Geologic Reconnaissance of Kiska Island Aleutian Islands, Alaska

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INVESTIGATIONS OF ALASKAN VOLCANOES

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PREFACE

In October 1945 the War Department (now Department of the Army) requested the Geological Survey to undertake a program of volcano investigations in the Aleutian Islands-Alaska Peninsula area. The first field studies, under general direction of G. D. Robinson, were begun as soon as weather permitted in the spring of 1946. The results of the first year's field, laboratory, and library work were assembled as two administrative reports. Part of the data was published in 1950 in Geological Survey Bulletin 974–B, "Volcanic Activity in the Aleutian Arc," by Robert R. Coats. The remainder of the data has been revised for publication in Bulletin 1028.

The investigations of 1946 were supported almost entirely by the Military Intelligence Division of the Office, Chief of Engineers, U.S. Army. The Geological Survey is indebted to the Office, Chief of Engineers, for its early recognition of the value of geologic studies in the Aleutian region, which made this report possible, and for its continuing support.

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GEOLOGIC RECONNAISSANCE OF KISKA ISLAND, ALEUTIAN ISLANDS, ALASKA

By Robert R. Coats, Willis H. Nelson, Richard Q. Lewis, and Howard A. Powers

ABSTRACT

Kiska Island, in the Rat Island group of the Aleutian Islands, is composed of two major geologic elements. The south half of the island is part of a submarine ridge, and the north half is a volcano. Kiska Volcano is a young composite andesitic volcano. It is underlain and flanked on the south by the Kiska Harbor formation, which represents remnants of an older composite volcano. The Kiska Harbor formation is unconformable with the Vega Bay formation to the south. The Vega Bay formation is a mass of deformed submarine volcanic rocks.

Both Kiska Volcano and the Kiska Harbor formation are composed of interbedded andesitic to basaltic pyroclastic rocks, lava flows, and sedimentary rocks formed of volcanic debris. The rocks of the Vega Bay formation are older and more deformed than the other rocks of the island; they are composed of moderately well indurated pyroclastic rocks and substantial amounts of dark submarine basalt flows and minor amounts of sandstone and conglomerate formed of volcanic debris.

The island was sculptured first by marine and fluvial erosion, and the southern part of the island was later modified by glaciation. The northern part of the island shows no signs of glaciation. The island is thinly veneered by volcanic ash derived largely from volcanoes on nearby islands.

INTRODUCTION

Kiska Island and its neighbor Little Kiska are the westernmost islands in the Rat Island group of the Aleutian Islands. Kiska has an area of 110 square miles, and Little Kiska has an area of 3 square miles. Kiska Island was one of the islands sighted by Bering on his voyage of discovery in 1741. At the time of its discovery it had a substantial Aleut population which thereafter rapidly declined and disappeared during the 19th century. During the latter part of the 19th century natives of Atka, with their families, were brought to Kiska each year to hunt sea otters. With the decline in numbers of sea otters and subsequent restrictions placed on hunting them, the annual visits continued, on a smaller scale, for fox trapping.

Kiska Harbor is one of the few good harbors in the Aleutians. A detailed survey of the harbor was made in 1904, but was never published. Additional surveys were made in 1934 and 1935 after which Kiska was closed to the public.

Kiska was occupied in 1942 by Japanese armed forces, and later in 1943 by American and Canadian armed forces. Since 1947 the island has been uninhabited.

This report is based on reconnaissance mapping by two parties of U.S. Geological Survey personnel. In 1947 Robert R. Coats, geologist, and Will F. Thompson, Jr., field assistant, were on Kiska for about 3 weeks; and during 1951 a party of 6 geologists, Dennis P. Cox, Joseph P. Dobell, Richard Q. Lewis, Willis H. Nelson, Howard A. Powers, and Edward C. Stover, Jr., spent about 3 weeks on the islands. During 1947, transportation was provided by the U.S. Coast and Geodetic Survey and by the U.S. Army. The help of the officers and men of these services is gratefully acknowledged. During 1951 transportation was by the U.S. Geological Survey's motorship *Eider* operated under the direction of Capt. Carl Vevelstad.

The parts of this report dealing with areal geology are the joint responsibility of all the authors; the interpretations of submarine topography have been made by Powers from detailed boat sheets, kindly furnished by the U.S. Coast and Geodetic Survey.

REGIONAL SETTING OF KISKA ISLAND

Kiska Island rises from the Aleutian Ridge in an area where the ridge appears to consist of two major linear elements (fig. 80). The larger and older element is the line of three approximately rectangular segments, partly separated from each other by the Heck and the Murray Seavalleys. The western segment is represented above sea level by the Near Islands; the eastern segment, by the southern part of Kiska, Little Kiska, Rat, and Amchitka Islands; the middle segment is entirely submerged. The rocks of these islands (and, by inference, of these segments of the Aleutian Ridge) are mostly older than late Tertiary, and the landforms of the islands were produced by faulting and erosion (Gates, Fraser, and Snyder, 1954; Gates and Gibson, 1956; Coats, 1956; Powers, Coats, and Nelson, 1960). The smaller and younger linear element is a line of active or dormant volcanoes—Buldir, Kiska, Segula, Khvostof, Davidof, Little Sitkin, and Semisopochnoi—the Buldir Depression with its associated seamounts, and numerous other submarine features between Kiska and Semisopochnoi Islands that are inferred to be of volcanic origin (Coats, 1953, 1956, 1959; Nelson, 1959; Snyder, 1957, 1959). Some parts of the composite volcanoes of this linear element are of Recent

A. SOUTHERN PART OF KISKA ISLAND

View is southwest from above center of island. Note steep west slope (right) fronting the submarine Murray Seavalley and gentle east slope (left center) fronting Vega Bay. Photograph by U.S. Navy.

B. KISKA VOLCANO AND PART OF PLATEAU REGION

View is north from Kiska Harbor (foreground). Photograph by U.S. Navy.

A. VOLCANIC BOMB

Bomb has weathered out of the Vega Bay formation about one-half mile northeast of Dark Cove.

B. BRECCIA IN KISKA HARBOR FORMATION

Block is from the cliffs at North Head on the north side of Kiska Harbor. Shows poor sorting and lack of bedding.

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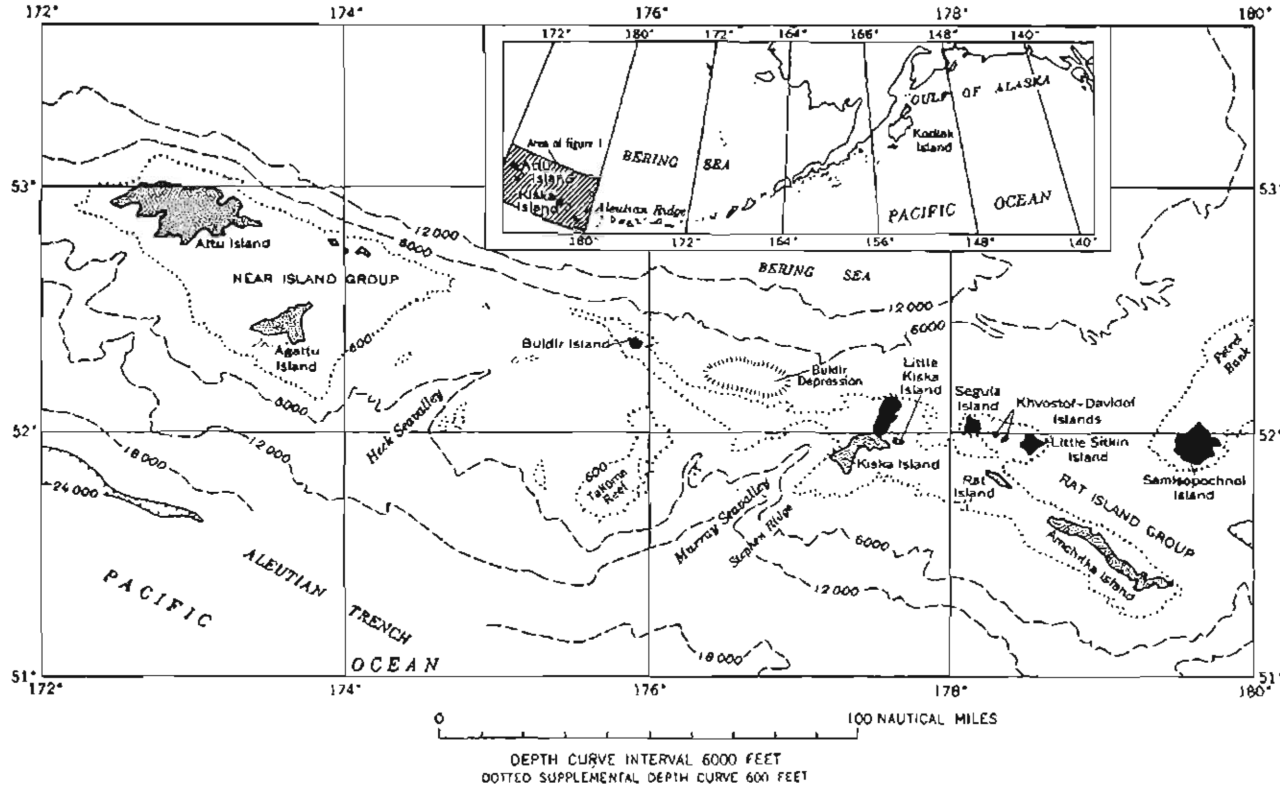

FIGURE 80.—Location of the Aleutian Islands and Kiska Island on the western Aleutian Ridge. Stippled pattern shows islands on the southern linear element of the ridge; solid pattern shows active and dormant volcanoes on the northern linear element.

age; the oldest parts are believed to be no older than late Tertiary because the degree of destruction of their volcanic forms by erosion is similar to that of the Kanaton volcanic rocks on Kanaga Island that contain marine fossils of Pliocene age (Fraser and Barnett, 1959).

Kiska Island includes parts of both these major linear elements; the north half of the island has topographic and geologic features characteristic of the younger northern linear element, and Little Kiska and the south half of Kiska have characteristics similar to the islands of the older southern linear element.

LOCAL TOPOGRAPHY

SUBMARINE TOPOGRAPHY

The general aspect of the submarine topography near the shore of the southern half of Kiska Island differs from that near the north half.

Along the south and southeast coast there is a broad and fairly continuous bench between 300 and 350 feet in depth on which a number of knobs are indicated by closed 300-foot-depth contour lines. Closer inshore, the shape of the 100- and 200-foot-depth contours suggests ridge and valley topography. Along the west coast of southern Kiska, adjacent to Murray Seavalley, there is no broad bench at depths of 300 feet, and the suggestion of ridge and valley topography is expressed only by the 100-foot-depth contour.

Offshore to the east and the west of the north half of the island, the submarine topography is characterized by seamounts with relief of several hundred feet, both circular and irregular in shape, and by closed depressions with irregular, angular shapes and depths of as much as several hundred feet below their rims. North of the cone of Kiska Volcano, the submarine slope below a depth of 200 feet appears to be a continuation of the subaerial slope of the cone.

SHORELINE AND RAISED MARINE EROSIONAL FEATURES

The sea cliffs around Little Kiska and Kiska, except those around Kiska Volcano, are mostly not subjected to marine erosion at the present time. Colluvium, talus, or beach deposits, all covered with well-established vegetation, lies at the base of the sea cliffs out of reach of present storm waves. The turf-covered beach deposits are behind and several feet above the modern storm beach deposits, and they commonly are the site of early Aleut dwellings and kitchen midden. Similar shore features are described from other Aleutian islands (Byers, 1959; Powers, Coats, and Nelson, 1960) and have been interpreted as the result of a prehistoric lowering of sea level by a few feet.

The coastline of Kiska Volcano, in contrast, is continuous cliff that ranges in height from a few tens of feet to over 1,500 feet, most of which is being subjected to present marine erosion. In a few places massive rock faces extend below sea level, but at the base of much of the cliff is talus and boulder beach material that is being worked by storm waves.

A few terraces at altitudes up to 220 feet appear to have been formed by marine erosion. The terrace inland from Vega Point at an altitude of 140–160 feet truncates both bedded clastic rock that has an apparent dip of as much as 20° SE., and lava (in Vega Point) that is jointed in vertical columns. The terrace is almost undissected. A bench on both sides of Dark Cove at an altitude of 220 feet truncates bedded tuffaceous sandstone that dips about 13° SW. Rounded boulders as much as a foot in diameter, now pitted and broken, are found on the surface of this bench east of the cove. A lower terrace east of Dark Cove truncates this same sandstone at an altitude of 65 feet.

ISLAND TOPOGRAPHY

The island comprises three regions with conspicuously different topography; the south half, a region of strong dissection dominated by a sharp, sinuous drainage divide; the north-central part, a region of isolated plateaus; and the northern tip, which is the symmetrical cone of Kiska Volcano. The landforms in the first two regions are the result of destructional processes, faulting and erosion, whereas the form of Kiska Volcano is principally constructional, slightly modified by erosion. Much of the surface of the island is covered by a poorly drained blanket of tundra vegetation; there are no trees on the island. Between the tops of the sea cliff and an altitude of 500 feet the vegetative cover is nearly complete and outcrops are very scarce, but small, shallow, peat-walled lakes are common.

The south half of the island contains the highest destructional landforms; several of the peaks exceed 1,400 feet altitude and the highest peak is somewhat over 1,800 feet (pl. 72*A*). The drainage divide is much closer to the northwest coast. Streams on the northwest slope occupy short, deep amphitheatrical valleys, whereas the valleys of the southeast slope are longer and less deeply entrenched. The longer streams are characterized by straight stretches and abrupt, angular changes of direction; their courses appear to be fracture controlled. Most of the northwest-trending valleys, and the more northerly of the southeast-trending valleys head in well-developed glacial cirques in which some cirque lakes still remain. Other glacial landforms such as roches moutonnées and irregular closed bedrock depressions, now occupied by ponds, are abundant both in valleys and on ridge surfaces, but no striated and polished rock surfaces were seen. Marginal or terminal moraines are not present, but thin deposits of till are exposed in a few artificial cuts.

In the north-central region of nearly or completely isolated plateaus, the maximum altitude of about 1,200 feet is a prominence on the gently undulating surface of the largest plateau (pl. 72*B*). Over much of this region the plateau surfaces truncate the layered structure of the bedrock, but locally, as in the flat area at an altitude of 900 feet to the southwest of Sredni Point, the surface conforms to the attitude of the uppermost layer of country rock. Several small ponds at different altitudes occupy depressions in bedrock. Most of the high surface is mantled with a colluvium of angular fragments broken from local bedrock mixed with small amounts of volcanic ash.

Most of the surface of Kiska Volcano is the constructional surface of block lava flows modified slightly by stream erosion. Locally, the gullied surface is underlain by bedded pyroclastic material. In general, the local relief on the surface of the cone is due to steep flow margins, collapsed lava channels, arcuate flow ridges, and similar features related to the emplacement of viscous lava. None of the surface of the cone appears to have been glaciated.

GEOLOGY

GENERAL FEATURES

As noted previously, Kiska Island lies at the junction of, and is composed of parts of, two major geologic elements that diverge to the east (fig. 80). The southern part of Kiska and Little Kiska are part of a submarine ridge that extends southeastward and includes Rat Island and Amchitka Island. The northern part of Kiska is formed by Kiska Volcano, which is one in a line of volcanoes that includes Buldir, Segula, Khvostof Davidof, Little Sitkin, and the volcanoes on Semisopochnoi Island.

The southern part of Kiska is composed of interbedded pyroclastic rocks and laval flows, mostly of basaltic composition, with minor amount of intrusive rocks. These rocks, which are here given the name Vega Bay formation, are more deformed and altered than the younger rocks to the north. The source or sources of these rocks has not been recognized.

After their deposition, the rocks of the Vega Bay formation were intruded by a gabbro mass now exposed east of Gertrude Cove. The rocks of the Vega Bay formation are altered for a distance of about one-third mile on all sides by this gabbro mass, and alteration elsewhere in the same region suggests that the gabbro may be more extensive at depth.

The northern part of Kiska, from Kiska Harbor northward, is made up chiefly of pyroclastic rocks and flows that form an erosional remnant of an older volcano, surmounted by the slightly dissected cone of Kiska Volcano, which has been active in relatively recent time.

Much of Kiska Island was probably glaciated during Pleistocene time. Subsequent to the glaciation of blanket of fine stratified basaltic ash was laid down over most of the land surface, north of Gertrude Cove by several successive eruptions. Subsequently the ash has been stripped by the wind from more exposed localities and redeposited on more sheltered sites as fine, nearly structureless deposits, closely resembling loess and locally as much as 6 feet thick. The distribution of volcanic ash is not shown on the geologic map (pl. 71).

VEGA BAY FORMATION

The rocks that underly the south half of Kiska and most of Little Kiska Island are here named the Vega Bay formation. The formation is composed predominantly of pyroclastic rocks interbedded with substantial amounts of flow rocks and minor amounts of sandstone and conglomerate, which consist of reworked volcanic material.

The pyroclastic rocks are all rather drab colored and range from thin layers of well sorted, fine tuff to thick layers of unsorted tuffaceous volcanic breccia. They are composed of fragments that range from fine dust to blocks several feet in diameter. The small fragments are glass shards, scoria, and broken crystals of pyroxene and plagioclase; the larger fragments are volcanic bombs and broken pieces of volcanic rock (pl. 73*A*). Many of the fragments, especially the smaller ones, are dull in luster owing to the development of secondary minerals and mineraloids, principally palagonite, nontronite, and saponite, probably formed by alteration of volcanic glass. Most of the material in these rocks is probably basaltic in composition.

Most of the flows are compact dark-gray predominantly crystalline rocks, but locally they are vitrophyric. Most of the flows are probably basaltic. The chemical composition of a sample of a flow from the ridge summit 4½ miles northwest of Bukhti Point is given in column 1, table 1.

Pillow structure is common, notably on the west side of the small peninsula at the head of Sargeant Cove. The pillows are composed of fine-grained dark-gray basalt with a darker glassy selvage about 1 inch thick forming the outermost part of the pillows. The interstices between pillows are filled in part with greenish earthy material, apparently a hydration product of basaltic glass, and in part with pale-grayish-green limestone, probably a consolidated limy mud into which the basalt flowed.

The sedimentary rocks consist of fragments of volcanic rock that range from silt to cobbles. The fragments are subangular to subrounded and consist largely of porphyritic basaltic lava; a few are chalcedony and red and green jasper.

In general, the rocks of the Vega Bay formation south of latitude 51°55′ are relatively unaltered except for the change of olivine to iddingsite or bowlingite, and of glass to palagonite, nontronite, or saponite. However, north of this latitude, in the central part of the island and including Little Kiska, alteration of many rocks is conspicuous, and in some it has obliterated the original minerals. The assemblage of secondary minerals, includes albite, chlorite, epidote, calcite, titanite, and quartz. The alteration of these rocks may be related to the gabbro, which is exposed east of Gertrude Cove, and which may extend under the altered area.

Mode of origin.—The Vega Bay formation was largely the product of submarine deposition of basalt as indicated by pillow lava with interstitial limestone; however, conglomerate and sandstone, made up of fragments of the volcanic rocks of the formation, suggest that some parts of the formation may have been exposed to subaerial or marine erosion during its accumulation.

Thickness.—No complete sequence of the Vega Bay formation is exposed. Along the coast of Vega Bay between long. 177°22′ and 117°25′ E., west of Gertrude Cove, which is the type locality, the rocks all dip to the west, and the section apparently is uninterrupted. Here there is about 2,000 feet of the Vega Bay formation, a minimum value for the thickness of the formation.

Age.—As noted above the parts of Kiska and Little Kiska Islands that are underlain by the Vega Bay formation, are part of a submarine ridge that is also surmounted by Amchitka and Rat Islands. The composition, degree of deformation, and alteration of constituents of the rocks of the Vega Bay formation are similar to that of rocks on Amchitka and Rat Islands that contain fossils of late Oligocene or early Miocene age, and on this basis the Vega Bay formation is considered to be of middle Tertiary age.

GABBRO

About 1 square mile of gabbro is exposed along the south coast, east of Gertrude Cove. A body of similar rock (whose boundaries could not be mapped in the dense fog that prevailed during the available time) crops out in a saddle on the summit ridge (in the vicinity from which sample 51N23 was collected). These rocks contain grains ranging from 1 to 3 mm in size, and are composed of euhedral to subhedral tabular plagioclase, subhedral tabular clinopyroxene, with an interstitial matrix of chlorite, some saponite, a little alkalic feldspar, and small crystals of apatite and opaque oxides. A few patches of bowlingite(?) may be pseudomorphic after olivine, and a few patches of chlorite may be pseudomorphic after orthopyroxene with bronzite structure. The plagioclase is labradorite, some of which is progressively zoned to an outer rim of oligoclase. An analysis of this gabbro is given in column 2, table 1. On the whole, the gabbro is little altered in contrast to the altered rock of the Vega Bay formation into which it is intruded. The gabbro is probably of middle Tertiary age.

KISKA HARBOR FORMATION

The rocks which occupy about 30 square miles in the north-central part of the island are here named the Kiska Harbor formation. The rocks are unconformable on the Vega Bay formation on the south, and to the north are covered by the rocks of Kiska Volcano and alluvium. On Little Kiska, water-laid rocks of the Kiska Harbor formation lie in a depositional contact unconformably on a north-sloping surface eroded on steeply dipping beds of Vega Bay formation. On Kiska Island, the contact between these two formations is probably a fault.

The Kiska Harbor formation consists of subaerial lava flows, autoclastic breccias, pyroclastic rocks, and water-laid pumiceous sand and conglomerate. Lava flows predominate in the north and water-laid beds in the south. The type section of the pyroclastic facies of the formation is the bluff north of Trout Lagoon at the head of Kiska Harbor; that of the lava flow facies is in Sredni Point. Between these two extremes the flows and sedimentary rocks interfinger; the flows thin southward and grade into autoclastic breccias, and the sedimentary layers thin northward. Pyroclastic layers are interbedded with the flows and water-laid sedimentary rocks, and some of the coarser pyroclastic layers resemble the autoclastic parts of flows. One discontinuous lava flow and one discontinuous volcanic breccia layer are mapped as members of the formation. This volcanic breccia layer is believed to be of autoclastic origin.

The water-laid pumiceous sand and conglomerate are composed exclusively of volcanic debris. Most of this material is crossbedded; in some places the crossbeds are inclined dominantly to the east and southeast, in other places they are inclined to the south and southwest (pl. 74). The finer fragments are shards and mineral crystals; the larger fragments are pieces of volcanic rock. Some of the fragments are light- to medium-gray or yellowish-gray finely vesicular rocks; others are somewhat darker and more compact. Both kinds are slightly porphyritic. The specific gravity of the vesicular rocks ranges from 1.5 to 1.95, and the specific gravity of the darker rocks from 1.75 to 2.61. The lighter colored fragments consist of plagioclase phenocrysts that have a median composition of An_{66}, green hornblende, and augite, all embedded in a hypohyaline groundmass composed of plagioclase microlite in clear glass. The glass makes up about 60 percent of the groundmass and has an index of refraction of 1.50. The lighter rock includes some microxenoliths of magnetite-rich lava that includes oxyhornblende phenocrysts. The lighter rock is probably dacite. The principal phenocrysts in the darker fragments are zoned plagioclase with a median composition of An_{62}, and augite. The groundmass consists of plagioclase laths and microlite, hypersthene and pyroxene needles, magnetite grains, and about 30 percent of brown glass with a mean index of refraction of 1.525. The composition of the darker rock is andesitic to basaltic.

The lava flows of this formation vary in thickness from a few to several hundred feet. Many flows exhibit columnar jointing and many are vesicular. The lack of pillow structures suggests that these are subaerial flows. The rocks in these flows are all vitrophyric with numerous phenocrysts of plagioclase (bytownite-labradorite) as much as 4 mm. across in either a dark vitric groundmass, or dark-gray somewhat diktytaxitic groundmass. Smaller phenocrysts of hypersthene are the most abundant (as much as 10 percent) dark minerals, and clinopyroxene is always present. The chemical analysis of a sample of one of these flows from Little Kiska Head is given in column 4, table 1.

The volcanic breccia is made up of coarse angular to subrounded basalt fragments in a matrix of dark-brownish-gray fine-grained volcanic debris (pl. 73*B*). The basaltic fragments are as much as 2 feet in diameter. Locally the proportion of rock fragments to matrix is low, and the rock is a finely divided yellowish-brown material that resembles pyroclastic tuff with a few scattered angular rock fragments. More commonly rock fragments predominate. The fragments are chiefly medium-gray finely crystalline, slightly porphyritic basalt, with a small volume of irregular vugs. Phenocrysts are plagioclase, olivine, and augite as much as 2 mm across; their abundance varies from sample to sample, the feldspar from 1 to 25 percent, and olivine and augite from less than 1 to 5 percent. The chemical composition of a specimen of this rock is given in column 3, table 1.

Locally this breccia grades into massive flow basalt. This fact rules out a pyroclastic origin for the unit in spite of the pyroclastic appearance of its matrix. Possibly the fragmentation of this breccia is the result of a part of the flow entering water. In addition some of the fragmentation may be normal autobrecciation due to flowage of a cooling lava.

CROSSBEDDING IN PUMICEOUS PHASE OF KISKA HARBOR FORMATION

Section is on north side of Kiska Harbor. Shows poor sorting, lenticularity of beds, concave bedding, and persistence in vertical cliffs. View shows about 8 feet of section.

In the vicinity of Haycock Rock the Kiska Harbor formation is more altered than it is elsewhere. This alteration is probably the result of fumarolic action either associated with the extrusion of the rocks of the Kiska Harbor formation, or the extrusion of the rocks of Kiska Volcano.

Mode of origin.—The dominance of reworked volcanic debris in the south and the gradual northward increase in the abundance of flows suggest an eruptive source to the north. It seems likely that the source of the rocks that make up the Kiska Harbor formation was in about the same locality as the present Kiska Volcano, and that the formation is all that is left of an older volcano that occupied approximately the same site as the present-day volcano.

Age.—The Kiska Harbor formation overlies, and is thus younger than, the Vega Bay formation; and it is in turn overlain by the rocks of Kiska Volcano, which are at least as old as Pleistocene. The rocks of the Kiska Harbor formation resemble the rocks of dissected composite volcanoes on the north end of Tanaga and Kanaga Islands that contain fossils of Pliocene age. The Kiska Harbor formation is thus probably late Tertiary or early Pleistocene in age.

ROCKS OF KISKA VOLCANO

The rocks of Kiska Volcano are interbedded flows and pyroclastic rock that form the composite volcano at the north end of Kiska Island. The flows of this unit range from a few feet to more than 100 feet in thickness. Locally they have red top and bottom breccias. They are gray fine-grained porphyritic andesites. Some of them are hypersthene andesite, in places with a trace of olivine; and some are two-pyroxene andesite. Table 1 gives analyses of specimens from three flows. The debris, which makes up the pyroclastic rocks, ranges in size from fine volcanic ash to large volcanic bombs. The fragments range from vesicular to massive and from glassy to fine grained. Individual ash layers are generally much more extensive than individual flows.

On the west coast, 2 miles south of Vulcan Point, a minor subsidiary cone has been truncated by marine erosion. At least one thin lava flow with a coarse breccia top of hypersthene-olivine andesite, extensive exposures of tuff-breccia, and one dike or plug of hypersthene-augite-hornblende andesite are exposed in the shore cliffs.

Five of the most recent flows on Kiska Volcano are mapped separately on the basis of the degree of preservation of original surface details, and on the sparsity of vegetation or pyroclastic cover. The young lava flows are uniformly block lava. Where they have accumulated on relatively gentle slopes, as at Sirius Point and on the southeast side of the volcano, they have come to rest with very steep flow fronts as much as 100 feet high. Most of the lava flows weather nearly black, but are medium gray to light brownish gray on fresh surfaces. They are augite-hypersthene andesites, locally with a little olivine; the plagioclase is labradorite. Some of the vesicular lapilli collected near the summit crater are richer in glass and darker in color than most of the flows, and they contain traces of brownish-green hornblende. Chemical analysis of the lava from Sirius Point is given in column 9, table 1.

Age.—The surface of Kiska Volcano has not been glaciated, so the surface flows must be younger than the time of last major glaciation, though the interior flows of the cone might be as old as late Pleistocene. The most recent flows still show original cooled surfaces, and these flows cannot be many hundreds of years old. At any given altitude the most recent flows of Kiska Volcano are more heavily vegetated than are flows erupted during the 20th century on other Aleutian Islands, which suggests that the most recent flows on Kiska are one to several centuries old.

SURFICIAL DEPOSITS

DUNE SAND

The principal areas of sand dunes are at the mouth of Salmon Lagoon, at the head of Kiska Harbor, and at the heads of Beach and Bluff Coves. The highest dunes, which attain a height of 125 feet, are south of the entrance to Salmon Lagoon. All the dunes are close to beaches from which the sand was derived. The dunes form only in areas underlain by the Kiska Harbor formation, apparently because that is the only formation which provides sufficient fine-grained material.

ALLUVIUM

The alluvium on Kiska Island has been deposited in a depression that resulted from a lava flow blocking the lower end of a broad swale northwest of Haycock Rock, in the low area south of Kiska Volcano which is closed off from the sea by bars, and in some of the larger valleys. In part these deposits are deltaic. In most places these deposits are still accumulating, but locally they are slightly dissected, such as the small body southwest of Reynard Cove. Most of the alluvium consists of silt, sand, and gravel; near the foot of Kiska Volcano it includes poorly sorted fanglomerate.

BEACH DEPOSITS

Most of the beach deposits are composed of coarse material that ranges from pebbles to boulders 2 feet and locally 3 feet in diameter. Sand beaches are rare, and are confined to some of the more sheltered bays; elsewhere the coasts are exposed to intense wave action, and fine-grained material is speedily transported to deeper water. The most conspicuous beach deposits form the bars west of West Kiska and Christine Lakes; these deposits are largely gravel and cobble material. The altitude of the highest berm of these exposed beaches is as much as 20 feet.

VOLCANIC ASH

Volcanic ash forms a thin discontinuous blanket not shown on the geologic map. The ash is commonly bedded and is made up of angular fragments that range in size from fine dust to pieces 2 mm across. A composite sample of volcanic ash contains palagonitized pumice fragments, fragments of clear glass with an index of 1.495, plagioclase grains (chiefly sodic labradorite), hornblende, augite, olivine, hypersthene, and magnetite. Many of the mineral grains have sharp unworn faces that show they have undergone little reworking. This, and a predominance of unbroken crystals, suggest that the ash is crystal-vitric tuff.

The following table presents a measured section of Recent volcanic ash about 2,300 feet northwest of the northwest corner of Kiska Harbor.

Material	Grain size	Color (Goddard and others, 1948)	Thickness (inches)
Top of section:			
Reworked ash	Fine	Moderate-yellowish-brown (10*YR* 4/3).	7
Ash	do	Light-yellowish-brown (10*YR* 5/2) grading upward to medium gray.	1. 4
Do	do	Light-yellowish-brown (10*YR* 5/2).	2
Do	do	Light-yellowish-brown (10*YR* 5/2) grading upward to medium gray.	2
Do	Medium	Dusky-yellowish-brown (10*YR* 3/2) grading upward to medium gray.	3. 4
Do	do	Moderate-yellowish-brown (10*YR* 5/4).	0. 5
Do	Fine to medium.[1]	Dusky-yellow-green (5*GY* 5/2)	2. 5
		Total thickness	18. 8
Disintegrated bed-rock.			

[1] Contains two layers, 2 mm thick of coarser fragments.

Little evidence is available to permit determination of how much of the finer ash is derived from Kiska Volcano, and how much from Little Sitkin or Segula volcanoes to the east, both of which appear to have been more active than Kiska Volcano in recent time; the lack of any rapid changes in thickness or grain size with distance from

Kiska Volcano suggest the derivation of most of it from Segula or Little Sitkin.

In many places, the bedded ash is overlain by brown, nearly structureless loesslike pyroclastic material, which may be as much as 6 feet thick in sheltered spots. This loesslike ash is probably derived from the bedded ash, inasmuch as the bedded ash is missing from places exposed to wind erosion, and the massive ash is found largely in sheltered locations at lower altitudes. It is overlain by peat of variable thickness, so it is not being formed at the present time, and is exposed mostly in artifical cuts.

STRUCTURE

Kiska and Little Kiska Islands, taken together, are composed of three structural units, which correspond with the three major rock units of the islands. The parts of the islands underlain by the Vega Bay formation are the oldest and structurally most complex parts; the parts underlain by the Kiska Harbor formation are younger and structurally less complex; and Kiska Volcano is the youngest part and has the least structural complexity.

Linear features of two dominant trends are recognized on aerial photographs. These features trend about N. 30° E., and about N. 60° W. A few of them are continuations of normal faults recognized in the field. Haycock Depression, the deep submarine trench east of the island, and a smaller trench west of Kiska Volcano may be related to the system of northwestward-trending faults. Other submarine features, such as Murray Seavalley and Stephen Ridge, shown by Gibson and Nichols (1953, pl. 1), appear to be controlled by northeastward-trending faults.

The Vega Bay formation is the most deformed. Most of the beds dip rather steeply and appear to be folded. Southwest of Gertrude Cove most of the rocks dip westward, which suggests that the dominant structure there is the limb of a large fold. North of Gertrude Cove the rocks of the Vega Bay formation seem to dip mostly away from the gabbro intrusive mass, which suggests that the dominant local structure in that area is a large dome.

Most dips in the rocks of the Kiska Harbor formation are less than 15°, and the dominant structure there seems to have resulted from gentle tilting of blocks between normal faults. The lowlands south of Kiska Volcano probably are downdropped on the north side of at least two faults that trend parallel to the N. 60° W. group of lineaments. The lava flow member of the Kiska Harbor formation, mapped in this area, is the key bed that demonstrates this downdropping. Some of the bedded rocks of the formation under the lava flow member have dips several degrees steeper than the base of the flow. Part of this discordance may be due to discordance of initial dips, but some of it seems to represent intermittent structural dislocation during the accumulation of the rocks of the Kiska Harbor formation. The large submarine Haycock Depression to the east, and a smaller submarine depression due west of Kiska Volcano, are alined with this downdropped zone. These submarine depressions are inferred to be younger than the Kiska Harbor formation; if older than, or coincident with, the deposition of these rocks, the depressions would probably have been filled.

All the structure that has been observed in the rocks of Kiska Volcano can be attributed to original dip of the flows and pyroclastic layers that make up the volcano.

GEOLOGIC HISTORY

The known geologic history of Kiska Island begins with the eruption of basaltic pyroclastic material and flows probably from a number of subaerial and submarine vents. This material accumulated to an unkown thickness; parts of it were exposed to subaerial and marine erosion from time to time and redeposited as conglomerate and volcanic graywacke. These rocks, represented by the Vega Bay formation, were disturbed by block faulting and intruded by small bodies of gabbro. Subsequently, a composite volcano grew above sea level north of an island composed of these older rocks, and erupted large quantities of fine dacite pumice, which accumulated in stream valleys and sheltered embayments. Continuing eruptions deposited breccias and lava flows of olivine basalt and pyroxene basaltic andesite. These rocks make up the Kiska Harbor formation. After a long period of erosion the island was uplifted, perhaps by block faulting, during which time several terraces, now above sea level, may have been cut by marine planation. During the Pleistocene, ice probably covered much of Kiska Island perhaps more than once. Localized volcanic activity began to build Kiska Volcano, perhaps during part of the epoch of glaciation, but eruptions continued until very recent times. Minor amounts of volcanic ash, mostly from volcanoes on other islands, represent some of the most recent deposits on Kiska and Little Kiska Island.

Evidence of historic activity of Kiska Volcano is scanty. The earliest report (Egbert, 1905) states that solfataric activity was noticeable in the crater. Egbert's description of the form of the crater corresponds closely to that seen in 1947; this suggests that the activity in the crater during the intervening years was probably no more than solfataric. Newspaper reports in June 1943, shortly before the island was occupied by American and Canadian forces, tell of an ash eruption accompanied by earthquakes, but in 1947, when the mountain was climbed, no evidence of any recent ash eruption, and no solfataric or fumarolic activity were noted.

TABLE 1.—*Chemical and spectrographic analyses and norms of igneous rocks from Kiska and Little Kiska Islands*

	1	2	3	4	5	6	7	8	9
Chemical analyses [Analyses 1-6 by L. Kehl; analyses 7-9 by M. Balazs]									
SiO_2	49.29	48.54	51.65	57.87	57.62	57.90	56.66	58.24	57.12
Al_2O_3	15.64	20.16	19.89	18.34	17.36	17.76	18.22	17.87	17.92
TiO_2	.82	.78	.89	.65	1.03	.69	.78	.74	.78
Fe_2O_3	2.37	4.67	3.02	3.31	2.46	2.55	2.65	2.85	2.81
FeO	6.92	5.16	5.38	3.97	5.12	4.32	4.82	4.18	4.73
MnO	.15	.16	.16	.15	.19	.14	.15	.14	.16
MgO	10.70	4.31	4.23	3.13	2.70	3.58	3.69	3.33	3.69
CaO	9.93	11.64	9.47	7.39	6.26	7.74	8.25	7.62	7.80
Na_2O	2.61	2.49	3.13	3.64	4.38	3.44	3.07	3.34	3.02
K_2O	.44	.45	.86	1.34	1.48	1.35	1.55	1.50	1.84
H_2O-	.46	.22	.52	.11	.20	.09	.02	.03	.02
H_2O+	.73	1.37	.68	.07	.80	.11	.05	.02	.00
P_2O_5	.11	.06	.16	.17	.27	.17	.14	.14	.15
CO_2	.00	.05	.01	.00	.00	.00	.01	.00	.00
F	.02	.02	.04	.03	.04	.03	.02	.02	.02
BaO	.02	.01	.03	.02	.04	.03	---	---	---
Total	100.21	100.09	100.12	100.19	99.95	99.90	100.08	99.97	100.06
Less O	.01	.01	.02	.01	.02	.01	.01	.01	.01
Total	100.20	100.08	100.10	100.18	99.93	99.89	100.07	99.96	100.05

Spectrographic analyses

[Analyst: P. R. Barnett. Quantities in parts per million. Looked for but not found: Ag, As, Au, B, Be, Bi, Cd, Cs, Ge, In, La, Mo, Nb, Pb, Pt, Sb, Sn, Ta, Th, Tl, U, W, Zn]

Ba	200	100	400	400	500	500	400	400	400
Co	60	30	30	20	20	20	100	80	90
Cr	400	6	30	4	4	60	6	5	10
Cu	100	200	200	50	70	50	40	40	60
Ga	10	10	10	10	10	9	10	10	10
Li	1	1	4	7	5	10	------	------	------
Ni	200	10	30	4	<1	20	6	6	10
Rb	<20	<20	<20	20	20	40	------	------	------
Sc	40	50	40	20	30	20	30	20	30
Sr	500	1,000	800	700	600	600	400	400	400
V	400	500	400	200	200	200	200	200	200
Y	40	40	60	60	70	50	40	30	40
Yb	3	3	4	4	5	3	4	4	4
Zr	40	10	60	100	100	100	100	100	100

TABLE 1.—*Chemical and spectrographic analyses and norms of igneous rocks from Kiska and Little Kiska Islands*—Continued

	1	2	3	4	5	6	7	8	9
					Modified CIPW norm				
Quartz		2.5	2.8	11.0	8.3	10.7	9.5	11.9	10.2
Orthoclase	2.5	2.5	5.3	8.1	8.9	8.1	9.2	8.9	10.8
Albite	22.0	21.0	26.7	30.9	36.9	29.1	25.9	28.3	25.4
Anorthite	29.7	42.5	37.4	29.5	23.4	29.1	31.1	29.2	29.8
Wollastonite	7.8	6.1	3.5	2.6	2.7	3.6	3.6	3.1	3.3
Ferrosilite	5.2	4.6	6.2	3.7	5.9	4.9	5.6	4.3	5.2
Enstatite	14.3	10.8	10.6	7.8	6.8	9.0	9.2	8.3	9.2
Fayalite	3.5								
Forsterite	8.8								
Magnetite	3.4	6.7	4.4	4.9	3.6	3.7	3.8	4.2	4.2
Ilmenite	1.5	1.5	1.7	1.3	2.1	1.4	1.5	1.5	1.5
Apatite	.3	.2	.3	.4	.5	.4	.4	.4	.4
H_2O	1.2	1.6	1.2	.2	1.0	.2	.1	.1	.0
CIPW symbol	III.5.3.(4)5	II(3)4.(3)4.(4)5	II.(3)4.3.4"	II.4(5).''3.4	II.(4)5.2''.4	II.4(5).3.4	II.4(5).3.4	II.4(5).3.4	II.4(5).3.4
Rittmann symbol	B8	B8	B8	A7	B7	A7	A7	A7	A7

1. Olivine basalt, Vega Bay formation: phenocrysts olivine (altered to bowlingite) and clinopyroxene. Specimen 51P65. Lat 51°57'52" N.; long 177°25'24" E.
2. Gabbro, Vega Bay formation: plagioclase zoned from labradorite to oligoclase, clinopyroxene and orthopyroxene. Specimen 51N23. Lat 51°56'50" N.; long 177°22'12" E.
3. Olivine basalt breccia, Kiska Harbor formation: rich in phenocrysts of bytownite-labradorite, olivine (altered to bowlingite), and clinopyroxene. Specimen 51P54. Lat 51°59'38" N.; long 177°31'37" E.
4. Porphyritic andesite, Kiska Harbor formation: rich in phenocrysts of labradorite, orthopyroxene, and clinopyroxene. Specimen 51N6. Lat 51°58'15" N.; long 177°38'17" E.
5. Fine-grained dike, intrusive rocks in Kiska Harbor formation: few microphenocrysts of labradorite, very few of clinopyroxene. Specimen 51L10. Lat 52°00'23" N.; long 177°35'22" E.
6. Porphyritic andesite, from the Kiska Volcano: rich in phenocrysts of labradorite, orthopyroxene, clinopyroxene, and rare remnants of oxyhornblende altered to opaque dust. Specimen 51L22. Lat 52°05'15" N.; long 177°33'11" E.
7. Porphyritic andesite, from the Kiska Volcano: phenocrysts of bytownite-labradorite, clinopyroxene, orthopyroxene, and rare olivine. Specimen 47AO75. Lat 52°07'13" N.; long 177°39'00" E.
8. Porphyritic andesite, from the Kiska Volcano: phenocrysts of bytownite, orthopyroxene, and clinopyroxene. Specimen 47AO76. Lat 52°06'55" N.; long 177°40'00" E.
9. Porphyritic andesite, from the Kiska Volcano: phenocrysts of bytownite-labradorite, clinopyroxene, and orthopyroxene. Specimen 47AC74. Lat 52°08'14" N.; long 177°36'18" E.

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