TEC-13

Grandview Geology

IDA. 105

PRELIMINARY DESCRIPTION OF ANSCHUTZ FEDERAL NO. 1 DRILL HOLE

OWYHEE COUNTY, IDAHO

By

D. H. McIntyre

Open-File Report 79-651

1979

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

Data available to us to date on the Anschutz Federal No.1 drill hole include the following:

1. Location: NE 1/4 SW 1/4 sec. 13, T. 5 S., R. 1 E, Owyhee County, Idaho.
2. Well cuttings.
3. Geophysical logs (gamma, caliper, borehole-compensated sonic, compensated neutron-formation density, IES/DIL composite).
4. Temperature log.

On the basis of these data, the following principal conclusions were reached:

1. The hole is located west of the principal resistivity anomaly defined by audio-magnetotellurics (AMT)(Hoover and Tippens, in Young and Whitehead 1975). The hole is about 5 km west of the 10 ohm-meter contour (26 HZ, north-south electric line) shown by Hoover and Tippens in Young and Whitehead (1975). The hole is not located on any prominent anomaly shown on available aeromagnetic or gravity maps.
2. Sedimentary rocks in the upper 707 m (2,320 ft) of the hole, chiefly volcanic siltstone and mudstone, are not hydrothermally altered. Expandable clay and framboidal pyrite in these rocks are normal products of volcanic glass decomposition, shallow burial, etc., and probably could be found in this unit at these depths anywhere in the area.

3. High permeability and severely altered rocks are restricted to several discrete zones, chiefly within the upper portion of the hole; the zones are listed in a section entitled "Generalized Descriptions of Units." The lack of severe alteration effects in the upper sequence of rhyolite is particularly remarkable because strongly altered zones bound it both at top and bottom. One other unit ("silicic lava A"), however, is so strongly altered (silicification, epidote, chlorite, local carbonate) in its upper portion that it could readily pass as a pre-Tertiary metavolcanic rock. The alteration in this rock diminishes downward, indicating that the alteration was caused by solutions concentrated in the permeable zone located toward its top.

4. Below the sedimentary unit the principal rock types include little altered rhyolite lavas and lighter colored, somewhat more altered rhyolites; these altered rhyolites may include some of those exposed in the Silver City District and probably also include rocks that do not crop out in the highlands. The Silver City District rocks are middle Miocene in age. Thin basalt units are intercalated throughout the section below the volcanic mudstone unit, and they all look alike. All are ophitic lavas, variably altered. Such rocks occur elsewhere in the units called Banbury Basalt (10 m.y. and younger; Armstrong and others, 1975) and in middle Miocene lavas of the highlands north of Silver City (McIntyre, 1972).

5. The hole bottoms in granitic rock. This corroborates the suggestion by Young and Whitehead (1975), based on chemistry of the thermal waters, that the Bruneau-Grandview area has a substrate with granitic mineralogy. This occurrence of granitic rock also indicates that the structural relief between the hole and the Snake River Plain margin, where granitic rocks crop out, 13 km (10 mi) to the southwest, is approximately 3,560 m.

6. Maximum temperature recorded in the hole was 149° C at 3390.9 m (11,125 ft), which was recorded 67 hours after circulation ceased. This temperature is consistent with the silica geothermometer temperatures for wells in the area (Young and Whitehead, 1975). A simple calculation of heat flow, using average conductivity values of Brott, Blackwell, and Mitchell (1978), gave 1.7 HFU for 150°C bottom hole temperature and 1.8 HFU for 160°C. These values are essentially identical to those determined elsewhere in the area from shallow wells (1.6-1.8 HFU; Brott, Blackwell, and Mitchell, 1978). A further rough calculation, assuming 9.1 km of granitic rock beneath the wellsite (Hill and Pakiser, 1966, fig. 15, plus data from the well) and using an average Idaho batholith heat-generation value of 3.3 HGU and mantle heat flow of 1.4 HFU (Brott, Blackwell, and Mitchell, 1978), gives a total heat flow of 1.7 HFU. This is identical to what is observed in the area. This result shows that the heat flow observed in the vicinity of the well can be explained by a very simple steady-state model without calling upon special or unique assumptions.

Generalized Descriptions of Units

Sedimentary Rocks

Sediments in the upper 378 m (1,240 ft) of the hole are chiefly yellowish-gray (5Y8/1) and pinkish-gray (5YR8/1) volcanic siltstone and mudstone containing expandable clay and minor, but conspicuous amounts of carbonate. Prior to clay alteration, these rocks were rich in shards of silicic volcanic glass. Crystalline material is notably lacking throughout the section. Small cavities, which appear to be molds of vanished organic remains, are lined with framboidal pyrite. In some specimens the cavities approximate the shapes of ostracode shells. In a few cuttings, ostracode shells are present and the framboidal pyrite is absent. A few specimens contain carbonized plant debris, which changes the rock color to light brownish-gray (5YR6/1). Diatoms were not searched for, but probably are present in minor amounts in some specimens.

Below 378 m (1,240 ft) the sediments still are essentially crystal-free volcanic siltstone and mudstone, but they differ from the sediments above this level in the following ways:

1. Induration--chips in cuttings notably harder and more angular than those above.
2. Color--notably more drab and dark than above, ranging from light olive gray (5Y6/1) and olive black (5Y3/1) near top downward to various shades of gray (N7; N5)
3. Expandable clay--less conspicuous.
4. Framboidal pyrite--rare or absent.
5. Carbonate--rare or absent.

6. Short normal resistivity--a uniform 2 ohm-meters, in contrast to the highly variable 4 to >10 ohm-meters higher in the section. A layer of basalt tuff may be present near 378 m (1,420 ft). An apparently thin layer of porcellanite occurs near 518 m (1,700 ft). A thin basalt intrusive mass (gamma log suggests a 6 m (20 ft) maximum thickness) occurs near 519 m (1,900 ft). Evidence for intrusion is the marked induration and darkening of the sediments immediately above the basalt. Another extremely indurated horizon in the sediments occurs near 643 m (2,110 ft). Cuttings and the gamma log show that no basalt was intersected by the hole at this level, but the induration suggests that a basalt intrusive mass is present nearby.

<u>Banbury Basalt</u> 707-783 m (2,320-2,570 ft)

Ophitic basalt lava, variably altered--matrix sometimes altered to green-gray clay-like material; also in cuttings are green-gray soft fibrous bundles of clay-like material. Also present are minor amounts of white bleached lava, probably linings of fractures.

<u>Silicified porphyry</u> 783-829 m (2,570-2,720 ft)

Strongly altered lava or intrusive mass with quartz and feldspar (K-Spar?) phenocrysts--groundmass mostly strongly silicified, with massive replacement, fracture-filling, and fracture-lining with quartz. Disseminated sulfides are pyrite, chalcopyrite, and an unidentified dark-gray mineral. Oxidation of sulfides produced chiefly hematite. Less-altered cuttings show conclusively that this rock is not merely an altered equivalent of the underlying rhyolite unit.

<u>"Rhyolite-1"</u> 829-963 m (2,720-3,160 ft)

Grayish-red-purple (5RP4/2), grayish-purple (5P4/2), and grayish-red (5R4/2 and 10R4/2) aphanitic lava, mostly unaltered, with sparse microphenocrysts of plagioclase, oxidized mafics (where unoxidized are green pyroxene), and magnetite. Quartz rarely present. Pyrite fracture-coatings common near top. Locally a little alteration to celadonite; rarely epidote fracture coatings.

<u>"Rhyolite-2"</u> 963-1,006 m (3,160-3,300 ft)

Light-olive-gray (5Y6/1) to greenish-gray (5GY6/1) lava; matrix often replaced by opal or chalcedony. Microphenocrysts of glassy feldspar (chiefly plagioclase?), possible minor quartz, magnetite (often altered to hematite), and minor pyroxene. Celadonite locally a matrix replacement.

<u>"Rhyolite-3"</u> 1,006-1,448 m (3,300-4,750 ft)

Chiefly olive-gray (5Y4/1) aphanitic lava with variable reddish-brown colors due to oxidation; sparse microphenocrysts of plagioclase, pyroxene, and magnetite. Remarkably uniform for so thick a unit (442 m; 1,450 ft). Locally minor celadonite staining or replacement. Readily recognized chill zones both top and bottom.

Silicic lava A 1,448-2,222 m (5,600-7,290 ft)

Chiefly greenish-gray (5GY6/1) aphanitic lava with sparse microphenocrysts of plagioclase and chloritized mafic. Variably altered to epidote, chlorite, and occasional secondary carbonate; pyrite as fillings and sparse disseminations common. Part of unit has abundant quartz as filling of hairline fractures and as massive replacement. Intensity of alteration variable, but tends to diminish toward bottom of unit.

Altered ophitic basalt 2,222-2,262 m (7,290-7,420 ft)

Dark-greenish-gray (5G4/1), brownish-gray (5YR4/1), and grayish-purple (5P4/2) altered lava with green waxy feldspar pseudomorphs and oxidized clayey interstitial matrix; altered to sericite and chlorite at base.

Silicic lava 2,262-2,356 m (7,420-7,730 ft)

Greenish-gray (5G6/1) aphanitic lava with sparse microphenocrysts of plagioclase, altered pyroxene(?) and magnetite. Altered biotite(?) may be present high in unit. Perlitic vitrophyre at top altered to sericite and chlorite.

Silicic lava C 2,356-2405 m (7,730-7,890 ft)

Light-gray (N7) to pale-purple (5P6/2) aphanitic lava that lacks microphenocrysts. Often finely mottled, with flow-alined opaque needles; some specimens contain minor epidote, chlorite,and quartz. Upper contact zone is quartz, sericite,and chlorite rock with relict perlitic fractures.

Altered ophitic basalt 2,405-2,426 m (7,890-7,960 ft)

Grayish-red-purple (5RP4/2) and grayish-green (10G4/2) altered lava; contains chlorite, ±hematite,and minor interstitial epidote.

Alteration diminishes toward base, where color is medium dark gray (N4).

Silicic lava D 2,426-2,542 m (7,960-8,340 ft)

Light-greenish-gray aphanitic lava with microphenocrysts of plagioclase, magnetite, very sparse quartz, and altered pyroxene; sparse pyrite commonly present. Alteration notably less than in higher units. Top is quartz-chlorite-sericite-altered perlitic vitrophyre. Vitrophyre also within unit in upper portion.

Silicic lava E 2,542-2,640 m (8,340-8,660 ft) Slightly higher gamma than "D"

Greenish-gray (5G7/1) aphanitic lava with very sparse microphenocrysts of magnetite, quartz, plagioclase, and chlorite after pyroxene(?). Quartz diminishes, plagioclase increases downhole. Locally minor epidote fracture coatings.

Silicic lava F 2,640-2,841 m (8,660-9,320 ft) Slightly lower gamma than "E"

Looks like "E."

Porphyritic rhyolite 2,841-3,112 m (9,320-10,210 ft)

Light-greenish-gray (not on chart) aphanitic lava with prominent quartz phenocrysts. Feldspar phenocrysts prominent only in lower part of unit. Locally has chlorite pseudomorphs after mafics.

Arkosic sediments 3,124-3,325 m (10,250(?)-10,910 ft)

Light-gray (N8), brownish-gray (5YR3/1), pinkish-gray (5YR8/1), and greenish-gray (5G5/1) fine granitic detritus; chips in cuttings are hard aggregates of quartz and feldspar grains, often rounded, often partly coated by films of sericite. At two levels the arkosic rocks are interrupted by occurrences of brownish-gray (5YR3/1) aphanitic rock with, rarely, microphenocrysts of quartz and feldspar. Two chips from the cuttings show a "welded-appearing" contact of aphanitic rock and arkosic rock. The dark rock might represent (1) a dike cutting the sediments, (2) a lava unlike any other in the hole, or (3) lava fragments incorporated in the sediments.

"Ophitic basalt in lower part of hole"

Basalt layers at these levels were difficult to characterize because of massive contamination by uphole caving. Without the gamma log, it would be impossible to know whether any of the basalt in cuttings at these levels was in place or not. Cuttings at 3,170-3,173 m 10,400-10,410 ft) contain ophitic basalt with fresh plagioclase; rock is brownish black (5YR2/1). Cuttings at 3,331-3,335 m (10,930-10,940 ft) contain little-altered olive-black (5Y2/1) ophitic basalt.

Granitic rock 3,338-3,391 m (10,950-11,125 ft) T. D.

The concern here is to be sure that we are dealing with genuine granitic rock in situ and not merely with a relatively coarse arkosic sandstone or sand and gravel. The following features suggest to me that we are, indeed, dealing with the real thing:

1. Larger chips show quartz and feldspar, as much as 4 mm in size, intergrown in typical granitic texture. Well-crystallized, chloritized biotite also is present.
2. The caliper log shows a small, stable hole in this interval. This would be unlikely for uncemented arkose. If cementation were present, films of the cementing material (such as silica) ought to show up in the cuttings. None were seen.
3. The gamma log shows a level of radioactivity distinctly lower than that for arkosic sediments higher in hole.

Porous Zones Indicated by Log Data

The sonic and neutron-density logs define several zones of probable high permeability that correlate well with features observed in the cuttings. The zones are as follows (neutron density log begins at 1,250 m (4,100 ft)):

698-794 m (2,290-2,310 ft)--Sonic----------	Just above top of Banbury Basalt.
771-829 m (2,530-2,720 ft)--Sonic----------	Coincident with silicified porphyry, with disseminated sulfides; probably a major zone.
1,006 m (3,300 ft)--Sonic----------------	Contact of "rhyolite-2" and "rhyolite-3".
1,448-1,478 m (4,750 to 4,850 ft)--Sonic------------- 1,448 to 1,478-1,494 m (4,750 to 4,850-4,900 ft)--Density	Silicified zone with sulfides; may be a major zone.
1,670-1,759 m (5,480-5,770 ft)--Sonic----- 1,664-1,667 to 1,768 m (5,460-70 to 5,800 ft)--Density	Poor sample return this interval; some samples brecciated, silicified; may be a major zone.
2,993 m (9,820 ft)--Density--------------	No data from cuttings.
3,336-3,338 m (10,945-10,950 ft)--Sonic and Density-----	Basalt-granitic rock contact.

References cited

Armstrong, R. L., Leeman, W. P., and Maldé, H. E., 1975, K-Ar dating, Quaternary and Neogene volcanic rocks of the Snake River Plain, Idaho: American Journal of Science, v. 275, p. 225-251.

Brott, C. A., Blackwell, D. D., and Mitchell, J. C., 1978, Tectonic implication of the heat flow of the western Snake River Plain, Idaho: Geological Society of America Bulletin, v. 89, p. 1697-1707.

Hill, D. P., and Pakiser, L. C., 1966, Crustal structure between the Nevada Test Site and Boise, Idaho, from seismic-refraction measurements, in Steinhart, J. S., and Smith, T. J., eds., The earth beneath the continents: American Geophysical Union Geophysical Monograph 10, p. 391-419.

McIntyre, D. H., 1972, Cenozoic geology of the Reynolds Creek Experimental Watershed, Owyhee County, Idaho: Idaho Bureau of Mines and Geology Pamphlet 151, 115 p.

Young, H. W., and Whitehead, R. L., 1975, An evaluation of thermal water in the Bruneau-Grand View area, southwest Idaho; with a section on A reconnaissance audio-magnetotelluric survey, by D. B. Hoover and C. L. Tippens: Geothermal Investigations in Idaho, part 2, Idaho Department of Water Resources Water Information Bulletin no. 30, 126 p.

Anschutz Federal No. 1
NE ¼ SW ¼ sec. 13, T. 5S, R. 1E.