



GEOLOGIC MAP OF THE MAKUSHIN VOLCANIC FIELD, UNALASKA ISLAND, ALASKA

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DISCUSSION

This map covers most of the north and east of Unalaska Island, which is the extent of the Quaternary Makushin volcanic field (MVF). The map expands upon previous geologic mapping, in particular the early regional mapping of Unalaska Island by the U.S. Geological Survey (Drewes and others, 1961) and the detailed mapping of the geothermal areas conducted by the Alaska Division of Geological & Geophysical Surveys (Nye and others, 1984) (see Correlation Index). This study emphasizes the Holocene-Pleistocene eruptive history of Makushin Volcano and its satellite vents. Stratigraphic nomenclature of Drewes and others (1961) for the Tertiary Unalaska Formation is retained but modified to conform with the nomenclature of Nye and others (1984). We have used many informal names to help describe and locate the volcanic rock deposits associated with the Makushin volcanic field.

Unalaska Island forms an elongated land mass roughly parallel to the Alutian Arc trend. Backrock consists of altered andesitic intrusions and extrusive rocks, and volcanoclastic sedimentary rocks (Drewes and others, 1961) of the Unalaska Formation (map units Tu, Tm, and Tc). Vertebrate fossils found near the town of Unalaska have been identified as *Desmarestia*, a distinct relative of the modern sea cow, which places the formation as being younger than the Holocene (Nye and others, 1984; R. G. Goff, pers. comm., 1997). Plant fossils in the upper Nalekin Valley of a species of *manisuris* (Nye and others, 1984) suggest that the Unalaska Formation may be a young as the Holocene (Nye and others, 1984). No lithologic difference is evident between the older and younger parts of the Unalaska Formation, and the Quaternary volcanic rocks are not clearly distinguished from the older rocks. The age of the Unalaska Formation is highly uncertain because of the occurrence of boulder bed deposits that contain lithic fragments of a Pliocene-age gabbroic stock (Qp) (Nye and others, 1986). Of the several granulitic batholiths (G) mapped by Drewes and others (1961) on the island, only Captain's Bay pluton appears within the area covered by this map. The age of this pluton is thought to be middle Miocene according to K-Ar age determinations (Langford and Hill, 1979). Other intrusive outcrops designated as Qm occur near the Makushin volcanic field and are of a gabbroic stock (Nye and others, 1984) which, in several areas, is highly altered by present-day hydrothermal activity. K-Ar ages determined from detrital amphibole and biotite in veins in the gabbroic stock, as well as from amphibole from contact breccias suggest that the gabbroic stock may be much younger than the Captain's Bay pluton—perhaps as young as a few Ma (Quinn, 1989). A hypabyssal texture to the formation indicates a more shallow emplacement depth than the older plutons (Nye and others, 1986) and may suggest it is related to the Quaternary volcanic activity. Numerous dikes and sills of basalt, andesite, and dioritic composition (Qd) intrude into the Unalaska Formation and the Quaternary volcanic rocks.

Nye and others (1986) noted an unconformity exists between Tertiary volcanic activity recorded in the Unalaska Formation and the Quaternary volcanic rocks restricted to the north end of the island. In the field, Makushin lavas can be differentiated from older volcanic deposits by their lack of tectonically-induced foliation. Although most radiometric age determinations are less than 1 Ma for lavas associated with the Makushin volcanic field (Nye and others, 1984; this study), a small number of basaltic lavas from western Driftwood Valley yielded ⁴⁰Ar/³⁹Ar ages of 2.49–0.68 Ma (table 2). It is possible initiation of volcanic activity associated with the Makushin volcanic field began as early as the Pliocene. The volcanic field is dominated by the 0.01-Ma-old Makushin Volcano (Makushin Volcano) and contains a series of satellite vents trending northeast to southwest, south and east of Makushin Volcano, a northwest-trending flank fissure on the north side of Makushin Volcano, and a series of cinder cones, spatter cones, and mounds and several flows scattered across the northern part of Unalaska Island. Thick deposits of basalt and andesite flows, debris avalanches, lahars, and pyroclastic flows from Makushin Volcano were produced by explosive, relatively small volume eruptions characteristic of polygenetic stratovolcanoes (Nye and others, 1984). The bulk of the older Makushin lavas were most likely erupted from the summit area of the volcano. Stratovolcanoes were made of fossil vents from resistant gabbro along the northwest and west ends of the island. Wind and southwest of Makushin Volcano, large stratovolcanoes of older Makushin deposits form a broad shield of ribbon lavas of approximately 540 km indicating a major ancestral cone was located near the modern volcano (Nye and others, 1984). Deposits of high-velocity older Makushin lavas in the eastern part of the map may have been erupted from ancestral cones in that area. One fossil vent was recognized between Table Top Mountain and Wide Bay Cone. The Makushin Volcano (Qm) and the younger Lava Valley flow (Qm2) occur along the southern flank of modern Makushin Volcano. Flows of older Makushin lavas on the north side of the island form a rugged coastline along Korgin Point (Qm) and the Makushin Volcano (Qm) and the younger Lava Valley flow (Qm2) (table 2). A similar age (49 ± 6 ka) was determined for a poorly exposed lava flow (Qm) situated between Upper Bishop Point Valley and Korgin Point (Qm).

Holocene lavas from Makushin Volcano partially fill Pleistocene glacial valleys and are represented on the map as Lava Valley flows (Qm1 and Qm2), and Bishop Point flow (Qm3). These units have a wide range in composition from basalt to trachyte (figure 1). Note the wide variation in composition from adjacent flows such as the older Lava Valley flow (Qm1) and the younger Lava Valley flow (Qm2) (figure 1 and 2). The Makushin cinder cones (Qm) consist of olivine and andesite interbedded plagioclase (An₅₀) and olivine (F₅₀) crystals up to 10 cm in diameter. The Makushin cinder cones (Qm) are similar to the cinder cones of the Makushin Volcano that is a typical shield volcano. The Makushin cinder cones are similar to the cinder cones of the Makushin Volcano that is a typical shield volcano. The Makushin cinder cones are similar to the cinder cones of the Makushin Volcano that is a typical shield volcano.

The satellite vents produced high-volume, individually homogeneous deposits characteristic of monogenetic eruptions. Individual vents are differentiated by location, petrology, and stratigraphy and occur along a zone parallel to the Alutian Arc trend. None showed evidence of activity into historic times and similar eruptions have occurred elsewhere, most notably at Korgin Point (Qm) and the Makushin Volcano (Qm). The satellite vents were analyzed for ⁴⁰Ar/³⁹Ar ages. Only the dates from Table Top Mountain and Pakushin Cone are statistically different from zero with ages of 11.7 ± 0.4 Ma and 11.7 ± 0.4 Ma, respectively. The satellite vents were analyzed for ⁴⁰Ar/³⁹Ar ages. Only the dates from Table Top Mountain and Pakushin Cone are statistically different from zero with ages of 11.7 ± 0.4 Ma and 11.7 ± 0.4 Ma, respectively.

The vent far the Lava Ramp flows (Qm) is almost certainly located somewhere on the upper Makushin Volcano flank, possibly from the summit area. Approximately 8 to 10 Ma (Nye and others, 1984) the Makushin Volcano was a shield volcano oriented eastward down valley before turning north to fit Driftwood Valley. The lack of well-developed, or even a few, debris avalanches, lahars, and pyroclastic flows from Makushin Volcano were produced by explosive, relatively small volume eruptions characteristic of polygenetic stratovolcanoes (Nye and others, 1984). The bulk of the older Makushin lavas were most likely erupted from the summit area of the volcano. Stratovolcanoes were made of fossil vents from resistant gabbro along the northwest and west ends of the island. Wind and southwest of Makushin Volcano, large stratovolcanoes of older Makushin deposits form a broad shield of ribbon lavas of approximately 540 km indicating a major ancestral cone was located near the modern volcano (Nye and others, 1984). Deposits of high-velocity older Makushin lavas in the eastern part of the map may have been erupted from ancestral cones in that area. One fossil vent was recognized between Table Top Mountain and Wide Bay Cone. The Makushin Volcano (Qm) and the younger Lava Valley flow (Qm2) occur along the southern flank of modern Makushin Volcano. Flows of older Makushin lavas on the north side of the island form a rugged coastline along Korgin Point (Qm) and the Makushin Volcano (Qm) and the younger Lava Valley flow (Qm2) (table 2). A similar age (49 ± 6 ka) was determined for a poorly exposed lava flow (Qm) situated between Upper Bishop Point Valley and Korgin Point (Qm).

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