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DEPARTMENT OF THE INTERIOR
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Federal Center, Denver, Colorado 80225

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(Amchitka-25)
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CALCULATED IN SITU ROCK DENSITY FROM GRAVITY OBSERVATIONS, UA-1 (CANNIKIN) EMPLACEMENT HOLE, AMCHITKA ISLAND, ALASKA

By

D. L. Healey

Abstract

Gravity observations were made on the ground surface and at a depth of 5,854 feet in drill hole UA-1. Two attempts to measure the free-air gradient utilizing the headframe over the drill hole were unsuccessful owing to mechanical vibrations in the structure. Because of the uncertainty in the measured free-air gradients these values were discarded and the average value (0.09406 mgal/ft) was used in the calculations. The calculated in situ bulk density is 2.36 g/cc. The weighted average bulk density determined from 47 core samples taken in the adjacent UAE-1 drill hole is also 2.36 g/cc. An analysis of selected portions of density logs provides an in situ bulk density of 2.37 g/cc.

Introduction

Drill hole UA-1 is located at Site C in the east-central part of Amchitka Island at coordinates N. 5,704,185.92; E. 646,321.59, Universal Transverse Mercator grid, Zone 60. Geographic coordinates are lat 51°28'68" N.; long 179°06'24.27" E. The ground surface elevation is 207.68 feet. The hole is cased to a depth of 6,104 feet with 54-inch steel casing. A chamber, to be centered at a depth of 5,875 feet, was partially mined when the gravity observations were made on November 19, 1970. The chamber observation was made at a depth of 5,854.33 feet. The geology of UA-1 and the adjacent UAE-1 hole have been described by Gard, Lee, and Way (1969), Lee and Morris (1969), and Lee (1969a, b).

The surface and chamber gravity observations were corrected for the effect of gravity-meter drift, earth tides, and drill-hole and chamber voids. The resulting measured interval gravity value was 203.51 mgal. This value together with the interval depth (5,854.33 ft), the compartment elevations for the Hammer terrain correction (Hammer, 1939), and the assumed average free-air gradient (0.09406 mgal/ft) (Heiskanen and Vening Meinesz, 1958, p. 148) were input for computer program Code Moria for the density calculation. The computer program was modified from one described by Hearst (1968). The operation of Code Moria has been described by Healey (1970, p. B54). Table 1 summarizes the UA-1 calculations.

The calculated in situ bulk density is 2.36 g/cc. In nearby UAE-1 drill hole, 47 core samples were taken between the surface and a depth of 5,854 feet. The weighted average saturated bulk density for these core samples is also 2.36 g/cc. In addition, a detailed study of the gamma-gamma density logs taken in UAE-1 was made by Bath, Miller, and Quinlivan (1971), and the results indicate an in situ bulk density of 2.37 g/cc. In his study, Bath discarded 40 percent of the density logs as being unusable owing to caving or other uncompensatable sidewall irregularities. Assuming that the discarded portions of the density log correspond to the less dense portions of the hole (the zones most likely to cave) Bath's results may be slightly high.

Two attempts were made to measure the free-air gradient at the UA-1 site by utilizing the headframe over the hole. Gravity observations were attempted at heights of 40.25 and 30.25 feet. At each height

Table 1.--Calculation of the in situ bulk density for rocks penetrated by emplacement hole UA-1, Amchitka Island, Alaska

Station	Relative gravity (mgal)	Terrain correction (mgal)	Interval depth (feet)	Interval gravity (mgal)	Interval terrain correction (mgal)	Vertical gradient (mgal)	Interval density (g/cc)
Surface	0	-0.3022	5,854.33	203.51	5.5892	0.0338	2.36
Chamber	203.51	5.2871					

mechanically induced vibrations constantly agitated the gravity meter, which precluded reliable readings. The two readings are thought to be in error by as much as 0.1 mgal. An error of this magnitude would change the measured free-air gradient by more than 3 percent and would change the calculated bulk density by more than 5 percent. If the doubtful free-air measurement is used in the computer program, the calculated value is 2.49 g/cc. This is 0.13 g/cc (5.24 percent) higher than the value of 2.36 g/cc that was obtained by using the average free-air gradient. This value (2.36 g/cc), supported as it is by the core and density log data, indicates that the average free-air gradient was applicable in this instance.

References

Bath, G. D., Miller, C. H., and Quinlivan, W. D., 1971, Interpretation of a gravity survey of Amchitka Island, Alaska: U.S. Geol. Survey Rept. USGS-474-93, 50 p.; available from U.S. Dept. Commerce, Nat. Tech. Inf. Service, Springfield, Va. 22151

Gard, L. M., Lee, W. H., and Way, R. J., 1969, Preliminary lithologic log of drill hole UAE-1 from 0 to 5,028 feet, Amchitka Island, Alaska: U.S. Geol. Survey Rept. USGS-474-46, 2 p.; available from U.S. Dept. Commerce, Nat. Tech. Inf. Service, Springfield, Va. 22151

Hammer, Sigmund, 1939, Terrain corrections for gravimeter stations: Geophysics, v. 4, no. 3, p. 184-194.

Healey, D. L., 1970, Calculated in situ bulk densities from subsurface gravity observations and density logs, Nevada Test Site and Hot Creek Valley, Nye County, Nevada, in Geological Survey Research 1970: U.S. Geol. Survey Prof. Paper 700-B, p. B52-B62.

Hearst, J. R., 1968, Terrain corrections for borehole gravimetry: Geophysics, v. 33, no. 2, p. 361-362.

Heiskanen, W. A., and Vening Meinesz, F. A., 1958, The earth and its gravity field: New York, McGraw-Hill Book Company, Inc., 470 p.

Lee, W. H., 1969a, Some physical properties of rocks in drill hole UAe-1, Amchitka Island, Alaska: U.S. Geol. Survey Rept. USGS-474-48, 13 p.; available from U.S. Dept. Commerce, Nat. Tech. Inf. Service, Springfield, Va. 22151

Lee, W. H., 1969b, Lithologic log of emplacement drill hole UA-1 from 5,000 to 6,500 feet, Amchitka Island, Alaska: U.S. Geol. Survey Rept. USGS-474-4, 4 p.; available from U.S. Dept. Commerce, Nat. Tech. Inf. Service, Springfield, Va. 22151

Lee, W. H., and Morris, R. H., 1969, Preliminary lithologic log of drill hole UAe-1 from 5,000 to 7,000 feet, Amchitka Island, Alaska: U.S. Geol. Survey Rept. USGS-474-47, 3 p.; available from U.S. Dept. Commerce, Nat. Tech. Inf. Service, Springfield, Va. 22151

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