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BOISE GEOTHERMAL PROJECT

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ABSTRACT

Utilization of geothermal waters for space heating in the Boise area has a long and successful history. In 1890 enterprising men sought to develop the springs so wells were drilled and the water piped to what was then one of the world's largest natural hot mineral water natatoriums. Shortly after the natatorium was completed the hot water lines were extended down Warm Springs Avenue to begin heating homes. The heating of these homes has been continuous since the system was started. Past history and recent geologic, geophysical and hydrological information indicate there is a capable geothermal reservoir in the area near Boise, Idaho.

INTRODUCTION

The critical energy deficit facing the Western World has forced the serious consideration of alternative sources of energy. One of these, geothermal energy, has attracted increased attention during the last few years. In the United States the major research effort in both public and private sectors has been directed towards electrical power generation aspects of the geothermal resource.

At the present time and in the foreseeable future, space heating appears to be one of the most important uses of low temperature (less than 80°C) geothermal water. The climatic situation of Idaho coupled with the extensive geothermal anomalies within Idaho indicate a tremendous potential. Several large population centers and many smaller communities are located ideally for use of the geothermal resource for space heating.

HISTORY

History indicates low temperature geothermal use in Idaho has taken place since the beginning of permanent settlement in the middle 1800's. At the present time a relatively large space heating operation is supplying geothermal heat to almost 200 customers along Warm Springs Avenue in Boise, Idaho. This system has been in continuous operation since 1890 when two 6 inch wells were drilled to a depth of 400 feet and obtained a flow of 800,000 gallons per day of 77°C water. In 1891 lines were extended from the wells to two homes on Warm Springs Avenue for heating and supplying domestic water. In 1892 a natatorium opened which was advertised as the second largest hot water pool in the United States with a capacity of 300,000 gallons. The hot water line was subsequently extended into the city of Boise.

By 1898 several attempts had been made to increase the flow of the system without success. At this point a new 16 inch well was drilled, an older 6 inch well was enlarged to 16 inch, and two pumps were installed which increased the hot water supply to 1,200,000 gallons per day. By about 1917 nine miles of main line pipe had been installed supplying heating water to many homes and several businesses in Boise.

At the peak of the geothermal system there were over 400 homes and a number of businesses being supplied with hot water for both heating and domestic purposes. By 1964 the number had dropped to approximately 244 homes and businesses because of the introduction of low cost natural gas. In 1970 the number had dropped to 200 homes and less than ten businesses. The present system is heating approximately 170 homes along Warm Springs Avenue.

Recently the system was released from the Boise Water Corporation and formed into the Warm Springs Water District. Future plans of the new water district include expansion of the geothermal heating system to include additional homes and businesses as new main lines are installed. At the present time a State Laboratory Building is being connected to the system to be heated by the geothermal waters.

Several other areas in Boise have been developed for utilization of geothermal water. Two greenhouses 5 miles northwest of the Warm Springs system are using geothermal water for heating purposes and have been since 1922. In several other areas near Boise individual homeowners have drilled shallow wells and are using the hot water for space heating.

Renewed interest in geothermal energy in the Boise area resulted in an integrated investigation to detect, delineate, and evaluate the geothermal resource along the Boise Front. The U.S. Energy Research and Development Administration sponsored a Boise Geothermal project which was initiated on January 1, 1975. The project set out to investigate the possibility of heating part of the State Capitol complex and related

public buildings with geothermal energy. Geological, geophysical, and hydrological studies were done in the Boise area. The integrated interpretation of all these data in order to build a geologically sound model of the geothermal system is extremely important.

GEOLOGY

Geological studies in the area consisted of two levels of approach: 1) field geological mapping and 2) remote sensing studies. The objective of the remote sensing study, conducted by Dr. William Hall of the University of Idaho, was to map linear features which may be indicative of faulting so the field geologist can more readily recognize target areas. These investigations of the Boise Foothills area permit a semi-regional analysis, thus providing information of structural control of the geothermal fluids.

Geologic material around Boise ranges from recent fluviatile sediments of the Boise River flood plain to cretaceous rocks of the Boise Ridge. The flood plain deposits are mainly fluviatile sediments deposited by the Boise River and its tributaries and consist of interbedded sand and gravel. The Boise Foothills north and east of Boise are comprised of Quaternary-Tertiary sediments of the Glenns Ferry Formation. The Glenns Ferry Formation is composed of nonindurated, complexly intertonguing sands, silts, and clays with minor amounts of volcanic material and basaltic lava flows. The formation is generally unconsolidated but grades into well consilidated sandstone in certain local areas. The consolidated areas generally coincide with areas of thermal alteration due to invasion of silica rich geothermal fluids. The Boise Ridge is the major topographic feature to the north and east of Boise and is composed of cretaceous granitic rocks of the Idaho batholith.

Boise appears to be on the down-thrown block of a major fault known as the Foothills Fault (Hollenbaugh, 1973). The Boise Foothills are located on the up-thrown block of this same fault. The fault extends approximately nine miles along the base of the Foothills. According to Hollenbaugh the Foothills Fault is not a single fault but is, instead, a part of a system of faults that define a regional zone of weakness along the northern margin of the Snake River Plain.

In the southern portion of the study area the Glenns Ferry Formation exhibits a southeast-northwest trending fault system as mapped by Hollenbaugh (1973). Several strong NE-SW trending linear patterns have also been noted using photogeologic methods (Hall, 1975). These major linears are thought to be structurally controlled and correspond to major drainages trending southwesterly from the Boise Ridge.

GEOHYDROLOGY

Groundwater, within the study, area can be divided into three distinct but interrelated systems: 1) a shallow water-table system in the recent alluvium of the Boise River flood plain, 2) a deeper water table and artesian system in the Boise Valley, and 3) a geothermal system which originates deep in the fractures of the Idaho batholith and migrates upward into overlying sediments.

Geohydrologic investigations involved on site visits of hot wells in the Boise area and temperature profiles of those wells where access was feasible. In the wells of no access of a pump, temperature of the pumped water was obtained.

To understand the distribution and occurrence of the geothermal system, the geothermal wells and surface warm water springs were compared to linear maps prepared by Hall (1975) and known faluts mapped by Hollenbaugh (1973). Upon comparison of the linear and fault maps with geothermal springs and wells it appeared the anomalies lie along linear or fault intersections. This information gave evidence that the geothermal system may be structurally controlled and the target areas for exploratory drilling should be near fault and/or linear intersections.

DRILLING

A drilling program was then initiated which involved three intermediate depth core holes (approximately 500 feet) and two exploratory holes. The intermediate core holes were designed to gather information on geothermal gradients and thermal alteration of minerals in the target areas. They also gave valuable information on subsurface geology in the Boise Front area. The two exploratory holes were drilled in major linear intersection where previous drilling confirmed an above normal geothermal gradient. The exploratory wells, which were drilled approximately one and one half miles from the existing Warm Springs Wells, proved successful intersecting 76°C geothermal water at the 800-1,100 foot depth. Initial flow testing of these wells did not indicate any interference with the existing Warm Springs Wells. Long term testing of the wells is programmed for the spring of 1977.

DISCUSSION

Investigations during the course of this study indicate the geothermal resource is located in a zone of intersecting linear structures. The major structure which appears to be influencing geothermal occurrences is the Boise Front Fault system, a northwest-southeast fault zone which coincides with the southern edge of the Boise Front. This fault zone is intersected by northeast-southwest linears which correlate with many of the major stream drainages of the Boise Front. Geothermal springs reported in historical accounts and most recent hot wells are located in the vicinity of these fault and/or linear intersections.

Surface geological mapping has shown several

areas of silicified sandstone which were cemented with silica rich geothermal fluids. These silica cemented sandstones are located along fault zones within the Boise Front with a majority of the outcrops situated between Table Rock and the Veteran's Administration Hospital complex.

Igneous activity has occurred within the Glenns Ferry Formation which may be linked to the contact of the batholith and Glenns Ferry Formation rather than fault systems. Drill core information reveals the basalt is highly altered due to hydrothermal activity. This indicates that geothermal fluids have been in contact with the basalt at some time in the past, although several wells in the Boise area are presently producing geothermal water from fractured basalt systems.

Deeper wells in the Boise Valley near the foothills are producing warm water. This indicates that some of the geothermal waters must be mixing with the colder near surface waters in the upper alluvial aquifer system.

Geology, geophysics, hydrology, remote sensing and finally test drilling indicate the geothermal resource in the Boise area is directly related to the fault system of the area. The resource appears to be within reasonable drilling depths where north trending faults of linears intersect with the Boise Front Fault zone. The faults appear to be a permeable zone capable of transmitting geothermal fluids to the surface. Wells located within the fault zones will tap the resource at reasonable depths but wells located out of the fault zone will tap only the cold aquifer system or a mixed system of hot geothermal waters and cold percolating groundwaters.

Probable drilling areas for low temperature geothermal production is the area east of the Veteran's Administration Hospital complex along the Boise Front. The major linears intersect with the Boise Front Fault system within this zone. The two successful E.R.D.A. exploratory wells are located within the western portion of this area.

CONCLUSIONS

To the nortwest of Boise, several other areas of hot water exist. These areas are the Dry Creek Valley and the zone between Pierce Gulch and Polecat Gulch. Temperatures exceeding 38°C have been found in both areas.

The hot water zones in these areas have also been found to be associated with mapped linears and known faults. Both the deep fracturing in the Idaho batholith and the secondary fracturing expressed by the linears is very important in transmitting the hot geothermal water to the surface.

Although the majority of the water in the area west of Boise is not hot enouth to produce electricity or heat numerous building complexes, it is of sufficient temperature to heat several homes in the local area.

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