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GEOTHERMAL EXPLORATION PROGRAM AT ORE-IDA NO. 1, ONTARIO, OREGON

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ABSTRACT

A geothermal test well was drilled at Ontario, Oregon in 1979, to a depth of 10,054 feet. Temperatures below 7,100 feet depth are greater than 310°F. Massive basalts were not encountered until 8,135 feet depth. The hole did not respond to initial flow tests. The hole has not been pumped nor equilibrium temperatures measured.

Introduction

Ore-Ida Foods No. 1, a deep geothermal test hole, was spudded at Ontario, Malheur County, Oregon on August 19, 1979. The hole was drilled to a total depth of 10,054 feet by November 7, 1979. Testing and logging activities continued to November 27, 1979, after which the rig was moved from the site and the hole capped with a pressure-tight flange, valve and pressure recorder.

The well was drilled in order to develop a source of hot water for the Ore-Ida Foods, Inc. processing plant at Ontario. A cooperative program was contracted between Ore-Ida Foods and the U. S. Department of Energy. Ore-Ida Foods was serviced by CH2M-Hill as principal consultant, and GeothermEx, Inc., as technical consultant for exploration. The Department of Energy was serviced by EGG-Idaho as program manager.

The well has not been officially observed nor tested to determine how close it came to its objectives. Nitrogen stimulation tests did not produce fluid. Infill appeared to be restricted to less than 15 gallons per minute. It is reported that artesian flow of about 1 gallon per minute at about 70°F with a wellhead pressure of about 80 psi developed by February 1980.

The well has not been pump-tested, although water now stands in the casings to surface. The hole is fully cased and/or lined to total depth. No equilibrium-condition temperature logs have been run to total depth, which would not only provide temperature information but indications of fluid entry as well. No down hole pressure tests have been made. No spinner tests have been attempted. Therefore, the critical results of the hole are not known. The equilibrium temperature gradient, zones of fluid entry, amount and kind of formation damage, if any, from drilling and testing, are all conjectures. Determination of the suitability of the well for stimulation must await careful metered flow tests.

Full sets of geophysical logs were run in the hole. Except for intervals from surface to 925 feet depth, and 7,952 to 8,182 feet depth, there is complete log coverage, including overlap in an interval between about 6,800 and 7,160 feet. From the temperature logs and maximum reading thermometers, an equilibrium temperature of 347°F at a depth of 7,960 feet has been extrapolated from modified Horner plots. This is the lowest depth from which sufficient data exists. An independent method was used to calculate an equilibrium temperature of 320° ± 10°F at a depth of 7,150 feet. Geochemical geothermometry of well fluids sampled provides an average cation (Na-K-Ca) value of 350°F at 8,000 feet depth.

Original Geothermal Prospect Concept

The selection of the general site for a geothermal test well program at Ontario, Oregon, was based on a large volume of regional and local geological and geophysical data from published and unpublished sources. These data were originally summarized in the Ore-Ida Technical Proposal, Volume I, and were supplemented in reports by CH2M-Hill and by Gardner and Koenig.

The Ontario, Oregon, site is located at the center of the western Snake River Plain geomorphic province. The Snake River Plain province is an arcuate structural and topographic depression which extends from about 25 miles (45 km) northwest of Ontario, eastward and northeastward across southern Idaho, to the vicinity of Yellowstone Park, Wyoming. The western part of the depression is referred to as the Snake River Basin. The basin is bounded on the north by the mountainous region of central Idaho including the Idaho batholith, and on the south by the Owyhee uplift. At its northwest end the basin is terminated against the Blue Mountains uplift of east-central Oregon.

The existence of geothermal potential in the Snake River Basin is suggested by the history of late Cenozoic volcanism and tectonic activity. This general evidence is supported by the occurrence of thermal waters in many locations, including springs and shallow water wells around the basin margins, at the Bruneau-Grandview area and Givens Hot Spring on the south; at Cow Hollow, the Owyhee River Canyon and Vale on the northwest; and at Boise and Weiser on the north. Further evidence of a geothermal anomaly occurs in the relatively high geothermal gradients encountered in some deep hydrocarbon exploratory test wells drilled within the basin, including Chevron's Highland Land and Livestock Co. No. 1 and Halbouty's J. N. James No. 1.

The Ore-Ida No. 1 well was the second deep geothermal test drilled in the Western Snake River Basin. The Ontario site was chosen within the restriction of a 3-mile radius from the plant location, rather than on the basis of basin-wide studies to select a site having most exceptional prospect merit. The site was chosen as one with high risk, located where regional heat flow and other geophysical and geological information supported a field test of the geothermal resource. Site selection was made on the basis of several assumptions about the region. The assumptions are summarized below, with a discussion of their validity, in the light of results from Ore-Ida No. 1.

1. Heat Flow and Temperature gradients. Regional heat flow studies indicate that the Ontario area is in a zone averaging 2.5 heat flow units (100 mWm^2). Calculations of heat flow based on the Ore-Ida data generally confirm the original precepts. The corresponding geothermal gradient ranges from about 5°F/100 ft (90°C/km) near surface in clags and siltstones to about 3.5°F/100 ft (60°C/km) in deeper parts of the hole, in altered volcanic rocks. The predicted temperature of 320°F at 7,000 feet depth by Gardner and Koenig was unusually accurate.

2. Reservoir rocks--Depth and Subsurface Distribution. It has been considered by some geologists that Miocene basalt units, equivalent to the Columbia River Group or Owyhee Basalt, are the most likely potential reservoir units for geothermal fluids in the subsurface section. This assumption appeared plausible because of the widespread distribution of basalts outcropping on both sides of the Snake River Basin and the occurrence of considerable amounts of basalts in a few deep wells. Within the western Snake River Basin, only 10 of 35 deep wells have penetrated sufficiently deep to encounter significant amounts of basalt. Eight of these tested potential hydrocarbon-bearing sandstones, rather than waterflow potential from basalts. Thus, formation tests of basalt intervals are available only from the Ore-Ida No. 1 well. A few instances of lost circulation have been reported from wells while drilling in basalt, but these are inadequate information points to define the reservoir potential of specific deep formation objectives. Thus, a regional basalt reservoir (or reservoirs) has not yet been identified from the data now available. The delineation of reservoir objectives should be the most important factor in further studies in this region. Hydrothermal alteration of basalts may severely reduce original permeability in breccia zones and fractures. It was suggested by Gardner and Koenig that permeability, except in major recent faults, might be too low to provide a reservoir with adequate flow. This is not yet resolved at Ore-Ida No. 1. We cannot say whether we intercepted a major fault.

3. Significance of Structure in Localizing Prospects. The most important assumptions about the role of faulting in geothermal prospecting are that fracture systems associated with fault zones enhance porosity in brittle rocks, and that the fault systems provide conduits for thermal waters, from which waters may disperse into other aquifers. This assumption is supported by the association of important thermal anomalies with fault zones around the Snake River basin as well as to the south in many areas of the Basin and Range Province.

Drilling has not yet encountered or identified specific structural objectives. The identification of important intra-basin fault zones appears to be an important factor in locating sites for future geothermal tests. Consequently, surveys to attempt to locate fault zones are given high priority in recommendations for future work.

Recommendations are submitted herein to suggest ways to improve the quality of information available for geothermal well siting and reduce the exploration risks for future holes drilled in the western Snake River Plain.

1. Temperature Gradient and Heat Flow Studies. Temperature gradient holes should be sited and drilled to appropriate depths after gravity and seismic surveys to investigate structural and possible gradient anomalies in the areas considered promising for deep tests. Gradient holes should be scheduled to depths of at least 2,000 feet in order to penetrate near-surface effects.

2. Reservoir Rock Depth and Subsurface Distribution. The definition of the distribution of potential reservoir rocks requires that an accurate base for subsurface correlations exists. Several correlation tools are available, including conventional lithology, rock chemistry and radiometric ages, and sophisticated geophysical log and test data analyses.

3. Structural Definition. The available structural data from wells and geophysical surveys are inadequate for a detailed study of faults. Acquisition of new data should be accomplished by gravity and seismograph surveys. Gravity and seismograph surveys should be designed particularly to test a probable fault system between Parma, Idaho and Malheur Butte, Oregon. It is along that trend that a basin bounding or major intra-basin fault system capable of enhancing permeability is most likely to be found.