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GEOTHERMAL BRANCH

INTER-OFFICE MEMORANDUM

SUBJECT: Summary of Alum Temperature Observation Hole 56-29

DATE: April 14, 1982

cc: H. D. Pilkington
W. M. Dolan

TO: H. J. Olson

FROM: J. E. Deymonaz

Temperature observation hole 56-29 near the old Alum Mine was spudded on December 8, 1981 and completed to 1,490 feet (454m) on December 21, 1981. Total cost of the hole was approximately $50,000.

The hole was drilled at the same location as O'Brien hole 3-A. Hole 3-A was drilled to a depth of 325 feet (100m) and had a gradient of 438^{o}C/km with a bottom hole temperature of 64.75^{o}C.

Lithology

The upper 350 feet (107m) was drilled in sediments of the Esmeralda Formation consisting of gray, greenish-gray, white and brown tuffaceous siltstones and sandy siltstones. Minor dissiminated pyrite and sporadic hard silicified zones were encountered throughout this interval.

From 350-365 feet clay and hard dark-gray siltstones were encountered, apparently the upper weathered portion of the Paleozoic section.

Below 365 feet is a fairly uniform sequence of dark gray, to dark greenish-gray silicic siltstones with considerable pyrite both dissiminated and filling fractures. The amount of pyrite decreased with depth with some zones between 365 to 1,000 feet containing over 10%. The siltstones are similar to the Lower Cambrian Harkless Formation which is widely exposed nine miles east of the drill site in Paymaster Canyon. The Harkless is composed of approximately 3,500 feet of siltstones and quartzitic siltstones with minor limestones in the lower portion of the section.

Hydrogeochemistry and Hydrology

The upper 785 feet (239m) of the hole was air drilled and the first fluids were encountered at 630 feet (192m). Water volume increased with depth to approximately 60 gpm at 785 feet. The maximum flow line temperature of the water at the surface was 80°C although measured temperatures at this depth are in excess of 105°C. The difference is due to cooling by the air lifting the fluids to the surface and conductive cooling along the borehole.

At 785 feet seals in the downhole hammer failed, apparently due to the high temperatures. The water was air lifted from the hole for two hours without injecting foam prior to pulling the hammer and a water sample was collected. The sample temperature was 80°C and had a salty (NaCl) taste.

Analysis of the samples reveal a water (Table 1) high in Na, Cl, Mn, Mg and Li. Silica geothermometers indicate minimum temperatures in excess of 165°C. The high lithium, and high salinity are chemically similar to waters in Clayton Valley to the south rather than to waters in Big Smokey Valley to the north.

Temperatures

Not surprisingly, temperatures in the upper portion of the hole parallel those measured in the O'Brien hole. A gradient of 445°C/km appears fairly constant in the Esmeralda. In the Paleozoic section, above the water level, the gradient drops 20% to 367°C/km. This drop is due to the increased thermal conductivity of the silicic siltstones. The contrast in conductivity is not as great as might be expected and this could have two causes:

1. Silicified zones within the Esmeralda increasing the sediments conductivity.

2. The pervasively fractured nature of the Paleozoic section in the mine area decreasing the bulk thermal conductivity of the section.

The resulting thermal conductivities for the Esmeralda and Paleozoic siltstones are probably in the order of 6.0 and 7.5 respectively.

Entering the section where fluids were encountered the gradients drop rapidly to approximately 11°C/km in the lower 125m of the hole. The rapid decrease in gradients is most likely due to the pervasively fractured nature of this portion of the Paleozoic section encountered in the drilling. The fractured, uniform character of the rock with no apparent extensive lateral hydrologic barrier in the drilled section would allow for slow convection of the heated waters cooling slowly as they rise, resulting in the depressed gradient. The lack of any gradient reversals and a maximum bottom hole temperature of 118.38°C suggests the heat source for the waters encountered is beneath or in the general proximity of the drill hole.

No significant increase in gradients would be expected until a hydrologic barrier with considerable lateral extent (i.e., phyllites, schists, clay alteration, thrust fault, or intrusive contact) is penetrated. Widespread granitic intrusivews associated with the Sierra Nevada Batholith outcrop a few miles to the east and elsewhere in the county and may also underlie the Alum area. If this is the case the associated alteration halo could provide the required aquaclude. Phylites, schists and thrusting also occur in the surrounding mountain ranges and could exist under the area and provide the needed hydrologic barriers.

J. E. Deymonaz

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TABLE 1

Analysis of water sample collected from Alum hole 56-29. Sample W-14298.

Temperature	80°C
Discharge	60gpm
Depth	665-775 feet
Taste	Strong NaCl
Odor	Moderate H_2S
SiO_2	190ppm
Na	2700
K	320
Ca	87
Mg	20
Li	10.0
Cl	4600
F	5.3
HCO_3	12.3
B	33
Mn	150
Mo	15ppb
pH	8.5
Conductivity	13,000mmho/cm
Tqtz no steam loss	176.5°C
Tqtz max steam loss	165.3°C
T chalcedony	154.8°C
TNa-K-Ca	231.7°C
TNa-K-Ca-Mg	149.9°C

HOLE ALUM 56-29