LITHOLOGIC LOG OF DRILL CUTTINGS FOR
NORTHWEST GEOTHERMAL CORP.
DRILL HOLE AT LOST CREEK NEAR
MOUNT HOOD, OREGON

by

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Open-file report
80-1166

INTRODUCTION

In August, 1979, Northwest Geothermal Corporation completed a drill hole near Lost Creek (T3S, R8E, Sec. 28AA) on the west flank of Mount Hood, Oregon (Fig. 1). Splits of 43 samples of drill cuttings collected at 10 foot (3.05 m) intervals in the 131.1 m drill hole were obtained courtesy of J. Hook and H. J. Meyer.

The samples were wet sieved through a 200 mesh (0.074 mm) screen and both fractions were air dried and saved. Cuttings retained on the screen were systematically studied by binocular and petrographic microscopes, X-ray diffraction, and scanning electron microscope (SEM). Slurry slides of finely-ground, hand-picked alteration material and representative rock types were run at $1/2^{\circ}$/min. from 3° to 38° 2θ using unfiltered Cu $K\alpha$ radiation on a Norelco X-ray diffractometer equipped with a focusing monochrometer. SEM studies were made using a Cambridge Steroscan 180 scanning electron microscope that is capable of providing qualitative chemical data through energy-dispersive X-ray analysis (EDAX).

LITHOLOGIC LOG OF LOST CREEK DRILL HOLE CUTTINGS

The Lost Creek drill hole was sited in a unit mapped by Wise (1968, 1969) as Quaternary reworked debris consisting of post-glacial, partly morainal and partly water-transported, detritus. From the surface to about 73.2 m, the drill cuttings are composed of this reworked heterogeneous detrital material. The remainder of the cuttings (from 73.2 to 131.1 m) consist of hornblende andesite.

Secondary mineralization is sparse in the reworked detrital sediments; however, the hornblende andesite contains a variety of hydrothermal minerals shown in Figure 2. The figure also shows the distribution of vapor-phase tridymite and α-cristobalite (?), montmorillonite from drilling mud (?) (closed circle "●" in Figure 2), and several minerals, calcite, gypsum, aragonite, vaterite (unstable form of $CaCO_3$), thaumasite ($Ca_3 Si(OH)_6 (CO_3) (SO_4) \cdot 12 H_2O$), ettringite ($Ca_6Al_2 (SO_4)_3 (OH)_{12} \cdot 26 H_2O$), and brownmillerite ($Ca_2(Al, Fe)_2O_5$) (all shown as a plus sign "+" in Figure 2), that are undoubtedly constituents in the cement that was introduced during drilling (Taylor, 1964). Several samples display tiny, yellowish, delicate clusters of radiating calcite crystals deposited on andesite grains and crusts of tiny calcite crystals that coat cement grains (grains composed of the introduced cement constituent minerals listed above). These precipitates probably formed due to reactions produced by the introduction of cement to the drill hole.

Reworked detritus

Nearly every sample from the reworked detrital section has a few (up to ~10%) well-rounded, red- to brown-stained andesite grains that contain clear plagioclase phenocrysts and clinopyroxene, magnetite, and K-feldspar (?) (in sample X-rayed). The topmost sample (at 3 m) and a sample from 67.1 m have brown fine-grained sandstone and siltstone grains composed of plagioclase, α-cristobalite, quartz, hematite, and orthopyroxene. Several samples contain a few grains that are siliceous, red to orange iron-stained, or bleached white and represent most of the secondary minerals in the detrital portion of the drill hole.

The majority of cuttings above 76.2 m consist of varying percentages of black glassy andesite, light-gray andesite, and medium-gray andesite. All three andesites contain clear plagioclase (andesine ? by X-ray diffraction analysis) phenocrysts, and the light- and medium-gray andesites have a few brown orthopyroxene phenocrysts. X-ray diffraction work indicates that the three andesites contain fairly abundant α-cristobalite, some magnetite, and minor amounts of orthopyroxene, clinopyroxene, and amphibole. In addition, the light- and medium-gray andesites have traces of tridymite and possibly K-feldspar.

Hornblende andesite

Cuttings from the bottom half of the drill hole (below 76.2 m) are from a light-gray, porphyritic, hornblende andesite. Phenocrysts consist of white plagioclase (andesine ? by X-ray diffraction analysis) and a black amphibole (hornblende). Whole rock X-ray traces also show minor clinopyroxene and K-feldspar (?) and several alteration minerals.

Wise's (1969) north-south cross-section (B-B') nearly intersects the drill hole site and shows reworked detritus overlying the Rhododendron formation. The drill hole does penetrate the detrital section; but the lower portion does not resemble Wise's description of the Rhododendron formation nor is it similar to the Pliocene andesites above the Rhododendron formation on Zigzag Mountain. The drill cuttings, as well as rock samples collected upstream just below Burnt Lake (see Figure 1), all appear to be hornblende andesites that are similar to the Quaternary plugs and flows about 3 to 4 miles NNW of the drill site (Plate 1 of Wise, 1969). These rocks have not been dated; but similar rocks at Mill Creek Buttes (NE of Mount Hood in Figure 1) that Wise also mapped as Quaternary hornblende andesite have a K-Ar age of 7.5 ± 0.4 m.y. (White, 1979) and are somewhat older than Wise's estimate.

SECONDARY MINERALIZATION

Reworked detritus

The distribution of vapor-phase minerals, hydrothermal alteration minerals, and drilling mud and cement contaminants in Lost Creek drill cuttings are shown in Figure 2. Tridymite and α-cristobalite occur in most samples from the detrital section and are probably vapor-phase minerals that formed during cooling of the lava flows from which the clastic debris was derived. One sample of hematite from 6.1 m also appears to be a vapor-phase mineral since the euhedral, hexagonal (?) crystal (EDAX shows only Fe) in Figure 3 was found in a cavity along with tridymite (not shown in the figure).

Several samples have a few siliceous, orange- to red-stained, and white bleached grains. Hematite was identified in X-ray traces of some of the grains; but most of the stained particles apparently contain amorphous iron oxide. The siliceous and white bleached grains are composed predominantly of chalcedony. X-ray patterns also show minor opal, natroalunite, kaolinite, montmorillonite, mixed-layer illite-montmorillonite, and mixed-layer chlorite-vermiculite. Iron oxides, sulfates, and silica minerals occur near the summit of Mount Hood due to fumarolic alteration (Beeson, et al., 1980) and might be expected in reworked detritus. In fact, erratic cobbles containing similar secondary minerals were found by the author in

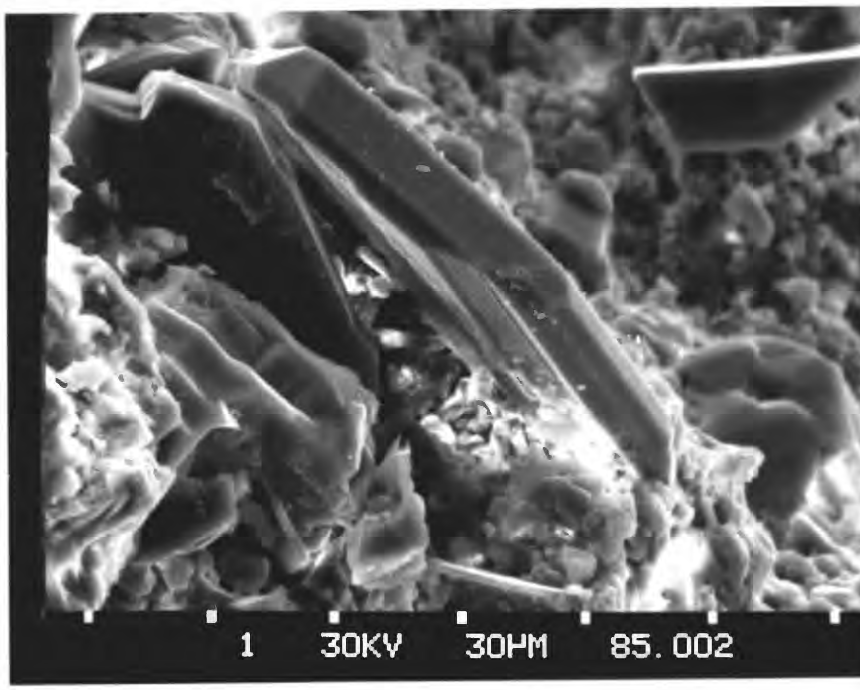

Figure 3. Scanning electron micrograph of euhedral, hexagonal(?), vapor-phase hematite crystal in drill cuttings from 6.1 m. Distance between white tick marks at bottom is 30 microns.

several areas around the flanks of the mountain. Kaolinite and pyrite are also compatable with acidic alteration conditions; however, the other clay minerals and isolated occurrances (usually 1 or 2 grains) of laumontite, calcite, chlorite and epidote must have formed under other non-acid conditions before being deposited in the detrital section.

Hornblende andesite

Nearly all of the X-ray diffractograms in this unit show the presence of at least some quartz. No quartz grains were observed under the binocular microscope or in any of 3 thin sections of grain mounts from 76.2, 100.6 and 131.1 m. The quartz seen in X-ray patterns may be secondary vein material (chalcedony); although X-ray traces of a couple samples of clear veinlet material showed mostly zeolites and very little chalcedony. Thus, it appears likely that the chalcedony is extremely fine-grained and could not be seen through the murky matrix of the thin-sections.

Chlorite-vermiculite is the dominant clay alteration mineral in this unit (Fig. 2). Twenty X-ray traces of the mixed-layer clay show an (001) X-ray peak at 14.2 A that is more intense than the (002) peak at 7.1 A. The (001) peak expands slightly to 14.8 A and several of the (002) peaks appear to split into 7.1 and 7.4 A peaks after being placed in an atmosphere of ethylene glycol at 60^{o}C for 1 hour; a reaction similar to that noted by Weaver (1956) for mixed-layer chlorite-vermiculite. Four of the samples analysed displayed an additional broad peak at about 16.2 to 17A after the ethylene glycol treatment which may indicate the presence of montmorillonite. Also, one sample may consist of just vermiculite since no 7 A peak was observed and the low, broad 14.5 A (001) peak appeared to expand only slightly to about 14.6 A following glycolation.

In addition to being an introduced cement constituent, natural calcite occurs in clear, thin veinlets in association with the zeolite minerals chabazite and stilbite. Several chabazite crystals from one of the veinlets are shown in Figure 4. Two other zeolite minerals, laumontite and epistilbite, were identified along with prehnite in several X-ray traces and appear to be filling tiny cavities in the andesite.

Most samples contain some reddish staining and hematite was identified on several X-ray diffractograms. Opaque magnetite grains in thin-sections have red borders which suggests that some of the hematite is an alteration product of magnetite.

A single grain in the sample from 121.9 m contains native copper. The yellowish-orange metallic mineral (Cu identified by EDAX) occurs as discrete rounded particles that are covered by a thin oxide (?) coating (Fig. 5) or as striated grains (Fig 6). One particle may display the maleable character of the element since it appears to be flattened and spread out over the surrounding grain surface (Fig. 7). Semiquantitative spectrographic analyses of a few panned concentrate stream sediment samples that were collected upstream from the drill hole site and a mineralized rock sample collected just below Burnt Lake show Cu values that are considerably greater than background for Mount Hood (Keith, et al., 1980).

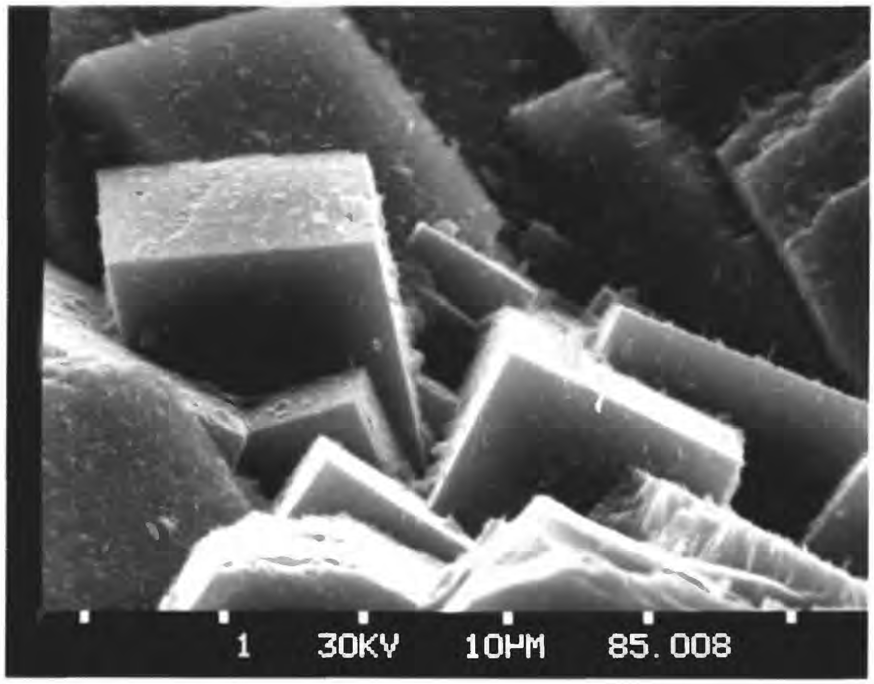

Figure 4. Scanning electron micrograph of "cubic rhombs" of chabazite vein material from 82.3 m. Distance between white tick marks at bottom is 10 microns.

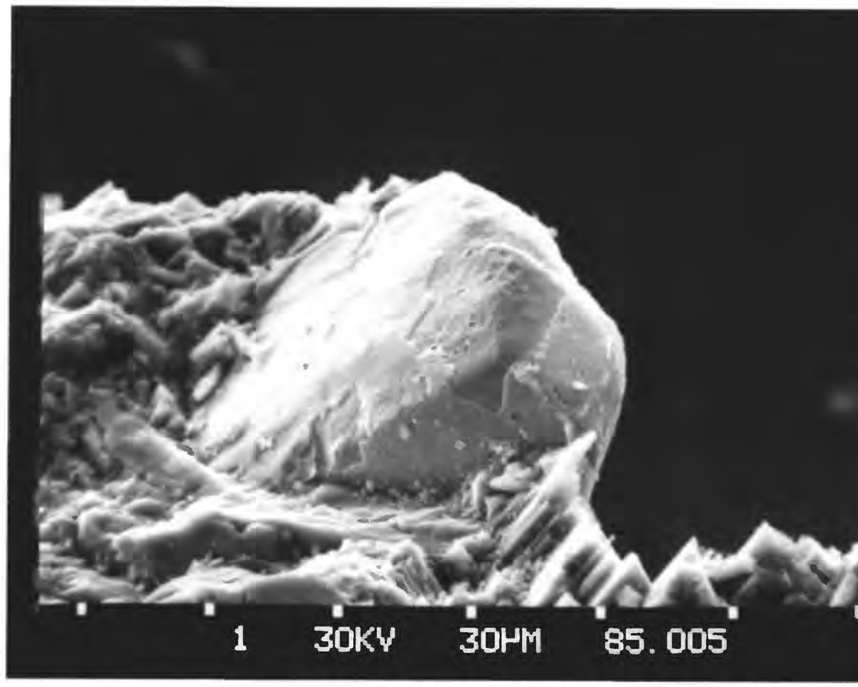

Figure 5. Scanning electron micrograph of rounded, oxide(?), coated grain of native copper from 121.9 m. Distance between white tick marks at bottom is 30 microns.

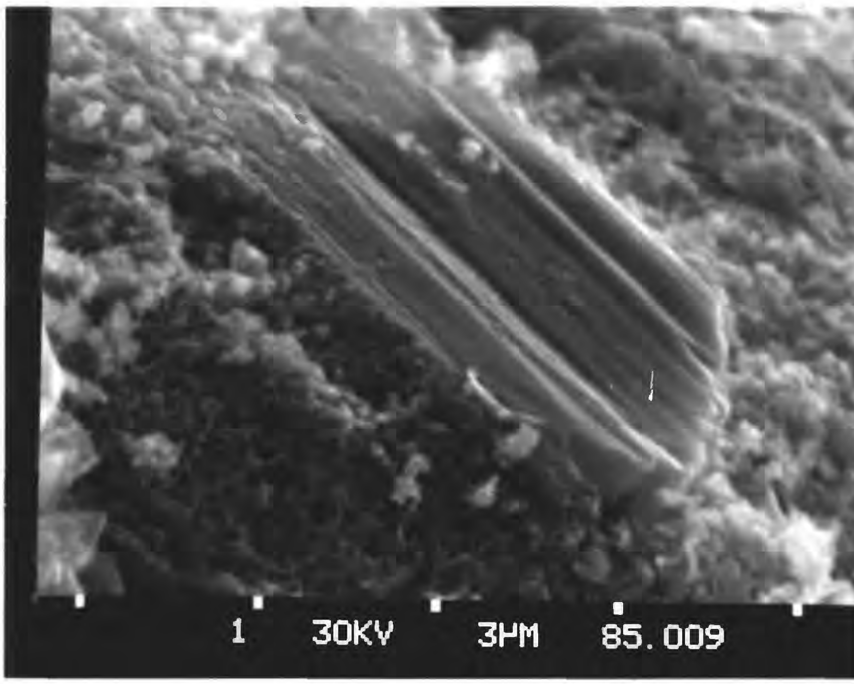

Figure 6. Scanning electron micrograph of striated grain of native copper from 121.9 m. Distance between white tick marks at bottom is 3 microns.

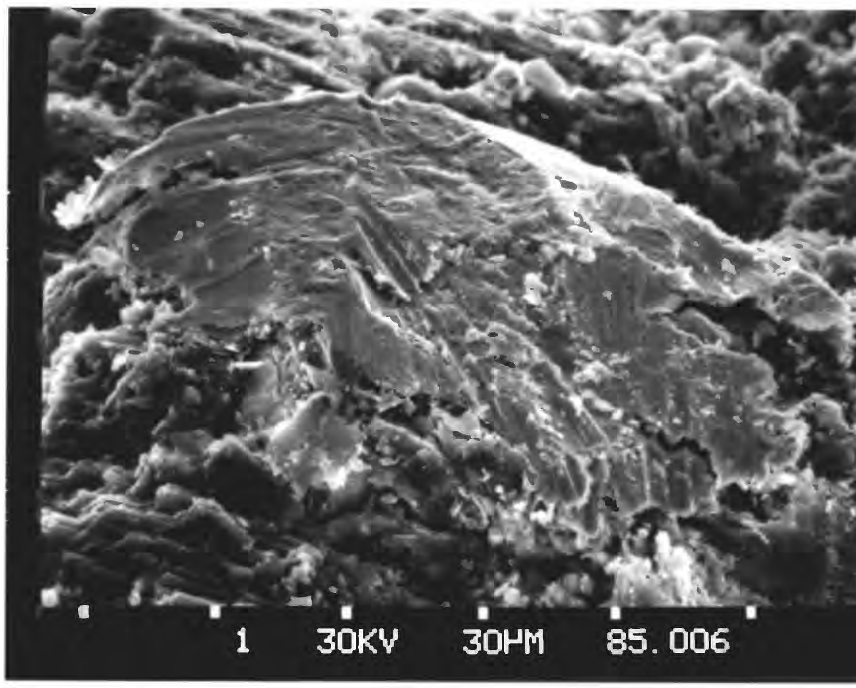

Figure 7. Scanning electron micrograph of flattened malleable(?) native copper grain from 121.9 m. Distance between white tick marks at bottom is 30 microns.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance of R.L. Oscarson in obtaining the scanning electron micrographs and M.H. Beeson for discussions on the petrography of the thin sections.