SURFICIAL DEPOSITS AND SEDIMENTARY ROCKS*

Qa **Alluvial deposits [Holocene and Pleistocene]**—Vary from coarse, subangular rock fragments to fine sand and silt; locally include considerable pumice near volcanic centers. As mapped, unit locally incorporates minor areas of other Quaternary surficial units …

Qb **Beach and other marine deposits [Holocene and Pleistocene]**—Moderately well stratified and sorted sand and gravel on beaches and in wave-cut scarps at several elevations, and mud and silt in estuaries

Qls **Landslide and other colluvial deposits [Holocene and Pleistocene]**—Coarse, angular rubble that forms landslides, talus cones, and rock glaciers, as well as weakly stratified, silty rock debris and stony organic-rich silt that forms solifluction deposits…

Qm **Moraines and other glacial deposits [Holocene and Pleistocene]**—Poorly sorted, nonstratified glacial drift that forms end, lateral, and ground moraines and moderately well sorted and stratified ice-contact and outwash deposits…

Tmr **Milky River Formation (Pliocene)**—Named by Galloway (1974, p. 381, 384) and defined by Detterman and others (1981), who designated type locality as northeast spur of unnamed mountain 12 km east of Bear Lake (sec. 14, 15, and 22, T. 48 S., R. 69 W., Chignik A-7 1:63,360-scale quadrangle). Formation is of variable thickness (as much as 600 m) and consists of volcanogenic, nonmarine sedimentary rocks and interlayered flows and sills. Lower part of unit consists nearly entirely of coarse, highly crossbedded and channeled, fluvial volcanic sandstone and cobble-boulder conglomerate. Rocks are poorly indurated, are dark brown to gray, and have clasts composed almost entirely of volcanogenic debris… [The Milky River Formation is mapped at a single locality within the map area, at the northernmost bedrock exposures on the western shore of Herendeen Bay. An estimated 20 m-thick interval there represents the lower part of the formation, and consists of dark gray to brown cross-bedded sandstone with abundant magnetic grains and poorly sorted pebble-cobble-boulder conglomerate.] Unit unconformably overlies Bear Lake Formation (unit Tbl) and conformably underlies Pliocene(?) and Quaternary volcanic flows … and surficial deposits…

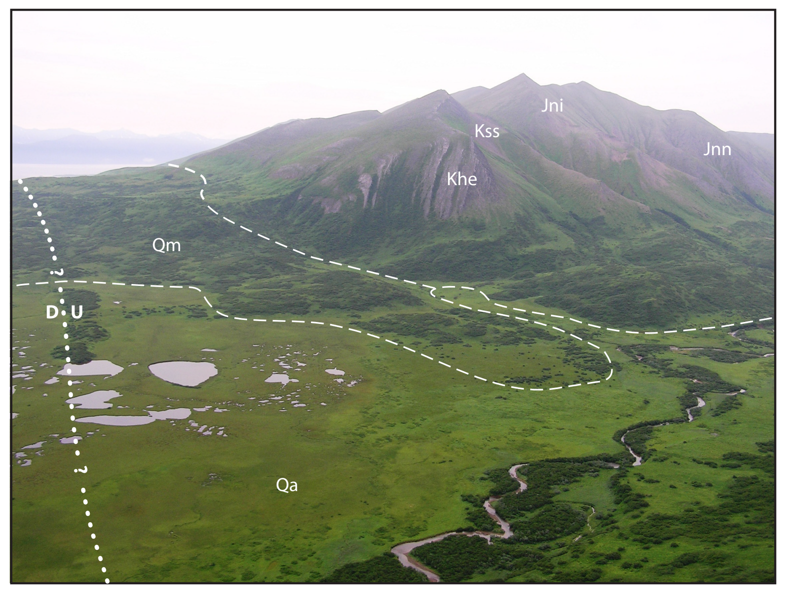
Tbl **Bear Lake Formation (late Miocene)**—Named by Burk (1965, p. 89-92; see also, Allison and Addicott, 1973) for exposures on ridges along and running eastward from Bear Lake. Type locality was clarified by Detterman and others (1981) as on southeast slope of unnamed mountain 10 km east of Bear Lake (secs. 27 and 28, T. 48 S., R. 69 W. of Chignik A-7 and Port Moller D-1 1:63,360-scale quadrangles). In map area, unit locally reaches thickness of 300 to 500 m and consists of inner-neritic marine and nonmarine (Wisehart, 1971; Nilsen, 1984) sandstone, conglomerate, siltstone, and shale. The Bear Lake is distinguished from other local Tertiary units by its greater abundance of nonvolcanic debris and its better degree of sorting. Rocks are dark brown to pale yellowish brown. Sandstone is moderately well sorted and grains are moderately well rounded. ... Formation is abundantly fossiliferous; fossils are mainly pelecypods, gastropods, and echinoids of late Miocene age (Louie Marincovich, Jr., and C.W. Allison, written commun., 1978, *in* Detterman and others, 1981), most of which lived in shallow, nearshore environments in water less than 100 m deep (Marincovich, 1983, and written commun., 1985, *in* Detterman and others, 1996). [Thickness of the Bear Lake Formation onshore is estimated not to exceed about 1,000 m (Detterman and others, 1996)]. Contact between the Bear Lake Formation and the locally underlying Meshik Volcanics (unit Tm) and Stepovak and Tolstoi Formations (units Ts and Tt, respectively) varies from a disconformity to an angular unconformity. Contact between the Bear Lake and the overlying Milky River Formation (unit Tmr) is generally disconformable; however, contact is an angular unconformity locally…

Ts **Stepovak Formation (early Oligocene and late Eocene)**—Originally called the Stepovak Series by Palache (1904) for rocks exposed on east side of Chichagof Bay; later renamed the Stepovak Formation by Burk (1965; see also, Detterman and others, 1996); and divided into two informal members by Detterman and others (1996). Unit is age equivalent of volcanic rocks mapped … as Meshik Volcanics (unit Tm). ... Reference section described by Detterman and others (1996) begins on ridge top in sec. 12, T. 52 S., R. 71 W., continues southwesterly into sec. 13, and then southerly into sec. 24 and on to Pacific coast (Port Moller C-1 1:63,360-scale quadrangle). Reference section has 2,030 m exposed, approximately evenly [and informally] divided into a (lower) siltstone member and an (upper) sandstone member (Detterman and others, 1996). Lower member is a deep-water turbidite deposit composed of dark-brown laminated siltstone and shale and interbedded sandstone that commonly shows graded bedding and rip-up clasts. Upper member, rich in unaltered volcanic debris, was deposited in a shallow-water shelf environment; megafauna distributed throughout upper member are characteristic of water depths no greater than 30 to 50 m (Louie Marincovich, Jr., written commun., 1983 to 1986). [Exposures on northern shoreline of the Staniukovich peninsula include vesicular lava flows and flow breccias that transition upward to volcaniclastic sandstone and conglomerate. Some brecciated lavas contain sparse volcaniclastic sandstone matrix with robust *Thalassinoides* burrows amid barely reworked cobble- to boulder-size flow breccia fragments, suggestive of autobrecciated flows entering the shallow marine environment. The overlying marine volcaniclastic beds contain locally abundant oysters and other bivalves, as well as carbonate concretions and occasional cobble-to boulder-size dropstones of mixed volcanic lithologies.] Upper and lower contacts of formation are structurally conformable with the ... Tolstoi [Formation (unit Tt)] but are considered disconformities because considerable time gaps exist between younger and older units

Tt **Tolstoi Formation (middle Eocene to late Paleocene)**—Named and defined by Burk (1965; see also, Detterman and others, 1981), who designated type locality along east shore of Pavlof Bay north of Tolstoi Peak. Detterman and others (1996), who have designated stratigraphic section exposed at type locality between Tolstoi Peak and Cone Peak (Port Moller B-5 and C-5 1:63,360-scale quadrangles) as type section, have also designated a reference section along east shore of Ivanof Bay, beginning at northeast corner of sec. 3 and continuing south along east shore of Ivanof Bay to southeast corner of sec. 10, T. 50 S., R. 66 W., (Stepovak Bay D-5 1:63,360-scale quadrangle), that is more representative of unit's lithology. In type section, lithology is characteristic of shallow marine sedimentation succeeded northward (stratigraphically upward) by delta-plain and fluvial deposits, mainly of braided-stream type. Reference section lithology is typical of a fluvial flood-plain, delta sequence, which is common in main part of the Tolstoi Formation. Lithic clasts in conglomerates are dominantly granitic and arkosic detritus and also include as much as 20 to 30 percent volcanic clasts. Most volcanic clasts are not fresh appearing; additionally, presence of granitic and arkosic detritus suggests a Mesozoic source rather than derivation from contemporaneous magmatic activity, which is in sharp contrast to most overlying units (Detterman and others, 1996)… [Tolstoi overlies Chignik Formation (unit Kc) and Hoodoo Formation (unit Kh) with a slight unconformity or disconformity. Tolstoi is disconformably overlain by the Stepovak Formation (unit Ts), Meshik Volcanics (unit Tm), and undifferentiated Tertiary volcanics (unit Tvu)]

Kc **Chignik Formation (Late Cretaceous, Maestrichtian to Campanian)**—Named by Atwood (1911, p. 41-48) for exposures at Chignik Lagoon and Chignik Bay; unit has a type section located on Whalers Creek (all locations in Chignik B-2 1:63,360-scale quadrangle north of map area). Burk (1965, p. 50) subdivided lower, nonmarine part of formation as his Coal Valley Member; however, Detterman and others (1996) consider the Coal Valley Member to be a useful mapping unit only between Port Moller and Herendeen Bay and state that exposures along east shore of Herendeen Bay at Coal Bluff are not Coal Valley Member but refer them, rather, to unnamed Tertiary strata. [This study (see text and sheet 1) rejects the assignment by Detterman and others (1996) of exposures at Coal Bluff to "unnamed Tertiary strata", and returns them to the Chignik Formation, based primarily on their highly distinctive conglomerate lithology rich in plutonic clasts.] The Chignik is a cyclic, nearshore-marine tidal-flat and nonmarine flood-plain and fluvial deposit (Fairchild, 1977; Detterman, 1978). [Thickness reaches 600 m between Port Moller and Chignik Bay (Wilson and others, 1999).] The Chignik is dominantly light-olive-gray to olive-gray sandstone that contains interbedded olive-gray to olive-black siltstone and conglomerate, which is composed of multicolored chert, white quartz, granitic clasts, and minor volcanic clasts. Nonmarine part locally contains coal beds as much as 2 m thick, which are source of coal produced at Mine Harbor around the turn of the twentieth century. The Chignik Formation unconformably overlies the Herendeen, Staniukovich, and Naknek Formations (units Khe, [Kss], and Jn, respectively) and conformably underlies the Hoodoo Formation (Kh) at Chignik Bay; However, the Hoodoo Formation can be considered a deep-water-facies equivalent of the Chignik, rather than an overlying unit (Mancini and others, 1978; Detterman and others, 1996). Where in contact, the Tolstoi Formation (unit Tt) unconformably overlies Chignik. Marine fossils, mainly pelecypods, indicate a late Campanian to early Maestrichtian age (J.W. Miller, written commun., 1983- 85)

Descriptions of the map units shown on Sheet I-1 are largely excerpted from the unit descriptions of Wilson and others (1995), with modifications as appropriate to the scope and interpretations of this study. Omission of original text is indicated by ellipses (...); added or revised text is in brackets([ ]). References are cited in accompanying report.

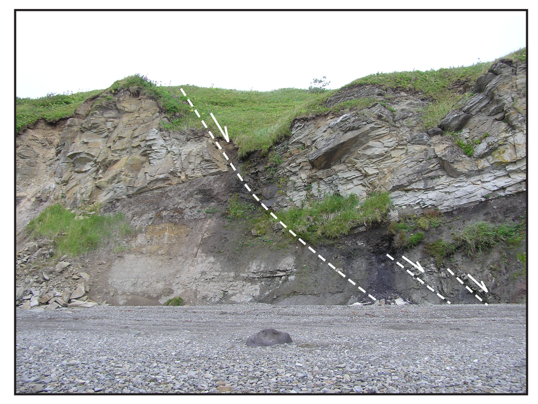


Aerial view toward the southeast of Staniukovich Mountain and low-relief coastal plain near mouth of Coal Valley, northern part of Staniukovich peninsula.

Coal Creek traverses alluvium and moraine deposits (units Qa and Qm, respectively) in lower part of photo. Queried and dotted line marks terrain lineament inferred to represent the trace of an inferred up-to-south fault or system of faults at the southern edge of the David River zone.

Resistant, moderately- to steeply- dipping beds of the Herendeen Formation (unit Khe) cap the northwest limb of the Staniukovich anticline in upper middle part of photo.

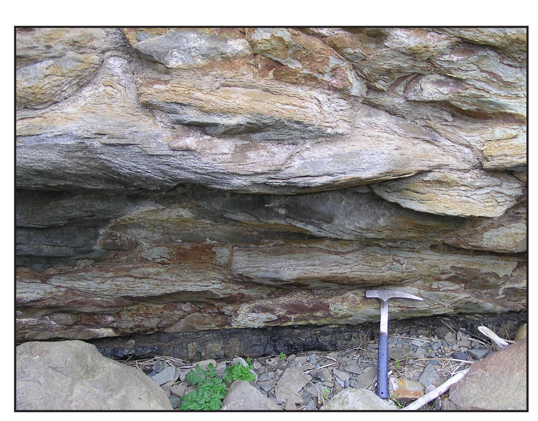

Exposures mapped as Milky River Formation (unit Tmr) northwest of Village Spit on west shore of Herendeen Bay, showing channelized, steeply cross-bedded sandstones (left) and poorly sorted conglomerate and conglomeratic sandstones (right).

Bear Lake Formation (unit Tbl) near Coal Point on west shore of Herendeen Bay, showing cross-bedded carbonaceous sandstone (left) and down-to-north normal separation (right) associated with subsidence of the southern North Aleutian basin along the David River zone.

Stepovak Formation (unit Ts) on north shore of Staniukovich peninsula, showing boulder- and cobble-sized basaltic dropstones in sandstone (d, left) and slightly reworked blocks of mafic flow breccia infilled by sandy matrix containing Thalassinoides burrows (T, right).


Tolstoi Formation (unit Tt), Herendeen Bay shoreline west of Grass Valley, showing marine sandstones containing large Thalassinoides gallery (dashed outline, left) and curved Paleophycus(?) burrows (right).

Chignik Formation (unit Kc) from outcrops on east shore of Herendeen Bay. Distinctive granitic clasts in conglomeratic facies at Coal Point (left), and cross-bedded nonmarine sandstone and coal facies at Bluff Point (right).

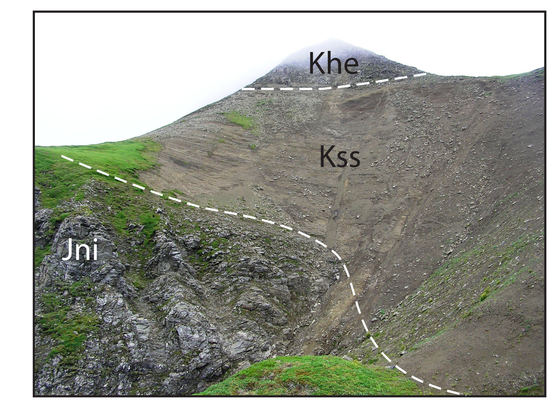
Kh **Hoodoo Formation (Late Cretaceous, Maestrichtian to Campanian)**—Named by Burk (1965, p. 59-63, 182; see also, Detterman and others, 1981) for exposures southeast of Hoodoo Mountain; type section of unit is located on southeast side of Hoodoo Mountain and along west side of upper Beaver River valley [in the Port Moller C-3 1:63,360-scale quadrangle]. Unit is typically dark-gray to black, thin-layered and rhythmically bedded, splintery to pencil-fracturing shale, siltstone, and fine sandstone, becoming [sandier] stratigraphically upward. At Hoodoo Mountain, section contains ammonite-bearing channel conglomerate composed of clasts of plutonic and volcanic rocks, chert, and quartz. Sandstone beds are 0.3 to 1 m thick and siltstone and shale beds are 1 to 2 m thick, although individual layers are as thin as 1 cm (Detterman and others, 1981). Depositional environment for most of unit is characteristic of lower slope of a submarine fan; structures imply submarine slumping and turbidity current flow. Locally, thick sandstone and conglomerate in upper part of unit implies an upper-fan-regime environment. Hoodoo can be easily mistaken for similar-appearing dark-green or brown siltstone of overlying Tolstoi Formation (unit Tt) or lower part of the Stepovak Formation (unit Ts), although color, style of fracturing, and fossils can help to distinguish units. In map area, the Hoodoo is, in part, age equivalent to Chignik Formation (unit Kc), which can be considered a shallow-water-facies equivalent of the Hoodoo (Mancini and others, 1978; Detterman and others, 1996)... [Wilson and others (1995, 1999) considered the Hoodoo to overlie the shallower-water deposits of the Chignik where the two units are in contact, in a transgressive sequence. Revised map relationships in the southwest part of the map area between Lefthead River and Deer Valley suggest that the Chignik may locally overlie the Hoodoo in a progradational sequence.] The Hoodoo is [normally] disconformably overlain by the Tolstoi Formation. Sparse megafauna indicates an age of late Campanian and early Maestrichtian (J.W. Miller, written commun., 1983-85)


Hoodoo Formation (unit Kh), between Deer Valley and Lefthead River south of Herendeen Bay. Graded, slightly convolute Tc-e turbidite beds with dewatering features (left) and general outcrop expression of interbedded sandstone-siltstone-mudstone beds (right).

Khe **Herendeen Formation (Early Cretaceous, Barremian and Hauterivian)**—Originally named the Herendeen Limestone by Atwood (1911, p. 39) for exposures along east shore of Herendeen Bay north of Mine Harbor; renamed the Herendeen Formation by Detterman and others (1996), who designate a 270-m-thick reference section in hills southwest of Hot Spring on Port Moller (sec. 14, T. 50 S., R. 73 W., Port Moller D-2 1:63,360-scale quadrangle). Originally described as limestone, rocks of formation are actually an unusually uniform calcarenaceous sandstone. Rocks are thin bedded, medium grained, and dusky yellow to pale yellowish brown on freshly broken surfaces, weathering to a conspicuous light gray. They have distinct platy fracture upon weathering and strong petroliferous [or sulfurous] odor when freshly broken. *Inoceramus* fragments form major component of formation, but complete specimens have not been found in map area. A belemnite similar to *Acroteuthis sp. A* (Jones and Detterman, 1966) has been found just east of Staniukovich Mountain. Ammonite fossils and other collections from Herendeen in Katmai area allow an age assignment of Hauterivian and Barremian for unit (J.W. Miller, written commun., 1983-85; Detterman and others, 1996). Herendeen conformably overlies the Staniukovich Formation (unit [Kss]) and is unconformably overlain by the Chignik Formation (unit Kc)


Herendeen Formation (unit Khe), showing resistant, interbedded medium to massive calcarenite beds on east shore of Herendeen Bay between Coal Bluff and Marble Point (left). Common, irregular cross-bedding records high wave-energy deposition in exposures west of Port Moller hot springs on north shore of Staniukovich peninsula (right).

Kss **Staniukovich Formation [upper siltstone unit] (Early Cretaceous, Valanginian and Berriasian)**—Originally named Staniukovich Shale by Atwood (1911, p. 25, 38) for exposures on Staniukovich Mountain. Burk (1965; see also, Detterman and others, 1981) changed name to Staniukovich Formation and included within unit a much larger variety of rocks of latest Jurassic and Early Cretaceous age; however, Detterman and others (1996) stratigraphically restrict unit to that originally described by Atwood (1911), and, as so restricted, its age is Early Cretaceous. Type section (Atwood, 1911) (sec. 30, T. 50 S., R. 73 W., Port Moller D-2 1:63,360-scale quadrangle) is composed of 246 m of light-olive-gray siltstone containing two light-olive-brown sandstone intervals, overlain by shaly olive-gray siltstone containing numerous calcareous nodules and concretions (Detterman and others, 1996). [As mapped for this study, unit Kss includes only the upper siltstone interval, which commonly weathers to form distinctive red-brown slopes. *Buchia*-rich sandstones of the lower part of Atwood's type section are not differentiated here from similar sandstones of the underlying Indecision Creek Member of the Naknek Formation.] Upper part of formation erodes readily and, therefore, is typically not well exposed; additionally, it contains few age-diagnostic fossils, whereas lower part has abundant megafauna, particularly the pelecypod *Buchia*, which indicates Berriasian and Valanginian age (J.W. Miller, written commun., 1982-88; Detterman and others, 1996). Upper and lower contacts of the Staniukovich are conformable with Herendeen and Naknek Formations, respectively (units Khe and Jn)



Upper siltstone unit of Staniukovich Formation (unit Kss), showing calcareous concretions (c) and contact with overlying Herendeen Formation (unit Khe) on east shore of Herendeen Bay between Coal Bluff and Marble Point (left). Unit commonly forms smooth, brown slopes between resistant, Buchia-bearing sandstones (mapped here with upper Naknek Formation, unit Jni) and Herendeen Formation (unit Khe) in upper Coal Valley (right).

Naknek Formation (Late Jurassic; Tithonian to Oxfordian)—Originally named Naknek Series by Spurr (1900, p. 169-171, 179, 181) for exposures at Naknek Lake, approximately 375 km north of the map area. Detterman and others (1996) have subdivided unit into five members on Alaska Peninsula, [two of which are believed to be present in the map area: the Indecision Creek Sandstone Member (unit Jni) and the Northeast Creek Sandstone Member (unit Jnn).] In map area, the Naknek is dominantly sandstone and siltstone of the Indecision Creek Sandstone Member, although … sandstone and conglomerate of the Northeast Creek Sandstone Member are also present in Herendeen Bay-Port Moller area and northwest of Sapsuk Lake. Megafossils, particularly pelecypod *Buchia* (Detterman and Reed, 1980, p. B38; J.W. Miller, written communs., 1982-88), are common, and the fauna, which also includes ammonites, indicate an age range of Oxfordian to late Tithonian (Late Jurassic). The Naknek is conformable with the overlying Staniukovich Formation (unit Kst), and, although its lower contact is not exposed in map area, the Naknek is known to disconformably overlie the Middle Jurassic Shelikof Formation northeast of Chignik, 30 km north of map area (Detterman and others, 1981). [Detterman and others (1996) identify the Alaska-Aleutian Range batholith as the main provenance of the Naknek Formation, which faunal evidence indicates ranges in age from about 138 to 155 Ma; thus the batholith was uplifted and eroded shortly after emplacement. In map area, Naknek Formation is divided into:]


Indecision Creek member of the Naknek Formation (unit Jni). Buchia molds in sandstone on east shore of Herendeen Bay at Shingle Point (left), and poorly sorted conglomeratic sandstone at head of Johnson Fork (right).

Jni **Indecision Creek Sandstone Member (Tithonian and Kimmeridgian)**— Medium-gray, fine- to medium-grained arkosic sandstone and siltstone. Fresh biotite and hornblende are minor, but important, components of sandstone

Jnn **Northeast Creek Sandstone Member (Oxfordian)**—Light-gray arkosic sandstone, locally crossbedded, containing magnetite laminae and thin beds of conglomerate

Arkosic sandstone of the Northeast Creek member of the Naknek Formation (unit Jnn) in coastal exposures in southern Herendeen Bay east of Bold Bluff Point. Light gray stripe is band of cataclasis and calcite veining associated with normal faulting that juxtaposes Northeast Creek member with Indecision Creek member.

VOLCANIC ROCKS

Qv **Volcanic rocks (Holocene and Pleistocene)**—Basalt, andesite, and dacite lava flows, volcanic breccia, lahar deposits, and debris-flow deposits, which cap ridges or form volcanic edifices. Lava flows are porphyritic, typically glassy, gray to black, and commonly vesicular; individual flows are locally as much as 30 m thick and are laterally continuous over large areas. Potassium-argon ages [regionally] are as old as 1.1 Ma (Dubois and others, 1987; Wilson and Shew, 1992; [Wilson and others, 1994])…


Porphyritic felsic to intermediate Quaternary volcanics (unit Qv, left) with common euhedral pyroxene phenocrysts, photographed in float east of Bold Bluff Point, derived from thick flows capping Pinnacle Peak near head of Herendeen Bay. Dacite porphyry (right) is from probable hypabyssal sill or similar shallow intrusion associated with Quaternary extrusives just south of map boundary west of Deer Valley.

Tiu **Intrusive rocks, undivided (Tertiary)**—Small intrusive bodies of quartz diorite or diorite, typically hypabyssal and containing phenocrysts of pyroxene or hornblende in a fine-grained groundmass. No potassium-argon ages are available for these rocks

Tvu **Volcanic rocks, undivided (Tertiary)**—Andesite, dacite, and basalt lava flows, tuffs, lahar deposits and volcanic breccia, all locally hydrothermally altered or hornfelsed. No potassium-argon ages are available and little stratigraphic control exists for these rocks, but outcrop and erosional patterns are similar to other Tertiary volcanic rocks

Tm **Meshik Volcanics (early Oligocene and late Eocene)**—Originally named the Meshik Formation by Knappen (1929, p. 198-201) for exposures along Meshik River and near Meshik Lake, in Chignik (1:250,000) quadrangle. Detterman and others (1996) renamed the unit the Meshik Volcanics and included a measured section from the Gulf Oil Co. Port Heiden Unit No. 1 borehole, located north of map area near Port Heiden (Chignik D-3 1:63,360-scale quadrangle). This borehole penetrated almost 1,765 m of the Meshik before reaching total depth, still within the Meshik (Brockway and others, 1975). [Unit forms extensive andesitic to basaltic flows in eastern part of map area that appear to originate from vent area in mountains southwest of Mud Bay; unit also locally includes dacitic lithologies. The Meshik is interbedded with reworked volcaniclastic rocks assigned to the Stepovak Formation; mapped formation depends on which rock type predominates. Potassium-argon ages on four samples in the map area range from about 30 to 38 Ma (Wilson and others, 1994). Lower contact is interpreted as an angular unconformity]


Meshik Volcanics (unit Tm) on north shore of Staniukovich peninsula. Lithologies vary, ranging from massive, uniform, nearly unaltered flows (left) to auto-brecciated, vesicular to amygdaloidal, more weathered flows (right).

Sheet I-2: Description of map units in the Staniukovich Peninsula -- Herendeen Bay area, Alaska Peninsula

P.L. Decker[1], R.R. Reifenstuhl[2], R.J. Gillis[2], and A.M. Loveland[2]
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Affiliation:
[1] Alaska Division of Oil and Gas
[2] Alaska Division of Geological & Geophysical Surveys