Volcanic stratigraphy and alteration mineralogy of drill cuttings from EWEB 4 drill hole, Clackamas County, Oregon

by

Terry E. C. Keith and James R. Boden

U.S. Geological Survey, Menlo Park, California 94025

Open-File Report 80-891

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

INTRODUCTION

EWEB 4 was the fourth of six geothermal gradient holes drilled by U.S. Department of Energy, Eugene Water and Electric Board, Sunoco Energy Development Company and Southland Royalty Company under U.S. Department of Energy, Region X, Grant No. DE-FG51-79ET 2743. Eugene Water and Electric Board (EWEB) was the contracting organization. Walter Youngquist, consulting geologist for EWEB, supervised the drilling and supplied splits of the cuttings and drilling information for this study.

EWEB 4 was sited at lat 44°58'34", long 121°48'18" (T. 7 S., R. 8 E., SENE 10), in the Mount Hood National Forest, Clackamas County, Oregon (fig. 1). Drilling commenced on September 17, 1979, at an elevation of 3760 feet (1146.3 m) above sea level, and reached a depth of 1160 feet (353.7 m).

Drilling information and cuttings were logged in feet; therefore, English units will be used, rather than metric, throughout this report. Cuttings were taken from EWEB 4 hole every 10 feet during drilling except at 10, 20, 110, 220, 470, 670, 1000, 1020 to 1090, and 1140 to 1160 (bottom) feet where there was no recovery.

In the laboratory, splits of the cuttings were washed through a 200-mesh screen, and both the coarse and fine fractions were saved. The coarse cuttings were studied with a binocular microscope and typical lithologies, as well as unusual and altered material, were selected for X-ray diffraction to determine the mineral components.

X-ray diffraction was done using a Norelco[1] unit with Cu radiation

---

[1] The use of trade names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

---

and a focusing monochrometer with a graphite crystal. Goniometer speed was 1° per minute, and recording chart speed was one-half inch per minute. Each sample was hand ground in an agate mortar and pestle and run as a smear made from a water slurry on a glass slide. Samples in which clay minerals were identified or suspected were glycolated at 60°C for at least one-half hour and then X-rayed again to determine structural expansion, if any.

A summary of volcanic stratigraphy and effects of alteration are reported here using the data obtained from the laboratory studies and the drill log. No chemistry is available on the cuttings, and no temperature data or geophysical logs from the drill hole are available at this time.

GEOLOGIC SETTING

The rocks in the vicinity of the drill site are andesitic lavas of the High Cascade Range although the area is near the boundary between the volcanic rocks of the High Cascade Range and those of the Western Cascade Range (Wells and Peck, 1961; Peck and others, 1964). An outcrop of light-gray porphyritic andesite near the drill site has a fine-grained groundmass of plagioclase, α-cristobalite, and phenocrysts dominantly of plagioclase and orthopyroxene.

VOLCANIC STRATIGRAPHY

General

EWEB-4 drill hole penetrates twelve andesite flows and flow units (fig. 2). The flows are all similar in appearance and mineralogy, and flow units consist of more than one flow which cannot be easily differentiated with cuttings. The andesite has dark- to medium-gray fine-grained groundmass composed of plagioclase, α-cristobalite, clinopyroxene, and hematite. In highly fractured intervals the groundmass is pink due to oxidation of iron in mafic minerals. Texture of the andesite is vesicular in the thicker flows and massive in the thin flows. Phenocrysts vary in abundance and consist dominantly of plagioclase (An_{32-41}), and hypersthene; olivine is present in some flows.

The thicker flows have vesicular, oxidized flow tops as indicated by abundant reddish oxidized fragments of microporphyritic andesite. Except for the oxidation of Fe, the mineralogy of the flow top andesite is the same as that of the gray unoxidized andesite.

Plagioclase composition was determined by the X-ray diffraction method of Smith and Yoder (1956) for three samples from depths of 130 feet (An_{32}), 690 feet (An_{38}), and 770 feet (An_{34-41}).

Sanidine appears in minor amounts in the groundmass at 420 feet and is present in most units to the bottom of the drill hole. Quartz is present in very minor amounts at 440 and 690 to 700 feet.

Fracture zones, lost circulation zones, and intervals of no recovery are indicated in figure 2 as obtained from the drill log. The fracture zones have an abundance of pink oxidized andesite fragments indicating some circulation of fluids. There is no rock material to indicate the nature of or reason for the lost circulation zones and intervals of no recovery.

ALTERATION MINERALOGY

The EWEB 4 drill hole contains very little material that can be ascribed to hydrothermal alteration. Minor amounts of reddish oxidized volcanic rock fragments and yellowish to tan fragments are present in several intervals, but the only change in mineralogy is the partial breakdown of mafic minerals to iron oxide.

Pink oxidized andesite are more abundant than gray counterparts in the highly fractured zones due to leaching and iron migration along the fractures. In flow units 7 and 8 iron has been deposited in patches on fracture surfaces as hematite.

Clay minerals (smectite-illite) are present in oxidized cinders at the surface and are probably due to surface weathering of basalt. The tan fragments in flow units 2 and 4 (fig. 2) contain some mixed-layer smectite-illite which may be due to hydrothermal or groundwater alteration rather than drilling material. Deeper in the drill hole, occasional clays, calcite, and minor amounts of ettringite and brownmillerite were identified on X-ray diffraction traces, but these minerals can all be attributed to drilling mud and cement (Taylor, 1964).

SUMMARY

The alteration in EWEB 4 drill hole is mainly Fe oxidation, leaching and occasional redeposition on fracture surfaces as the mineral hematite. Low-temperature hydrothermal alteration or groundwater activity could be responsible for the Fe alteration, but the crystallization of hematite must be due to a higher temperature process such as late-stage cooling of the lavas. Minerals, such as tridymite which are usually present in a high-temperature vapor-phase environment, were not found although a trace of tridymite may be present at 1010 feet. No vein or cavity deposits, other than hematite, are present in the cuttings.

REFERENCES

Peck, D. L., Griggs, A. B., Schlicker, H. G., Wells, F. G., and Dole, H. M., 1964, Geology of the central and northern parts of the Western Cascade Range in Oregon: U.S. Geological Survey Professional Paper 449, 56 p.

Smith, J. R., and Yoder, H. S., Jr., 1956, Variations in X-ray powder diffraction patterns of plagioclase feldspars: American Mineralogist, v. 41, p. 632-647.

Taylor, H. F. W. (ed.), 1964, The chemistry of cements, V. 1: New York, Academic Press, 460 p.

Wells, F. G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geological Survey Miscellaneous Geologic Investigation Map I-325, scale 1:500,000.

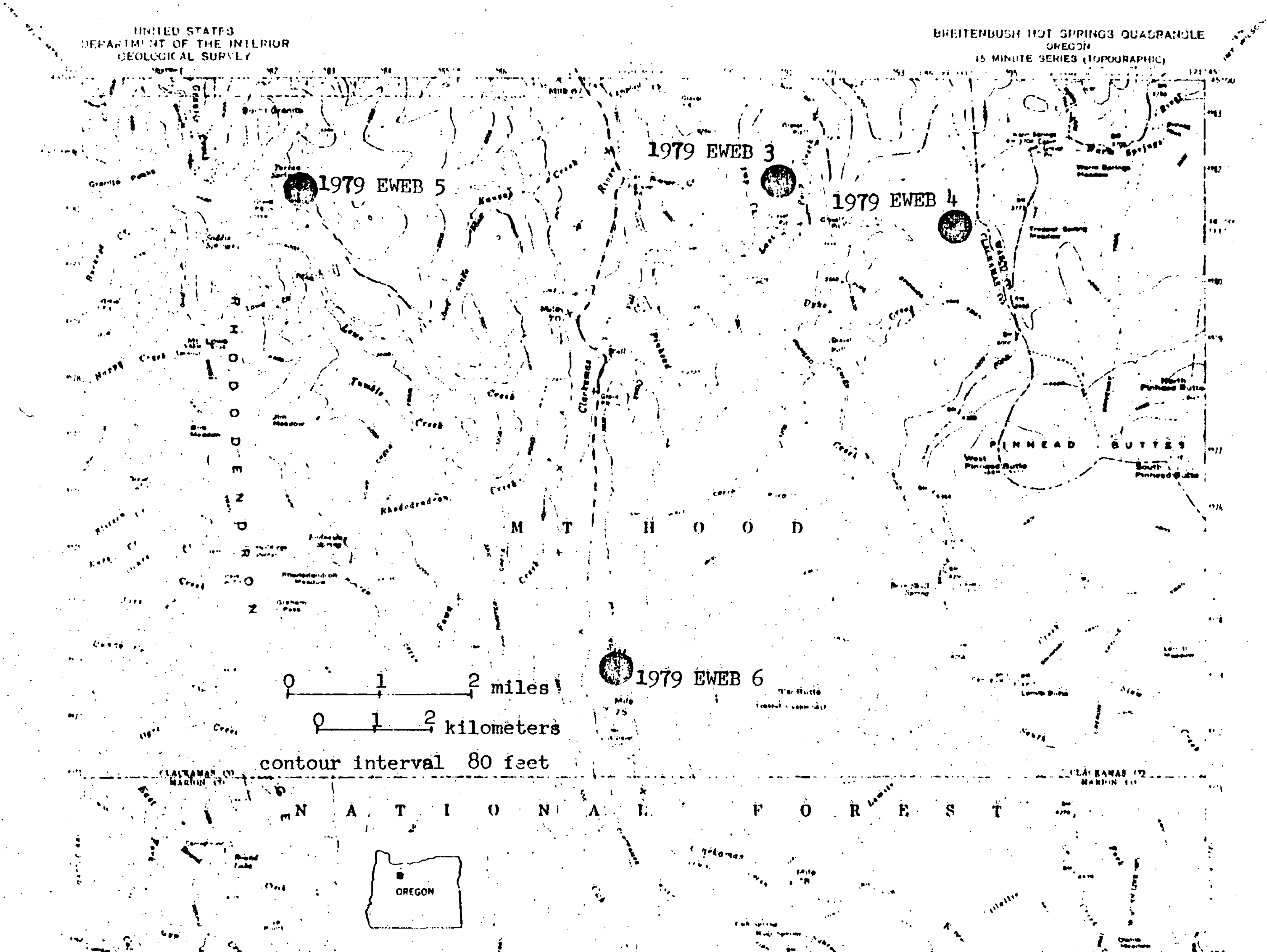

Figure 1. Location of EWEB 4 drill hole.

Depth, in ft	Unit	Physical Characteristics of dominant rock type	Comments
0–110	Overburden and basalt cinder	Red oxidized, porous, unconsolidated	110 ft. No recovery
110–200	Andesite flow 1	Dark-gray, vesicular	
200–220	"Soft zone"	Abundant synthetic drill material	220 ft. No recovery
220–290	Andesite flow unit 2	Multicolored fragments, gray, red, tan	282-284, 287-288 ft. Fractured zones
290–300	Andesite flow 3	Massive andesite	
300–420	Andesite unit 4	Gray, microporphyritic andesite; some mixed red and tan fragments	
420–430	Andesite flow 5	Massive	
430–470	Andesite flow unit 6	Gray, microporphyritic	470 ft. No recovery 476-484 ft. Fractured zone
470–750	Andesite flow unit 7	Massive gray, occasional pink oxidized andesite	694-699 ft. Fractured zone 694, 697, 701 ft. Lost circulation
750–810	Andesite(?) flow unit 8	Oxidized flow top underlain by slightly coarser grained, massive andesite	805 ft. Water loss
810–880	Andesite(?) flow unit 9	Oxidized flow top as above unit	880 ft. Soft zone
880–1010	Andesite(?) flow unit 10	Oxidized flow top as above units 8, 9	
1010–1020	Andesite flow 11	Dark-gray, massive andesite	1010 ft. Very hard zone
1020–1100	No recovery		1020-1090. No recovery
1100–1130	Andesite flow unit 12	Massive, pinkish-gray andesite	
1130–1160	No recovery		1140-1160. No recovery

Figure 2. Stratigraphic section of EWEB 4 drill hole.