DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

DRILLING DATA FROM EXPLORATION WELL 2-2A, NW¼, SEC. 15, T. 5 N., R. 31 E., IDAHO NATIONAL ENGINEERING LABORATORY, BUTTE COUNTY, IDAHO

by
[illegible]
[illegible]

EXPLANATION

Sand · Silty Sand · Silty Clay · Clay · Breccia · No Core Recovered

Rhyolitic Ash · Basalt · Welded Tuff · Vitrophyre · Cinders in Loess

Structures and Textures

- ○ Vesicular
- ● Amygdaloidal
- ⊙ Lithophysal
- ℮ Fossils
- // Fractured
- •– Flow break (on left of column)

Mineral and Lithologic Variations

- A Alteration (undetermined mineralogy)
- Ba Altered basalt fragments
- Ca Calcite
- Cl Clay (alteration product)
- Cx Calcite crystals in cavities
- F Iron oxide staining and alteration
- Op Opal
- P Palagonite
- S Silt and sand in fractures and openings within basalt flows
- Ss Slickensides
- V Vapor phase crystallization
- X Thin ash bed

DISCUSSION

The U.S. Department of Energy, in cooperation with the U.S. Geological Survey, drilled three exploration wells on the eastern Snake River Plain, Idaho, during the summer and fall of 1978. The wells were continuously cored, and range in depth from 2,000 ft (610 m) to 3,000 ft (914 m). The wells were drilled to obtain subsurface geologic information pertaining to geothermal exploration in three areas of the eastern Snake River Plain which have distinctly different types of geology.

Two of the wells are located on property of the Idaho National Engineering Laboratory (INEL), Idaho with the third well being located in Sugar City, Idaho (Embree and others, 1978).

This preliminary report describes the lithology, and shows the temperature distribution, and geophysical logs of well 2-2A, located on the INEL site in the NW 1/4, sec. 15, T. 5 N., R. 31 E., Butte County, Idaho. The well was located by the U.S. Geological Survey to obtain subsurface information on 1) the character and distribution of basaltic lava flows and interbedded sediments, 2) the age of the rocks and sediments, 3) the nature and extent of alteration of the rocks, and 4) an estimate of the heat flow in the area.

Drilling on well #2 began June 13, 1978. At a depth of 412 ft (126 m), difficulties were encountered in drilling. A new well (2A) was drilled approximately 20 ft (6 m) east of the original well site, reaching a total depth of 3,000 ft (914 m) on September 23, 1978. The logs presented here are a composite of both wells (2 and 2A).

The geology of the area near the well has been briefly described by Robertson, Schoen, and Barraclough (1974), Nace and others (1975); and Malde and others, (1971); the subsurface geology is generalized by Walker (1964). K-Ar dates of some of the volcanic rocks on the Idaho National Engineering Laboratory are reported by Chase (1972), and Armstrong and others (1975). Walker (1964) showed that the subsurface geology of the north central part of the eastern Snake River Plain consists of at least 3,317 ft (1,011 m) of interbedded Quaternary and Neogene basaltic lava flows and beds of silt and silty clay. Walker (1964) showed evidence that the sedimentary portion of the stratigraphic section is primarily alluvial in origin, consisting of stream and lake deposits.

In well 2-2A the basaltic lava flows are similar in texture and mineral composition throughout the upper 2,000 ft (610 m). There are over 54 separate basaltic lava flows in the drill core from well 2-2A. They are generally fine- to medium-grained, porphyritic, diktytaxitic olivine basalts. Phenocrysts include plagioclase and olivine in a groundmass of plagioclase, olivine, pyroxene, magnetite, ilmenite, and glass. Below about 1,900 ft (579 m), the basalts are hydrothermally altered and mineralized. This alteration and mineralization includes: filling of vesicles by calcite, zeolites, and serpentine; deposition of these same minerals along fractures; and serpentinization of the basalt, especially near some of the fractures. Many of the fractures show serpentinized slickensides. The clay-rich sediments in the lower 1,000 ft (300 m) of the well are also altered; evidence includes an overall greenish color to the clay-rich sediments, and the presence of altered grains of biotite and basalt.

At least 8 thin, rhyolitic air-fall ash beds are exposed in the drill core. The glass shards in these layers appear petrographically to be uneffected by the alteration. A crystal-poor, rhyolitic, lithophysal, densely welded ash-flow tuff, consisting of two flow units, occurs at a depth of 2,521 ft (768 m) to 2,558 ft (780 m). The lower flow unit consists of a black basal vitrophyre resting on a few feet of vitroclastic air-fall ash. The vitrophyre grades up into a densely welded, lithophysal, devitrified ash-flow tuff. The upper flow unit consists of about 2 ft (0.6 m) of devitrified densely welded ash-flow tuff. This ash-flow tuff is similar in texture and mineral content to ash-flow tuffs exposed at the southern end of the Lemhi Range, as described by Ross (1961), Chase (1972), and Malde and others (1971).

Continuing studies on rocks and sediments from this well will investigate their age, geochemistry, alteration, paleontology, magnetic properties, and possible correlations.

Table 1.--Geophysical log information concerning drill hole 2-2A, located in the NW 1/4, sec. 15, T. 5 N., R. 31 E., Butte County, Idaho.

Log No.	Log Type	Date Logged	Logged Interval Feet	Logged Interval Meters
1	Temperature 1/	9-22-78	0-2640	0-805
2	Temperature 1/	9-24-78	2640-2990	805-911
3	Temperature 2/	10-01-78	221-2614	67.5-797
4	Gamma 1/	9-22-78	0-2640	0-805

1/ Logged by N. L. McCullough Co., Box 5185 W. Yellowstone Hwy., Casper, Wyoming 82601.

2/ Logged by Charles A. Brott and David D. Blackwell, Institute for the Study of Earth and Man, Geothermal Laboratory, 253 Heroy Building, Southern Methodist University, Dallas, Texas 75275.

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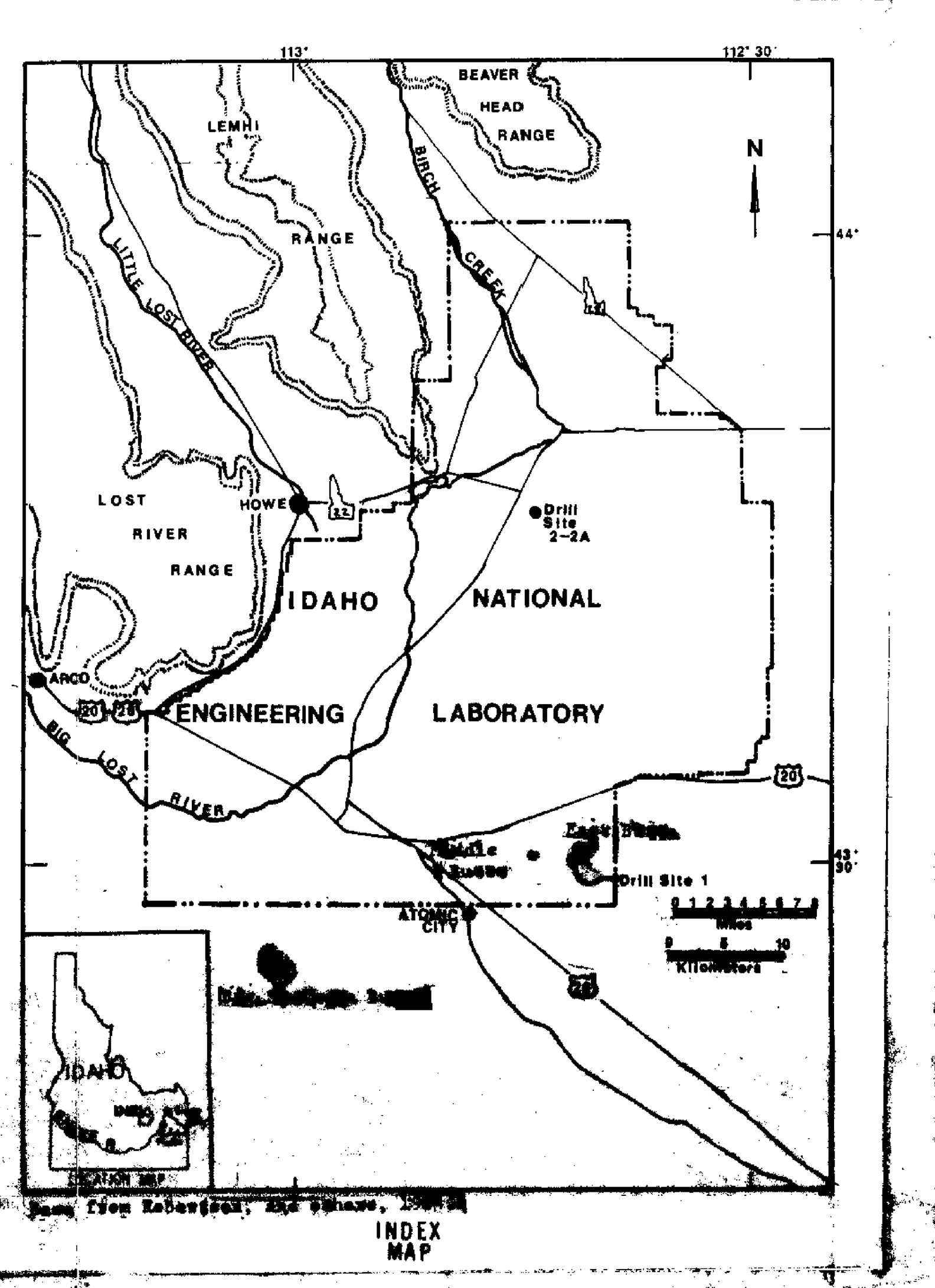

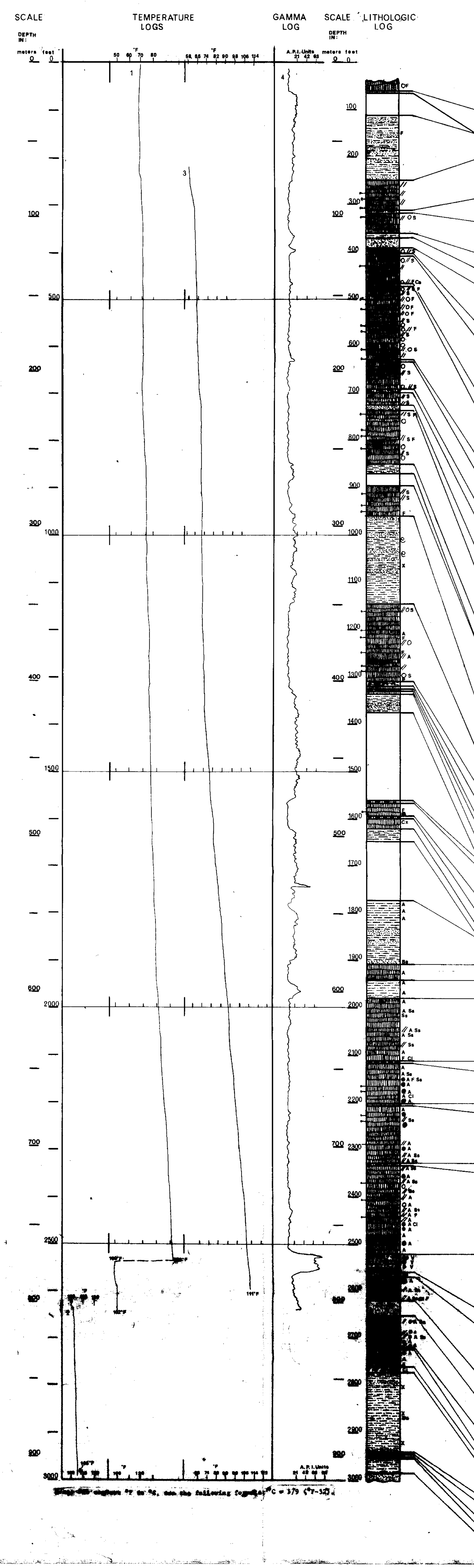

To convert °F to °C, use the following formula: °C = 5/9 (°F-32)

LITHOLOGIC DESCRIPTIONS

Basalt--Reddish-brown to medium-gray, fine-grained, diktytaxitic, dense to vesicular, porphyritic olivine basalt. Phenocrysts include lath-shaped, euhedral to subhedral crystals of plagioclase as much as 1 cm long, and yellow-green, anhedral to subhedral crystals of olivine about 1 mm long. The plagioclase phenocrysts make up 40 percent to 70 percent, and the olivine phenocrysts make up 7 percent to 10 percent of the rock

Sand--Brown to reddish-brown, angular to subangular, medium- grained arkosic sand. The mineralogy is dominated by quartz and feldspar; granules (<1 mm) of dark-brown to black fine- grained basalt are common

Silty clay and sand--Interbedded gray to grayish-brown silty clay, and brown to olive-gray, well-sorted, fine- to medium-grained, subangular to subrounded, arkosic, quartz sand. Silty clay is the dominant lithology and commonly contains small sand lenses which measure 5 cm in length and 2 cm in height

Basalt--Dark-gray to brown, and black, fine-grained, diktytaxitic, dense to vesicular, porphyritic olivine basalt. Vesicles range in size from 1 mm to 4 cm and constitute 2 percent to 30 percent of the rock volume. Olivine occurs as small (<1.5 m), anhedral to subhedral, green vitreous phenocrysts, which make up 3 percent to 5 percent of the rock volume. Phenocrysts of small (<1 mm) gray lath-shaped crystals of plagioclase constitute as much as 10 percent of the rock volume

Silty clay--Gray to brownish-gray, fine-grained silty clay, with 5 percent of the sample volume being subrounded quartz sand grains. Small (<5 mm) fragments of black fine-grained basalt are common in the Lower portion of the bed. The silty clay is of alluvial origin

Basalt--Medium- to dark-gray, fine-grained, diktytaxitic, dense to vesicular, porphyritic olivine basalt. The vesicles range in size from 1 mm to 5 mm and constitute as much as 5 percent of the rock volume. Lath-shaped phenocrysts of plagioclase, 1-2 mm, constitute from 1 percent to 5 percent of the rock volume. Olivine occurs as small (<2 mm), reddish-brown, vitreous subhedral phenocrysts

Silty clay--Light-brown, plane-bedded, very fine grained silty clay. Calcite-filled burrows are common in the middle part of this unit. The sediment is alluvial in origin

Sand--Light-brown to reddish-brown, fine- to medium-grained, subangular, iron-stained, micaceous, alluvial quartz sand. Pebbles of vesicular basalt are common in the lower 2 ft of this unit

Basalt--Brown to brownish-gray, fine-grained, diktytaxitic, vesicular, porphyritic olivine basalt. The vesicles are irregular in shape, average 5 mm, and constitute approximately 10 percent of the rock volume. Phenocrysts include small (<2 mm) euhedral plagioclase laths, and small (<2 mm) anhedral to subhedral crystals of olivine. Plagioclase and olivine phenocrysts make up 10 percent and 5 percent of the rock volume, respectively

Silty clay--Brown to brownish-gray, very fine grained silty clay. Small (1 mm) fragments of black to brown fine-grained basalt constitute as much as 15 percent of this unit

Basalt--Medium-gray to dark-gray, and brownish-gray, fine-grained, diktytaxitic, dense to vesicular, porphyritic olivine basalt. The vesicles are round to irregular in shape, range from 2 mm to 3 cm, and constitute as much as 20 percent of the rock volume. Phenocrysts include small (<3 mm) laths and plates of transparent vitreous plagioclase and small (<2 mm), green to greenish-brown, subhedral to anhedral crystals of olivine. Olivine phenocrysts make up approximately 5 percent of the rock volume. A thin (<1 ft) clay bed, separating lava flows, occurs at a depth of 429 ft (131 m). Small reddish-brown basalt cinders are common in the light-brown clay unit

Sand--Reddish-brown to grayish-orange, fine-grained, subrounded to subangular, quartz-rich alluvial sand and silty sand

Basalt--Reddish-brown, medium-gray to purplish-gray, and greenish-black, fine-grained, dense to vesicular, diktytaxitic, porphyritic olivine basalt. The vesicles are round to irregular in shape, range in size from 0.5 mm to nearly 3 cm, and constitute from 1 to 15 percent of the rock volume. Phenocrysts include euhedral to subhedral plagioclase laths (average size 1.0 mm), and small (<2 mm), reddish-brown to yellow-brown, vitreous, subhedral to anhedral crystals of olivine. The plagioclase and olivine phenocrysts make up 10 percent, and 3-4 percent of the rock volume, respectively

Silty clay--Orange to orange-brown, fine-grained silty clay with 10 percent of the volume being fine-grained, subangular, arkosic, alluvial quartz sand

Basalt--Medium-gray, and brown to brownish-gray, fine-grained, diktytaxitic, dense to vesicular, porphyritic olivine basalt. The vesicles are round (1-5 mm), and range from approximately 1 percent to 30 percent of the rock volume. Phenocrysts of anhedral to subhedral, green and reddish-brown, vitreous olivine crystals constitute 5 percent of the rock volume and average 3 mm in size

Silty clay--Light-brown silty clay. Pebbles of vesicular fine-grained basalt occupy approximately 10 percent of the sediment volume

Basalt--Medium- to dark-gray, brownish-gray, and reddish-brown, fine-grained, dense to vesicular, diktytaxitic, porphyritic olivine basalt. The vesicles are small (3-6 mm), mostly round, and occupy 1 to 10 percent of the rock volume. Olivine phenocrysts (1-2 mm) occur as reddish-brown to green, vitreous, anhedral to subhedral crystals occupying 2-4 percent of the rock volume

Sand and silty clay--Red-brown, medium- to fine-grained, quartz-rich, iron-stained alluvial sand grading downward into brown to light-brown silty clay. A few pebbles (up to 2 cm) of vesicular basalt occur in the sand and silty clay

Basalt--Dark- to medium-gray, and reddish-brown, fine-grained, dense to vesicular, diktytaxitic, prophyritic olivine basalt. The vesicles are round to irregular in shape, range in size from 1 mm to 1.5 cm, and occupy 2 to 20 percent of the rock volume. Small phenocrysts of plagioclase and olivine are present throughout this set of basalt flows. Plagioclase phenocrysts occur as euhedral laths (1-2 mm), and make up 2-4 percent of the rock volume. Olivine phenocrysts constitute about 3-5 percent of the rock volume and occur as anhedral to subhedral (<2 mm), reddish-brown vitreous crystals

Silty clay--Reddish-brown to brown to yellowish-brown, sandy, silty clay. Small clasts (<1 mm) include fine-grained basalt and angular pink microcline. The sand is fine grained, subrounded, and quartz rich and makes up <10 percent of this unit

Basalt--Medium- to dark-gray, reddish-brown, and brownish-gray, fine-grained, diktytaxitic, dense to vesicular, ilmenite-rich olivine basalt. The vesicles are mostly irregular in shape, and range from 0.5-2 mm in diameter. Ilmenite occurs as small (<1.0 mm), elongate, euhedral blades and makes up approximately 3-5 percent of the rock volume. Olivine occurs as reddish-brown, vitreous, subhedral crystals (<.7 mm) constituting approximately 1-3 percent of the rock volume. Thin sediment beds separate several individual flows, at the following depths; 913 ft (278 m), 918 ft (280 m), 934 ft (285 m), 937-943 ft (286-287 m), and 945 ft (288 m). The sediment layers are chiefly medium to dark gray and brownish gray silty clays and sandy silts, probably of eolian origin

Silty clay and sand--Light-brown, and greenish-gray, bedded, poorly-sorted, sandy, silty clay interbedded with brownish-gray, fine- to medium-grained, poorly sorted, subangular to subrounded, quartz-rich alluvial sand. Basalt grains (average size 1-2 mm) are common throughout. Small lenses of sand within the silty clay are common from depths of 1,085-1,100 ft (331-335 m). Fossils, including snails and clams, occur at 1,007-1,010 ft (307-308 m). A thin, 6-in. (15-cm), fine-grained, rhyolitic, vitroclastic, air-fall ash layer occurs at 1,063 ft (324 m)

Basalt--Dark- to medium-gray, brownish-gray, greenish-black, and reddish-brown, fine-grained, diktytaxitic, dense to vesicular olivine basalt. Vesicles are mostly small (5-7 mm), round to irregular, and make up 1-55 percent of the rock volume. Olivine is present as 1-mm anhedral to subhedral grains making up about 1-3 percent of the rock volume

Sandy silt--Light-brown to orange-brown sandy silt (loess) containing glassy, vesicular to dense basalt pebbles

Basalt--Medium- to dark-gray, fine-grained, dense to vesicular basalt. Phenocrysts include green olivine and sparse plagioclase

Silty clay--Greenish-gray, well-sorted, plane-bedded silty clay

Basalt--Medium- to light-gray, fine-grained, diktytaxitic, porphyritic olivine basalt. Olivine occurs as small, subhedral, yellow-brown, vitreous phenocrysts, consisting up to 3 percent of the rock volume

Silty clay and sand--Gray to brownish-gray to yellowish-gray, poorly-sorted, alluvial, sandy and silty clay; interbedded with thin beds of quartz-rich, fine-grained, poorly sorted, magnetite-bearing sand

Silty clay--Grayish-brown, slightly sandy to silty clay

Basalt--Dark- to medium-gray, fine-grained, dense, vesicular to amygdaloidal, olivine basalt. The vesicles and amygdules are sparse, and are lined and filled with euhedral calcite rhombs, and zeolites. Olivine occurs as small (<1 mm) anhedral to subhedral crystals, which constitute up to 2 percent of the rock volume

Silty clay--Gray to brown, poorly-sorted eolian, sandy to silty clay with 10 percent fine-grained subrounded quartz sand

Basalt--Gray to greenish-gray, fine-grained, dense, amygdaloidal basalt. The amygdules are mostly filled with calcite and zeolites

Silty clay--Gray to greenish-gray, plane-bedded, alluvial silty clay

Silty clay, clay, and sand--Green to greenish-gray alluvial silty clay, interbedded with thin layers of green clay, and brown, fine- to medium-grained, quartz-rich sand

Basalt--Gray to dark-gray, and greenish-black, fine-grained, dense, porphyritic, altered basalt. Phenocrysts of small (<2 mm) lath-shaped crystals of plagioclase make up 5 percent of the rock volume

Silty clay--Light-brown to greenish-gray, poorly sorted, tuffaceous silty clay of alluvial origin

Basalt--Dark-green to greenish-black, fine-grained, altered, dense, amygdaloidal basalt. Several fractures exhibit slickensides and some appear to be serpentinized. Alteration of the basalt is often most intense near these slickensides

Clay--Greenish-gray highly altered(?) clay

Basalt--Greenish-black, dark-green, greenish-brown, and reddish-brown, fine-grained, fractured, amygdaloidal, highly altered basalt

Sand--Greenish-gray, fine-grained, silty, poorly sorted, quartz-rich sand

Basalt--Greenish-gray to dark-green, and dark-brown to greenish-black, fine-grained, highly altered, fractured, amygdaloidal olivine basalt. The olivine is altered to iddingsite and occurs as small crystals (<1 mm) that make up 3-4 percent of the rock volume. A thin reddish-brown altered scoriaceous zone occurs between 2,231 ft (680 m) and 2,237 ft (682 m)

Silty clay--Gray to brown silty clay of eolian origin

Basalt--Purplish-gray, greenish-gray, and dark-gray to greenish-black, fine-grained, vesicular, amygdaloidal, highly altered olivine basalt. The olivine is altered to iddingsite and occupies approximately 5 percent of the rock volume. The amygdules show up to 3 stages of mineralization including zeolites, calcite, and serpentine

Rhyolitic welded ash-flow tuff--Gray to brownish-gray, purplish-gray, black, and pink, fine-grained, crystal-poor, vitric to devitrified, lithophysal to spherolitic, eutaxitic, densely welded ash-flow tuff. The ash-flow contains two flow units. The lower flow unit is approximately 30 ft (10 m) thick and consists of a densely-welded basal vitrophyre which grades upwards into a spherolitic, lithophysal, devitrified, densely welded ash-flow tuff. The lower flow unit rests on approximately 2 ft (0.6 m) of [illegible] vitric air-fall ash. The upper flow unit is approximately 5 ft (1.5 m) thick, and consists of [illegible] devitrified, crystal-poor, eutaxitic, densely welded ash-flow tuff

Silty clay--Light- to [illegible], tuffaceous, plane-bedded, silty clay. Small pebbles of dark-gray altered fine-grained basalt are common in the lower 3 ft (1 m) of the bed

Basalt--Brownish-gray and dark-gray, altered, dense to vesicular, amygdaloidal, porphyritic olivine basalt. Vesicles range from approximately 1 mm to approximately 5 mm in size and make up 30 percent of the rock volume. A few vesicles are filled with 2 or 3 generations of mineralization including zeolites, calcite, and serpentine. Phenocrysts of euhedral plagioclase (<1 mm) and altered olivine amount to less than 2 percent of the rock volume. Many fractures in the basalt show serpentinized slickensides

Silty clay and sand--Reddish-brown, brown to light-brown, and gray, plane-bedded silty clay of alluvial origin; interbedded with gray to light-brown, subangular to subrounded, sorted, quartz-rich alluvial sand

Basalt--Gray to dark-gray, and greenish-black, altered, vesicular to amygdaloidal, fractured olivine basalt. Vesicles are round and average 3-5 mm in diameter, making up 5-15 percent of the rock volume. Amygdules are present at a depth of about 2,703 ft (824 m). Several of the fractures show serpentinized slickensides

Silty clay--Light-brown to greenish-gray silty clay, 5-10 percent of which is fine-grained quartz-rich sand

Basalt--Black to dark-gray, highly altered amygdaloidal basalt

Basalt--Brown, black, and tan, brecciated, altered basalt

Silty clay and sand--Interbedded greenish-gray sandy and silty clay of alluvial origin; and green to gray, medium- to fine-grained, angular to subangular, arkosic, poorly sorted alluvial sand. Three thin, vitroclastic, rhyolitic air-fall ash beds occur within this sediment bed at the following depths: 2,802 ft (854 m), 2,857 ft (871 m) and 2,919 ft (890 m)

Rhyolitic air-fall ash--Gray to bluish-gray, fine-grained, vitroclastic, rhyolitic air-fall ash

Silty clay--Greenish-gray to gray, plane-bedded, tuffaceous silty clay. Pyritized roots are present at a depth of 2,947 ft (898 m)

[illegible] air-fall ash--Gray to bluish-gray, [illegible], fine-grained, vitroclastic, rhyolitic air-fall ash

[illegible]--Greenish-gray, plane-bedded, tuffaceous, alluvial silty clay

[illegible] to greenish-gray, coarse- to medium-grained, subangular to subrounded, poorly sorted, quartz-rich alluvial sand