists, geophysicists, hydrologists* and other specialists help in the search. If the geothermal prospect is found, then *land ownership, permitting and leasing specialists* obtain rights for exploration and development. *Project managers* and *drillers* work with geologists to plan a drilling program to prove the resource.

A successful well requires the cooperation of many special workers--*tool pushers, mud loggers, pipefitters, cement truckers and water truckers*. If the temperature of the resource is low, *fish farmers* and *greenhouse growers* use it to grow fish or flowers. *Architects, builders and heating experts* plan and build houses heated by low-temperature geothermal waters. If the temperature is high enough to make electricity then other



experts, accountants and bookkeepers, corporate attorneys, public relations professionals, government regulatory experts, administrative assistants, and receptionists play their part. Geothermal is a young, developing industry. *Researchers* in private and government institutions work on technology improvements. All of these people work in the geothermal industry to keep power turbines rolling and clean electricity coming to you and me.

HOT STUFF

MATCHING

1. Coal, oil, natural gas
2. Visible features of geothermal energy.
3. A deep hole in the ground fitted with a pipe used to carry underground steam to electrical turbines.
4. Molten rock between the earth's crust and its core.
5. Rock heated by magma that is close to the earth's surface.
6. A device that turns when steam pushes its blades to generate electricity.
7. Stew cooked by geothermal heat in the Azores.

TRUE OR FALSE

- T or F 1. Magma is lava below the earth's surface.
- T or F 2. The U.S. is dependent on foreign sources for at least 50% of its current oil supply.
- T or F 3. Geothermal energy sources are not affected by changing weather conditions.
- T or F 4. Geothermal energy is available practically everywhere, if you just dig down far enough.

WORD SCRAMBLE

RAGMELHOTE
WEARBEELN YNREEG

BUMPER STICKER CONTEST

The Geothermal Education Office is looking for slogans promoting geothermal that can be used on bumper stickers. How about a clever geothermal/environmental message? Favorite entries will be published in the next *Steam Press*. Winners will receive some hot surprises, including, of course, a free bumper sticker! Jot down your entries and mail them to: GEO, 664 Hilary Drive, Tiburon, CA 94920.

For More Info On...

GEOTHERMAL ENERGY
Geothermal Education Office
664 Hilary Drive
Tiburon, CA 94920
1-800-866-4GEO

Geothermal Resources Council
2001 Second Street, #5
Davis, CA 95616
(916) 758-2360

Geo-Heat Center
Oregon Institute of Technology
3201 Campus Drive
Klamath Falls, OR 97601-8801
(503) 885-1750

OTHER ENERGY INFORMATION
National Energy Education Development Project (NEED)
P.O. Box 2518
Reston, VA 22090
(702) 860-5029

National Energy Foundation
5160 Wiley Post Way
Salt Lake City, UT 84116
(801) 539-1406

National Wildlife Federation
(Ask for slides, *Let's Clear the Air!*)
1412 Sixteenth St., N.W.
Washington D.C. 20036

Renew America
1400 Sixteenth St., N.W.
Washington D.C. 20036



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THE GEOTHERMAL JOURNAL
Geothermal Education Office
664 Hilary Drive
Tiburon, CA 94920
1-800-866-4GEO

The Geothermal Education Office is a non-profit organization working to ascertain that today's youth understand:

- the urgency of protecting our environment while providing needed energy;
- the resultant need for the world to look to renewable energy sources as an important way to sustain our planet;
- what geothermal energy is, what it does, and its growing place in providing necessary clean energy.

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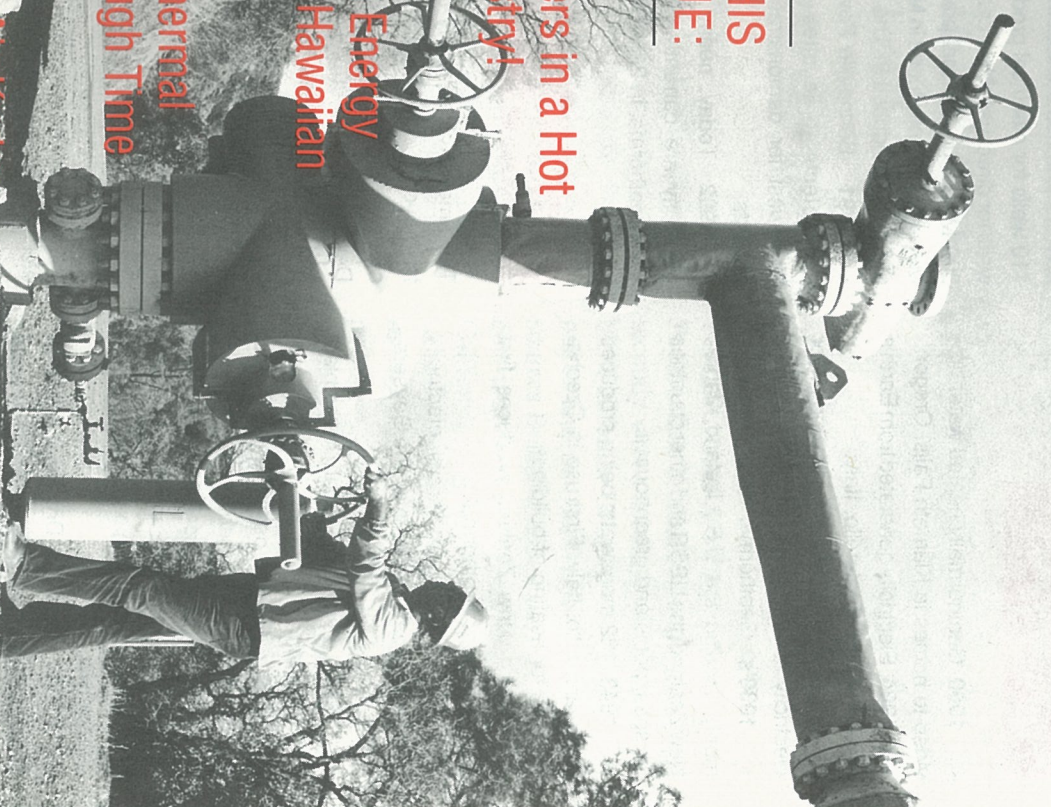
VOL. 2, NUMBER 1

IN THIS ISSUE:

Careers in a Hot Industry!
Clean Energy Goes Hawaiian

Geothermal Goes Through Time

Klean Air Kudos



(If you answered TRUE to all of the above, you are absolutely right!)

(8) Enr
7. E. Word Scramble: Geothermal, Renewable
'9, '9, '9, '3, '1, 'B, '2, 'F, '3, '4, 'A, '5, 'A, 'D, 'D.

Cover: A geothermal field operator turns a valve on a wellhead and sends geothermal steam safely on its way through insulated pipelines to a generating plant where it is converted to electricity. Photo: Unocal