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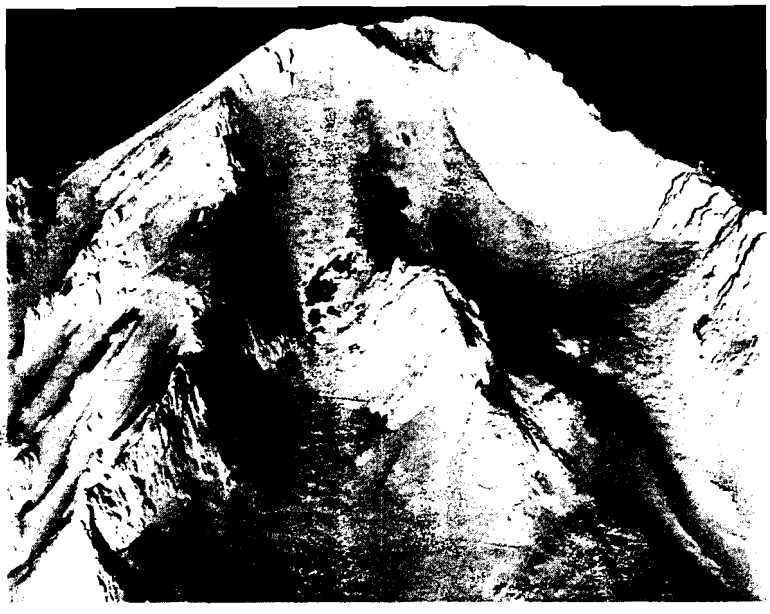

Photo courtesy Herbert Schlicker, Oregon Department of Geology and Mineral Indus

PACIFIC NORTHWES GEOTHERMAL: REVIEW AND OUTLOOK

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Mount Hood, Oregon, with fumaroles—sym of the extensive Cenozoic volcanic terrains ing the geothermal prospector in the P Northwest.

The tremendous volumes of young volcanics which exist here together with its position on the Pacific Rim makes the Pacific Northwest a prime geothermal exploration target. Oregon, for example, has more of its land, percentage-wise, classed as geothermally attractive exploration territory by the U.S. Geological Survey than any other state in the Union. Extensive volcanic areas are known in the Pacific Northwest with ages younger than one million years, and many flows and volcanic centers are less than 10,000 years old.

Against this attractive exploration setting, however, only a modest amount of exploration work has been done, considering the large areas which should be tested. This article reviews some of the more significant developments this past year in Idaho, Oregon, and Washington, suggests what may occur in 1976, and points out the critical role the Federal Government now has in either turning off or turning on this energy resource.

Idaho

Two geothermal wells were drilled under the auspices of ERDA in the Raft River KGRA. Both found substantial amounts of hot water. RRGE-1 had a bottomhole temperature of 146° C at total depth of 4989 feet with an average flow of 650 gallons per minute. RRGE-2, drilled to 5988 feet, found 147° C water with an average flow of 800 gallons per minute. Both wells bottomed in a quartz monzonite, but production comes from higher zones, chiefly in a calcareous tuff with some siltstones and gravels. The report by Aero jet Nuclear Company for ERDA on the projec states:

> An evaluation of the available geologic da from RRGE-1 and RRGE-2 indicates that t major portion of the geothermal resour may occur directly above the Precambri quartz monzonite (above 4000 feet). T water migrates into the valley basin from considerable distance away and from hig er elevations than the surrounding mou tains. It percolates downward until it e counters the quartz monzonite acting like "hot plate," transmitting the heat fr depth to the water. The faulting in the s tem encourages upward migration of t hot water wherever it occurs.

The source of the heat in the Raft River KGR therefore, remains unknown. However, the mount of heat is impressive. Other wells drill in the valley in total suggest that perhaps much as 100 square miles or more may be und lain by these moderate temperature hot wate In view of this vast amount of energy potentia available, ERDA proposes to proceed with de lopment of the area to demonstrate the use a economics of these waters for electric pow generation, and also use of the resultant low temperature effluent in industrial processes a in agriculture.

Aerojet Nuclear Company, for ERDA, h made a preliminary estimate that in an ener system using isobutane to drive the turbine ge erators with a geothermal resource of the te

perature now known in the Raft River valley the capital costs of a 10Mw system would be $1,066/Kw, and $640/Kw for a 50Mw system. One of the purposes for developing this Raft River site is also to determine if technology can be perfected to cut down these costs. There are a number of innovations on the horizon which suggest this is quite likely. To facilitate the development and local use of this heat, the Raft River Electric Co-operative whose members are the principal private landowners here, has set up a wholly-owned subsidiary, the Raft River Geothermal Research and Development Co-op, Inc., with Edwin Schlender, retired General Manager of the Raft River Co-op, as Executive Vice President and General Manager. Anyone wishing to visit the Raft River site would do well to contact Mr. Schlender in Malta, Idaho where the visitor will subsequently find a warm welcome and a most gracious and helpful host.

It is noteworthy in considering the very large amount of heat apparently present in the Raft River area, that U.S. Geological Survey circular 726 (p. 39) states the relatively unknown and unheralded Bruneau-Grandview, Idaho geothermal area has 200 times the stored heat of the Raft River area!

At Boise, Idaho a water well drilled at the State Penitentiary in the 1890's accidentally discovered a strong flow of 170° F water which was subsequently used since then to heat some of the fortunate residents along Warm Springs Avenue. Some of the pipes were made of redwood or cedar and are still functioning to supply the 170 houses yet on this system. Originally some 450 residents had geothermal heat but later some decided to "go modern" and get on gas or oil; now they are urgently trying to get back to geothermal.

In a joint project between ERDA and Boise State University, this geothermal zone is now being explored and a well has been drilled to a depth of about 1000 feet and completed as an artesian well flowing 163° F water. Geothermometry projects a temperature of about 250° F for this reservoir, which, geology indicates, extends for at least 15 miles along the foothills north of Boise. The water has a low mineral content and excessive mineral precipitation is not a problem. An urban renewal development currently involving eight blocks of downtown Boise is projected to be heated by this source, and within two years the State Capitol building will be converted to use geothermal heat, a project strongly backed by Governor Andrus. Thus Idaho will be the first state to have a geothermal Capitol. (It might also be noted that the Boise home of Senator Frank Church is geothermally heated, so Idaho will not only have the first geothermal Capitol, but even now claims the only geothermally heated United States Senator.)

The outlook for Idaho is for continued development of both the Boise and Raft River sites, with a generally increased tempo of exploration through the rest of the State's geothermal terrains. However, the mixture of private lands, and Federal lands on which lease applications have in many cases, not yet been processed, together with the continued propensity of the USGS to declare areas as KGRAs combine to inhibit geothermal exploration in Idaho, as elsewhere, in the Pacific Northwest.

Oregon

The dual jurisdiction claimed by both the State Geologist and the State Engineer over geothermal drilling in Oregon was finally resolved in favor of the State Geologist through House Bill 2040 signed into law by Governor Bob Straub July 1, 1975, thus ending a long dispute which had made drillers wary of coming to Oregon. An additional piece of legislation, House Bill 3185, was also enacted providing for the formation of geothermal heating districts, the issuing of general obligation bonds, revenue bonds, and the levying of taxes for these districts. In a State which already is a leader is geothermal heating, the legislation will no doubt significantly enhance this sort of development.

At Klamath Falls, the Oregon Institute of Technology continues to be an outstanding geothermal success story with all of its buildings heated from two geothermal wells (with a third as standby). Costs per year are running under $20,000 with the expense for fuel oil needed to do the same job currently estimated at about $300,000. A wide variety of establishments in the Klamath Falls area are now going to geothermal heating to add to the more than 600 homes, several schools, and some commercial buildings already enjoying geothermal economy. The proposed establishment at the Oregon Institute of Technology of a Geothermal Engineering and Technology division will provide a center for further research and training. Professors John Lund (Engineering), and Paul Lienau (Math-Physics) are the principal moving forces in this organization at present.

Some heat-flow hole drilling was done by Amax Exploration in Oregon at several localities,

operations for which were headquartered in Amax's Portland office headed by Dr. H. Dean Pilkington. A test hole was started by Pacific Power and Light on Weyerhaeuser land in eastern Oregon. One deep test was drilled late in 1975 by San Juan Oil Company, on a farmout from Gulf, near Adel, and was abandoned at objective depth of 7,516 feet. Geochemistry of the waters in this area did not appear to other observers to make this a particularly favorable location.

As part of a long term program to prepare a comprehensive heat-flow map of the State of Oregon, Oregon's State Department of Geology and Mineral Industries continued its heat-flow hole drilling program, chiefly along the Brothers Fault Zone in central Oregon, and completed a similar program in the Vale area of eastern Oregon. Information obtained from these studies is now on open file at the State Department of Geology and Mineral Industries office in Portland. To obtain it, contact R.E. Corcoran, State Geologist. Of particular interest in connection with this study was the drilling of one test well in the Glass Butte area which found an indicated geothermal gradient of more than 190° C/Km. Other geological and geophysical work was also conducted both by the State of Oregon and the U.S. Geological Survey including a variety of magnetic, electrical, and gravity surveys. Some of these data are now also on open file in the State Department offices in Portland. That Department, in a project jointly financed by the State of Oregon, the U.S. Geological Survey, Portland General Electric Company, and the Eugene Water and Electric Board, also initiated a series of geological studies over a nearly 100 mile long portion of the central part of the western and high Cascades. This is preparatory to a heat-flow hole drilling program to begin there this summer.

Five KGRA sales were held in 1975 in eastern and central Oregon, with the highest average acreage bid ($17.90 acre) paid by Chevron Oil for acreage in the Alvord area east of the Steens Mountains. Next highest bid was $16.16 by Union Oil for leases in the Vale KGRA. At present more than 30 companies are active or hold geothermal interests in Oregon.

Among the more interesting other developments, the continuing studies by geologist John Hook and associates who have lease applications on the flank of Mt. Hood with a view toward the possible tapping of hot waters to be used for space heating in the greater Portland area, and the project headed by Richard Bowen to geothermally heat the Mount Hood ski lodge are noteworthy. Also, Andy Parker of Desert Gem Farms in Lakeview, Oregon is reportedly planning a 10-fold expansion of his geothermal greenhouse operation which supplies Oregon-grown tomatoes to Northwest markets in the winter months. Other similar geothermal greenhouse projects are in the planning stage in Oregon.

At 1975 year-end about 370,000 acres of geothermal leases were active in Oregon, but an additional 900,000 acres of leases applied for on Federal land had received no final action. This delay in processing Federal lease applications (most of them dating back to early 1973) is becoming an increasing concern and represents one of the major reasons why geothermal activity in Oregon is not progressing as it should, considering the attractiveness of the area.

The year 1976 will see further KGRA lease sales in Oregon including Klamath Falls, and Summer Lake. The State will continue its heat-flow hole drilling program, and the U.S. Geological Survey will pursue its geological and geophysical studies. If action can be obtained on some of the Federal leases applied for, increased industry activity can be expected and some deep holes may be drilled, but early removal of the "Federal bottleneck" to geothermal energy flow in Oregon does not appear very likely.

Washington

Geothermal exploration in Washington in 1975 was conducted by Amax Exploration which drilled several heat-flow holes near White Pass in Lewis County, by the Washington Department of Natural Resources which drilled six heat-flow holes in the Steamboat Mountain-Big Lava Bed area of Skamania County, and by the U.S. Geological Survey which continued to monitor the increased thermal activity of Mount Baker. Other organizations sampled hot springs, ran microseismic surveys, and conducted aerial infrared photographic studies of selected areas. Amax results are not released. Information available on the State operations in Skamania County showed an average heat-flow of about 1.5 to 1.7 microcals./cm. sq. sec. which is about normal for the Washington Cascade Range and, therefore, not particularly interesting. These holes were drilled in young lava flows.

In 1976, some additional thermal gradient measurements will be taken by the State in holes already drilled. Industry plans for Washington this

summer appear to be modest as far as it is now known.

OUTLOOK

Whereas Washington's geothermal potential is surely not determined, it appears that activity for 1976 will be concentrated more in Idaho and Oregon, with both geothermal electrical generating prospects explored as well as further development of space heating projects. The acreages which continue to be attractive are very large in both states, but present tax laws and the slow movement of the Federal agencies in acting on lease applications combine to delay assessment of what is the real size of this resource. There is every indication that these resources are large. Even if most of them are used in space heating, this will be an important development for the Pacific Northwest where much space heating is now done electrically. Donald Hodel, Bonneville Power Administrator, has stated that by the fall of 1978 Bonneville Power will be announcing a deficit of 2 million kilowatts or more. With virtually no hydrosites left to be developed (especially with the recent designation of the Lower Hell's Canyon area of the Snake River as a Wild River), any substantial increase in base load generation capacity will have to come from thermal sources-thermonuclear, coal, or geothermal. In view of the difficult times which nuclear programs are having it appears that coal and geothermal will be the chief candidates in the immediate future for development.

FEDERAL GOVERNMENT BARRIERS

The hour for developing new energy generating capacity in the Pacific Northwest is already so late that neither coal nor geothermal can come on stream fast enough to prevent power shortages from occurring, but each day that these resources are delayed in their development means unnecessary additional shortages in the future. Action is urgently needed on Federal lease applications.

Remedial tax legislation also is of the utmost importance, and it is difficult to understand how the Congress thought it would provide for geothermal energy development when the present unfortunate legislation was enacted. For example, if one drills a successful oil well, the oil can be produced almost immediately by hooking on to a pipeline or trucking out the product, and an early return on investment is received. Not so with a geothermal well. You must drill several additional wells beyond the discovery well to prove up the resource in quantity to justify building a geothermal plant. Including construction of the plant, this involves several years before there is any return on investment. Yet geothermal resources currently receive far less favorable tax treatment than does petroleum. It might also be added that most geothermal terrains, being volcanic, present much tougher and costlier drilling than does drilling for petroleum in the soft rocks in which it occurs. However, drilling costs and other intangibles can be immediately written off in oil and gas exploration; this is not true for geothermal operations. Petroleum enjoys a depletion allowance, especially now designed to encourage the small independent operator. Geothermal resources are currently regarded by law as a non-depletable resource which is contrary to the realities of the matter. Although geothermal energy ultimately comes from atomic decay in the Earth which is a continuous process for all practical purposes, the geothermal systems which must be formed in nature to transmit this heat to the well bore fast enough to be economic have a demonstrable finite life—estimated at The Geysers, for example, to be about 35 years.

The Congress presumably wishes to encourage United States' energy independence and develop new sources of domestic energy supplies. Yet there is virtually nothing in the present legislation which does this and many things which markedly discourage geothermal development. Until these serious legislated economic barriers to geothermal production are removed and affirmative action taken on the great number of yet unprocessed Federal land lease applications by the several Federal agencies concerned, chiefly the BLM and the Forest Service, geothermal resources will languish, and the situation has now reached the critical stage; indeed some segments of industry initially interested have already reduced or completely eliminated their geothermal exploration programs.

With the long-time electrically power-blessed Pacific Northwest now facing a power shortage, the development of geothermal resources is overdue. Hopefully, this year will see more positive action on both tax legislation, and the issuing of leases.

Acknowledgements

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