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DATA FROM A 1,000-FOOT (305-METRE) CORE HOLE IN THE LONG VALLEY CALDERA, MONO COUNTY, CALIFORNIA

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INTRODUCTION

Between late September and early November 1973, a 1,000-foot (305-metre) hole was drilled, cored, and logged within the Long Valley caldera as part of the U.S. Geological Survey program. In September 1974 the hole was cleaned out and 1¼-inch (32-millimetre) diameter pipe was cemented in place. The purpose of this report is to make available the data acquired from the core hole. The scope of this report includes the tabulation or otherwise systematic presentation of the data from the core hole and includes geophysical logs, temperature profiles, generalized lithology in the core hole, and results of porosity, hydraulic conductivity, and thermal-conductivity measurements on selected core samples.

For use of those readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English unit	By	To obtain metric unit
feet (ft)	3.048×10^{-1}	metres (m)
inches (in)	2.540	centimetres (cm)
inches (in)	2.540×10	millimetres (mm)
miles (mi)	1.609	kilometres (km)

LOCATION, DRILLING, AND CONSTRUCTION OF THE CORE HOLE

The drilling site is in the SW¼NE¼NW¼ sec. 19, T. 3 S., R. 29 E., about 0.65 mi (1.05 km) southwest of the Cashbaugh Ranch (fig. 1) at an altitude of about 6,980 ft (2,128 m), and is in the vicinity of the electrical resistivity anomaly ("Cashbaugh Low") delineated by Stanley, Jackson, and Zohdy (1973). Corresponding to the well-numbering system used in California by State agencies and by the U.S. Geological Survey, the core hole was assigned the number 3S/29E-19C1; however, in this and other U.S. Geological Survey reports, the hole is commonly referred to by its project well number, LVCH-1.

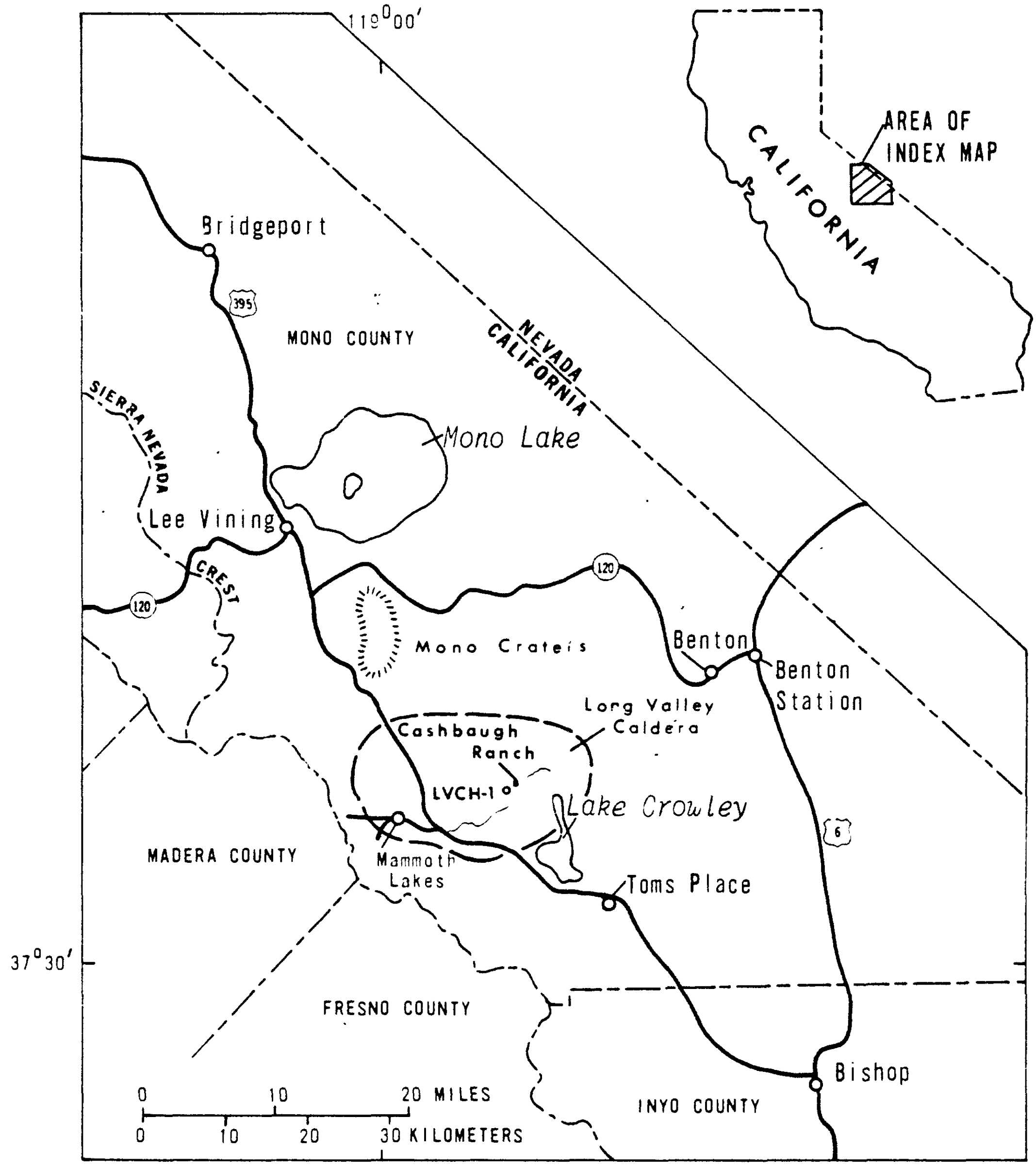

FIGURE 1.--Index map.

The truck-mounted drilling rig was equipped with a wire line in order to draw the core through the drill rods without removing the rods from the hole. From land surface to 100 ft (30.5 m) drilling was by conventional hydraulic rotary methods using a 5¾-in (14.6-cm) tricone bit. At 100 ft (30.5 m), a 4-in (10-cm) flush-jointed steel casing was set and grouted under pressure to the land surface where the casing was fitted with a high-pressure gate valve atop which was attached a "T" and a stuffing box. Drilling continued to a depth of 1,000 ft (305 m). All drilling below 100 ft (30.5 m) was done through the stuffing box and valve, and coring was continuous using an NC diamond core bit and a 5-ft (1.5-m) wire-line core barrel. Drilling mud was returned to the surface mud pit through a 4-in (10-cm) pipe in the side of the "T". This procedure of using a "T," stuffing box, and gate valve was adopted as a safety precaution after discussions with L. J. P. Muffler and D. H. White, U.S. Geological Survey, indicated its success in research drilling by the Survey in Yellowstone Park, Wyo. The equipment provided the capability of controlling and shutting off any hot water under pressure should it be encountered.

By late spring 1974 constrictions in the borehole from swelling clay strata prevented additional temperature-gradient measurements. In September 1974 the borehole was reamed to 972 ft (296 m), and a 1¼-in (32-mm) closed-end pipe was cemented in and filled with water for subsequent temperature-gradient measurements.

LITHOLOGY

The hole was cored continuously from the bottom of the cased interval at 100 ft (30.5 m) to its total depth of 1,000 ft (305 m). In general, the core recovery was excellent ranging from about 60-percent recovery for the upper 200 ft (61 m) of cored hole to a consistent 80- to 100-percent recovery thereafter.

The core obtained between 346 and 1,000 ft (105 and 305 m) was examined by R. A. Bailey, U.S. Geological Survey, and the core above 346 ft (105 m) was examined by the writer. The descriptions were then generalized to obtain the lithologic log shown in table 1. It is presented here as an aid to investigators working in the Long Valley area. A detailed examination of the core presently being made by R. H. Mariner, U.S. Geological Survey, will include X-ray diffraction analyses and a complete mineralogic description of the core.

TABLE 1.--Generalized lithologic log from LVCH-1

Description	Thickness (feet)	Depth (feet)
Not cored; drilled by conventional hydraulic rotary methods. In general comprising tuffaceous sediments, sand to gravel size; very hard and well cemented (SiO_2) in streaks.	102.5	0-102.5
Ashy or tuffaceous sediments, light- to medium-gray; poorly sorted, silt to coarse gravel with some lithic fragments to 2 in; locally beds up to 2 in of well sorted very fine to fine grained ashy sand. Poorly to fairly well compacted, well cemented (SiO_2) in streaks; generally massive, structure poorly defined. No carbonate minerals apparent.	122.5	225
Ashy or tuffaceous sediments, light- to medium-gray; generally finer grained and better sorted than above; locally, thin (<3 ft) beds of silt or silty clay; carbonate minerals evident below about 285 ft. Generally massive, some graded bedding. Thin (0.3 in) silt bed at 285 ft dips 16° with some deformation. Basal light to medium gray vitric ash with some pumiceous lithic fragments; well compacted, massive, noncarbonate.	102	327
Ash, white to buff and light- to medium-gray; silt to clay size. Generally well sorted and massive, some interbedded gray clay-altered ash and silty clay with some clays; sulfide-bearing. Thin horizontal bedding. Generally carbonate-bearing.	83	410
Gravel, gray, with pumice and obsidian and pebble pumice; commonly in zones 5-20 ft thick showing some graded bedding. Gray sand with gravel lenses. Brown to gray sandy ash, well sorted, even bedded, dip 0°. Thin beds of gray to white ash, silt to clay size, commonly well sorted, unconsolidated, massive to even-bedded, dip 0°. Probably water-bearing in the more permeable zones.	125	535

TABLE 1.--Generalized lithologic log from LVCH-1--Continued

Description	Thickness (feet)	Depth (feet)
Ashy sediments, light-gray to white, thin-bedded. Extremely deformed, local vertical bedding, folded, faulted. Gray clay with gravel lenses; dip 30-40°. Some minor dark gray to brown fine pebbly gravel with obsidian and dark gray sand; massive.	40	575
Clay, dark-gray to grayish-brown, in part with clasts of obsidian and pumice, thin-bedded to massive; dip 0°. Upper 7 ft of obsidian-pebble conglomerate grading upward into sand.	17	592
Ashy sediments, light-gray to white, with crystals of hornblende and biotite; thin bedded. Greenish pumiceous sand showing some clay alteration; grades upward into dark gray sand with white pumice clasts; dip 0°.	15	607
Ash, interbedded gray-white to brown, very fine, and brown to gray-brown clay with minor gray to gray-white sand and gravel; bedding is thin (varved) to massive, dip 0°. Thin sand bed at 625 ft contains fragments of hornblende-biotite-rhyolite pumice.	28	635
Sand, predominantly grayish, and tuffaceous sand. Basal 10 ft is alternate beds of gray pumiceous sand and white fine to very fine thin-bedded ash; local slump structures.	40	675
Pumiceous sand, light-gray unaltered, and unaltered obsidian pebble conglomerate, all showing coarse to fine graded bedding in two 7-ft sections. Basal 5 ft gray sandy ash. Unit is probably water-bearing to some extent.	27	702
Ashy sediments, buff, very fine grained, and sandy tuffaceous sediments, both well sorted; massive to thin-bedded, generally weakly developed. Dip 0° with local slump structures.	107	809

TABLE 1.--Generalized lithologic log from LVCH-1--Continued

Description	Thickness (feet)	Depth (feet)
Pumiceous tuff sediment, greenish, some clay alteration; minor greenish-buff sandy tuff sediment, fine to medium grained, cross-bedded; and gray to buff sandy ash with clay altered obsidian-bearing lenses. Dip 0-5°.	31	840
Tuffaceous sediment, dark-gray dirty; generally medium grained with progressively finer grained upward; distinct bedding, dip about 30°.	15	855
Ash, fine, light to greenish-gray, clay altered. Pumice fragments altered to granular zeolites. Plastically deformed.	9	864
Tuff, grayish-green; coarser grained near the base with white lapilli; massive.	30	894
Clay, medium-gray; massive.	14	908
Tuff, dark grayish-green granular, massive; contact dip about 65°. Some coarser grained fragments in a fine clay matrix. Minor pure white pumice lapilli altered to granular texture at the top.	32	940
Ash, grayish-green; coarse, pumice-rich; silica cemented. Some clay alteration near the top. Contact dip 40°.	20	960
Ash, light-gray to buff, brown to green; very fine to fine grained; thin-bedded to massive, dip generally <10° but up to 30° at the base with numerous minor reverse faults with about 0.1 in displacement; 4 in beds of dark organic-rich material below 980 ft.	40	1,000

TEMPERATURE MEASUREMENTS

Bottom-hole temperatures were measured in the hole during the course of drilling. They were obtained using either a maximum-reading thermometer or a thermistor thermometer and a resistance measuring system similar to the one described by Sass, Lachenbruch, Munroe, Green, and Moses (1971). Simultaneous measurements made with both thermometers were in agreement within about 0.5°C. Bottom-hole temperatures (fig. 2) were measured only after a minimum of 16 hours had elapsed since the cessation of drilling operations.

Twelve hours after completion of the hole a continuous temperature profile (fig. 3) was made by the well-logging crew. Twenty-four hours later, temperatures were measured at 20-ft (6.1-m) intervals. The data were included in a report by Sass, Lachenbruch, and Munroe (1974). The temperature in the hole was measured 4 months later by Paul Twitchell and 7 months later by R. H. Merkel, both of the U.S. Geological Survey. Bottom-hole temperature measurements and profiles constructed from temperature measurements obtained by the U.S. Geological Survey are shown in figure 2.

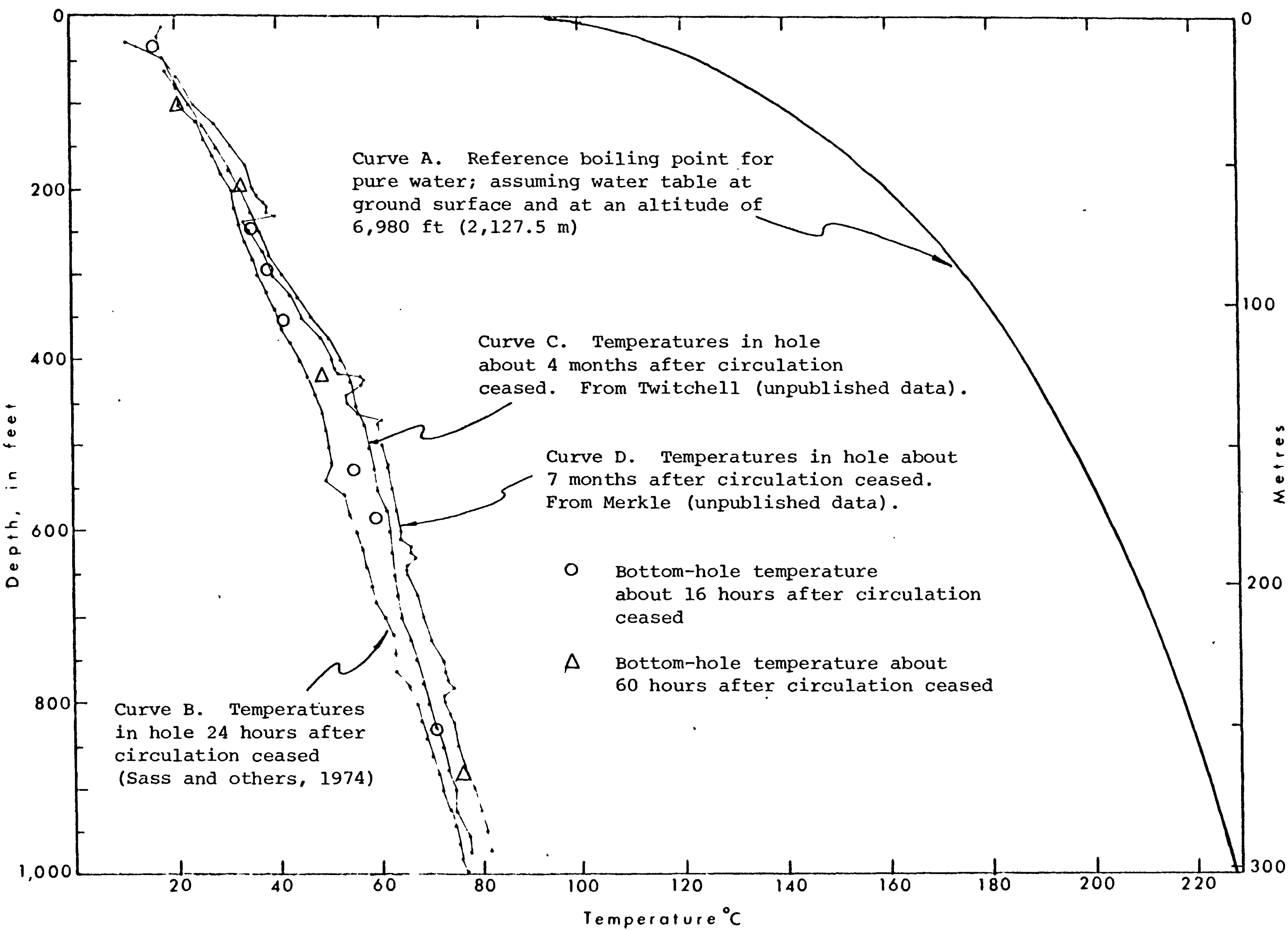

FIGURE 2.--Temperatures in LVCH-1.

GEOPHYSICAL LOGS

Geophysical logging of the test hole was done under government contract to Welex. Supervision of the logging was by Richard H. Merkle of the U.S. Geological Survey. Electric, radioactivity (gamma, neutron), fracture finder (micro-seismogram), caliper, and temperature logs were obtained and are included in figure 3. Copies of the original logs may be inspected at the U.S. Geological Survey offices in Laguna Niguel, Calif., or Denver, Colo.

POROSITY, HYDRAULIC CONDUCTIVITY, AND THERMAL CONDUCTIVITY

As the drilling progressed, samples of the core were sealed in plastic tubes to retain their moisture content. These samples were transported to the Geothermal Studies Laboratory of the U.S. Geological Survey in Menlo Park, Calif., for thermal-conductivity testing. The results of these tests are included in the report by Sass, Lachenbruch, and Munroe (1974). Several intervals of core were selected for hydrologic testing, and samples were sent to the Hydrologic Testing Laboratory of the U.S. Geological Survey in Denver, Colo. When saturated core samples were not available, water was introduced into the dehydrated core samples before testing. Core samples containing visible quantities of clay were not used for resaturated testing. Laboratory determinations of specific gravity, porosity, carbonate content, hydraulic conductivity, and thermal conductivity are tabulated in table 2.

TABLE 2.--Summary of test results on cores from LVCH-1

Depth (feet)	Specific gravity of solids ($gm\text{-}cm^{-3}$)	Total porosity (percent)	Average CO_3 content (weight percent)	Hydraulic conductivity ($metres\text{-}day^{-1}$)	Thermal conductivity[1] ($mcal\text{-}cm^{-1}\text{-}sec^{-1}{}^{\circ}C^{-1}$)
a209	2.40	--	0.5	--	--
275	2.34	59.8	.7	6.88	--
392	2.40	35.0	0	5.3×10^{-1}	--
436	2.33	50.2	.05	5.9×10^{-2}	--
a466	2.18	--	--	--	--
475.7	--	--	--	--	1.79
480	2.33	63.1	--	3.8×10^{-1}	--
492	--	--	--	--	2.13
515	2.37	56.9	0	2.9×10^{-2}	--
522	--	--	--	--	1.91
545.5	--	--	--	--	2.04
553.5	--	--	--	--	1.62
563	2.60	39.6	0	4.6×10^{-7}	--
572	--	--	--	--	1.10
576	--	--	--	--	1.78
587	--	--	--	--	2.46
606	2.72	45.2	--	1.1×10^{-6}	--
612	--	--	--	--	1.87
625	--	--	--	--	1.85
685	2.37	62.4	--	1.9×10^{-6}	--
750	2.69	62.3	--	4.1×10^{-6}	--
817.5	--	--	--	--	1.69
822.5	--	--	--	--	2.37
823	2.67	52.1	--	8.7×10^{-7}	--
984.8	--	--	--	--	1.69
1,000	2.69	56.5	--	5.9×10^{-7}	--

[1]Data from Sass, Lachenbruch, and Munroe, 1974.
a. Sample disturbed.

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