Ocean Floor Structures Northeastern Rat Islands Alaska

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INVESTIGATIONS OF ALASKAN VOLCANOES

GEOLOGICAL SURVEY BULLETIN 1028-G

Prepared in cooperation with the Departments of the Army, Navy, and Air Force

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1957

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 55 cents (paper cover)

PREFACE

The U. S. Geological Survey, in response to the October 1945 request of the War Department (now Department of the Army), made a reconnaissance during 1946–54 of volcanic activity in the Aleutian Islands-Alaska Peninsula area. Results of the first year's research, field, and laboratory work were hastily assembled as two administrative reports to the War Department. Some of the early findings, as recorded by Robert R. Coats, were published in Bulletin 974–B (1950), Volcanic activity in the Aleutian arc, and in Bulletin 989–A (1951), Geology of Buldir Island, Aleutian Islands, Alaska.

Unpublished results of the early work and all data gathered in later studies are being published as separate chapters of Bulletin 1028.

The investigations of 1946 were financed principally by the Military Intelligence Division of the Office, Chief of Engineers, U. S. Army. From 1947 until 1955 the Departments of the Army, Navy, and Air Force jointly furnished financial and logistic assistance.

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ABSTRACT

Configuration of the ocean floor near the northeastern Rat Islands, presented here by depth contours at 100-foot intervals, reveals many volcanic, sedimentary, and tectonic structures, and erosional features. The most striking submarine feature is a 35-mile long scarp between Little Sitkin and Semisopochnoi Islands which can be traced into a subaerial caldera fault system on Little Sitkin Island.

INTRODUCTION

The northeastern Rat Islands are in the Aleutian chain immediately west of the 180th meridian (fig. 37). Six large islands, Segula, Khvostof, Davidof, Little Sitkin, Semisopochnoi, and Rat, and five small islands, Pyramid, Lopy, Tanadak, McArthur Reef and Sea Lion Rock, are within the area studied. Prewar native fox trappers and wartime military sentries were the last temporary inhabitants of the northeastern Rat Islands and, today, the nearest permanent human habitations are more than 200 miles away on the Near and Andreanof Islands.

During preparation of the Little Sitkin Island geologic map (Snyder, in preparation) it was observed that a prominent scarp on the ocean floor is correlative with several branches of a subaerial caldera fault. This scarp was traced further in the submarine topography. All submarine topography of the northeastern Rat Islands was then compiled on one map (pl. 22); the description and interpretation of this map is the substance of this report.

The data upon which plate 22 is based were taken from published topographic maps of the Corps of Engineers, from one topographic manuscript, and from 18 smooth sheets (sounding charts) of the Coast and Geodetic Survey. The original scales of the maps and smooth sheets ranged from 1:20,000 to 1:100,000. A key to density of the sounding data (number of soundings per unit area) is provided by figure 38.

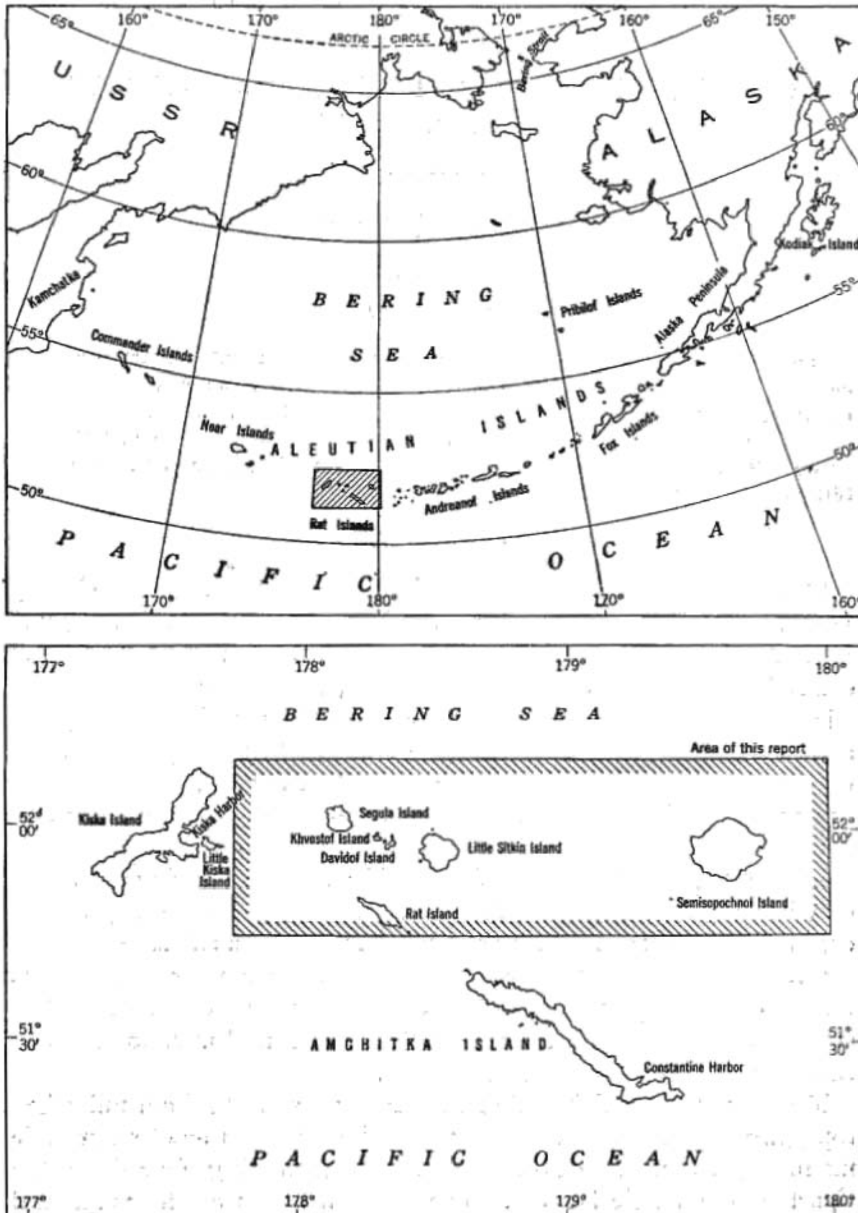

FIGURE 37.—Index map of the Aleutian Islands, including the Rat Islands, and land bordering the Bering Sea; index map of the Rat Islands showing areas mapped on plate 22 and figure 38.

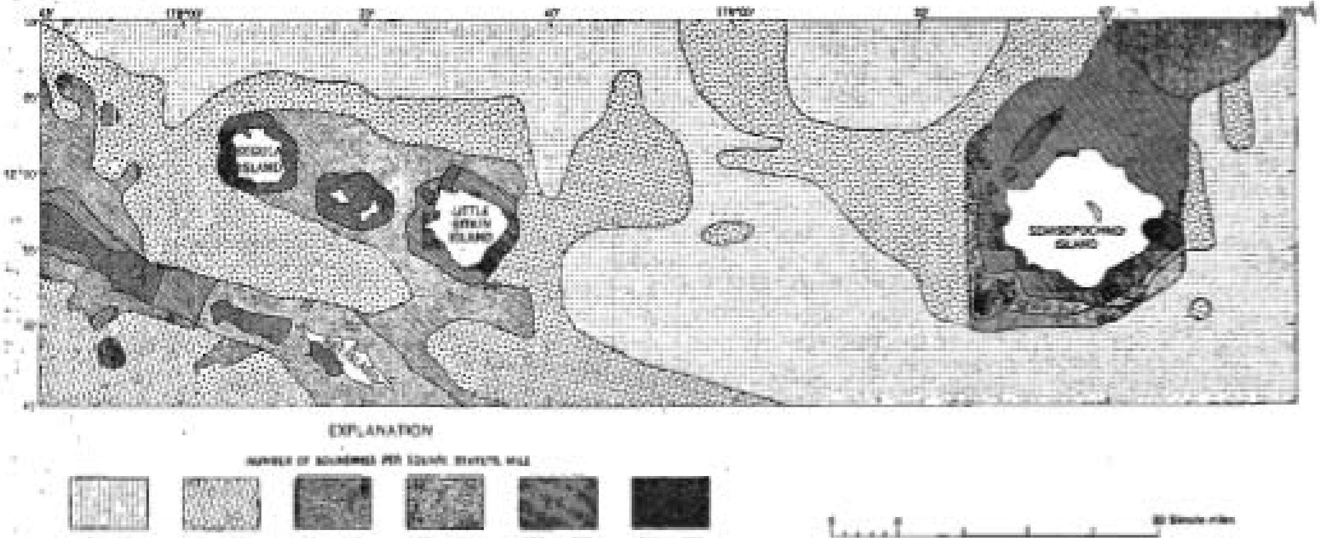

FIGURE 38.—Sounding-density control for submarine topography shown on plate 22.

CLASSIFICATION OF SUBMARINE TOPOGRAPHY

Unlike some other volcanic structures fringing the Pacific Ocean, those of the Aleutian Islands are hidden beneath the sea. Structural inferences, however, may be drawn from the configuration of the sea floor. An excellent small-scale map (approximately 1:440,000) of the entire Rat Island Group (Gibson and Nichols, 1953, pl. 1) and available seismic data proved the existence of numerous fault traces on the sea floor of the greater Rat Island area. Several of these faults have been plotted on a smaller scale map (approximately 1:3,960,000) by Gates and Gibson (1956, fig. 12).

This report is an interpretation of a map (pl. 22) of the submarine topography of a small area in the northeastern Rat Islands that shows several features overlooked by Gibson and Nichols. Topographic features shown on plate 22 are classified as:

1. Linear troughs and scarps.
2. Meandering or linear canyons.
3. Large, subconical hills.
4. Broad, gently rounded banks.
5. Broad, flat plains.
6. Small, elongate or irregular hills.
7. Irregularly fluted ridge crests.

Linear troughs and scarps.—A prominent topographic feature shown on plate 22 is an east-west scarp, here named the Prokhoda scarp, which extends 35 statute miles eastward from Prokhoda Point (51°54′ N., 178°31′ E.) on Little Sitkin Island to Semisopochnoi Island. The faults which branch from the southern part of the Caldera no. 2 fault on Little Sitkin Island trend toward the Prokhoda scarp (Snyder, in preparation).

The Prokhoda scarp faces on the north an enormous flat-floored depression, here named the Pratt depression, and is backed by a curvilinear parallel ridge. The maximum relief is more than 1,250 feet. The average slope of the scarp in the steeper central part is about 15°. The ridge and scarp are broken in the center into two segments so that the west half was apparently displaced a half mile south. Displacement was probably along a tear fault that trends about N. 20° E. This is the only place where the submarine contours seem to express horizontal displacement. Elongate depressions or scarps at several places on the south side of the ridge suggest parallel faults downthrown on the south. The medial ridge appears to be a horst about 1½ miles wide. The surface of the block south of the horst slopes gently south toward the Oglala trough and this block has been downdropped to a lesser extent than the block forming the Pratt depression. The extremities of the Prokhoda scarp disappear in shallow water, but on the western end there appears to be a landward extension.

A scarp similar to the Prokhoda scarp extends from a depression shown in the northwest corner of the map, here named the Haycock depression, to Oglala Trough southeast of Little Sitkin Island. Kiska Volcano is alined with this scarp. Off the East Cape of Amchitka maximum relief of the scarp is more than 4,650 feet, but in the area shown on figure 38 the relief is only 2,000 feet. Dissection of this scarp east of Rat Island suggests that it is older than the Prokhoda scarp.

Many other small troughs and ridges revealed by the submarine contours trend parallel to the Aleutian Crest. West of Little Sitkin Island the volcanic centers are alined about N. 65°–80° W. A possible fault in line with this trend is estimated by Gates and Gibson (1956, figs. 12 and 13) to dip about 60° north. A scarp that trends N. 65° W. off Finger Point is alined with fumarolic centers on Little Sitkin Island (Snyder, in preparation).

A fissure trending N. 20° W. bisects Segula Island, but is not expressed in the submarine topography (Nelson, in preparation). A scarp that begins at the western end of Oglala Trough, trending N. 13° W., apparently represents a fault that curves through Little Sitkin Pass into the upper reaches of Sitkin Canyon and down another canyon on the north slope which trends N. 14° E. Another long, curving structure that begins with a south-facing scarp that trends N. 65° W. north of Gunners Cove, Rat Island, and continues eastward along the north edge of Oglala Trough is represented southeast of Little Sitkin Island by a curving (N. 70° E. to N. 50° E.) string of five closed depressions and other topographic irregularities which may represent a fault dipping steeply under Little Sitkin Island. Other, smaller faults of diverse orientation probably exist in the complicated topography north of Oglala Trough.

Most of the submarine ridges and troughs around Semisopochnoi Island radiate from the island. Ashore, numerous volcanic vents are grouped along strong zones of crustal weakness that trend almost perpendicular to Petrel Bank to the northeast (Coats, R. R., written communication). A bank northwest of Semisopochnoi Island, here named Tuman Bank (52°03′ N., 179°33′ E.), is bounded on the northeast by a series of structural lineaments trending about N. 30° E.; the northwest margin is marked by a series of troughs and ridges trending N. 10° E. which resemble hogbacks with the steep slope facing east and the gentle slope facing west.

Meandering or linear canyons.—Canyons such as Segula Canyon, Oglala Trough, Sitkin Canyon, the small canyons on the scarp east of Rat Island, and those radiating from the southern flank of Semisopochnoi probably have a complex origin. There are many suggestions of structural control, which have already been cited, but there are also suggestions of submarine erosion, probably by turbidity currents. Although Sitkin Canyon lacks large branches suggestive of tributaries (Gibson and Nichols, 1953, p. 1183), its resemblance to an erosional canyon is quite striking. Slip-off slopes and undercut banks are expressed well by the contours. Here and elsewhere in the area the flat floors and unbroken longitudinal profiles suggest the channeling of sediment-laden submarine currents. Probably fault scarps or fault zones in many of the canyons control the course of submarine "drainage" in a manner similar to that of their subaerial counterparts.

Large, subconical hills.—Large subconical mounds from several hundred to several thousand feet high probably represent composite cones built by volcanic extrusions. Kay Sea Cone, Williams Crater, McArthur Reef, the two cones in Segula Canyon (51°57′ N., 178°07′ E., and 52°00′ N., 177°55′ E.), and cones southeast of Semisopochnoi (51°51′ N., 179°50′ E.; 51°48′ N., 179°46′ E.; and 51°50′ N., 179°40′ E.) are examples of smaller piles. The low mound south of Khvostof Island (51°56′ N., 178°17′ E.) may also be a small truncated cone (Nelson, in preparation). The platform-type structures supporting Segula, Davidof, Khvostof, Little Sitkin, Kiska to the west of the area, and Semispochnoi, are examples of larger piles.

Broad, gently rounded banks.—Two large banks shown on plate 22 are the Aleutian Crest and Petrel Bank. The Aleutian Crest is a long, broad ridge extending from Rat Island to Tanadak Island and beyond. Petrel Bank is part of Bowers Bank which is a long curving shallow platform that extends northeastward from Semisopochnoi Island; it was charted first by the Coast Guard cutter Chelan in 1935 (Hutchins, 1937, p. 543). These banks are regarded as "tectonic constructions"—that is, crustal blocks which were lifted to their present positions by tectonic forces. This belief is based on the presence of submarine lavas and tuffs on Rat Island, and on Amchitka Island to the south of this area, above 1,000 feet altitude (Powers, H. A., written communication, and Gates and Gibson, 1956, p. 132).

Broad, flat plains.—The flat floors of canyons or basins shown on figure 38, Segula Canyon, Sitkin Canyon, Oglala Trough, Pochnoi Sea Valley, Pratt depression and the basin beneath Little Sitkin Pass, probably are the result of sedimentary fill. The mechanism of transportation and deposition of this fill could be that of turbidity currents carrying material supplied partly by erosion and partly by volcanic eruption. The large, nearly flat area in the sector northeast of Kay Sea Cone contains five small conical hills, each paired with a neighboring depression probably created by compaction of bottom muds by the weight of the nearby volcanic pile.

Small, elongate or irregular hills.—The elongate hills shown on figure 38, such as the hills between Williams Crater and Kay Sea Cone, are believed to be lava flows or shallow laccoliths that bowed up small amounts of overlying mud. (A few may be asymmetric cones.) The irregular topography southeast of Little Sitkin probably is due partly to submarine lava flows. The elongate hills are from 1 to 2 miles long and a maximum of 500 feet high. Igneous bodies of similar dimensions are found in sea-cliff exposures along the southern coast of Unalaska Island. Because these bodies, which are associated with pillow lavas, are intrusions in argillaceous rocks, it is believed that they were originally injected into unconsolidated bottom muds. On Unalaska these sills or laccoliths have demonstrably bowed up the overlying strata. It is possible that originally they resembled the mounds shown on figure 38. The elongate hills are found in areas susceptible to fissuring, such as southeast of Little Sitkin Island, and north of Kay Sea Cone along the east-west zone which is the hinge line of the downdropped Pratt depression block.

Irregularly fluted ridge crests.—Complex fluted topography is characteristic of the inshore areas of all islands and also is found on the summits of the Aleutian Crest, Tuman Bank, and Petrel Bank. This complex topography probably was formed by submarine erosional forces such as waves and powerful tidal currents, or by subaerial erosional forces during times of lowered sea level at glacial maxima. Because a greater number of soundings per unit area was taken here than in the offshore areas it cannot be stated definitely, as yet, to what extent the submarine inshore topography is more complex than that of the offshore areas.

LITERATURE CITED

Gates, Olcott, and Gibson, William, 1956, Interpretation of the configuration of the Aleutian Ridge: Geol. Soc. America Bull., v. 67, figs. 12, 13, p. 132.

Gibson, W. M., and Nichols, Haven, 1953, Configuration of the Aleutian Ridge—Rat Islands-Semisopochnoi Island to west of Buldir Island: Geol. Soc. America Bull., v. 64, pp. 1173–1188, pls. 1, 2.

Hutchins. I. W., 1937, Discovery of a new reef near Attu Island: Geog. Jour. (London), v. 90, p. 543.

Nelson, W. H., in preparation, Geology of Segula, Davidof and Khvostof Islands, Alaska: U. S. Geol. Survey Bull. 1028.

Snyder, G. L., in preparation, Geology of Little Sitkin Island, Alaska: U. S. Geol. Survey Bull. 1028.

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