

A Gravity Survey of the Island of Niihau, Hawaii¹

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ABSTRACT: Gravity data collected on Niihau support geologic evidence that the island is an erosional remnant of a dead shield volcano whose center of volcanism was just east of the present Niihau highlands. Bathymetric and gravity evidence offer clues to a genetic link between Niihau and west Kauai; onshore gravity suggests a continuous Bouguer high connecting the two regions. This link would be in accord with ocean-bottom topography, which shows a prominent ridge rising above sea level at Niihau and at Kaula Rock to the west.

A GRAVITY SURVEY of the island of Niihau, Hawaii, was made December 10–12, 1963. It is a pleasure to acknowledge the logistic support, the check of place names, and the hospitality of Aylmer Robinson, Manager, Niihau Ranch. Without his interest this work would not have been possible. I am indebted also to Niihau residents Melvin Pahulehua, Gilbert Pahulehua, Jr., Jacob Kanahale, and Keoki Keamoai, who helped me reach the station sites on Niihau.

Stations were selected by use of the existing 1929 U. S. Geological Survey topographic sheet to determine their elevations. Because of the somewhat generalized character of this map, elevations at many stations may be in error by as much as 20 ft. Such an error in elevation would lead to an error of about 1.4 mgal in the Bouguer anomaly, if we assume a density of 2.3 g/cm³ for island rocks down to sea level. This basic uncertainty of exact elevation made it superfluous to consider other, much smaller, variables. Thus, I did not make corrections for tidal gravity changes or for meter drift. The latter correction, however, would have been especially small because of the accuracy of the LaCoste and Romberg low-drift portable gravity meter used in this survey. The table of principal facts is reported elsewhere (Hawaii Inst. Geoph., 1965, Table 8).

Despite its rather small land area Niihau exhibits a large positive Bouguer anomaly similar to those anomalies found on other Hawaiian

volcanoes. A linear high, outlined by the 280-mgal contour, crosses Niihau in a direction N 70° E (Fig. 1) approximately parallel to the submarine ridge which joins Niihau, Kauai, and Kaula (Stearns, 1947: Fig. 3). A 280-mgal high also enters Kauai (Krivovy et al. p. 354 in this issue) from the direction of Niihau, but no gravity data are available over the submarine ridge between Kauai and Niihau.

Geologic mapping indicates that Niihau is a remnant of an ancient volcanic shield which had its center offshore east of the highlands (Stearns, 1947; Macdonald, 1947). The gravity map (Fig. 1) supports this interpretation. Comparison of the gravity field of Niihau with the fields of other, less dissected Hawaiian volcanoes (Kinoshita et al., 1963) suggests that the original volcanic center of the Niihau volcano is close to its eastern shore. Kilauea and Mauna Loa have their centers of volcanism within 10 miles of the 280-mgal contour on their flanks or rifts. An offshore gravity survey between Kauai and Niihau would be of interest because it might delineate the central portion of the original Niihau volcano and clarify the relation between Niihau and west Kauai.

The N 70° E trend of the Kaula-Niihau-west Kauai ridge (Stearns, 1946: Pl. 1) is perpendicular to the northwest trend of the main Hawaiian ridge. Recent bathymetric surveys (U. S. Navy Hydrographic Office, 1961) have detailed a system of topographic lineaments which give the appearance of having been parted by the growing Hawaiian ridge. These lineaments trend N 70° E to N 80° E, about parallel to the Kaula-Niihau-west Kauai ridge.

¹ Publication authorized by the Director, U. S. Geological Survey.

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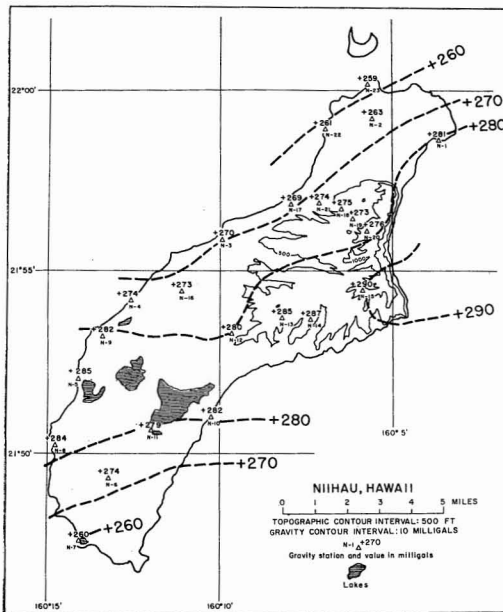


FIG. 1. Bouguer anomaly map of the island of Niihau, Hawaii.

West of the Hawaiian ridge it is possible that these lineaments have been covered by sediments; magnetic anomalies (U. S. Navy Oceanographic Office, 1962) suggest that they do exist, as geophysical expressions if not topographic ones.

Bathymetric data, as well as geomagnetic data from sea-borne surveys demonstrate a remarkable linear pattern of folding or faulting which seems to be a fundamental characteristic of the floor of the Pacific Ocean. This pattern is clear in the northeastern Pacific, but is confused elsewhere by the growth of volcanic chains. In the area of the Hawaiian Islands a

line of growing volcanoes is covering the pre-existing ocean floor with its eroded and extruded products. The Kaula-Niihau-west Kauai volcanic group, although associated structurally, chemically, and generically with the younger volcanoes to the southeast, seems—by virtue of its strike—to be controlled by the confluence of recent tectonism with earlier structure.

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