

PACIFIC NORTHWEST GEOTHERMAL: REVIEW AND OUTLOOK

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INTRODUCTION

While agreements to build plants are being signed in Utah, Nevada, and New Mexico, and geothermal plants continue to be built in California, the Pacific Northwest lags in geothermal development. This is in spite of the fact that the potential of the region appears to be very substantial. The Cascades are the largest single young volcanic province in the 48-adjacent states, geophysical and geological studies are encouraging, the eruption of Mount St. Helens is dramatic testimony to the geothermal prospects of this region, and the Cascades are the site of the largest federal land geothermal lease play in the United States, with some 500 square miles now under lease application just in Oregon. However, very few leases have been issued. Nearly 500 lease applications are on file in the State of Oregon alone. How the federal government on the one hand wants alternative indigenous U.S. energy resources developed, and on the other hand sits on geothermal lease applications in many cases now for more than six years with no action, is a situation which demands some early explanation.

A modest amount of geological and geophysical work by federal and state agencies, and by private organizations was conducted during the past year. Some is underway at present, and additional work is contemplated next year. The U.S. Geological Survey continues its five year program of geothermal evaluation of the Cascades of California, Oregon, and Washington. A broad data-base is being accumulated, but the deep drilling (6,000 to 10,000 feet) needed to seriously test the prospects of this region has been lacking, again, chiefly because no company will commit the size of funds necessary to do such drilling unless they have firm

lease positions.

This article reviews, by state, some of the recent more important activities related to geothermal development in Idaho, Oregon and Washington, indicates the present status of geothermal operations, and suggests what may possibly occur in this region in the year or two ahead.

IDAHO

The Raft River project five megawatt binary power plant is nearly ready to go on line. It will be the first electric geothermal installation in the Pacific Northwest. The deep well (approximately 10,000 feet) drilled on the Idaho National Engineering Laboratory site (the old Arco atomic energy reservation) had a reported bottom-hole temperature in the vicinity of 300 to 340 degrees Fahrenheit, but with very little fluid. Tests for the space heating project at Rexburg, as of this writing, continue, but with problems there of shutting off the cool shallow waters from the presumably warm deeper waters. The State of Idaho is drilling toward 2000 feet at the edge of the Capitol grounds building complex for a space heating source. The City of Boise has decided to attempt a space heating project through the services of a private contractor, and a private warm water service agreement would be made, assuming drilling by the contractor is successful.

The outlook for the coming year in Idaho is for more work on the shallower low temperature geothermal resources. One possible deeper test (to 5,000 feet) may be drilled. Federal leasing problems in eastern Idaho just west of Yellowstone Park are not yet fully resolved.



Figure 1. Eruption of Mount St. Helens, May 18, 1980. Photo by Don Wilson, Staff Photographer, The Oregonian.

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OREGON

Oregon has seen a rather steady flow of lease applications filed, but very few have been issued. The Oregon Cascades now have some 500 square miles under geothermal lease application. This appears to be the largest federal geothermal lease play in the United States, and includes such names as Sunoco Energy Development Company, Union Oil Company of California, Southland Royalty Company, ARCO, Chevron Resources, Portland General Electric Company, Northwest Natural Gas, and the Eugene Water & Electric Board. A number of fairly large lease block applications also have been filed in private individual names. Union Oil was the winning bidder in early 1980 on 1,040 acres in the Breitbush KGRA, a tract adjacent to a substantially larger lease held by Sunoco Energy Development Company. Large leases are either held or under application in the Vale and Bully Creek areas of eastern Oregon, the Crump Valley, Glass Butte, Newberry Crater, and Lakeview areas, and in the Alvord Desert region of central Oregon.

The State of Oregon, through the Oregon Department of Geology and Mineral Industries, largely with U.S. Department of Energy Funds, continues its regional temperature gradient drilling program, and a number of shallow (500 foot) wells were drilled in 1979 and 1980. More are contemplated, assuming continued funding. This program has resulted, among other things, in the publication in late 1978 of Special Paper 4, Heat Flow of Oregon, and a 1/500,000 map Preliminary Geothermal Resource Map of Oregon.

These may be obtained from the Oregon Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon 97201. The final report, Geothermal Resource Assessment of Mount Hood, prepared by the Oregon Department of Geology and Mineral Industries (DOGAMI) under a U.S. Department of Energy contract was issued in July, 1979, and may also be obtained from DOGAMI.

The 1978 Oregon Legislature set up an Alternate Energy Development Commission (AEDX), peripheral to which a Geothermal Task Force was appointed.

The Draft Report of the AEDC, and the report of the Geothermal Task Force are now complete. These papers seek to identify the prospects and problems of geothermal development in Oregon, offer suggestions as to what the State of Oregon might do to further such development, and give, to some extent, the State of Oregon's position in these matters. A handbook, Oregon: A Guide to Geothermal Energy Development, was also prepared. Copies of all three of these publications may be obtained free of charge from the Oregon Department of Energy, Room 102 Labor and Industries Building, Salem, Oregon 97310.

The Eugene Water & Electric Board (EWEB), with funds obtained chiefly from the U.S. Department of Energy, but with supplementary money provided by EWEB, Sunoco Energy Development Company, and Southland Royalty Company proposed in 1979 to drill from five to seven geothermal gradient wells to 2000 feet west of the crest of the north-central Cascades (approximately from Santiam Pass to just southeast of Austin Hot Springs). Six of these wells were completed to depths ranging down to 1967 feet. Gradients were measured, the cuttings have been studied by the Petrology and Geochemistry Section of the U.S. Geological Survey in Menlo Park, and a final report will be placed on open file with the Oregon Department of Geology and Mineral Industries before the end of 1980. A set of cuttings is also on file with that organization in Portland. A duplicate set is in repository at the University of Utah Research Institute in Salt Lake City.

Drilling continues at Mount Hood, both on the Timberline Lodge heating project where a 2000-foot well is now being deepened to 4000 feet, and on the regional assessment of the area by the U.S. Geological Survey (supervised by James Robison of the USGS). A total of four wells are projected to be drilled in this study, two to 1000 feet, and two to 2000 feet. The space heating project (potentially for Portland), located on the west side of Mount Hood in the Old Maid Flat region (Northwest Natural Gas Company lease), is also being pursued.



Figure 2. Temperature gradient logging by Oregon Department of Geology and Mineral Industries of Eugene Water & Electric Board Number 1. (Fish Lake Creek well, SE¼ 32, 13S 7E, Linn County, Oregon. Depth 1835 feet).

A well drilling there now (see Figure 3), if carried to projected depth of 5,000 to 7,000 feet, will be the deepest well so far drilled in all of the Oregon Cascades.

The Bully Creek area of eastern Oregon, and the Crump Valley and Alvord Desert areas of central Oregon saw 2800-foot or shallower drilling recently, and exploration work continues in all three regions. In the case of the Alvord Desert, Anadarko Production Company was the winning bidder on 4,960 acres of KGRA acreage, but has subsequently been given a roadblock in the form of the "Oregon Snail Darter"--the Borax Lake Chub, a two-inch minnow of no commercial value, which is a remnant Pleistocene Lake inhabitant, and is now leading a precarious existence in a 10-acre warm water pond in the Alvord Desert. The U.S. Fish and Wildlife Service has issued an emergency notice stating that "although the chub is confined to a 10.2 acre lake on private land, the Critical Habitat was determined

to be 3840 acres including four sections with the Anadarko leases." The Bureau of Land Management, therefore, is prohibited from issuing these leases until some understanding is reached with the Fish and Wildlife Service, and in fact the leases may never be issued. A detailed examination of numerous patches of sagebrush in the 3840 acres of the Alvord Desert cited by the Fish and Wildlife Service has not turned up the chub, so it is presumed that at the moment the chub does indeed just inhabit the 10.2 acre lake, but perhaps it is thinking about extending its range. In any event, if or how this impasse will be resolved has yet to be determined. Hearings will ultimately be held. Hopefully, Anadarko can offer some arrangement to protect the chub's interests which will be satisfactory to the authorities. The Alvord area appears to have excellent geothermal development prospects.

Elsewhere in Oregon, a deep (slightly more than 10,000-foot) well at the Orinda Foods Inc. (potato processing) plant in Ontario found bottom-hole temperature in excess of 400 degrees Fahrenheit, but no fluid in quantity. At lakeview, Northwest Natural Gas Company continues to drill and to study the prospects

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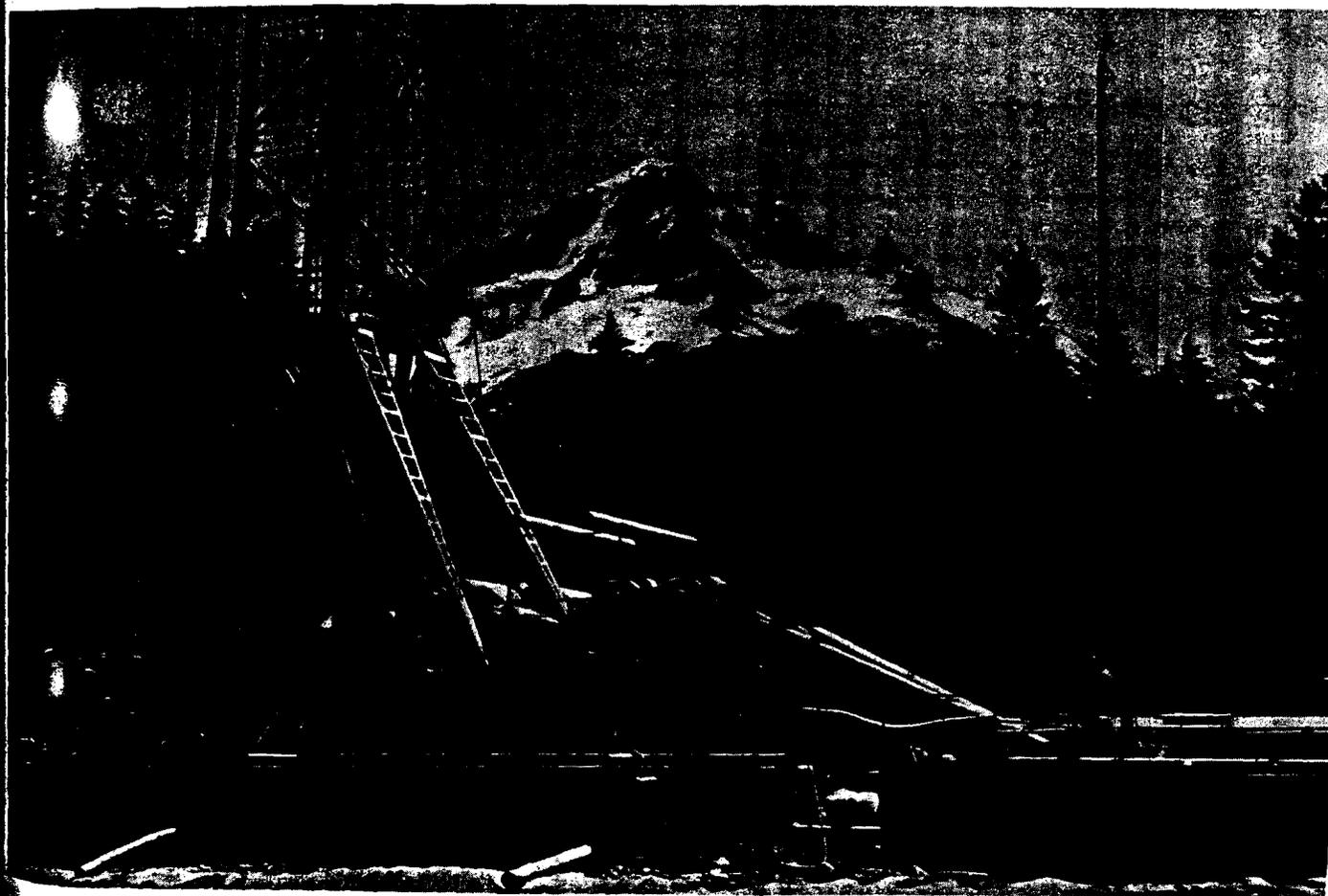
for a district space heating project. Similar studies continue by the Geo-Heat Utilization Center (Oregon Institute of Technology) in the Klamath Falls area. On the west side of the Cascades a geothermal space heating feasibility study for the City of Oakridge was completed by Richard Bowen. The Oregon Department of Geology and Mineral Industries is now drilling some shallow gradient holes in that area.

On the Glass Butte area geothermal prospect, between Bend and Burns in central Oregon, it is reported that the two principal lease-holders, Phillips Petroleum and Francana Resources, Inc. have worked out an agreement for exploration there. Some drilling to, at least 2000 feet, is expected next year.

The U.S. Geological Survey completed its drilling program started a couple of years ago in the Newberry Crater area. Drilling equipment was moved out in late summer of this year (1980). Presumably results of these operations will be on open

file shortly. A U.S. Geological Survey program to identify, sample and analyze geothermally altered areas in the Cascades was conducted this summer in an effort to determine, regionally, the more prospective geothermal areas. Sunoco did some heat flow drilling in 1980 in the Cascades in the general vicinity of their interests in the Breitenbush KGRA, and on other lease application areas held them west of the Cascade crest. Other companies conducted a variety of geological studies in the Cascades, results of which remain proprietary as of this time.

Figure 3. Deep test (projected to 5,000 to 7,000 feet) drilling August, 1980 on Northwest Natural Gas Company lease in Old Maid Flat area, west side of Mount Hood. Mount Hood in background. Taylor Drilling Company rig, Chehalis, Washington. Photo by John Hook.



The outlook for Oregon is for continued modest exploration programs with small additional lease positions being filed upon, assuming the federal lease log-jam is not broken. What has been perceived to be a somewhat negative attitude toward geothermal development in Oregon by Oregonians appears to be changing. The establishment of the Alternate Energy Development Commission and the Geothermal Task Force are such indications. Oregon, which imports 87% of its energy, can hardly afford to ignore what energy resources may lie within its borders. However, the decision in this regard, in effect, is largely up to the federal government as far as geothermal resources are concerned. The federal lease processing delay is a major impediment to geothermal development. If leases were issued in quantity, and in a reasonable fashion (units large enough to be useful and not broken up by various constraints), geothermal exploration and development would greatly increase.

WASHINGTON

The eruption of Mount St. Helens has greatly increased attention to geothermal resources in Washington. A considerable number of additional geothermal lease applications have been filed in the broad general region of St. Helens, and also on the northwest flank of Mount Rainier, and in the Mount Baker area. A study of the warm to hot water potential of the Northwest flank of Mount Rainier is being negotiated. The Washington State Energy Office and the Interagency Geothermal Development Council have prepared a draft geothermal plan for the State of Washington.

Recently, the Washington Department of Natural Resources drilled 10 geothermal gradient wells. Included in this work was an east-west profile just south of Mount Rainier across the Cascade crest, three well in the Mount St. Helens region, and two at Camas, Washington. The two at Camas proved to be cool. The others generally show a regional geothermal gradient in the southern Cascades of Washington (Mount Rainier and south) of about 45 to 55 degrees centigrade per kilometer.

Of the three holes drilled in the Mount St. Helens area, one was destroyed by the eruption. The other two are still being observed. It is interesting to note that the one on the south flank of Mount St. Helens is cold and isothermal at four degrees centigrade proving conclusively, of course, that there is no geo-heat of consequence in the area! This statement might be accepted except for the events of the spring of 1980, and especially on May 18th (see Figure 4). This circumstance does point up a noteworthy fact. These are 500-foot holes, and the shallow groundwaters in the heavy snow and rain areas which are the Cascades of Oregon and Washington are major barriers to surface or near-surface expressions of the leakage of geothermal waters. Such shallow holes, unless located where the regional water table can be penetrated, and not located where vadose waters predominate, are virtually useless for heat gradient determinations. Not only are such holes useless for observations, but drilling them is a great problem in itself, with lost circulation and through flows of large volumes of water common and severe.

A study of well records by Mike Korosec, geothermal geologist with the Washington Department of Natural Resources, Division of Geology and Earth Resources, identified some 22 cities, towns, and hamlets in the Columbia Basin which apparently have warm waters with heat qualities sufficient to be possible space heating resources. This matter is being pursued, with special near-term emphasis likely to be given to the Ephrata and Yakima areas.

There was no industry activity in Washington this past year, except that the Burlington Northern Railroad has been giving some thought to the geothermal resources it may have on its extensive Washington land holdings. No known industry plans exist for next in firm form yet, but a number of discussions are underway. The Washington Department of Natural Resources will continue its heat flow drilling program and extend its profile across the Cascades from White Pass to Yakima. The matter of space heating from the low temper-

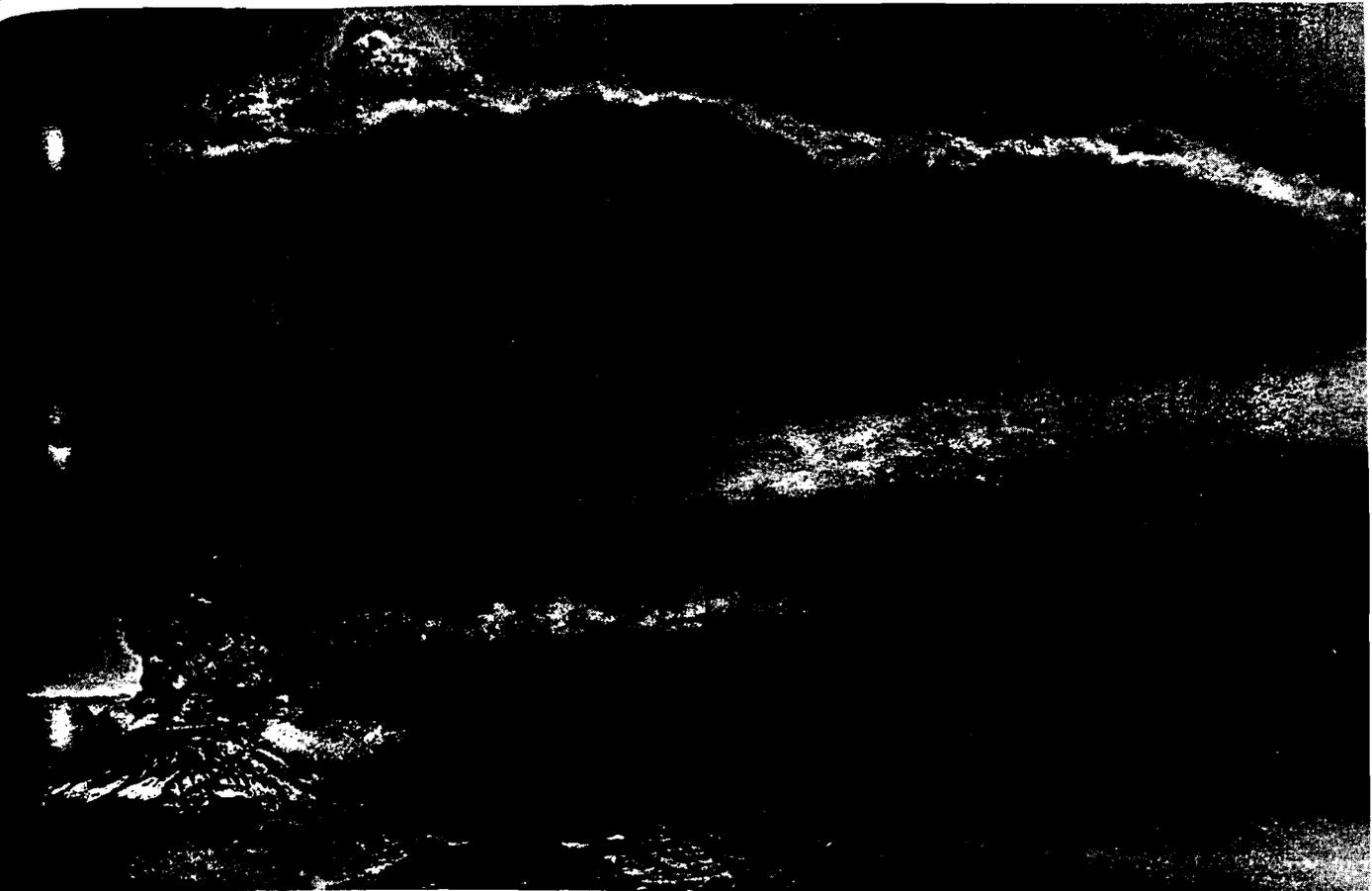


Figure 4. Mount St. Helens on May 18, 1980. Photo taken approximately 20 miles away with wide angle lens, which, even at that distance, did not quite capture all of the ash cloud. Photo by Don Wilson, Staff Photographer, The Oregonian.

...ure geothermal resources in the Columbia Basins will be also pursued.

SUMMARY AND OUTLOOK

Geothermal exploration and development activity was at a moderate pace this past year in the Pacific Northwest. However, with the large number of leases which are on application now, if the federal geothermal lease barrier can somehow be broken, activity should greatly increase. It is unlikely that companies would relinquish their firm lease positions (assuming they get such) in such promising areas as the Oregon Cascades without some extensive deep drilling. In regard to the geothermal

promise of the Cascades, it was this writer's privilege to visit New Zealand earlier this year, bringing along some of the geological and geophysical data from the Cascades. Useful and illuminating discussions were held with the personnel of the United Nations Geothermal Institute at the University of Auckland, with personnel of the Department of Scientific and Industrial Research (DSIR) at Wellington (which government agency provides basic data on New Zealand resources, including geothermal), and with the scientists at the Wairakei Geothermal Office at Wairakei. Through international work agreements, many of these people have become experienced in geothermal terrains and exploration, not only in New Zealand, but in Chile, the Philippines, El Salvador, and Indonesia. A comparison of data from these areas with studies we have from the Cascades indicates that if the same tools are measuring the same things in the Cascades as they are in other geothermal areas of the world, that the Cascades

have just as promising prospects, just as large (if not larger) anomalies, and just as great if not greater anomaly contrasts, as in other parts of the globe where geothermal resources are now known and being developed.

If the geothermal lease situation can be expedited, greatly increased exploration activity should take place within the next 12 to 24 months in the Pacific Northwest. Preliminary company budgets are now being prepared, and are reported in several instances to include money for deep drilling, contingent, again, on having firm leases in hand. In this regard, however, any continuation of the inordinate delays in issuing leases will surely see a major industry turn-away from geothermal exploration in the Northwest in favor of more promising places to put money. The facts from all across the United States are these:¹ Obtaining a lease from the Bureau of Land Management has taken an average of 97 weeks, and only 18% of the last six years' applicants have actually obtained leases. Obtaining a lease from the Forest Service has taken about 111 weeks. Leases have been issued to only two percent of all applicants.

In the forest regions of the Pacific Northwest, numerous lease applications have been on file for more than six years with no action taken. Such hearings as have been held, with the resulting decisions as indicated in the environmental impact statements, give serious doubt as to whether or not the concept of "multiple use" of the forest lands is really being implemented. At best, only a very small percentage of any Pacific Northwest national forest area will prove to have geothermal potential. Furthermore, of that percentage, only one-fifth to one-fourth of the surface of that area will be utilized for geothermal installations. The bulk of geothermal operations are conducted underground, and trees or whatever can continue to grow as before over much of the acreage producing geothermal energy. Area for area, three to four times and in some instances much more energy can be obtained per square mile

¹ Data from a 1980 study by the Energy Division of Booz. Allen & Hamilton, Inc.

of surface utilized for geothermal development as can be obtained from areas flooded for dam sites, and the visual and environmental impact of geothermal development is much less than flooding a valley. Furthermore, important to the Northwest, geothermal development will not interfere with the love-life of the salmon, as do dams. A final point is that geothermal power is base-load power, and not subject to drought as are the hydro-power sources of the Northwest.

It is fair to say that geothermal development in the Pacific Northwest is at a cross-roads. Leasing is the key, and decisions should be made soon, or interest will decline markedly. It is unreasonable for the federal government to hold lease application money (which could return 10% to 15% interest in the market place) for six years with no action.

The electric power situation in the Northwest, long a region of cheap kilowatts, is becoming critical. The Bonneville Power Administration has stated that 1983 is the "year of insufficiency." That is, after 1983 no additional power is likely to be available from the Bonneville system. Northwest utilities will have to find other sources. Furthermore, the Bonneville Power Administration is proposing rate increases which will result in the cost of electricity to the Northwest publicly owned utilities by the middle of this decade four times higher than it was during most of 1979. An 88% increase was imposed in December, 1979, and the BPA plans six increases by 1986 on top of the increase imposed last December. The three nuclear plants now being built by the Washington Public Power Supply System have seen their costs rise from an estimated \$1.55 billion to \$8.7 billion, all of which means that alternative, and currently more costly energy sources, including geothermal, will rapidly become more attractive even in the traditionally low-cost power area of the Pacific Northwest.

The economic tide, therefore, seems to be turning in favor of geothermal development. There are many indications, even from the very preliminary exploration work which has been done, and beyond the testimony of Mount St. Helens, that a major geothermal energy base exists in this region, and the fundamental out-

book is promising.

ACKNOWLEDGMENTS

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