

# PACIFIC NORTHWEST GEOTHERMAL

## 1976 Review 1977 Outlook

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### INTRODUCTION

The great majority of the better geothermal prospects in the Pacific Northwest are on federal lands. With very few federal land lease applications processed and issued this past year in the Northwest, significant deep geothermal exploration lagged in 1976. Federal, state, and academic scientific studies showed some increase, and several additional private non-electrical geothermal energy installations were built.

However, with the Columbia River system likely to show record low flow during 1977, interest in alternative local energy sources has picked up markedly in the region. Sizable alternative potential energy sources are largely geothermal. As a result there appears to be a new awareness on the part of both the public and politicians of the potential importance of geothermal energy to this part of the United States.

The chief question continues to be whether or not substantial economic geothermal resources do exist in this region, which, with its great volume of recent volcanics, and located in the high heat flow area which is the East Pacific Rim, is so very promising. It is both a tantalizing and a frustrating situation. Hopefully, the present numerous institutional barriers can be at least partly eliminated in 1977, and significant deep drilling can begin, thus making a start toward answering the basic question as to the quality and quantity of geothermal resources here.

This article reviews some of the more important events in geothermal exploration and development in Washington, Oregon, and Idaho in 1976, and again points out, as was done in a similar review article last year, the critical role of the federal government now in turning off or turning on this energy resource. A forecast is made of some of the geothermal developments which are likely to occur in the Northwest in 1977.

### WASHINGTON

There was no significant exploration for geothermal resources in the State of Washington during 1976, nor any leasing activity. The status of geothermal resource ownership beneath state and private lands in Washington also is still in limbo. A bill has been introduced in the 1977 legislature which states that "geothermal resources are *sui generis* in nature and are therefore included in the public domain to be developed only in such a manner as will enhance the public health, safety, and welfare."

As most geothermal resources appear to be on federal lands in Washington, and as the federal government has firmly stated that such resources belong to the federal government, what the State of Washington decides about private and state lands may not be particularly significant. However, lack of resolution of this issue surely does not help geothermal exploration, for state and private lands are no doubt intermingled to some extent with federal land. As of this moment, the bill has been put on the inactive list by the legislature, and it may not be taken up again this current (1977) session.

The chief geologic areas of interest for geothermal exploration appear to be the major stratovolcanoes of the Cascades, Baker, Glacier Peak, Rainier, Adams, and St. Helens. All of them have histories of recent eruptive activity, and all have thermal springs or fumaroles associated with them. It should also be noted that studies by Dr. David Blackwell in 1973 indicate that the mantle rocks of eastern Washington are hotter than normal, with a heat flow similar to that of the Basin and Range Province in Nevada. Blind geothermal areas may exist in eastern Washington beneath the thick sequence of basalts.

In general it appears that geothermal exploration and related activities will continue at a rela-

tively low level in Washington in 1977 as compared with Idaho and Oregon.

## OREGON

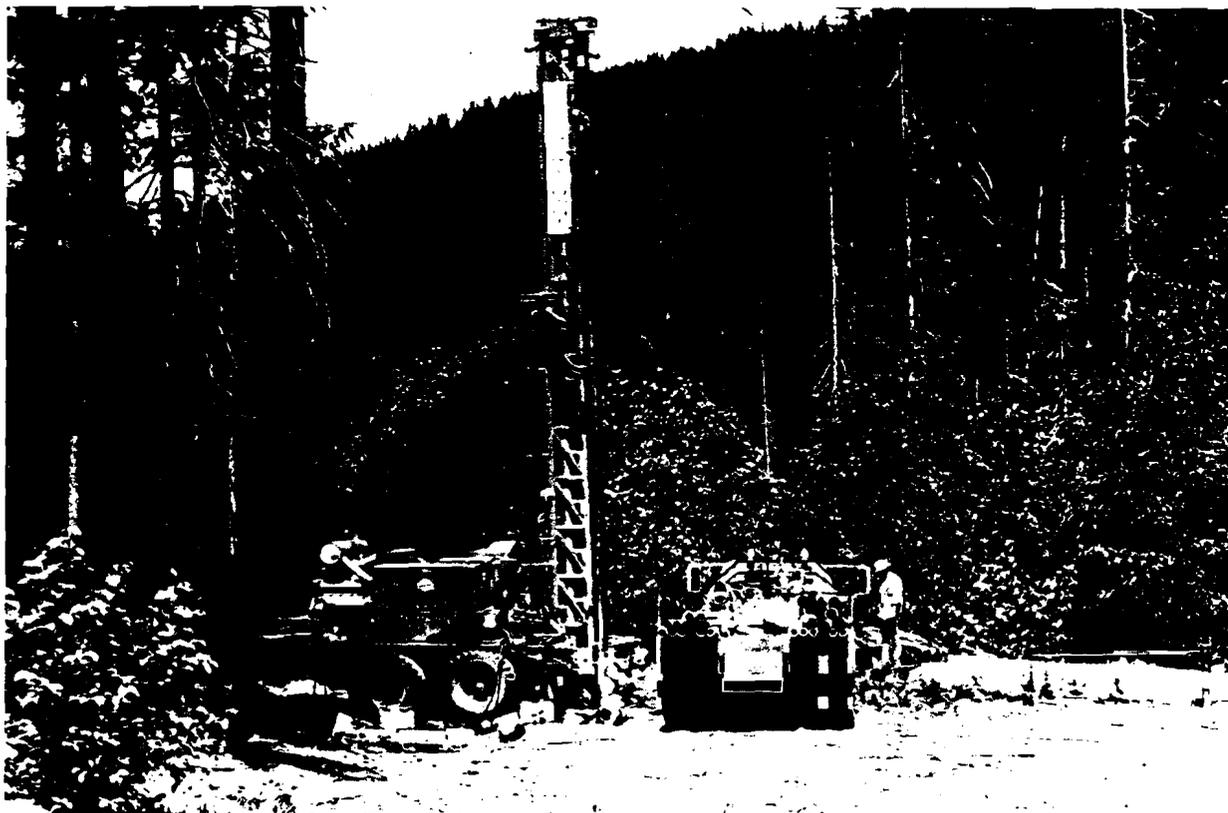
Industry activity in Oregon declined somewhat from the previous year, but geothermal studies by government and university researchers increased. A Geothermal Task Group was appointed advisory to the Oregon Department of Energy to see what the State of Oregon might do to encourage geothermal development. The result was a study titled: *Geothermal Development in Oregon: A Planning Report*, issued in February, 1977, and made available to the Governor and members of the state legislature. Copies can be obtained by writing to Dr. Fred Miller, Director, Oregon Department of Energy, 528 Cottage Street, NE, Salem, Oregon 97310.

Several industry groups conducted various exploration programs in Oregon east of the Cascades. Chevron drilled gradient holes in the Bully Creek area west of Vale in Malheur County, in

the Alvord Desert near Fields, and in Warner Valley south of Adel. Amax Exploration also did gradient drilling in the Bully Creek area. Phillips Petroleum drilled gradient holes near Newberry Volcano south of Bend, and in the Glass Buttes area in central Oregon. It was near Glass Buttes that a State of Oregon exploration team previously had drilled a hole with a gradient of 190°C/Km.

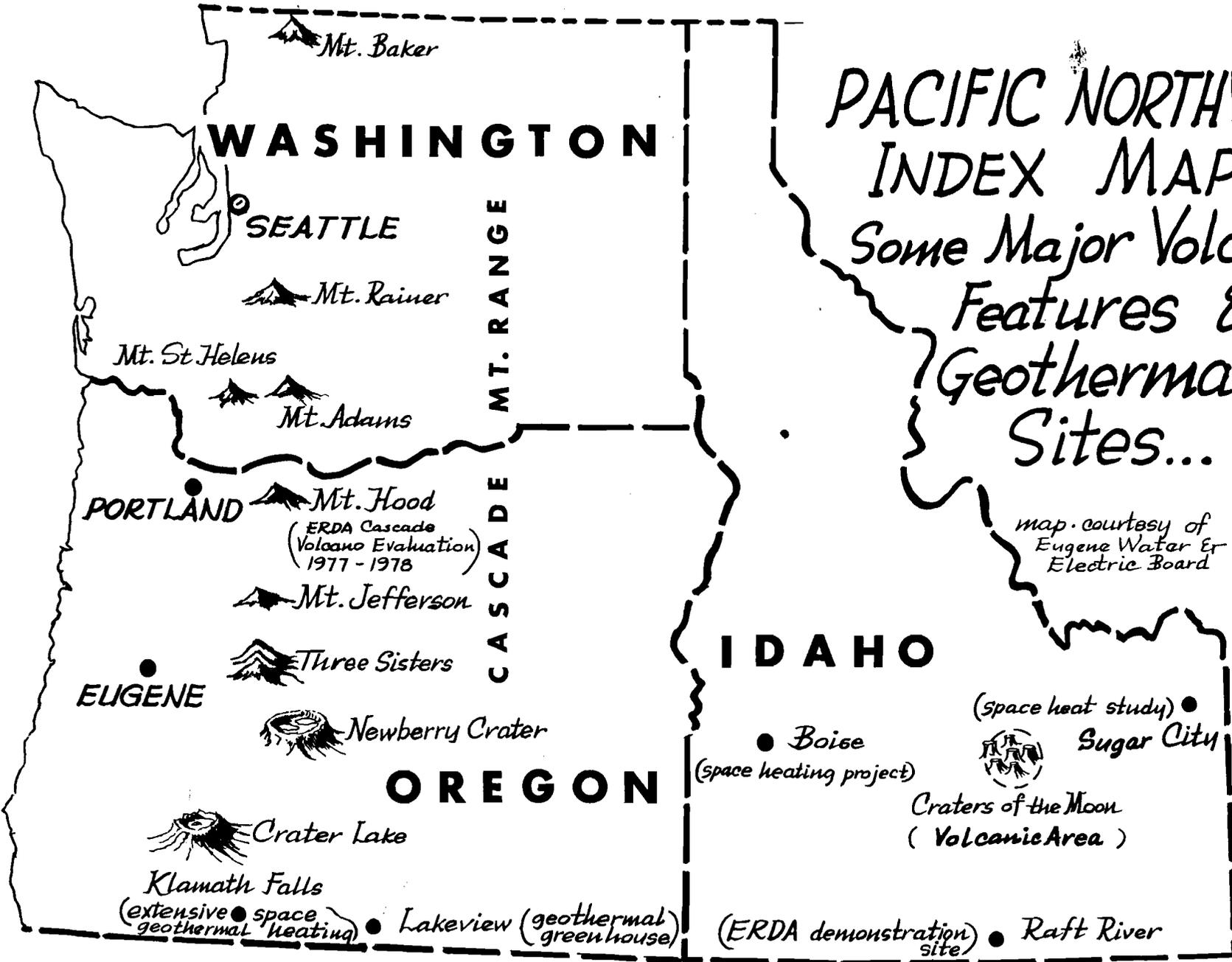
The only deep test was that by Thermal Power Company drilled to a depth of 5,842 feet south of Klamath Falls, but caving and loss of tools forced abandonment. This well, also, was the only deep industry test drilled in all the Pacific Northwest in 1976. A 2000-foot gradient hole was drilled in a joint venture by Pacific Power and Light with Weherhaeuser Company northwest of Klamath Falls.

The Oregon Department of Geology and Mineral Industries (DOGAMI) did heat flow drilling along the Brothers Fault Zone in Harney and Deschutes counties with funding provided by a U.S. Geological Survey grant. DOGAMI also drilled a series of 500-foot gradient holes in the Cascades (Figure 1) west of the crest, from near



**Figure 1.** Oregon Department of Geology and Mineral Industries contract drilling rig making hole on Cascade geothermal gradient drilling project, Willamette National Forest, August 1976.

# PACIFIC NORTHWEST INDEX MAP... Some Major Volcanic Features & Geothermal Sites...



McCredie Hot Springs on the south all the way north to Mount Hood, a distance of more than 125 miles. The highest gradient (corrected gradient) found was 224°C/Km near Austin Hot Springs in Clackamas County. As this hole was quite near the hot spring, another was drilled about 2½ miles to the east, and it too showed a high gradient, 166°C/Km, indicating the possibility of a substantial heat flow anomaly in the area. This Cascade drilling project was funded by the State of Oregon, the U.S. Geological Survey, and by contributions from Portland General Electric Company, and the Eugene Water and Electric Board. Both of these utilities have filed on federal acreage in various parts of the Cascades within the past six months.

All temperature gradient information obtained by the Oregon Department of Geology and Mineral Industries in their several drilling programs, can be obtained by writing them at 1069 State Office Building, Portland, Oregon 97201.

Geologist John Hook and associates, in cooperation with Northwest Natural Gas Company, continued to investigate prospects for using hot water from the Mount Hood area for space heating and industrial needs in the greater Portland area. The economics of this appear attractive, but environmental and legal roadblocks have appeared, solutions to which are still pending.

The Geo-Heat Utilization Center of Oregon Institute of Technology at Klamath Falls continued studies of various aspects of down-hole heat exchangers, greenhouse and aquaculture geothermal applications, and heating districts. A joint study of food processing applications of geothermal energy for sugar beets and other row crops of the Vale-Ontario, Oregon area, and in the Klamath Basin was initiated by Oregon Institute of Technology, DOGAMI, and the Oregon Department of Economic Development, with funding from the U.S. Energy Research and Development Administration.

The Geo-Heat Utilization Center puts out a quarterly bulletin with a variety of useful information and reports on non-electrical uses of geothermal energy. Copies may be obtained by writing to Paul Lienau, Director, Geo-Heat Utilization Center, Oregon Institute of Technology, Klamath Falls, Oregon 97601.

Utilization of hot waters in Oregon increased modestly in 1976, chiefly with continued development for space heating applications at Klamath Falls. Geothermal water is currently being used also to heat greenhouses at Cove, Lehman Hot Springs, Lakeview, Vale, and Klamath Falls. Klamath Falls, also, with the use now of geo-

thermal waters to heat a hospital, may be able to boast of being the only city in the world offering cradle to the grave geothermal living.

With a geothermally heated hospital, one can enter this world in Earth-heat comfort, subsequently go to geothermally heated primary and secondary schools, then to a geothermally heated university (Oregon Institute of Technology), get married in a geothermally heated church, live in a geothermally heated house (there are more than 600 such houses) which house was built with millwork manufactured in a geothermally heated factory (Maywood Industries) on the south-east side of Klamath Falls, drive a car out of a geothermally heated showroom, and finally be buried from a geothermally heated mortuary. If one has led a less than exemplary life here, the geothermally heated mortuary will therefore even provide a preconditioning environment for what may have to be faced in the hereafter.

Federal geothermal lease (KGRA) sales were held in the following areas: Klamath Falls, Summer Lake, Vale, and Crump Geyser. Winning bidders on various tracts were Thermal Power Company, Southern Union Production Company, Chevron, Union Oil, and Amax. The highest price paid was for 3525 acres in the Vale KGRA with a bid of \$21.11/acre by Union Oil Company. Oddly enough, the lowest winning bid on any Oregon acreage in 1976 was in the same area by Amax, with a bid of \$1.16/acre.

In summary of geothermal leasing in Oregon, more than two million acres are now either applied for or are under lease. A total of 78,136 acres of noncompetitive leases and 53,226 acres of competitive leases were in effect on federal lands in Oregon at the beginning of 1976. Another 1,200,000 acres of noncompetitive leases are now pending. A substantial portion of the noncompetitive leases not yet issued are on National Forest Lands, and not a single acre of such land has been given in lease in the state. Environmental impact statements (EIS) are becoming very time consuming and costly, some have not yet even been started, and subsequent hearings and reviews results in even more delays.

The Willamette National Forest, where large acreage applications are now on file, has broken its area into three units, the first of which to be given an EIS being the Breitenbush area. This EIS appears as a very comprehensive two volume work: a 139 page narrative, and a 211 page appendix. One thousand copies were printed. The initial public hearing was held November 17, 1976 at the State Capitol in Salem, at which meeting several persons said they had not had time to

read the statement (it does take time!) but that they were opposed to it. One may question the future of a democracy when citizens are opposed to something they have not even read.

It might also be noted that comments received for the public record included some from other federal agencies, one of which stated that the report (all 350 pages of it) was inadequate in some parts, particularly with regard to earthquake problems (although the area is markedly aseismic), and suggested that a tectonic model of the central Cascades be discussed. As no adequate model exists of this area, presumably this would lead to another study which could take several years, and when completed its validity could probably still be questioned at best.

Also, it might be observed that an evaluation of earthquake hazards with regard to geothermal plants is probably not especially critical in the first place—surely not nearly so important as with nuclear plants. What really can happen to a geothermal installation? A few cracks in the concrete and a generator jolted a bit. Shut-off valves exist on all the wells. If any area of energy development is suffering from overstudy and government regulation, to the detriment of getting on with the job of developing basic resource information it is geothermal. We have talked about geothermal resources for years but we still really don't know how much we are talking about, perhaps by several magnitudes. Deep drilling for basic resource information is urgently needed.

For 1977, despite the general lack of federal leases being issued, several companies plan various geophysical studies in Oregon, both in the Cascades and to the east. Shallow gradient hole drilling programs will also be conducted. The State of Oregon, through DOGAMI, will conduct a fairly intensive study of the geothermal resources of the greater Mount Hood area. The Forest Service will continue to prepare the various environmental impact statements which are needed, but completion dates, and termination of hearings and reviews have no very predictable time frame.

## IDAHO

Some of the more speculative leases in Idaho were dropped this past year; minor lease activity continued in eastern Idaho. Occidental Petroleum increased its lease positions in several areas of the state, in part by picking up leases from others. At least two ventures more or less promotional in nature were initiated in the Boise area, but nothing has resulted from these activities to date.

Geothermal activity and interest in Idaho this past year centered chiefly around two projects—the Boise space heating development, and the Raft River project. At Raft River, additional reservoir engineering studies were conducted on the first two wells drilled, RRGE-1 and RRGE-2. Well RRGE-3 was drilled in 1976 to be the third well in a triangle designed to give a better analysis of the Raft River Valley geothermal reservoir.

It was programmed to have three "legs." Drilled initially to approximately 4200 feet, the first directional leg was then drilled to 5853 with little indication of flow, and an air lift produced only about 200 gallons per minute. Second and third legs were drilled to 5532 feet and 5917 feet, respectively, with maximum free flow of the well increasing to 800 gallons per minute. The markedly greater production obtained for the relatively modest cost of drilling additional legs to the well provide an interesting and instructive case history. A fourth well is being drilled for reinjection testing, but could be drilled deeper later for production purposes. Tentative plans for installation of a generator of 5 to 10 megawatts have been made.

Corrosion testing, and heat exchanger and cooling tower engineering design experiments continued at Raft River. Both aquaculture and agriculture programs also were in effect during 1976 and the results look quite promising. The fish thrived in geothermal waters, and grain grown, using geothermal water for irrigation, had better growth rates than grain on adjacent areas, and the general nutritional and trace element characteristics of the grains were satisfactory. Further such experiments will be conducted in 1977 together with an attempt to bring some private industry into the area to implement the total resource utilization concept for the Raft River area. The Raft River Electric Cooperative, and its geothermal subsidiary, continued to offer every assistance in this project.

At the Boise geothermal space heating project, which is a joint effort by Boise State University, Idaho Bureau of Mines and Geology, and the Idaho National Engineering Laboratory, five exploratory wells have been drilled in the Boise Front Fault area, along the foothills on the north-east side of Boise. The deepest well (Figure 2) went to total depth 1283 feet, and developed 194 gallons per minute artesian flow with an outlet temperature of 167 degrees Fahrenheit after 12 hours flow. A project summary report was made to the Governor of Idaho indicating that 10 state buildings plus about three times as many other buildings could eventually be heated at less than 70 percent of current fossil fuel heating costs.



**Figure 2.** Well BHW-1 of Boise space heating demonstration project. Well flowed 194 gpm with outlet temperature of 167°F. Some of state buildings including capitol to be heated by this project visible in distance.

The project is being installed in small units; the State Health Lab is now heated in this manner.

The catastrophe which was the failure of the Teton Dam has provided at least one positive prospect—the opportunity to possibly put Sugar City, almost totally destroyed by the flood, on an economical municipal geothermal heating system. This is being studied along with the Boise project. A similar space heating program for the small community (39 buildings) of Butte City, Idaho is also being considered.

The year 1977 should see additional progress on all these projects. A generating unit at Raft River seems a possibility. Hopefully, also, some deep drilling by private companies will prove up other geothermal areas in Idaho, a state which appears to have very large Earth-heat resources.

#### **FEDERAL GOVERNMENT VERSUS ENERGY**

Here and abroad the production of Earth-derived energy resources is only about one-half a geolo-

gical problem; the other half is political and institutional. In the case of geothermal development in the United States, and particularly in the Pacific Northwest, the balance at the moment is at least 80 percent political and institutional problems, and 20 percent geological. President Carter did give one line to geothermal in his energy address to Congress stating that geothermal developments should be given the same tax incentives as oil and gas. Additionally, however, something has to be done to speed up the issuing of federal leases, so important in the Northwest. Virtually all conversations I have had with companies involves the matter of "when will the federal leases be issued?"

One possible solution might be to issue the leases subject to a later environmental impact statement—if needed—and then issue drilling permits via the environmental analysis report route (an in-house Forest Service procedure) for an area sufficient for a drilling site (about 65,000 square feet is needed—less than two acres).



**Figure 3.** *One of many cut-over areas available for drill sites, with minimum environmental impact in Pacific Northwest forests. Photo taken in Breitenbush environmental impact statement area, looking north across Breitenbush Valley, Willamette National Forest, Oregon, 1976.*

Pacific Northwest forest areas have a very well developed network of heavy duty logging roads providing easy access to numerous logged over areas where the drilling of a deep test well on a two-acre site would have virtually no environmental impact (Figure 3). The issuance of leases on adjacent acreage with no surface entry allowed prior to a later environmental impact statement would preclude throwing the area into a KGRA if something were found, and preserve the operator's exploratory risk investment. The grim fact of exploration is that most areas would not be productive. The bright spot of that circumstance would be that one would avoid the need for voluminous, expensive, time-consuming environmental studies and subsequent wrangling at public hearings over areas which are non-productive.

If we know that a resource exists and have some idea of its potential, then environmental impact statements and public hearings become

meaningful. Reasonable value judgements can then be made with regard to the tradeoffs involved: the environmental impact for a given amount of energy which might be produced. Such hearings and environmental statements would then become worthwhile for all concerned. As it is, one now has the firm feeling, based on long exploration experience, that a great deal of time and money and argument are being spent over areas which will never be productive.

It is imperative that we assess our geothermal resources. Do the western United States and the Gulf Coast really have a great potential? The nation needs to know, for geothermal energy is the last great Earth-held energy frontier in the United States. Our gas, oil, coal, and shale oil potentials are fairly to very well known. Only geothermal resources remain to be assessed. The bulk of the problem of evaluating these resources lies squarely with the federal government in terms of issuing leases, and providing a reasonable set

of tax laws wherein the industry can operate. Industry is ready to make the effort and expenditures to find out what is there. Let us get on with the task.

### ACKNOWLEDGMENTS

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### ADDENDUM

Since this article was prepared for publication, the Bureau of Land Management has issued an Instruction Memorandum with regard to "Issuance of Noncompetitive Oil and Gas and Geothermal Leases Pending Completion of LUP/EIS's on National Forest Lands." This memorandum states that the BLM is the "primary authority" for such leasing on public lands including such lands in the national forests.

It further states that noncompetitive leases can be issued on national forest lands with provision for no surface entry, but that ultimate surface entry might be made under certain conditions, and that the Forest Service has approved this procedure. This arrangement would facilitate the evaluation of geothermal resources in an area where national forest land was intermingled with state and/or private land on which entry could be made and deep drilling conducted.

In such instances, the adjacent national forest lands could also be leased and thus the land position of the exploration company or individual could be protected. If geothermal resources were found, then the area could not be declared a KGRA and the land position of the exploration company lost as a result.

This arrangement provides a partial solution to the present delays and problems with national forest land leasing caused chiefly by prolonged preparation of land use plans and environmental impact statements, and subsequent hearings thereon. It should be noted, however, that the memorandum carries the notation that it expires 12/31/77.