U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Sitka National Historical Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Sitka National Historical Park

sitk_geology.pdf

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Geologic Resources Inventory Map Document for Sitka National Historical Park

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Geologic Resources Inventory Map Document

Sitka National Historical Park, Alaska

Document to Accompany Digital Geologic-GIS Data

sitk_geology.pdf

Version: 8/24/2016

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Sitka National Historical Park, Alaska (SITK).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit Listing** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) **Geologic Cross Sections** – Cross section graphic extracted from a source map.

6) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park (s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS map for Sitka National Historical Park, Alaska (SITK):

Digital Geologic Map for Sitka National Historical Park (SITK)

Karl, S.M., Haeussler, P.J., Himmelberg, G.R., and Zumsteg, C.L., 2015, Geologic Map of Baranof Island, Southeastern Alaska, U.S. Geological Survey, Scientific Investigations Map SIM-3335, 1:200,000 scale. (SIM-3335). *(GRI Source Map ID 76027).*

Berg, H.C., and Grybeck, D.J., 2005, Alaska Resource Data File, Sitka Quadrangle, Alaska, U.S. Geological Survey Open-File Report OF-2005-137, 1:250,000 scale. (OF-2005-1376). *(GRI Source Map ID 75173).*

Grybeck, D.J., 2005, Alaska Resource Data File, Port Alexander Quadrangle, Alaska, U.S. Geological Survey Open-File Report OF-2005-1168, 1:250,000 scale. (OF-2005-1168). *(GRI Source Map ID 76054).*

Additional information pertaining to each source map is also presented in the GRI Source Map Information (SITK MAP) table included with the GRI geology-GIS data.

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Sitka National Historical Park, Alaska (SITK) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qu - Unconsolidated deposits, undivided). Units are generally listed from youngest to oldest based on source map correlations; some age inconsistencies might exist. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (SITK UNIT) table included with the GRI geology-GIS data.

Cenozoic Era

Quaternary Period

g - Glacier
Qu - Unconsolidated deposits, undivided
Qda - Dacite flows of Crater Ridge
Qafr - Pyroclastic flow deposits of Crater Ridge
Qafd - Dacite air-fall tuffs of Mount Edgecumbe
Qafa - Andesitic air-fall tuffs of Mount Edgecumbe
Qafb - Basaltic air-fall tuffs of Mount Edgecumbe
Qafu - Undifferentiated pyroclastic deposits of Mount Edgecumbe
Qr - Rhyolite dome of Crater Ridge
Qa - Andesite and basaltic andesite flows of Mount Edgecumbe
Qb - Basalt flows of Mount Edgecumbe

Tertiary Period

Tif - Felsic intrusive rocks

Cenozoic Era and (or) Mesozoic Era

TMZs - Serpentinite

Cenozoic Era

Oligocene Epoch

Togd - Granodiorite of Gut Bay

Oligocene Epoch to Eocene Epoch

Toet - Tonalite
Toetm - Migmatite

Eocene Epoch

Tegb - Gabbro
Tegd - Granodiorite
Tet - Tonalite

Paleocene Epoch

Ts - Sandstone of Whale Bay

Cenozoic Era and Mesozoic Era

Tertiary and Cretaceous Periods
TKa - Argillite of Necker Bay
TKv - Volcanic rocks of Port Alexander

Cretaceous Period
Ksv - Volcanic rocks of Sitka Graywacke
Ks - Sitka Graywacke
Kss - Semischistose Sitka Graywacke

Cretaceous and Jurassic Periods
KJkk - Khaz Complex
KJks - Sandstone
KJkv - Volcanic rocks and chert

Mesozoic Era
MZsc - Schist
MZgn - Gneiss
MZum - Ultramafic rocks

Early Cretaceous Period
Kt - Tonalite of Alexander Terrane

Jurassic Period
Jt - Tonalite of Wrangellia Terrane
Jqd - Quartz diorite
Jd - Diorite

Triassic Period
TRp - Pinnacle Peak Phyllite
TRsv - Metasedimentary and metavolcanic rocks
TRm - Metalimestone
TRg - Goon Dip Greenstone

Paleozoic Era

PZsv - Metasedimentary and metavolcanic rocks of Nakwasina Sound
PZa - Amphibolite

Age Unknown
unmapped

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions were derived from U.S. Geological Survey Scientific Investigation Series Map SIM-3335

g - Glacier (Holocene)

No additional unit description provided. *GRI Source Map ID 76027* (SIM-3335)

Qu - Unconsolidated deposits, undivided (Quaternary)

Poorly sorted to well-sorted, massive, lenticular, and laminated clay, silt, sand, gravel, and boulders locally cover bedrock, sometimes to depths of many meters. Sediments include tidal mudflat, alluvial, colluvial, and glacial deposits, undivided. Glacial outwash deposits, peat, and unsorted till locally include thin layers of volcanic ash and lapilli tuff. *GRI Source Map ID 76027* (SIM-3335)

Qda - Dacite flows of Crater Ridge (Holocene)

Dark-brownish-gray, vesicular, plagioclase-phyric dacite. Massive dacite has local subtle flow foliation on the floor of a crater on Crater Ridge, Kruzof Island. Dacite has subseriate to porphyritic texture; phenocrysts include 10–12% plagioclase, 1–2% orthopyroxene, 1–2% clinopyroxene, and traces of opaque minerals (Riehle and others, 1989). *GRI Source Map ID 76027* (SIM-3335)

Qafr - Pyroclastic flow deposits of Crater Ridge (Holocene)

Massive deposits of poorly sorted ash, tuff, pumiceous lapilli, and blocks of dark-gray vitrophyre. Pumiceous lapilli are low-silica rhyolite (Riehle and others, 1989). Pyroclastic flows contain as much as 50% by volume lithic clasts composed of aphyric to sparsely porphyritic vitrophyre similar in major-element composition to the rhyolite domes (>70% SiO2) of Crater Ridge (Riehle and others, 1992a). Vitrophyric clasts range up to 1 m in size. The deposit at the vent on Crater Ridge is >80 m thick and includes five main depositional units (Riehle and others, 1989). Three different pyroclastic flow deposits have been identified on Mount Edgecumbe based on coherent directions of magnetization of vitrophyre clasts (Riehle and others, 1992a). *GRI Source Map ID 76027* (SIM-3335)

Qafd - Dacite air-fall tuffs of Mount Edgecumbe (Pleistocene)

Red-brown and dark-gray scoriaceous lapilli, pumice, breccia, and foliated vitrophyre. Lapilli are more than 75% glass by volume; the glass is yellow, pale orange, or pale brown when dry. On the rim of Mount Edgecumbe, the deposit is >50 m thick, compacted, and agglutinated into dense gray and red bands of dacitic vitrophyre (66–70% SiO2) (Riehle and others, 1989). Phenocrysts in the tuff are dominantly plagioclase, with subordinate clinopyroxene and orthopyroxene, and lesser opaque minerals and apatite. *GRI Source Map ID 76027* (SIM-3335)

Qafa - Andesitic air-fall tuffs of Mount Edgecumbe (Pleistocene)

Red-brown and dark-gray scoriaceous andesitic (57–63% SiO2) lapilli, breccia, and foliated vitrophyre, inferred to be compacted and agglutinated air-fall deposits (Riehle and others, 1989). Tuff includes 15–20% phenocrysts of plagioclase, 2–3% orthopyroene, 1–2% clinopyroxene, and trace opaque minerals. Plagioclase phenocrysts commonly contain glassy inclusions and granitic inclusions. Andesitic tephra

deposits are found as far as 30 km from the vents of the Mount Edgecumbe Volcanic Field (Riehle and others, 1992b). *GRI Source Map ID 76027* (SIM-3335)

Qafb - Basaltic air-fall tuffs of Mount Edgecumbe (Pleistocene)

Orange-weathering basaltic scoriaceous lapilli, mapped near vents where unit is >50 m thick (Riehle and others, 1989). Basaltic tephra deposits are found as far as 30 km from the vents of the Mount Edgecumbe Volcanic Field (Riehle and others, 1992b). *GRI Source Map ID 76027* (SIM-3335)

Qafu - Undifferentiated pyroclastic deposits of Mount Edgecumbe (Pleistocene)

Compositionally undifferentiated reddish to yellowish-brown lapilli and ash. *GRI Source Map ID 76027* (SIM-3335)

Qr - Rhyolite dome of Crater Ridge (Pleistocene)

Dark-gray, sparsely plagioclase and pyroxene porphyritic, pilotaxitic, low-silica rhyolite with scattered vesicles and near-vertical foliation contains 3–10% phenocrysts of plagioclase, <1% orthopyroxene and clinopyroxene, and trace opaque minerals (Riehle and others, 1989). *GRI Source Map ID 76027* (SIM-3335)

Qa - Andesite and basaltic andesite flows of Mount Edgecumbe (Pleistocene)

Andesite dome on top of Mount Edgecumbe is holocrystalline, porphyritic, vesicular, and contains 10–15% subhedral plagioclase phenocrysts, 3–5% orthopyoxene phenocrysts, 2–4% clinopyroxene phenocrysts, and trace opaque minerals; plagioclase phenocrysts commonly contain glassy inclusions (Riehle and others, 1989). Andesite domes are unglaciated. Andesitic flows are dark gray, banded to thinly plated with variably oriented flow foliation, and contain <2% plagioclase and pyroxene phenocrysts in a pilotaxitic, or sometimes hyalopilitic, groundmass (Riehle and others, 1989). Massive flows 15–30 m thick form seacliffs as much as 60 m high at Cape Edgecumbe. High-silica basaltic andesite flows are subseriate porphyritic, trachytic, or glomeroporphyritic, holocrystalline, and contain as much as 15% plagioclase, 3% clinopyroxene, 2% olivine, 1% orthopyroxene, and 2% opaque minerals (Riehle and others, 1989). Basaltic andesite 2 km west of Shoals Point contains plastically deformed xenoliths of graywacke and tonalite. This composite unit includes multiple andesite units described individually in Riehle and others (1989) that are collectively underlain by basalt flows and overlain by the dacite pyroclastic unit. *GRI Source Map ID 76027* (SIM-3335)

Qb - Basalt flows of Mount Edgecumbe (Pleistocene)

Massive, dark-gray, vesicular plagioclase, olivine, and clinopyroxene porphyritic basalt flows with intercalated breccia and aquagene tuff. A tuff intercalated with flows on the east coast of Kruzof Island contains marine macrofossils and benthic foraminifers that imply Pleistocene deposition in water 50–100 m deep (William Sliter, written commun., *in* Riehle and others, 1989). Flows appear to cluster in two groups: (1) a glomeroporphyritic, holocrystalline to vitrophyric plagioclase basalt that contains as much as 35% plagioclase, 3% olivine,and 1% clinopyroxene and (2) vesicular, diktytaxitic, diabasic, or equigranular to porphyritic olivine basalt that contains as much as 50– 60% plagioclase, 15–25% olivine, and 15–25% subophitic clinopyroxene (Riehle and others, 1989,1994). The plagioclase basalt has trace-element ratios similar to mid-ocean-ridge basalt and is located closer to the Fairweather Fault. The olivine basalt is mapped farther inboard (east) of the Fairweather Fault, has trace-element ratios that

suggest continental affinity, and has higher $^{87}Sr/^{86}Sr$ ratios than the plagioclase basalt (Riehle and others, 1994). Hornblende diabase and olivine diabase also intrude the Crawfish Inlet Pluton in dikes as much as 5 m thick. Loney and others (1975, p. 54) suggested that the olivine diabase dikes may be cogenetic with the Edgecumbe volcanics and noted that the olivine diabase dikes are glaciated. Most Edgecumbe basalts predate the LGM; the timing of Pleistocene glaciations on Mount Edgecumbe is poorly constrained. *GRI Source Map ID 76027* (SIM-3335)

Tif - Felsic intrusive rocks (Tertiary)

Very light gray to buff aplite and fine-grained granite. Forms dikes, dike swarms, sills, and small stocks. Contains <5% mafic minerals, which include biotite, hornblende, and pyrite. Not magnetic. Accessory minerals also include titanite and epidote. Some dikes are altered to quartz, albite, chlorite, calcite, and sometimes prehnite. Centimeter-to meter-scale felsic dikes are common throughout the map area. A small stock is mapped approximately 1 km southwest of Middle Arm Kelp Bay. *GRI Source Map ID 76027* (SIM-3335)

TMZs - Serpentinite (Tertiary and (or) Mesozoic)

Yellowish-brown-weathering, gray to black, clinopyroxene-antigorite and talc-tremolite-chrysotile serpentinite. Lenticular bodies of serpentinite range from a meter to more than 1.5 km in length and as much as 0.5 km in width. They mainly occur as concordant sills striking northwest and dipping steeply to the northeast (Guild and Balsley, 1942) and are mostly associated with strands of the Patterson Bay Fault. The serpentinite contains relict clinopyroxene and secondary talc, antigorite, tremolite, and thin layers and concentrations of chromitite and chromian spinel rimmed by metamorphic magnetite, which is inferred by Himmelberg and Loney (1995) to result from thermal metamorphism. Contacts between the serpentinites and the adjacent metasedimentary and metavolcanic rocks are sharp and locally sheared. The serpentinite bodies have strong pervasive foliations that are parallel to contacts. Weathered surfaces show internal breccia textures that predate the foliations, and Loney and others (1975) interpreted the serpentinites as tectonic intrusions. Chlorite-filled shear zones cut both the country rocks and the serpentinite bodies, leading Loney and others (1975) to infer that the talc-tremolite rocks formed at higher temperatures and deeper levels and were displaced upward along chlorite-filled shear zones. Serpentinite protoliths are inferred to be clinopyroxene-bearing olivine-rich ultramafic rocks similar to the ultramafic rocks at Red Bluff Bay (Himmelberg and Loney, 1995). *GRI Source Map ID 76027* (SIM-3335)

Togd - Granodiorite of Gut Bay (Oligocene)

Light-gray, medium-grained, hypidiomorphic hornblende-biotite granodiorite. Hornblende is roughly equivalent in abundance to biotite; color index is 5 to 15. The granodiorite is not magnetic. A high-temperature magmatic fabric is defined by mafic minerals near pluton margins. Plutons contain schlieren of hornblende tonalite and hornblende gabbro. No intrusive contacts have been observed between the Gut Bay Pluton and the Crawfish Inlet Pluton by Loney and others (1975) or in this report. Thin sections show cataclastic textures near contacts on the east side of the Crawfish Inlet Pluton. The topographic expression of a strand of the Patterson Bay Fault coincides with the contact between the plutons and falls within the area in which the plutons contain cataclastic textures; therefore, the fault is inferred to postdate emplacement of the Gut Bay Pluton. *GRI Source Map ID 76027* (SIM-3335)

Toet - Tonalite (Oligocene to late Eocene)

Light-gray medium-grained hornblende-biotite tonalite and gradational to subordinate granodiorite and trondhjemite. Color index ranges from 15 to 30. Tonalite and associated igneous rocks are not magnetic. Biotite exceeds hornblende, and the Kasnyku Lake Pluton contains as much as 5% red almandine

garnet, as large as 4 mm in diameter, as noted by Loney and others (1975, p. 47). The unit is mainly represented by the Kasnyku Lake Pluton, named by Loney and others (1975), which includes several ages of intrusions. Loney and others (1975) reported that “trondjhemite is an abundant and characteristic rock type that occurs as dikes and irregular plutons intruding the hornblende tonalite” around Kasnyku Bay and west of Takatz Lake. Pegmatite dikes intrude both phases. Loney and others (1975) also described a younger phase of tonalite that intrudes the Kasnyku Lake tonalite in the vicinity of Warm Springs Bay. The different phases of the Kasnyku Lake Pluton have not been systematically mapped previously or in our report. Unit includes the Vodopod Pluton west of Nelson Bay and the small stock in the bay south of Nelson Bay. *GRI Source Map ID 76027* (SIM-3335)

Toetm - Migmatite (Oligocene to late Eocene)

Migmatites consist of leucocratic neosomes with fine-to coarse-grained pegmatitic textures, and wavy, chaotic, and irregularly banded gneiss with septa and inclusions of host rock. The neosomes contain quartz, feldspar, and biotite and are locally gradational to segregation layering in gneissic host rocks. Migmatites are peripheral to intrusive rocks associated with Toet body in Takatz Bay and Warm Springs Bay. *GRI Source Map ID 76027* (SIM-3335)

Tegb - Gabbro (Eocene)

Dark-gray, coarse-grained, massive altered gabbro and norite that is altered to secondary hornblende, albite, magnetite, and abundant apatite (Buddington, 1926; Reed and Gates, 1942). Unit consists of a small body, about 15 m thick, east of Snipe Head on southwestern Baranof Island. The gabbro has intrusive contacts in graywacke semischist that trend parallel to the fabric of the host rocks. The gabbro does not have a foliation and postdates the metamorphic fabric in the host rocks. Mineralization in the body at Snipe Head consists of disseminated magnetite, nickeliferous pyrrhotite, chalcopyrite, and pentlandite in a lens of massive sulfide about 2 m in thickness, which is interpreted to be a magmatic segregation deposit (Buddington, 1925; Reed and Gates, 1942). The magnetite is enclosed in hornblende and pyrrhotite. The altered gabbro is different in composition from the dunite-wherlite and clinopyroxenite at Red Bluff Bay. The copper-nickel mineralization of the altered gabbro also differs from the chromite mineralization in the ultramafic rocks at Red Bluff Bay and chromite in the serpentinite lenses in the Patterson Bay Fault Zone. *GRI Source Map ID 76027* (SIM-3335)

Tegd - Granodiorite (early Eocene)

Light-gray, massive, medium-grained seriate, locally plagioclase porphyritic, biotite granodiorite gradational to hornblende-biotite tonalite. The granodiorite contains abundant inclusions of metasedimentary host rock and is less homogenous in composition and texture than the tonalite phases of the Eocene plutons (Reifenstuhl, 1986). K-feldspar is interstitial to quartz and plagioclase in the granodiorite; orthoclase is common and perthite is rare. Plagioclase phenocrysts range from 2 mm to 8 mm and are zoned and twinned with An contents ranging from An45 to An25 (Loney and others, 1975; Reifenstuhl, 1986). Biotite is consistently dominant over hornblende. Mafic minerals are subhedral and <5 mm in dimension. Color index ranges from 10 to 25. The granodiorite is not magnetic. Accessory minerals include zircon, titanite, apatite, opaque minerals, and rare allanite. Minor alteration to sericite, chlorite, and epidote is common. Aluminum in hornblende from the Crawfish Inlet Pluton and aureole mineral compositions indicate emplacement at approximately 3 kb (Brew and others, 1991b). Thermobarometric calculations for andalusite-and sillimanite-bearing samples from the thermal aureole south of the pluton indicate pressures of 3.4 to 6.9 kb (Zumsteg and others, 2003). *GRI Source Map ID 76027* (SIM-3335)

Tet - Tonalite (early Eocene)

Light-gray, medium-grained hornblende-biotite tonalite and biotite-hornblende tonalite, gradational to subordinate biotite-hornblende granodiorite, quartz monzonite, and quartz diorite. Tonalite is the dominant phase of the plutons in Crawfish Inlet, Redfish Bay, and Indigo Lake and on Kruzof Island. Tonalite in the core of the Crawfish Inlet Pluton is relatively homogenous, inclusion poor, and medium grained. Biotite is dominant over hornblende with subordinate muscovite. Biotite grains range from 2 mm to 4 mm in size; hornblende ranges from 1 mm to 3 mm in size. Color index ranges from 5 to 40. Tonalite is not magnetic. K-feldspar is interstitial and <2 mm in size. Locally the tonalite is plagioclase porphyritic, with phenocrysts ranging to 10 mm in size. Plagioclase is andesine, with an average composition of An33 (Reifenstuhl, 1986). Tonalite grades to small zones of medium-to dark-gray, medium-grained, hornblende±biotite±pyroxene quartz diorite with hornblende dominant. Crosscutting alaskite phases contain oligoclase, microcline, biotite, muscovite, and garnet. *GRI Source Map ID 76027* (SIM-3335)

Ts - Sandstone of Whale Bay (Paleocene)

Gray, thin-bedded to massive, medium-to fine-grained, siliciclastic sandstone, siltstone, and mudstone turbidites, alternating with meter-scale sections of argillite that contain thin layers and lenses of sandstone and subordinate, polymictic, matrix-supported conglomerate. Sand/shale ratios are mostly >1 and commonly >20:1. Turbidite bedding structures, including grading and ripple lamination, and centimeter to meter thickness indicate mainly inner fan facies deposition according to the model of Mutti and Ricci-Luchi (1972). Graded beds, flame structures, and thinning-upward cycles indicate beds are mostly upright with tops to east and northeast, suggesting that structural imbrication is dominant over isoclinal folding. Fold axes have shallow northwest plunges. Although primary depositional features are commonly preserved, primary detrital minerals are altered and recrystallized. These rocks contain metamorphic biotite, garnet, and andalusite indicating they are metamorphosed to greenschist facies. The rocks have a pervasive fabric that ranges from slatey cleavage to semischist and is truncated by Eocene intrusive rocks. The rocks contain pre-deformation boudinaged quartz veins, folded muscovite- and biotite-bearing quartz veins, and late, crosscutting, planar, post-deformation quartz veins that are perpendicular to bedding and fabric. *GRI Source Map ID 76027* (SIM-3335)

TKa - Argillite of Necker Bay (Tertiary and Cretaceous)

Dark-gray semischistose mudstone, argillite, pelitic phyllite, and muscovite schist that locally contain secondary biotite, almandine garnet, andalusite, sillimanite, and pyrite. The protolith is dominantly mudstone; subordinate thin beds of graywacke sandstone and limestone layers are locally preserved. In Necker Bay, phyllitic argillite contains lenses of limestone as much as 2 m thick. Sandstones locally have flaser bedding, turbidite bedding structures, slump structures, and soft-sediment deformational features. At Mount Muravief, the mudstone is matrix to a mélange that contains blocks of greenstone, volcanic wacke, and chert. The dark gray color and fine-grained sediments are inferred to indicate slow deposition in an oxygen-poor depositional environment such as a forearc slope. Metamorphic fabric and degree of recrystallization is variable in this unit. The pelitic semischist is tightly folded, locally rodded, and highly strained, and intercalated sandstone and chert beds are extended into strings of boudins. Early quartz veins that cut the unit are folded and boudinaged; late quartz veins fill tension gashes and are locally offset on steep sinistral faults. At Mount Muravief, the argillite unit has a pervasive fabric and a sharp, steep fault contact with the graywacke semischist unit (Kss). *GRI Source Map ID 76027* (SIM-3335)

TKv - Volcanic rocks of Port Alexander (Tertiary and Cretaceous)

Dark-green actinolite semischist interlayered with semischistose sandstone turbidites and pelitic phyllite. Protoliths are inferred to be mafic sills and flows. The greenstone semischist has a penetrative fabric. Metamorphic mineral assemblages include blue-green hornblende/ actinolite+biotite+epidote±garnet and actinolite+chlorite+calcite, indicating greenschist to epidote-amphibolite facies metamorphism. Greenstone semischists are mapped at Port Alexander, Port Conclusion, and Snipe Bay. *GRI Source Map ID 76027* (SIM-3335)

Ksv - Volcanic rocks of Sitka Graywacke (Cretaceous)

Dark-green mafic volcanic rocks are interlayered with graywacke turbidites as massive and amygdaloidal volcanic flows, pillow basalt, breccia,and thick sills. The volcanic rocks are locally recrystallized and contain secondary chlorite and epidote. The chemistry of the basalts is tholeiitic, and trace elements plot in ocean-floor fields on various trace-element diagrams (Decker, 1980a). These volcanic rocks are mapped on two islands in Sitka Sound; there are more extensive exposures to the north on Chichagof Island. *GRI Source Map ID 76027* (SIM-3335)

Ks - Sitka Graywacke (Cretaceous)

Tan-weathering, light-to dark-gray, massive to thin-bedded, medium-to fine-grained graywacke, named the Sitka Group by Berg and Hinckley (1963) and the Sitka Graywacke by Loney and others (1963). Unit includes massive graywacke sandstone in beds as much as 10 m thick, amalgamated beds with rafts of sandstone and mudstone, medium-to thick-bedded sandstone, graded beds, laminated beds, slumped beds, thin rhythmic beds of sandstone and mudstone, full Bouma sequence turbidites, argillite with slump structures and soft-sediment deformational features, and massive polymictic conglomerate. Sandstone locally contains web structures that indicate deformation during a semilithified state (Cowan, 1982b). Sandstone and siltstone turbidites are dominant, with subordinate meter-scale lenses of argillite and conglomerate. Intercalated basalt flows, sills, and dikes are mapped as unit Ksv when they have mappable thicknesses. Conglomerate is massive, mainly matrix-supported but locally clast-supported. Typical proportions of conglomerate clast types are 50% argillite, 25% mafic to felsic volcanic rocks, 20% graywacke; a few percent granite, diorite, chert, and vein quartz, and rare limestone and greenstone. Clasts are rounded to angular and very poorly sorted. Bases of beds are indistinct; scour or lag deposits have not been observed. Massive conglomerate is inferred to represent mass flows, corresponding to inner trench or canyon facies in the model of Mutti and Ricci-Luchi (1972). Massive, amalgamated sandstone beds and turbidites are interpreted to represent proximal fan, inner trench, canyon fill, and overbank deposits (Decker and others, 1979; Decker, 1980a). The lack of distal fan facies, defined in models of Mutti and Ricci-Luchi (1972), supports the interpretation that the Sitka Graywacke represents longitudinal trench deposits (Decker, 1980a). Sandstone mineralogy includes monocrystalline quartz, polycrystalline quartz, potassium feldspar, plagioclase, detrital biotite, muscovite, and chlorite, epidote, amphibole, argillite, phyllite, quartz mica schist, quartzite, carbonate, calc schist, greenschist, greenstone, mafic and felsic volcanic rock fragments, radiolarian chert, foliated chert, and coal. The average sandstone composition in the Sitka Sound area consists of 25% quartz, 20% plagioclase, 8% K-feldspar 12% shale, slate, or phyllite, 25% volcanic rock fragments, 3% hornblende, 3% biotite, and traces of white mica, myrmekite, and chert, interpreted to have volcano-plutonic provenance (Reifenstuhl, 1986). Decker (1980a) suggested subdividing the Sitka Graywacke of Loney and others (1963) into a thinner-bedded sandstone-siltstone-mudstone unit (Ford Arm Formation, newly named therein) and a more massive sandstone unit (Sitka Graywacke). The units cannot be distinguished by age or sandstone mineralogy, and the distinction is difficult to apply on Baranof Island, where thick sections of medium-to thin-bedded sandstone and mudstone alternate with massive sandstone. Both units of Decker (1980a) contain felsic and mafic volcanic and plutonic minerals and lithic fragments; both units contain roughly equivalent amounts of potassium feldspar (although

potassium feldspar is more altered in the Ford Arm Formation); and both units contain metamorphic rock fragments such as quartz-sericite schist, marble, and greenstone. Decker (1980a, p. 71) also noted that his Ford Arm Formation carried a stronger metamorphic overprint than the Sitka Graywacke. Differences in detrital zircon age populations in samples from a transect across Sitka Sound indicate potential for mapping structural panels of different age in the Sitka Graywacke. Samples from the western end of the transect contain younger zircons than the eastern samples, suggesting incremental, time-transgressive, seaward-propagating accretion of panels of Sitka Graywacke turbidites. Thin sections from the western, farther seaward, younger samples from the transect do not contain veinlets of quartz, calcite, or prehnite. Quartz-prehnite veins and clots are common in the eastern, more arcward, older set of samples, suggesting that the eastern set of samples is an older, more recrystallized structural package, possibly analogous to Decker's Ford Arm Formation, but a thin-bedded unit corresponding to the Ford Arm Formation was not identified on Baranof Island. The Sitka Graywacke is folded, but beds are dominantly upright with tops facing northeast. Stratigraphic thickness is unknown. Increasing age of the zircons to the northeast together with facing direction suggests imbrication of thrust panels of graywacke and westward time-transgressive deposition and structural thickening of the unit. The Sitka Graywacke has been thermally metamorphosed to hornblende-hornfels facies at pluton contacts and albite-epidote hornfels within a kilometer of the contacts, which together are indicated by a stipple pattern on the map. Aphanitic to fine-grained hornfels contains randomly oriented metamorphic biotite in narrow aureoles adjacent to most Tertiary plutons. Hornfels locally contains hornblende, garnet, and pyrite near pluton contacts. Near the contact with the Crawfish Inlet Pluton on the northwest side of Redoubt Lake, hornfels contains hornblende-cordierite-garnet (Reifenstuhl, 1986), interpreted to represent emplacement conditions of <2 kb,corresponding to metamorphism at a depth of <6.5 km (Brew and others, 1991b) for rocks on the north side of the pluton. South of the Crawfish Inlet Pluton, where the graywacke is regionally metamorphosed to greenschist and amphibolite facies, it is mapped separately as unit Kss (see below).On southern Baranof Island, thermal aureole mineral assemblages that include sillimanite overprint regional amphibolite facies metamorphic minerals in the graywacke semischist units Kss and Ts. *GRI Source Map ID 76027* (SIM-3335)

Kss - Semischistose Sitka Graywacke (Cretaceous)

Semischistose graywacke and mudstone containing biotite, almandine garnet, andalusite, and sillimanite, mapped south of the Crawfish Inlet Pluton. The dominant protolith is massive to thick-bedded sandstone; rhythmic turbidite bedding structures are locally preserved. Mudstone is metamorphosed to sericitic phyllite. The semischist and phyllite show evidence for two generations of folding and have a strong lineation that predates thermal metamorphism. The semischist is highly strained; pelitic layers are locally rodded and have quartz pressure shadows around porphyroclasts. The deformation fabric is northwest striking and is truncated by the Eocene Redfish Bay and Crawfish Inlet Pluton margins. Sillimanite, andalusite, and garnet isograds in the semischist are parallel to pluton margins and crosscut the regional metamorphic fabric. Calculated pressures and temperatures for garnet and biotite in andalusite-and sillimanite-bearing semischists yield P-T values that fall in the sillimanite stability field, mostly at pressures higher than the maximum stability of andalusite (Zumsteg and others, 2003). Early metamorphism of the semischist is recorded in pressures as high as 6.9 kb and temperatures around 755 °C, followed by rapid uplift and cooling at approximately 3 kb and 575 °C (Zumsteg and others, 2003).Calculations of temperature and pressure for garnet and biotite indicate metamorphism associated with pluton emplacement took place at about 3 kb and 575–630 °C for the andalusite-bearing samples and 665–740 °C for the sillimanite-bearing samples (Zumsteg and others, 2003). Three generations of quartz veins within unit Kss record evolution of the metamorphic history of the semischist: (1) the earliest metamorphic fabric in sandstone includes incipient, sparse quartz segregation layers accompanied by dismembered fold hinges that form strings of metagraywacke boudins; (2) a second generation of north-northwest-striking folded quartz veins cuts quartz segregation layers in the semischist; and (3) a third generation of vertical gash veins and planar quartz veins as much as 20 cm thick and 10 m long strike east-west, locally parallel to the Crawfish Inlet Pluton margin. Alteration and

copper mineralization at Mount Muravief is associated with the late gash veins that postdate deformation, metamorphism, and a fault contact between the graywacke semischist unit (Kss) and the pelitic unit (TKa). *GRI Source Map ID 76027* (SIM-3335)

KJkk - Khaz Complex (Cretaceous and Jurassic)

The Khaz Complex is a name revision herein for the Khaz Formation of Loney and others (1975). The name is revised because the term formation is used for stratigraphic units; rocks of the Khaz Complex do not retain internal stratigraphy, do not have stratigraphic relations to adjacent units, and are characterized by pervasive ductile to brittle, high-strain deformation textures. The Khaz Complex is composed dominantly of slatey argillite and tuff that contain blocks of various sedimentary, volcanic, plutonic, and metamorphic lithologies. The argillite, tuff, and graywacke matrix lithologies are locally massive, locally retain turbidite depositional features, and locally contain slump structures and slumped blocks. Chaotic deformation disrupts layering. Tectonic blocks incorporated into the matrix include volcanic and sedimentary rocks from the down going oceanic plate, sedimentary and igneous rocks from the accretionary wedge, metamorphic rocks from deeper in the subduction complex, and rocks derived from the upper plate that are mixed by multiple generations of faults. Blocks and matrix are disrupted and displaced along thrust faults, strike-slip faults, and extensional-slip faults, forming a tectonic mélange. In some places, a pervasive but inhomogeneous cataclastic fabric overprints soft-sediment-deformation textures in argillite, tuff, graywacke, chert, and limestone;in other places, high-strain phyllonitic to protomylonitc fabrics overprint folded metamorphic foliations and folded and boudinaged quartz±calcite±prehnite veins. Wispy centimeter-scale trails of gray mudstone or siltstone and green tuff are chaotically folded; lenses and blocks of sandstone, basalt, limestone, and chert form facoids and boudins. Faulted folds, cataclastic fabric, trains of boudins, and rotated boudins with asymmetric quartz-filled strain shadows indicate multiple stages of deformation during and after lithification and record progressive ductile and brittle deformation that is highly variable across the map area. Gray, fine-grained thermally recrystallized volcanic and sedimentary rocks in unit KJkk contain metamorphic biotite, andalusite, pyrite, and garnet in proximity to Tertiary plutons. Migmatite in Takatz Bay (unit Toetm) contains inclusions of hornfelsic mélange of unit KJkk that retain cataclastic textures, indicating cataclastic deformation predated the emplacement of the migmatite associated with the Kasnyku Lake Pluton. *GRI Source Map ID 76027* (SIM-3335)

KJks - Sandstone (Cretaceous and Jurassic)

Dull-green graywacke, volcanic wacke, argillite turbidites, and subordinate polymictic conglomerate. Unit also includes gray and green, thin-to medium-bedded volcaniclastic turbidites and interbedded tuff. Graywacke contains relict grains of quartz, plagioclase, volcanic lithic fragments, felsite, and chert. On Chichagof Island, graywacke has an average composition of 20.7% quartz, 14.5% plagioclase, 2.1% K-feldspar, 9.25% sedimentary rock fragments, and 39.7% volcanic rock fragments (n=6, Decker, 1980a). Volcanic wacke contains more volcanic lithic fragments than the graywacke and as much as 25% matrix. On northern Baranof Island, sandstone contains 5–15% quartz, 10–25% plagioclase, no K-feldspar identified by Na-cobaltinitrate staining (possibly due to recrystallization or alteration), 5–15% sedimentary rock fragments, and 40–60% volcanic rock fragments (Karl, n= 7). Conglomerate is matrix supported in some places, and clast supported in other places. Conglomerate clasts are dominantly sedimentary and volcanic, with subordinate diorite, chert, and limestone. Graywacke retains turbidite structures, including graded bedding, thinning-upward cycles in sections with equal amounts of sandstone and mudstone, and mud-dominated sections with centimeter-scale layers of siltstone. These bedding features suggest deposition in deep water. Intercalated layers of calcareous mudstone contain lenses of altered tuff as much as 4 m in thickness. Although bedding structures are preserved, thin sections show a pervasive deformation fabric, ranging from an anastomozing cataclastic shear fabric to a planar flattening fabric. Pebbles in conglomerate in Saook Bayare stretched to 5:1. The unit is altered, recrystallized, and contains quartz-calcite-prehnite veins. Secondary minerals include calcite, epidote,

chlorite, sericite, pyrite, prehnite, and very rare biotite. Plagioclase in most thin sections is altered to calcite. This unit is more volcaniclastic and more pervasively recrystallized and deformed than the Sitka Graywacke. *GRI Source Map ID 76027* (SIM-3335)

KJkv - Volcanic rocks and chert (Cretaceous and Jurassic)

Dark-green, fine-grained mafic volcanic rocks with meter-scale lenses of ribbon chert and subordinate mudstone and sandstone. Volcanic rocks include pillow basalt flows, breccia, and massive sills. Massive greenstones are fine grained, holocrystalline to devitrified hypocrystalline; some contain subophitic textures and may be sills; some may be volcaniclastic. Primary minerals include plagioclase and clinopyroxene; secondary minerals include epidote, chlorite, albite, quartz, carbonate, prehnite, and pumpellyite. Geochemical analyses of mafic volcanic rocks indicate compositions range from alkaline to tholeiitic, and trace elements plot in ocean floor, within plate, and in island arc fields (Karl, 1982). High Ti contents suggest some basalts may represent seamounts. Variations in thickness, texture, chemistry, and associated sedimentary rock types indicate the basalts are derived from a variety of magmatic sources and tectonic environments (Karl, 1982). Chert beds are 1–15 cm in thickness, in sections several to tens of meters in thickness. The volcanic rocks and chert do not have a penetrative fabric. Locally, greenstone has cataclastic or mylonitic textures. Mafic volcanic rocks associated with ribbon chert are mapped in Katlian Bay, Rodman Bay, Hanus Bay, and Kelp Bay. *GRI Source Map ID 76027* (SIM-3335)

MZsc - Schist (Mesozoic)

Dark-gray biotite schist and semischist, containing garnet, staurolite, andalusite, and (or) sillimanite. Primary structures are not preserved; segregation layering is poorly developed. Variations in calcareous and siliceous layering in the schist are inferred to represent original differences in composition. Protoliths are dominantly pelitic and include mudstone and volcaniclastic rocks. Metamorphic mineral assemblages are most commonly quartz-plagioclase-muscovite-biotite-garnet±staurolite±sillimanite and represent amphibolite facies assemblages (Zumsteg and others, 2003). Garnet porphyroblasts range from anhedral to euhedral and staurolite is subhedral. Sillimanite occurs as fine needles and mats. The schists contain granoblastic quartz and feldspar, and foliations are defined by mica and incipient segregation layering. Metamorphic conditions are inferred from thermobarometric calculations of mineral compositions that indicate temperatures ranging from about 620 to 780 °C at pressures of about 5.5 to 6.6 kbar (Zumsteg and others, 2003). Unit is gradational to gneiss unit MZgn. *GRI Source Map ID 76027* (SIM-3335)

MZgn - Gneiss (Mesozoic)

Gray and white, fine-to medium-grained, centimeter-banded quartzofeldspathic biotite gneiss and hornblende-plagioclase gneiss, containing garnet, staurolite, andalusite, sillimanite, and rare cordierite. The metamorphic mineral assemblage indicates amphibolite facies metamorphism. Thermobarometry of sillimanite-bearing gneiss yields temperatures ranging from 620 to 780 °C at pressures of 5.5 to 6.6 kb (Zumsteg and others, 2003). Quartz-plagioclase-muscovite-chlorite-biotite-garnet associations with overprinting hornfels texture occur near contacts with the Kasnyku Pluton and are considered to represent thermal recrystallization of pre-existing sillimanite-grade, regionally metamorphosed rocks (Zumsteg and others, 2003). Unit is gradational to schist (MZsc) and also gradational to chaotically disrupted quartzofeldspathic biotite hornblende gneiss intruded by ptygmatic quartz veins, masses of leucocratic neosome, pegmatite, and migmatite at the margins of the Kasnyku Lake Pluton. *GRI Source Map ID 76027* (SIM-3335)

MZum - Ultramafic rocks (Mesozoic)

Red-weathering, black, fine-grained dunite-wherlite and clinopyroxenite form a body 3 km by 6 km in Red Bluff Bay. Dunite, wherlite, and clinopyroxenite are both layered and massive, are not zoned, and retain cumulus textures. Massive dunite gradational to wherlite forms the west half of the body at Red Bluff Bay, is faulted against dunite-wherlite that is intruded by irregular masses and veins of clinopyroxenite, and alternates with clinopyroxenite in cumulus layers 2–50 cm thick in the east half of the body (Himmelberg and Loney, 1995). Chromian spinel layers and lenses occur in concentrations that have been prospected, but the chromite is iron rich and subeconomic (Guild and Balsley, 1942; Loney and others, 1975). Magnetite occurs as a secondary mineral resulting from serpentinization and recrystallization. All observed contacts at the margin of the Red Bluff Bay ultramafic body are faults, and no thermal aureole has been observed in adjacent metasedimentary and metamorphic rocks. The dunite-wherlite and clinopyroxenite are cut by north-and northeast-striking shear zones and are altered to talc along the shear zones. The presence of chromite deposits, the lack of primary magnetite and hornblende, high Mg numbers, and low Fe numbers distinguish Red Bluff Bay ultramafic rocks from Alaskan zoned ultramafic complexes that are interpreted to represent the roots of a volcanic arc (Himmelberg and Loney, 1995). Olivine and pyroxene compositions and textures of the Red Bluff Bay body do not indicate an origin as cumulates within an ophiolite complex, so the Red Bluff Bay body is not thought to represent a piece of oceanic crust faulted into the metasedimentary rocks (Himmelberg and Loney, 1995). High Cr contents suggest the ultramafic rocks in Red Bluff Bay may be analogous to blocks of the Border Ranges Ultramafic-Mafic Complex, derived from the mantle beneath an arc, in south-central Alaska (Burns, 1985; Debari and Coleman, 1989; Debari and Sleep, 1991; Bradley and others, 1999). *GRI Source Map ID 76027* (SIM-3335)

Kt - Tonalite of Alexander Terrane (Early Cretaceous)

Medium-gray to greenish-gray, medium-grained, hornblende tonalite, quartz diorite, diorite, leucogabbro, and gabbro. These intrusive rocks are heterogenous in composition and texture, commonly hypidomorphic-granular, locally layered, and locally foliated. Primary minerals include quartz and plagioclase (An35–78 , dominantly andesine), biotite, hornblende, and subordinate augite and olivine (Loney and others, 1975). Secondary minerals include calcite, prehnite, sericite, epidote, chlorite, titanite, magnetite, and serpentine. Color index ranges from 15 to 25. These intrusive rocks are magnetic. The pluton has cataclastic textures near the Peril Strait Fault. Mapped on Catherine Island. *GRI Source Map ID 76027* (SIM-3335)

Jt - Tonalite of Wrangellia Terrane (Late Jurassic)

Gray and green, massive, medium-grained, biotite-hornblende hypidiomorphic, seriate tonalite. Primary minerals include quartz, plagioclase (An35–45 ,andesine), biotite, hornblende, rare muscovite, garnet, and titanite (Loney and others, 1975). Commonly altered. Secondary minerals include calcite, albite, prehnite, epidote, chlorite, sericite, and magnetite. Color index ranges from 5 to 35. Geochemical element ratios indicate calc-alkaline affinities (Karl), suggestive of a magmatic arc source. Tonalite intruded amphibolite facies rocks (PZa), greenschist facies rocks (PZsv), and low-grade Triassic sedimentary and volcanic rocks (TRsv). No intrusive contacts with rocks of the Baranof Accretionary Complex have been observed. Mapped on the Duffield Peninsula and in Fish Bay. *GRI Source Map ID 76027* (SIM-3335)

Jqd - Quartz diorite (Middle Jurassic)

Green, medium-to fine-grained hornblende quartz diorite and diorite. Hornblende-biotite quartz diorite and tonalite. Medium-gray, medium-grained, locally has magmatic foliation defined by hornblende alignment. Mafic minerals are locally altered to epidote and chlorite. Quartz diorite also locally contains secondary

disseminated pyrite and chalcopyrite. Color index ranges from 35 to 40. Intruded amphibolite facies rocks (PZa) and greenschist facies rocks (PZsv). No intrusive contacts with rocks of the Baranof Accretionary Complex have been observed. *GRI Source Map ID 76027* (SIM-3335)

Jd - Diorite (Early Jurassic)

Green, medium-grained, hornblende±biotite diorite. Pervasively altered to chlorite, actinolite, and epidote. Color index ranges from 25 to 35. Diorite is not magnetic. Geochemical element ratios indicate calc-alkaline affinity (Karl), which suggests an arc source for the diorite. High-temperature magmatic foliations defined by aligned amphibole suggest syntectonic emplacement. In the Nakwasina Sound area, diorite has cataclastic textures in shear zones inferred to be associated with Tertiary strike-slip faults. *GRI Source Map ID 76027* (SIM-3335)

TRp - Pinnacle Peak Phyllite (Triassic)

Dark-gray to black carbonaceous phyllite alternates on a meter to decameter scale with subordinate light-green phyllite, metagraywacke, metachert, and thin layers of black marble. Dark-gray phyllite contains quartz, graphite, chlorite, calcite, white mica, and pyrite. Green phyllite and semischist contain quartz, albite, sericite, clinozoisite, chlorite, fuchsite, and actinolite. Locally, the phyllite contains chlorite pseudomorphs of garnet prophyroblasts. The dominant fabric is defined by chlorite and white mica that wrap around relict garnet porphyroblasts that have strain shadows. Some clinozoisite crystals are folded with kinks in the foliation. Sheafs of coarse-grained euhedral actinolite grow at a high angle to the dominant fabric. Black and green phyllite contain ubiquitous 1-to 5-mm-thick quartz segregation layers that are attenuated into boudins or rods, with isolated interfolial folds and wishbone hinges indicating extension. F2 fold axes plunge shallowly west-northwest in the Rodman Bay area. The metamorphic mineral replacement textures indicate greenschist-facies rocks underwent retrograde metamorphism during a high-strain deformational event. Protoliths are inferred to be carbonaceous mudstone, graywacke, chert, and fine-grained mafic volcaniclastic rocks. Graphitic phyllites are locally calcareous and contrast with siliceous argillites of the Khaz Complex. The unit is bounded by faults, and stratigraphic relations to other components of the Kelp Bay Group are not clear. Unit is considered to be part of the Kelp Bay Group based on structural position below the Border Ranges Fault, metamorphic history, and style of deformation; tectonic blocks of similar phyllite that are included in the Khaz Complex may be derived from this unit. Blocks of glaucophane-bearing greenschist occur in the Khaz Complex on the Khaz Peninsula, and glaucophane also occurs as discrete crystals associated with actinolite, epidote, clinozoisite, and chlorite in phyllonite and also in quartz veins in phyllite on Chichagof Island (Decker, 1980a). *GRI Source Map ID 76027* (SIM-3335)

TRsv - Metasedimentary and metavolcanic rocks (Triassic)

Gray and green interlayered volcaniclastic sandstone, mudstone, tuff, chert, limestone, and intermediate to mafic volcanic rocks that retain primary textures but contain secondary minerals that record low-grade metamorphism. In Nakwasina Sound and near Red Bluff Bay, the unit is recrystallized to greenstone, carbonaceous phyllite, marble, and semischist. The unit is composed dominantly of volcanic and volcaniclastic rocks, with interlayered marble and sooty, carbonaceous argillite. Augite and labradorite are relict primary minerals in the greenstone. Secondary minerals include epidote, pyrite, magnetite, and chalcopyrite. Common meter-scale lenses of limestone distinguish unit TRsv from rocks of the Kelp Bay Group. Rock types in TRsv alternate in layers meters to tens of meters thick and do not resemble the chaotically and pervasively deformed rocks that compose the Khaz Complex (KJkk). On Baranof Island, primary depositional textures are preserved in volcaniclastic rocks, pillowed greenstone, bedded limestone, argillaceous limestone turbidites, mudstone, and bedded chert. Limestone and chert commonly have stylolitic bed partings. Common fine-grained carbonaceous rocks suggest the unit includes deep-water or restricted-basin sedimentary deposits. Unit is folded, faulted, and locally

sheared; unit thickness is unknown owing to faulting. Tectonic blocks of TRsv may locally be faulted into the Khaz Complex; blocks of limestone and carbonaceous mudstone are suspected to be tectonic inclusions, possibly due to subduction erosion recycling processes as described by Clift and Vannucchi (2004), because they contrast with the siliceous argillite of the Khaz Complex and resemble rocks of the upper plate. Mylonitic structures in the TRsv unit at Red Bluff Bay postdate its metamorphic fabric. TRsv is intruded by Jurassic diorite in Nakwasina Sound and on northeastern Yakobi Island (Johnson and Karl, 1985). *GRI Source Map ID 76027* (SIM-3335)

TRm - Metalimestone (Late Triassic)

Light-gray, medium-to thin-bedded metalimestone, which locally contains fossils and primary bedding structures, and massive to banded white marble, locally interlayered with volcanic rocks. Unit ranges from meters to tens of meters in thickness. Metalimestone unit is in depositional contact with volcanic and volcaniclastic rocks of units TRg and TRsv. Mapped in Nakwasina Sound and north of Red Bluff Bay. *GRI Source Map ID 76027* (SIM-3335)

TRg - Goon Dip Greenstone (Triassic)

Massive mafic metavolcanic rocks locally contain vesicles and calcite-filled amygdules. Unit consists mostly of massive greenstone and locally includes pillow breccia, rare lenses of lapilli tuff, and feeder dikes. Greenstone is at least several hundred meters thick east of Patterson Bay. No marble was observed associated with the greenstone east of Patterson Bay, although thin lenses of limestone are found within the unit on Chichagof Island (Loney and others, 1975; Johnson and Karl, 1985). The greenstone contains sparse phenocrysts of plagioclase, hornblende, and augite. Secondary minerals include actinolite, chlorite, epidote, prehnite, pyrite, and chalcopyrite. Chemical analyses of volcanic rocks in the Patterson Bay area indicate they are low Ti, low Mg, low Al, low Nb, tholeiitic basalts that plot consistently in mid-ocean-ridge basalt (MORB) and enriched-MORB fields on element discriminant diagrams of Pearce (1982), Wood (1980), and Mullen (1982) (figs. 3A– 3E). On the same diagrams, they plot very much like the Goon Dip Greenstone on Chichagof Island, the Nikolai Greenstone of the Wrangell Mountains, and basalts of the Karmutsen Formation on Vancouver and the Queen Charlotte Islands, except some Karmutsen basalts also plot in island-arc tholeiite (IAT) fields (see Barker and others, 1989; Greene and others, 2009). TRg in Nakwasina Sound has relict pillow and pillow-breccia structures. It is thermally recrystallized adjacent to Jurassic diorite (Jd). TRg east of Patterson Bay locally has relict pillow structures, shows no fabric and no flattening of vesicles or amygdules, contains low greenschist-facies minerals including chlorite and epidote, and is thermally recrystallized adjacent to Tertiary plutons. *GRI Source Map ID 76027* (SIM-3335)

PZsv - Metasedimentary and metavolcanic rocks of Nakwasina Sound (Paleozoic)

Light-green, tan, and white, banded, siliceous, felsic, and calcareous semischist, quartzite, metatuff, and marble. Unit includes centimeter-scale bands of garnet-diopside-biotite schist. Buff-colored, massive aphanitic felsic rocks contain quartz eyes and may be metarhyolites. Felsic and silicic semischist locally have relict volcaniclastic textures. Marble and semischist contain sparse biotite, sericite, and (or) chlorite, epidote, diopside, and garnet. Composition and relict textures suggest protoliths include felsic and mafic volcanic breccia, tuff and volcaniclastic rocks, limestone, calcareous mudstone, siliceous mudstone, and chert. These protoliths and conodont fossils lead us to infer a marine depositional environment adjacent to a volcanic arc; bimodal felsic and mafic volcanic rocks suggest some volcanic rocks may represent an interval of arc extension. Exposed in Bear Bay and Deep Bay area of Sergius Narrows and in the Nakwasina Sound area. *GRI Source Map ID 76027* (SIM-3335)

PZa - Amphibolite (Paleozoic)

Dark-greenish-gray, banded amphibole schist and amphibolite gneiss of unknown thickness, and subordinate marble in lenses as much as 50 m thick. The most common lithology is quartz-andesine-biotite-hornblende schist, typically containing almandine garnet, that alternates with centimeter-scale plagioclase-hornblende and quartzofeldspathic layers. Amphibolite gneiss contains bands of hornblende-plagioclase and bands of biotite-hornblende-andesine-quartz±almandine garnet. These metamorphic mineral assemblages indicate greenschist and amphibolite-grade metamorphism. Locally, unit PZa contains aligned, elongate amphibole laths. Common accessory minerals include apatite, epidote, pyrite, and titanite. Amphibole schist and gneiss locally include banded calc-silicate gneiss and marble. The protolith of this unit, on the basis of bulk composition, was probably mafic volcanic and volcaniclastic rock with subordinate marine sediments. *GRI Source Map ID 76027* (SIM-3335)

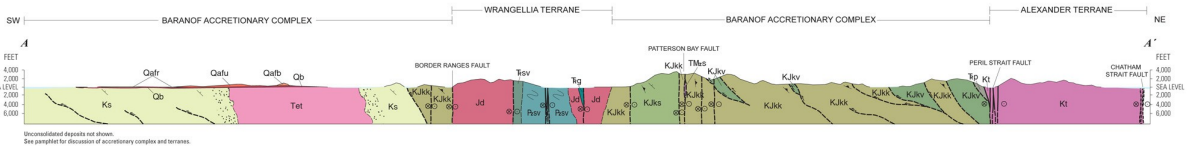
unmapped

No additional unit description provided. *GRI Source Map ID 76027* (SIM-3335)

Geologic Cross Section

The geologic cross section present in the GRI digital geologic-GIS data produced for Sitka National Historical Park, Alaska (SITK) is presented below. Cross section graphics were captured at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Extracted from: (SIM-3335).

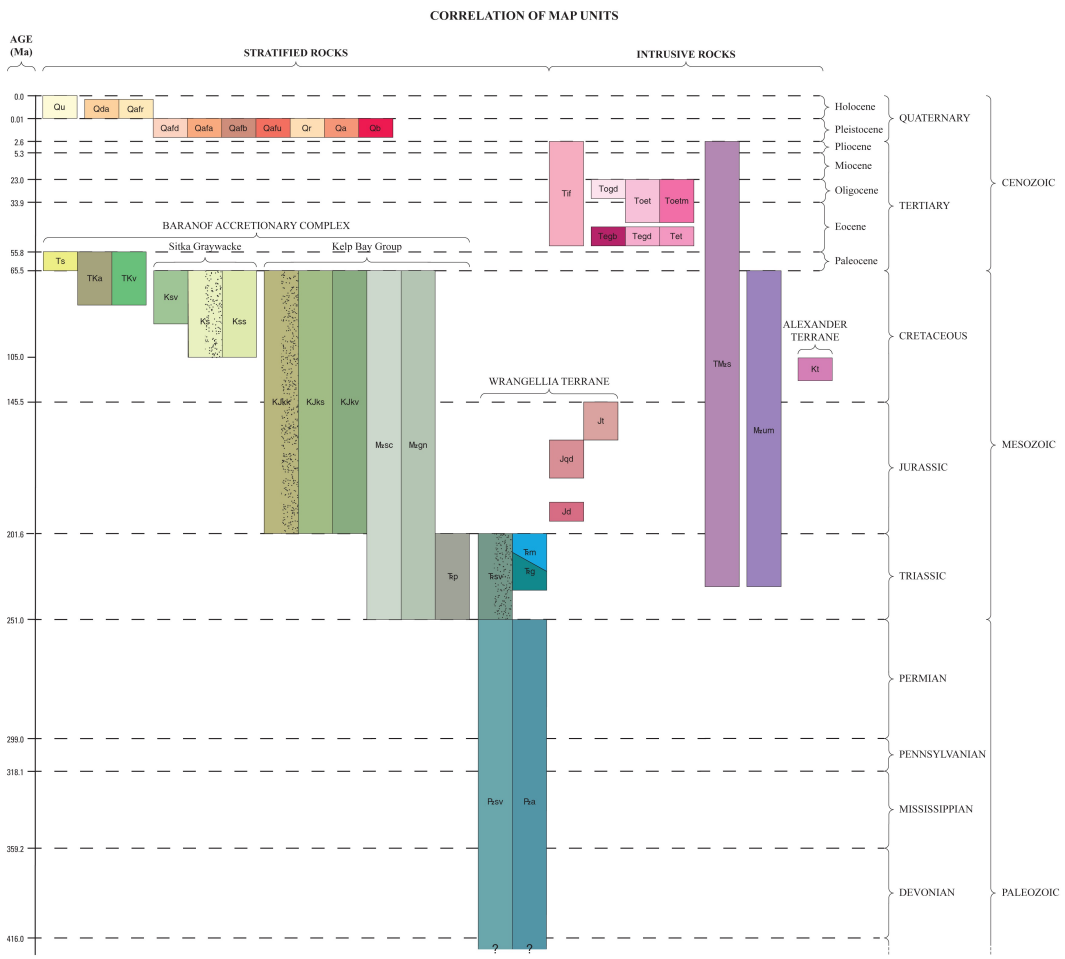
GRI Source Map Information

Geologic Map of Baranof Island, Southeastern Alaska (SIM-3335)

Karl, S.M., Haeussler, P.J., Himmelberg, G.R., and Zumsteg, C.L., 2015, Geologic Map of Baranof Island, Southeastern Alaska, U.S. Geological Survey, Scientific Investigations Map SIM-3335, 1:200,000 scale. *(GRI Source Map ID 76027).*

Note: The geologic units in the GRI digital geologic-GIS data are attributed with USGS Regional Unit Correlation Codes (NSACLASS) as defined within the USGS National Surveys and Analysis compilation of geologic mapping for the state of Alaska. HTML queries for pages describing most of the NSACLASS values can be constructed by appending the value to the url http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=

Correlation of Map Units



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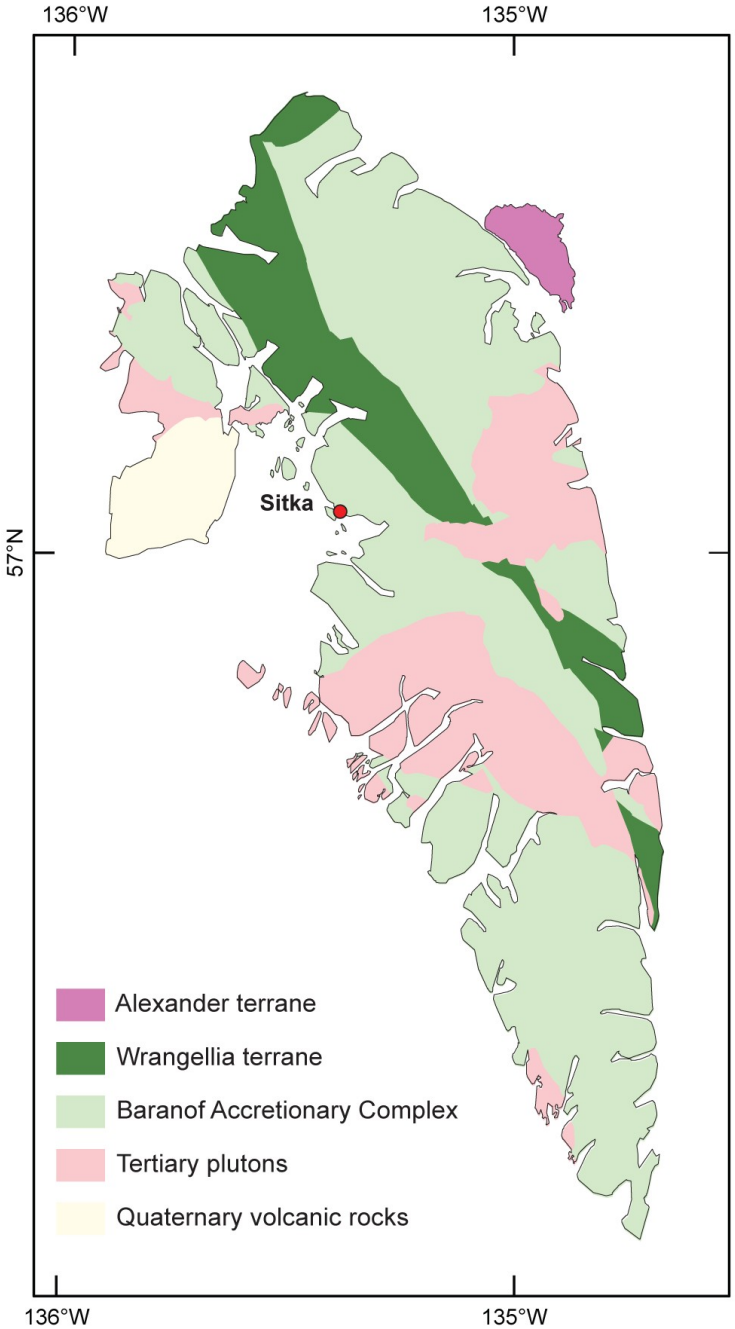
Map Location

Extracted from: (SIM-3335).

Index Maps

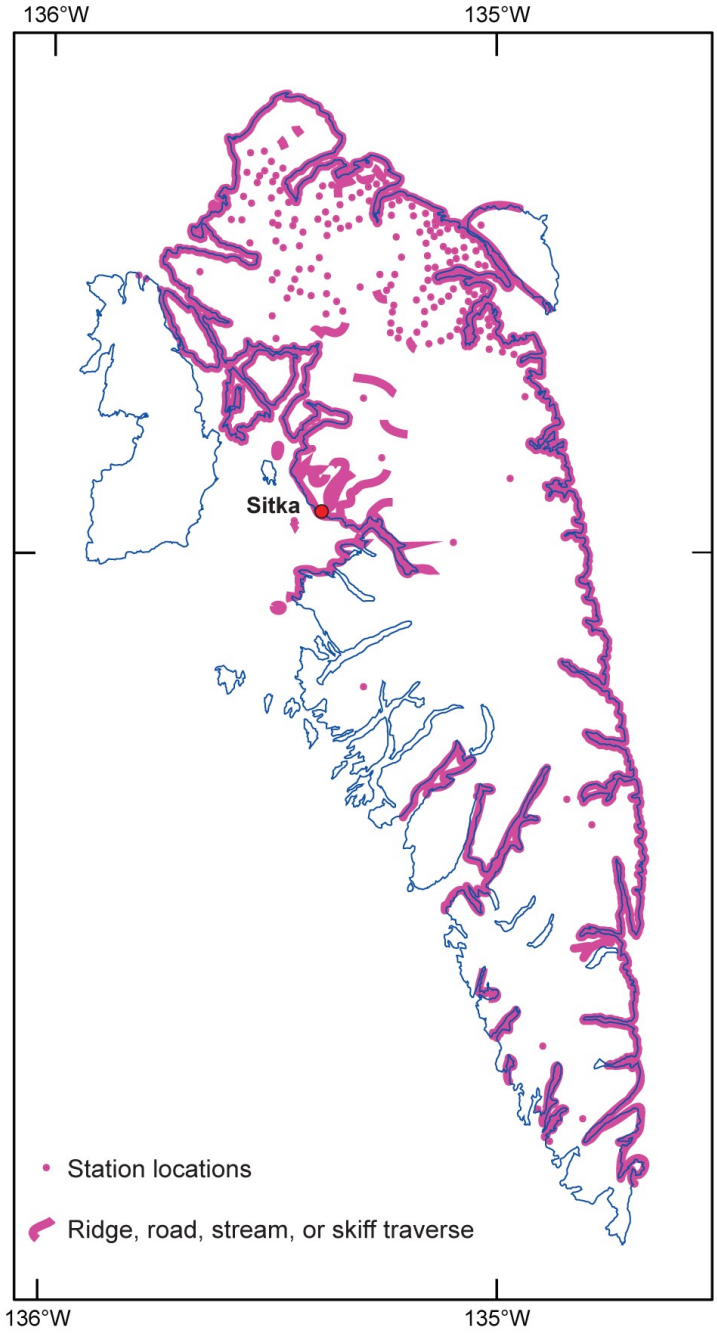
Index Map Showing Tectionic Terranes and Cenozoic Igneous Rocks



INDEX MAP SHOWING TECTONIC TERRANES AND CENOZOIC IGNEOUS ROCKS

Extracted from: (SIM-3335).

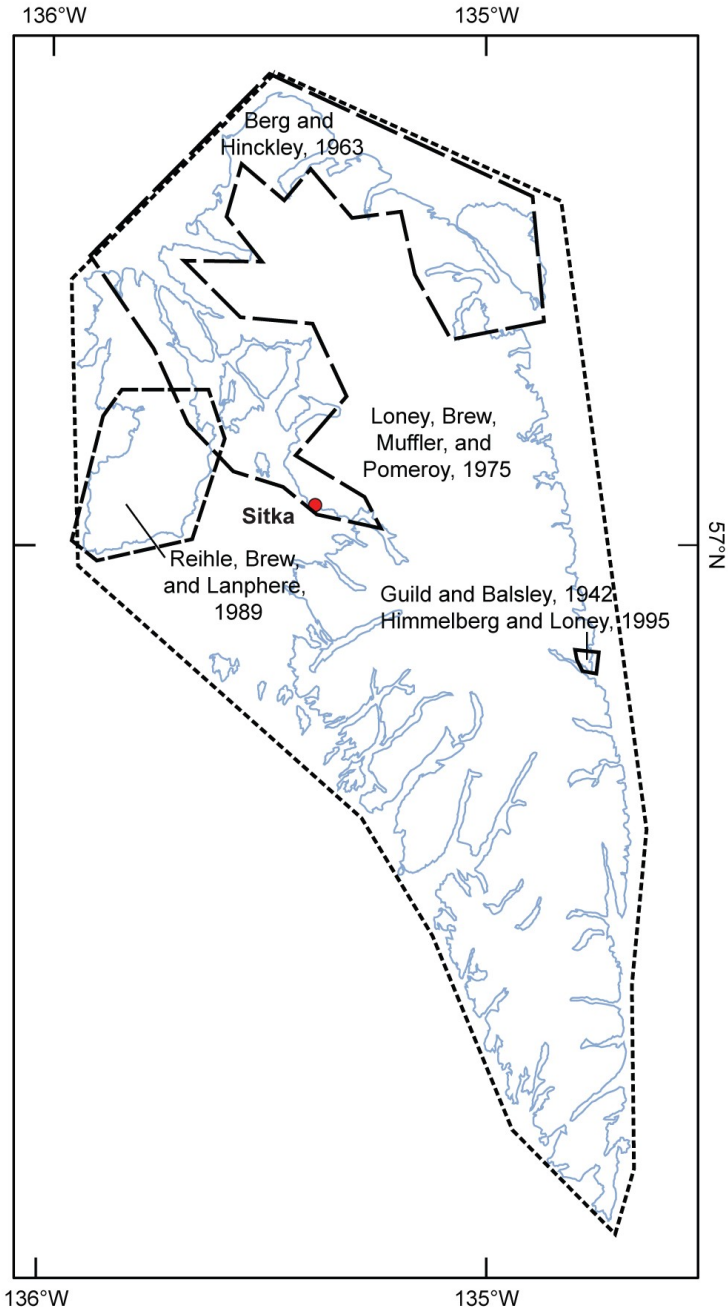
Index Map Showing Station Location and Traverses Made During This Study



INDEX MAP SHOWING STATION LOCATIONS AND TRAVERSES MADE DURING THIS STUDY

Extracted from: (SIM-3335).

Index Map Showing Supplemental Sources of Geologic Mapping



INDEX MAP SHOWING SUPPLEMENTAL SOURCES OF GEOLOGIC MAPPING

Extracted from: (SIM-3335).

Map Legend

EXPLANATION OF MAP SYMBOLS

Contact—Solid where location is accurate; dashed where location is approximate; dotted where location is concealed

Faults—Solid where location is accurate; dashed where location is approximate; dotted where location is concealed

High-angle fault—Arrows show relative motion

Thrust fault—Sawteeth on upper plate

Relative fault movement—Only on cross section

Toward

Away

Garnet **Metamorphic isograd**

Hornfels in contact aureoles

Bedding

40 **Inclined**—Showing strike and dip

58 **Overturned**—Showing strike and dip

Foliation

18 7 **Inclined**—Showing lineation

Vertical—Showing strike

Sample locality—Showing sample locality number (bold) and age

^{14}C—See table 1

K-Ar—See table 1

^{40}Ar/^{39}Ar—See table 1

U-Pb—Magmatic zircon age. See table 1

U-Pb—Detrital zircon youngest age. See table 2

Fossil—See table 3

Glacier

Extracted from: (SIM-3335).

GIS Data Source References

Features in the Geologic Map of Baranof Island are attributed with source information used in the production of that dataset. The GRI has retained that information for this project. Features in the GRI digital geologic-GIS data are attributed in the USGS Data Source field with the codes (in bold; e.g., DAS02) preceding the references below.

DAS02 Riehle, J.R., and Brew, D.A., 1984, Explosive latest Pleistocene(?) and Holocene activity of the Mount Edgecumbe volcanic field, Alaska, in Reed, K.M., and Bartsch-Winkler, Susan, eds., The United States Geological Survey in Alaska-Accomplishments during 1982: U.S. Geological Survey Circular 939, p. 111-115.

DAS03 Berg, H.C., and Hinckley, D.W., 1963, Reconnaissance Geology of Northern Baranof Island, Alaska: U.S. Geological Survey Bulletin 1141-O, 23 p., scale 1:125,000.

DAS04 Guild, P.W., and Balsely, J.R., Jr., 1942, Chromite deposits of Red Bluff Bay and vicinity, Baranof Island: U.S. Geological Survey Bulletin 936-G, p. G171-187.

DAS05 Himmelberg, G.R., and Loney, R.A., 1995, Characteristics and Petrogenesis of Alaskan-Type Ultramafic-Mafic Intrusions, southeastern Alaska: U.S. Geological Survey Professional Paper 1564, 47 p.

DAS06 Loney, R.A., Berg, H.C., Pomeroy, J.S., and Brew, D.A., 1963, Reconnaissance Geologic Map of Chichagof Island and northwestern Baranof Island, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-388, scale 1:250,000.

DAS07 DAS09, DAS20

DAS01 Snee - this study

DAS08 DAS09, DAS21

DAS09 Loney, R. A., Brew, D. A., and Lanphere, M. A., 1967, Post-Paleozoic radiometric ages and their relevance to fault movements, northern southeastern Alaska: Geological Society of America Bulletin, v. 78, p. 511-526.

DAS10 Reifenstuhl, R.R., 1986, Geology of the Goddard Hot Springs area, Baranof Island, southeastern Alaska: Alaska Division of Geological and Geophysical Surveys Public-data File 86-2, 82p., scale 1:40,000.

DAS12 Riehle, J.R., Brew, D. A., and Lanphere, M.A., 1989, Geologic Map of the Mount Edgecumbe Volcanic field, Kruzof Island, Southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-1983, scale 1:63,360.

DAS13 Aleinikoff-personal communication

DAS14 Brew, D.A., Drew, L.J., Schmidt, J.M., Root, D.H., and Huber, D.H., 1991, Undiscovered locatable mineral resources of the Tongass National Forest and adjacent lands, southeastern Alaska: U.S. Geological Survey Open-file Report 91-10.

DAS15 Friedman-this study

DAS16 Haeussler, P. J., Bradley, D. C., Goldfarb, R. J., Snee, L. W., and Taylor, C., 1995, Link between ridge subduction and gold mineralization in southern Alaska: Geology, v. 23, no. 11, p. 995-998.

DAS17 Ives, P.C., Levin, Betsy, Oman, C.L., and Rubin, Meyer, 1967, U.S. Geological Survey Radiocarbon dates IX: Radiocarbon, v. 9, p. 505-529.

DAS18 Layer-this study

DAS20 Loney, R. A., Brew, D. A., Muffler, L. P. J., and Pomeroy, J. S., 1975, Reconnaissance geology of Chichagof, Baranof, and Kruzof Islands, southeastern Alaska: U.S. Geological Survey Professional Paper 792, 105 p.

DAS21 Myers, J.D., and Marsh, B.D., 1981, Geology and petrogenesis of the Edgecumbe volcanic field, SE Alaska-The interactions of basalt and sialic crust: Contributions to Mineralogy and Petrology, v. 77, p. 272-287.

DAS22 This study

DAS23 Charles D. Blome (written comm. 11-25-1998)

DAS24 John W. Miller in Brew and others (1988)

DAS25 Anita G. Harris (written comm. 8-12-1993)

DAS26 Bruce R. Wardlaw in Karl and others (1989)

DAS27 Emile A. Pessagno (written comm. to G. Plafker 12-18-2003)

DAS28 David Jones in Plafker and others (1976)

DAS29 Charles D. Blome (written comm. 11-29-1994)

DAS30 NCGMP09--draft standard format for digital publication of geologic maps, version 1.1, available at http://ngmdb.usgs.gov/Info/standards/NCGMP09/.

DAS31 Federal Geographic Data Committee [prepared for the FGDC by the U.S. Geological Survey], 2006, FGDC Digital Cartographic Standard for Geologic Map Symbolization: Reston, Va., FGDC document number FGDC-STD-013-2006, 290 p., 2 plates.

DAS32 adapted from Neuendorf, K.K.E., Mehl, J.P., Jr., and Jackson, J.A., 2005, Glossary of Geology, 5th Edition, American Geological Institute, Alexandria, VA, 779 p.

DAS33 High resolution (~1:24,000 scale) National Hydrography Dataset polygons representing areal extents of water bodies. Accessed 2014. http://nhd.usgs.gov/index.html. Many small islands removed for display at scale of intended map.

DAS34 USGS MS Word template Map Manuscript_v1-0_04-11.dotx

Extracted from: (SIM-3335).

Report

A PDF of the companion pamphlet for SIM-3335 is available at the following link: Map Pamphlet

The map pamphlet contains information on the following topics:

Abstract
Introduction
Previous Investigations
Geology of Baranof Island
Paleozoic Rocks
Mesozoic Rocks
Cenozoic Rocks
Deformation and Metamorphism
M1: Pre-Late Triassic Regional Deformation and Amphibolite to Greenschist Facies Metamorphism
M2: Early Jurassic Thermal Metamorphism Related to Pluton Emplacement (~192 Ma)
M3: Middle to Late Jurassic Metamorphism Related to Pluton Emplacement (~173–155 Ma)
M4: Early Late Jurassic Deformation and Greenschist Facies Metamorphism (=155 Ma)
M6: Middle Cretaceous Deformation and Blueschist-Greenschist Facies Metamorphism (91–109 Ma)
M7: Late Cretaceous Prehnite-Pumpellyite Facies Metamorphism (=74 Ma)
M8: Early Eocene Deformation and Amphibolite Facies Metamorphism
M9: Late Early Eocene Thermal Metamorphism (~50 Ma)
M10: Middle Eocene to Early Oligocene Thermal Metamorphism (~43 Ma)
M11: Late Oligocene Thermal Metamorphism Related To Pluton Emplacement (~26 Ma)
Faults
Border Ranges Fault
Peril Strait Fault
Chatham Strait Fault
Fairweather-Queen Charlotte Fault
Patterson Bay Fault
Neva Strait-Silver Bay Fault
Hot Springs
Summary and Discussion
Acknowledgments
Description of Map Units
Stratigraphic Map Units
Baranof Accretionary Complex
Wrangellia Terrane
Intrusive Rock Units
Alexander Terrane
Wrangellia Terrane
References Cited

ARDF Port Alexander Quadrangle (OF-2005-1168)

Grybeck, D.J., 2005, Alaska Resource Data File, Port Alexander Quadrangle, Alaska, U.S. Geological Survey Open-File Report OF-2005-1168, 1:250,000 scale. (*GRI Source Map ID 76054*).

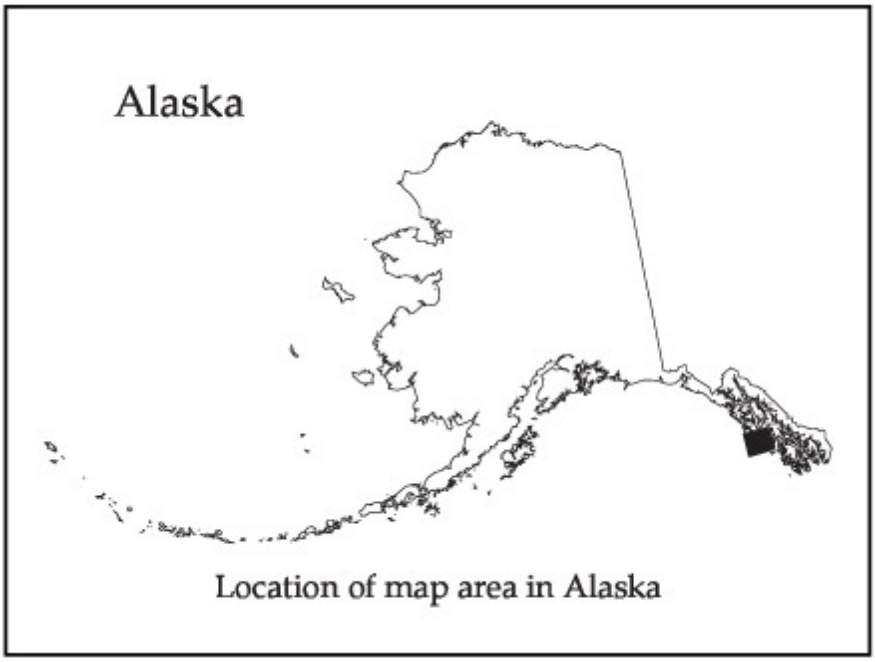
Report

The Alaska Resource Data File (ARDF) report for the Port Alexander, Alaska (OF-2005-1168) is available for download at the following link: Report PDF.

Data

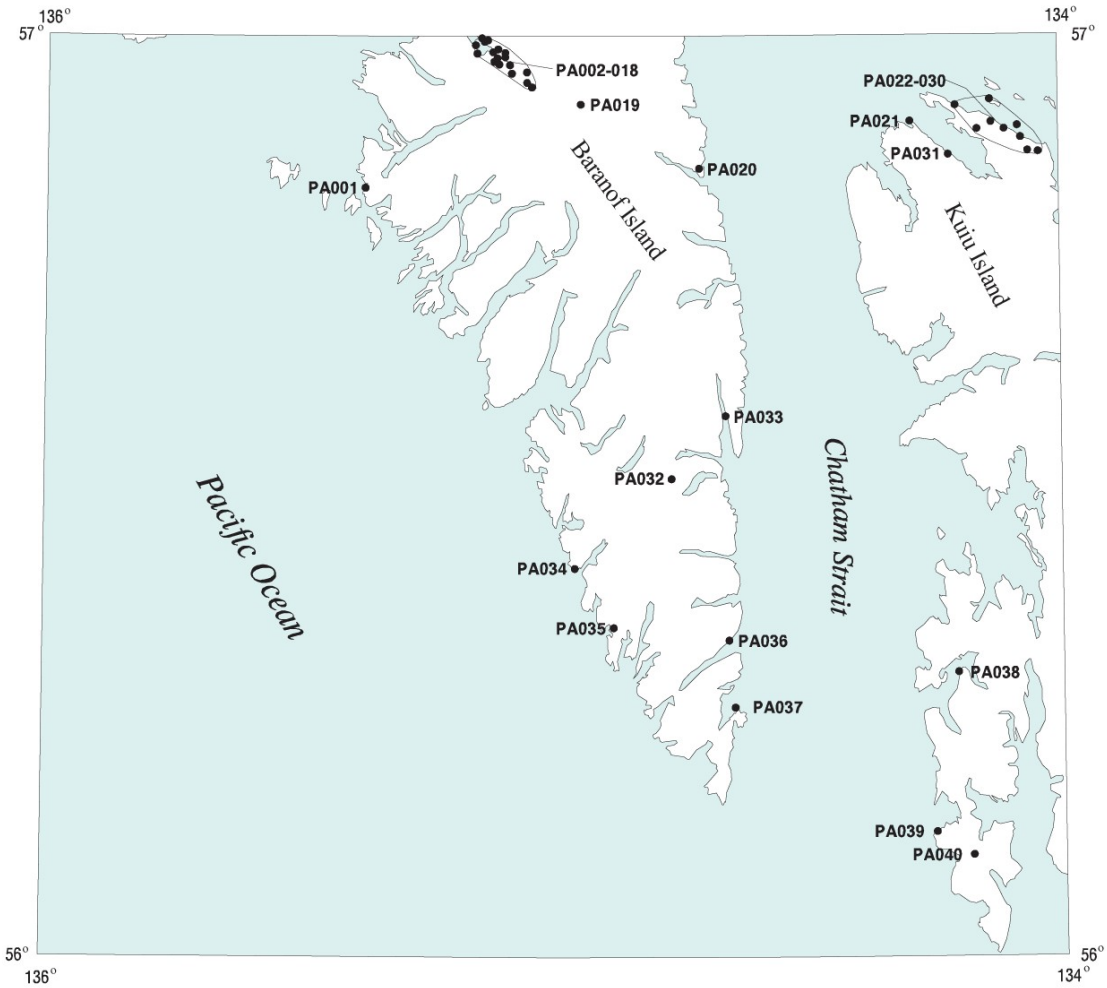
The Alaska Resource Data File (ARDF) data for the Port Alexander, Alaska (OF-2005-1168) are available for download at the following link: Data.

Location of Map Area in Alaska



Extracted from: (OF-2005-1168).

Mineral Occurrence Map



Distribution of mineral occurrences in the Port Alexander 1:250,000-scale quadrangle, Alaska

Extracted from: (OF-2005-1168).

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Extracted from: (OF-2005-1168).

ARDF Sitka Quadrangle (OF-2005-1376)

Berg, H.C., and Grybeck, D.J., 2005, Alaska Resource Data File, Sitka Quadrangle, Alaska, U.S. Geological Survey Open-File Report OF-2005-1376, 1:250,000 scale. (*GRI Source Map ID 75173*).

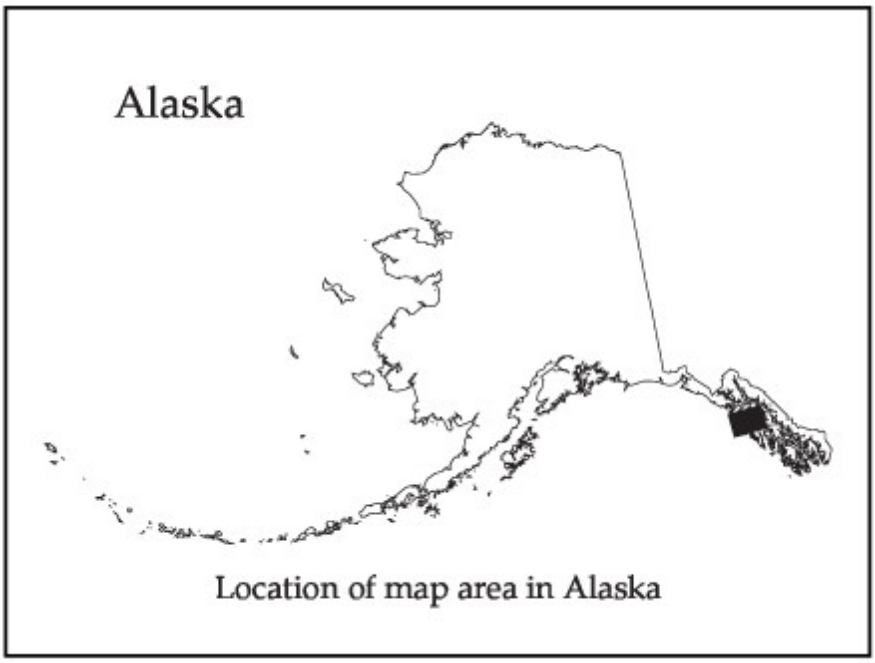
Report

The Alaska Resource Data File (ARDF) report for the Sitka Quadrangle, Alaska (OF-2005-1376) is available for download at the following link: Report PDF.

Data

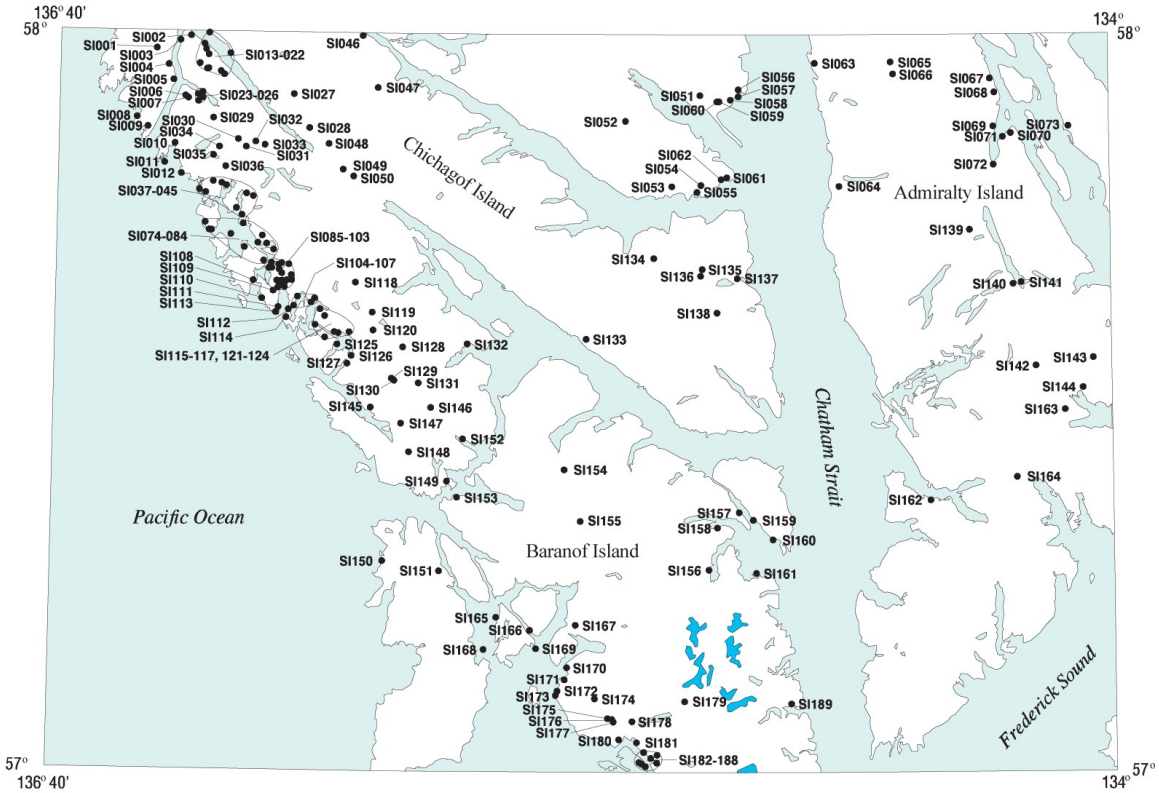
The Alaska Resource Data File (ARDF) data for the Sitka Quadrangle, Alaska (OF-2005-1376) are available for download at the following link: Data.

Location of Map Area in Alaska



Extracted from: (OF-2005-1376).

Mineral Occurrence Map



Distribution of mineral occurrences in the Sitka 1:250,000-scale quadrangle, Alaska

Extracted from: (OF-2005-1376).

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