OVERVIEW

Temperature Gradients

DOGAMI, in late 1978, successfully completed the drilling of eleven temperature gradient holes in the Mt. Hood area (Figure 1) to depths ranging from 76 to 152 m. Temperature gradients for the holes are shown in Figure 18 (Blackwell and Steele, 1979). Heat flow implications of these holes are discussed by the above authors. Those holes that were collared in the Columbia River Basalt or the Eagle Creek Formation were usable for heat flow determinations (1S/10E-9bc, 2S/6E-24ca, 3S/11E-1aa, and 2N/7E-31bd). The remainder of the holes that were collared in either andesite, alluvium, Pliocene volcanics, or plutonic rocks did not lend themselves to adequate heat flow analyses.

Based on the evaluation of the temperature-depth curves for the Mt. Hood area, it is apparent that holes collared in these materials need to be drilled much deeper than the heretofore depth of 152 m (500 ft). The quality of the data is affected by ubiquitous flows of water, lost circulation zones, indeterminate number of cinder and ash flows and/or soil or deeply weathered horizons. Thus, for holes not collared in the Columbia River Basalt or the Eagle Creek Formation, depth should be increased to at least a minimum of 305 m (1000 ft). The further upslope on the cone, the deeper the holes should be.

In order to better understand the heat flow regime of Mt. Hood, additional temperature gradient holes should be drilled

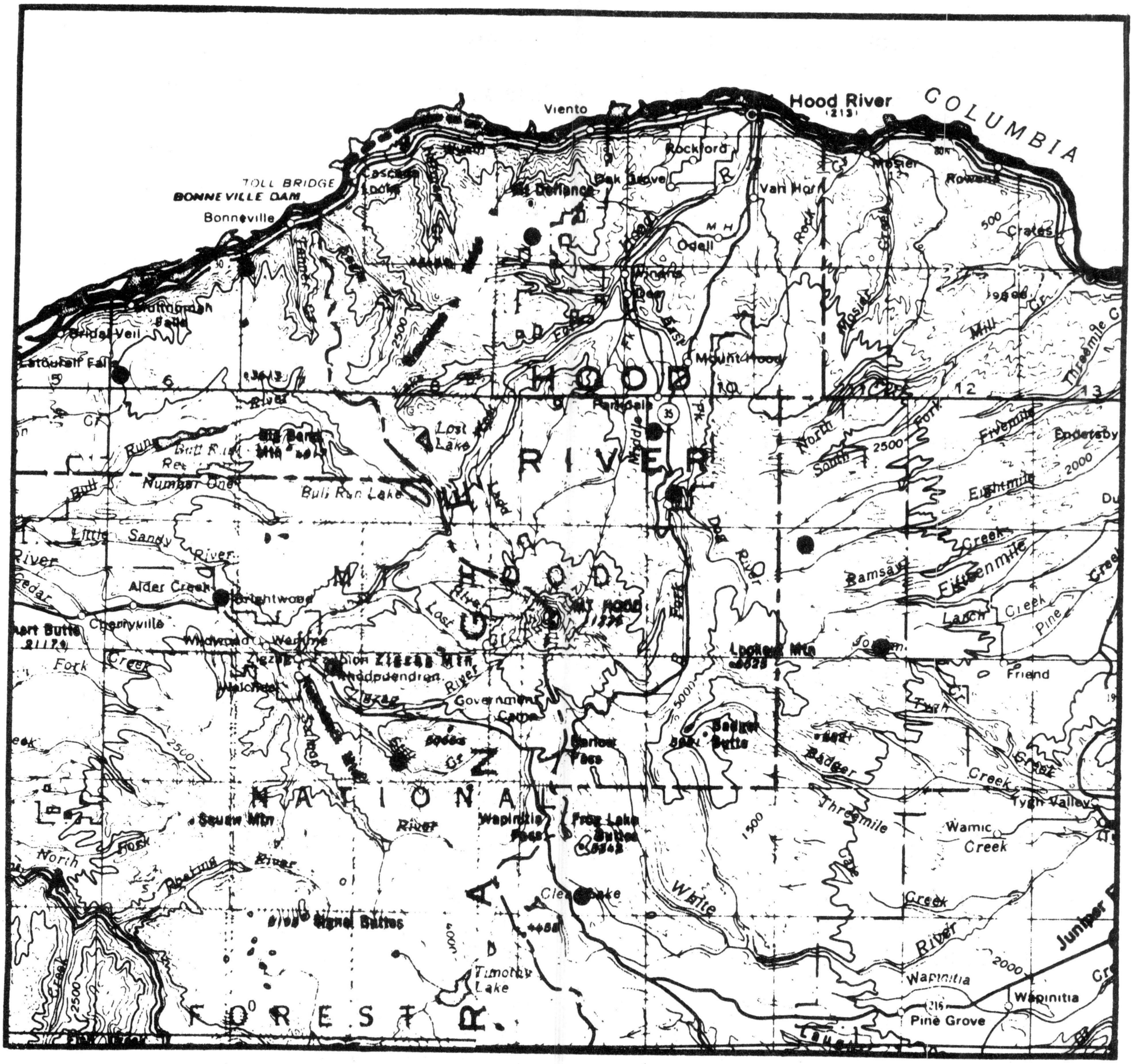


Figure 1. Location of temperature gradient holes, Mt. Hood area, Multnomah, Hood River, Clackamas and Wasco Counties. Scale - 1:500,000.

on the upper flanks of the cone and around the periphery or base of the volcano to fill in the gaps from the heat flow drilling recently completed. Northwest Geothermal Corp. has an ambitious drilling program with holes programmed to 500-2000 ft in depth for the southwesterly part of the Mt. Hood area. Further, the USGS plans to drill eight (8) hydrologic investigatory holes on or around Mt. Hood. Six holes are planned for the southern flank of the volcano; two holes on the northern flank. These holes, which are to be drilled to 500-2000 ft in depth, are to be equipped for temperature gradient measurements when the hydrologic studies are completed. It is entirely possible that the holes to be drilled by these two entities may suffice for the additional holes recommended.

The only geothermal anomaly discovered from the temperature gradient investigation was from a hole in Hood River Valley (1S/10E-9bc) northeast of Mt. Hood. The temperature-depth curve for this hole is shown in Figure 18 (Blackwell and Steele, 1979). This curve is characteristic of a shallow aquifer flow when the aquifer temperature is much above background temperature. Thus, water flowing in the aquifer heats the rock above and below the aquifer, resulting in the characteristic shape shown. Chemical analyses of the water from this hole suggest that the water may in fact be a geothermal fluid with a much higher geothermal temperature implied than is observed. This hole is immediately west of the Hood River fault northeast of the volcano and within a few kilometers east of a Holocene basaltic lava flow. Another temperature gradient hole drilled approximately 3 miles to the south (1S/10E-29ca), also along the Hood River fault, did not display the same temperature relationship. Thus, it appears that the low-temperature water (24°C) is probably related to the intrusion that resulted in the lava flow. These results are of sufficient interest that additional geologic-geophysical studies should be carried out to investigate the geothermal implications of the anomaly. The proximity to major energy comsumption centers in Hood River Valley and The Dalles is also a favorable feature of the anomaly.

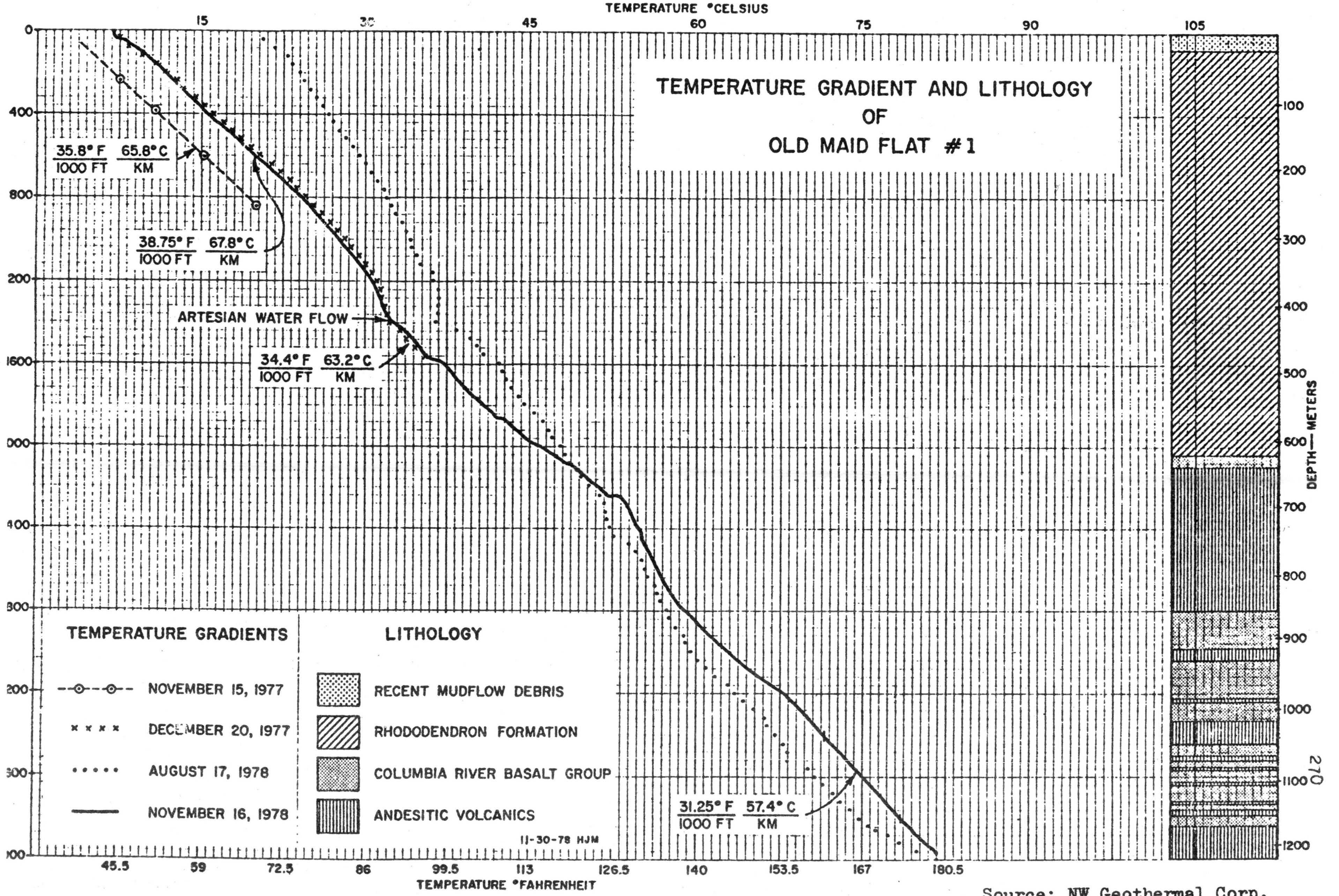
Temperature-depth relationships were also obtained from fifty (50) "free" holes, mostly water wells, as part of the Mt. Hood study. These holes were logged during 1977-79. The data were submitted to David Blackwell for heat flow modeling studies. Several anomalous temperature gradients were obtained from water wells near Powell Buttes, northeast of Bend, along the eastern margin of the High Cascade Range. For example, gradients in excess of 100°C/km were measured in two holes (16S/14E-16aa and 15S/14E-36aa) which are about 10 km apart. A bottom hole temperature of 37.5°C at 166.5 m and 31.7°C at 157 m were measured for the holes, respectively. According to Blackwell and Steele (1979), heat flow values for these two holes are in excess of 3.0 HFU. Additional studies including geologic mapping, spring sampling and associated water analyses as well as other "free" temperature gradient determinations, if available, should be initiated in order to more fully investigate the geothermal implications of this apparently anomalous area. In all probability, drilling of temperature gradient holes would be required.

Old Maid Flat No. 1/2

The drilling history of this exploratory hole was made available to DOE by Northwest Geothermal Corporation and repetition is not warranted. The geology of this hole is discussed in the report by Beeson and Moran (1979) as well as by Blackwell and Steele (1979). Geophysical logs, including dual induction, compensated density, temperature, drift, fracture, and acoustic velocity, are available from the above company and from DOGAMI (Open File Report 0-78-6). Copies of these logs were previously forwarded to DOE.

According to Beeson and Moran (1979), the Columbia River Basalt has been ostensibly penetrated in this hole. This formation, which was the primary exploratory target, underlies the Old Maid Flat site at a depth interval from 618 m (2022 ft) to 991 m (3250 ft). Temperature in this interval ranges from about 46.5 to 79.4°C (Figure 2). Bottom hole temperature is approximately 82°C at 1220.4 m (4003 ft). Rocks in the interval from 991 m to total depth consist of andesitic volcanics which may be the equivalent of the John Day or Eagle Creek formations of lower Miocene to upper Oligocene age. However, it is also possible that this interval may represent the lower part of the Columbia River Basalt Group.

For a discussion of intra-hole fluid movement, see Blackwell and Steele (1979). To date, Northwest Geothermal Corp. has not undertaken any fluid sampling for geochemical analyses.



Source: NW Geothermal Corp.

FIGURE 2

Because of the heat flow implications (Blackwell and Steele, 1979) consideration should be given to the deepening of this hole to at least 1830 m (6000 ft). Northwest Geothermal Corp. should be encouraged to do the necessary fluid sampling as well as flow-testing either prior to or subsequent to the recommended deepening.

Timberline No. 2

The drilling history of this hole (3S/9E-7ab) was forwarded to DOE by others. The geology is discussed by White (1979) and the temperature-depth relationship is shown in Figure 21 (Blackwell and Steele, 1979). A subsequent temperature log of the hole by the USGS in late May 1979 indicates the temperature-depth relationship to be similar to that shown on the aforementioned figure.

This hole (target depth: 2000 ft) was originally drilled to 420.7 m (1380 ft) in depth and because of several re-drills due to either stuck drill pipe or twist-offs, the hole was completed at 226 m (741 ft). This hole represents the second attempt to drill at Timberline Lodge on Mt. Hood. The first, drilled in 1977, penetrated less than 100 ft of the planned 500-foot target depth.

One of the 2000 ft deep hydrologic holes to be drilled by the USGS this year (see above) is sited at Mt. Hood Meadows (3S/9E-3cc). This proposed hole is approximately the same distance from the center of the cone as is the Timberline hole and therefore should provide the data that would have been available if the Timberline hole had been drilled to the target depth. Consideration should be given to drilling this hole to 3000 ft if conditions permit.

CONCLUSIONS

Notwithstanding the recommendation to deepen the Old Maid Flat hole, DOGAMI does not have sufficient data on hand to site a deep hole on or near Mt. Hood. Possibly when other data are made available from studies completed or in various stages of completion by the USGS and Lawrence Berkeley Laboratory that a firm recommendation can be made.

Provisions to carry out the several recommendations as indicated in the OVERVIEW should be engendered by DOE.

REFERENCES

Beeson, M. H., and Moran, M. R., 1979, Statigraphy and structure of the Columbia River Basalt Group in the Cascade Range, Oregon: PSU Grant No. 90-262-8126 from DOGAMI, unpublished report, 64 p.

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