Glacier Bay National Park and Preserve

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Glacier Bay National Park and Preserve

glba_geology.pdf

Version: 9/28/2020
Geologic Resources Inventory Map Document for Glacier Bay National Park and Preserve

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Geologic Resources Inventory Map Document

Glacier Bay National Park and Preserve, Alaska

Document to Accompany Digital Geologic-GIS Data

glba_geology.pdf
Version: 9/28/2020

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Glacier Bay National Park and Preserve, Alaska (GLBA).

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

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

For information about using GRI digital geologic-GIS data contact:
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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 national resource parks throughout the National Park System. 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 GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

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: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. 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: https://
www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.
GRI Digital Map and Source Map Citations

The GRI digital geologic-GIS map for Glacier Bay National Park and Preserve, Alaska (GLBA):

Digital Geologic-GIS Map of Glacier Bay National Park and Preserve and Vicinity, Alaska (GRI MapCode GLBA)

Digital GIS data was converted to the NPS GRI digital geologic-GIS geodatabase data model (v. 2.3) and ESRI 10.4 file geodatabase format from U.S. Geological Survey SIM-3340. For geologic units USGS NSA Class values were preserved, and for surficial units NSA Class values were used to divide the unit into more detailed sub-units. For geologic units located within the park boundary, Wilson and Karl, 2019, provided unpublished revised unit descriptions (based on SIM-3340 descriptions) that appropriately reflect the local geology of the park. The extent of the data converted includes portions of four 1 degree x 3 degree quadrangles (Juneau, Mount Fairweather, Skagway, and Yakutat) that cover Glacier Bay National Park and Preserve.


Digital data for five Alaska Resource Data File (ARDF) reports were converted and are represented in the GRI digital geologic-GIS data. These sources are listed below.


Additional information pertaining to each source map is also presented in the GRI Source Map Information (GLBAMAP) table included with the GRI geologic-GIS data.
Index Map
The following index map displays the extent of the GRI Digital Geologic-GIS map of Glacier Bay National Park and Preserve and Vicinity, Alaska (in black). The boundary of Glacier Bay National Park and Preserve (as of September, 2020) is displayed in green.

Index map by Jake Suri (Colorado State University).
Map Unit List

The geologic units present in the digital geologic-GIS data produced for Glacier Bay National Park and Preserve, Alaska (GLBA) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., g - Glaciers and permanent snowfields). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (GLBAUNIT) table included with the GRI geologic-GIS data.

Cenozoic Era

Quaternary Period
- g - Glaciers and permanent snowfields
- Qb - Beach deposits
- Qes - Estuarine deposits
- Qd - Dune deposits
- Qls - Landslide deposits
- Qc - Colluvium
- Osq - Supraglacial drift
- Ohg - Neoglacial drift
- Org - Rock glacier deposits
- Qa - Alluvium
- Qaf - Alluvial fan and talus deposits
- Qs - Unconsolidated surficial deposits, undivided
- Qv - Youngest volcanic rocks

Quaternary and Tertiary Period
- QTy - Yakataga Formation

Tertiary Period
- Tp - Topsy Formation
- Tcv - Cenotaph Volcanics and similar volcanic and hypabyssal rocks
- Tclp - Mt. Crillon-La Perouse suite ultramafic rocks
- Ty - Younger granitic rocks
- Toe - Granitic rocks
- Tegr - Tonalitic rocks
- Tog - Mafic and ultramafic rocks of the Valdez and Orca Groups, undivided
- Thi - Hypabyssal intrusions

Mesozoic Era

Cretaceous Period
- Kv - Valdez Group
- Kvg - Metavolcanic rocks of the Valdez Group
- Kvu - Volcanic rocks, undivided
- Kgb - Gabbro and diorite of southeast Alaska
- Kfg - Foliated granitic rocks
- Kbg - Gabbro
- Kmq - Migmatite and metamafic rocks
- Kfg - Sitka Graywacke, undivided
- Kmg - Granitic rocks of central and southeast Alaska
- Keg - Granite to granodiorite
- Kkbm - Khaz Complex

Cretaceous and Jurassic Periods
- KJmy - Mélange of the Yakutat Group
Diorite and gabbro of southeast Alaska
Gravina-Nuzotin unit
Yakutat Group, undivided

Cretaceous, Jurassic, and Triassic Periods
Kelp Bay Group, undivided

Jurassic Period
Granitic rocks of southeast Alaska

Triassic Period
Mafic volcanic rocks of Chilkat Peninsula
Hy Group igneous rocks, undivided
Hy Group sedimentary rocks, undivided
Hy Group, undivided
Nikolai and Goon Dip Greenstones and equivalent rocks
Quartz diorite and granodiorite
Whitestripe Marble of southeast Alaska
Metamorphic rocks of Dundas Bay

Paleozoic Era
Porcupine slate of Redman and others (1985)
Marble

Permian Period
Pybus Formation and Limestone of Sith-gha-ee Peak formation of Brew (1997)
Sedimentary rocks of Sith-gha-ee Peak formation of Brew (1997)
Volcanic rocks of Sith-gha-ee Peak formation of Brew (1997)

Permian and Pennsylvanian Period
Granodiorite, syenite and other granitic rocks

Devonian to Permian
Cannery Formation and Porcupine slate of Redman and others (1985), undivided

Mississippian and Devonian Period
Iyoukeen and Peratrovich Formations

Devonian Period
Freshwater Bay and Port Refugio Formations
Carbonate rocks of southeast Alaska
Black Cap Limestone
Karheen and Cedar Cove Formations
Gambier Bay Formation, undivided
Marble of the Gambier Bay Formation
Volcanic rocks associated with Black Cap Limestone

Ordovician to Devonian Period
Syenite, trondhjemite and granite

Silurian Period
Limestone
Clastic sedimentary rocks
Volcanic rocks
Neoproterozoic to Silurian Period

SZfw - Four Winds complex of Gilbert and others (1987) and similar rocks

No Age

um - Unmapped
Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Additional geologic unit descriptions sourced from the USGS geologic-GIS data for the Alaska region are accompanied by code (eg. YA002) identifying the original source for that description. Please see the USGS Source Map References page for references associated with these codes. Most Quaternary geologic units have been compiled into one geologic unit in the Geologic Map of Alaska source; those units are identified with the compiled unit noted.

**g - Glaciers and permanent snowfields (Quaternary, Holocene)**

Present snowfields and glaciers. Description from map: [Glacier Bay Geologic Map](https://example.com).

**Qb - Beach deposits (Holocene)**

- **Qb - Marine shoreline deposits (Holocene)**
  Mainly sand and gravel of present and former beaches, beach ridges, beach bars and spits. Includes smaller sand dunes. Unit description from source map: YA002.

  Unit compiled into **Qs** on [Geologic Map of Alaska](https://example.com).

**Qes - Estuarine deposits (Holocene)**

- **Ql - Lagoonal deposits (Holocene)**
  Intertidal mud and sand deposited in swamp areas between beach ridges and in tidal embayments. Unit description from source map: YA002.

  Unit compiled into **Qs** on [Geologic Map of Alaska](https://example.com).

**Qd - Dune deposits (Holocene)**

- **Qd - Dunes (Holocene)**
  Larger sand dunes associated with present beaches and streams. Unit description from source map: YA002.

  Unit compiled into **Qs** on [Geologic Map of Alaska](https://example.com).

**Qls - Landslide deposits (Quaternary)**

- **Qcl - Landslide (Quaternary)**
  Landslide deposits, undifferentiated. Unit description from source map: SK007.

- **Qls - Landslide deposits (Holocene)**
  Larger landslides; arrows show downslope movement direction. Unit description from source map: YA002.

  Unit compiled into **Qs** on [Geologic Map of Alaska](https://example.com).
Qc - Colluvium (Quaternary)
Colluvial deposits, undifferentiated. Unit description from source map: SK004.

Qct - Talus (Quaternary)
Talus and colluvial deposits. Unit description from: source map: SK005.

Qct - Talus (Quaternary)
Talus deposits and undifferentiated colluvial deposits. Unit description from source map: SK007

Qc - Colluvial deposits (Quaternary)
Unconsolidated colluvial deposits. Unit description from source map: SK021

Qt - Talus deposits (Holocene)
Larger areas of poorly sorted, angular deposits forming cones and aprons at the base of steep slopes. Unit description from source map: YA002.

Unit compiled into Qs on Geologic Map of Alaska.

Qsg - Supraglacial drift (Quaternary)

Qsm - Supraglacial drift (Quaternary, Holocene)
Unweathered, poorly sorted, pebble- to boulder sized rock debris on surfaces of alpine and valley glaciers. Unit description from source map: MF009.

Qsm - Supraglacial deposits (Quaternary)
Supraglacial deposits. Unit description from source map: SK012.

Qsm - Supraglacial deposits (Holocene)
Unsorted angular debris ranging in size from silt to blocks on surfaces of the present glaciers. Unit description from source map: YA002.

Unit compiled into Qs on Geologic Map of Alaska.

Qhg - Neoglacial drift (Quaternary)

Qd - Drift (Quaternary)
Glacial deposits, undifferentiated. Unit description from source maps: SK004, SK005, and SK007.

Qnd - Neoglacial drift (Quaternary)
Active moraines, and unsorted, matrix and clast supported debris flow deposits, including rockslides and mudslides. These deposits form contour bands around cirques and glacially carved valleys throughout the map area. Unit description from source map: SK021.

Qm - Younger end, ground, and lateral moraine deposits (Holocene)
Mainly till, but locally includes lacustrine and glaciofluvial deposits. Arrow indicates direction of ice movement as inferred from trend of elongate trenches and ridges. Advance of Hubbard Glacier culminated in Yakutat Bay between 1700 and 1791 A.D. Unit description from source map: YA002.

Unit compiled into Qs on Geologic Map of Alaska.
Qrg - Rock glacier deposits (Quaternary)

Rock glaciers, undifferentiated. Unit description from source maps: SK005 and SK007.

Unit compiled into Qs on Geologic Map of Alaska.

Qa - Alluvium (Quaternary)

Alluvial deposits, undifferentiated. Unit description from source maps: SK004, SK005, and SK007.

Unit compiled into Qs on Geologic Map of Alaska.

Qaf - Alluvial fan and talus deposits (Quaternary)

Alluvial fan deposits, undifferentiated. Unit description from source maps: SK005, SK007, and SK021.

Unit compiled into Qs on Geologic Map of Alaska.

Qs - Unconsolidated surficial deposits, undivided (Quaternary)

Unconsolidated, poorly to well-sorted, poorly to moderately well-stratified deposits, consisting of predominately of alluvial, colluvial, marine, lacustrine, eolian, and swamp deposits. Also includes widespread glacial and periglacial deposits that include end, lateral, and ground moraine and outwash deposits, as well as rock glacier deposits. These glacial deposits are of Holocene and Pleistocene age and may include small areas of potentially latest Tertiary deposits. Description from map: Glacier Bay Geologic Map.

Qs - Surficial deposits (Holocene and (or) Pleistocene)

Includes alluvium, colluvium, tidal mudflat deposits, and some glaciofluvial deposits. The distribution of most large areas of surficial deposits was mapped in the field, but the deposits have not been studied in detail; many small areas are not shown. Unit description from source map: MF003 and SK010.

Qa - Alluvial deposits (Quaternary)

Includes alluvium, colluvium, glacial till, and outwash. Unit description from source map: MF002.

Qs - Surficial deposits (Quaternary)

Surficial deposits - unconsolidated. Associated mineral deposits include placer Au. Unit description from source maps: MF003 and SK010.

Qu - Unconsolidated sedimentary deposits (Pleistocene and Holocene)

Alluvium, colluvium, and glacial deposits mapped by photogeologic methods; includes some Holocene ash and lapilli. (S.M. Karl: A mantle of sand, gravel, and silt on northern Chichagof Island represents glacial outwash.) Unit description from source map: MF004.

Qs - Surficial deposits (Quaternary, Holocene and (or) Pleistocene)

Alluvium, colluvium, tidal mudflat deposits, and some possible glaciofluvial deposits. Unit description from source maps: MF009 and SK012.
Qs - Undivided alluvial and colluvial deposits (Quaternary)
Undivided alluvial and colluvial deposits. Unit description from source map: SK003.

Qad - Alluvium and drift (Quaternary)
Alluvial and glacial deposits, undifferentiated. Unit description from source map: SK004.

Qca - Colluvium and alluvium (Quaternary)
Mixed colluvial and alluvial deposits, undifferentiated. Unit description from source maps: SK005 and SK007.

Qs - Surficial 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 represent tidal mudflat, alluvial, colluvial, and glacial deposits, undivided. Unit description from source map: SK021.

Qs - Alluvial and outwash deposits (Holocene)
Mainly fluvial and fluvi-glacial gravel, sand, and mud. Includes smaller areas of talus, glacial, and lacustrine sediments. Unit description from source map: YA002.

Qv - Youngest volcanic rocks (Holocene and Pleistocene)
Volcanic rocks ranging in composition from rhyolite to basalt. Along the Aleutian magmatic arc and the Wrangell Mountains, the rocks are predominantly andesite and lesser dacite and basalt of calc-alkaline and tholeiitic affinity in lava flows, volcanic breccia, lahars deposits, and debris-flow deposits. Lava flows and clasts in other volcanic deposits of unit are porphyritic, typically glassy, gray to black, and commonly vesicular. Unit also includes basaltic, basaltic andesite, and dacite parasitic cinder and spatter cones. Unit typically forms volcanic edifices; it also forms isolated outcrops that cap ridges, providing a good example of topography reversal, which results from erosion of surrounding country rocks, leaving exposed more erosion-resistant flows that formerly had occupied valleys. Individual flows are locally as thick as 30 m and are laterally continuous over large areas. Includes Edgecumbe Volcanics (basalt, andesite, and dacite) on Kruzof Island (Loney and others, 1975; Riehle and others, 1989) and unnamed basaltic to rhyolitic rocks on islands west of Prince Wales Island (Eberlein and others, 1983), and on Zarembo, Kuiu, and Kupreanof Islands (Brew and others, 1984). Rocks of Holocene age were recognized east of Wrangell Island (Elliott and others, 1981) and on Kruzof Island (Loney and others, 1975), and basaltic rocks of Holocene and (or) Pleistocene age are found on southern Kupreanof Island (Brew and others, 1985). On Revillagigedof Island and mainland to the east in the Ketchikan quadrangle (Berg and others, 1978, 1988) and at many other localities in southeast Alaska (Karl and others, 2012), this extrusive unit consists of alkaline-olivine basalt that forms volcanic cones, columnar jointed lava flows, and boulder flows that contain pumice and scoria; it also includes lenses of ash and lapilli a few centimeters to a few meters thick-too small to show on the map. Includes post-glacial flows and pyroclastic deposits that overlie glacial deposits and landforms. On generalized map, included as part of unit QTvi. Description from source map: Geologic Map of Alaska.

Qb - Lamprophyric basalt (Pleistocene and Holocene)
Lamprophyric basalt on Lisianski Inlet (S. M. Karl: is spessartite in thin section. Inferred by Rossman in 1959 to be post-glacial based on prominent location in Lisianski Inlet.). Unit description from source map: MF004.

QTtyf - Yakataga Formation (Quaternary and uppermost Tertiary)
Mudstone, siltstone, sandstone, and diamicite. Interbedded gray to dark-gray and greenish-gray siltstone, mudstone, and sandstone predominate in lower third of formation. Till-like diamicite is
interbedded with siltstone and sandstone in all but the lowest part of the formation and is the dominant rock type in the upper part of the formation. Conglomerate is a minor lithology throughout the formation and scattered larger clasts, presumably dropstones, are present in all lithologies. These rocks represent diverse marine and glaciomarine clastic continental shelf deposits. George Plafker (written commun., 2002) reports that the Yakataga Formation is at least 4,000 m thick in the Mount Saint Elias and Mount Fairweather quadrangles. In most exposures outside of GLBA, the Yakataga Formation is conformable and gradational on the underlying Poul Creek Formation; locally there is an angular unconformity of up to 15 degrees (Plafker and Addicott, 1976). Age control derived from abundant mollusks and foraminifers, although most are identical to living species (Winkler and Plafker, 1981; Plafker and Addicott, 1976). Description from source map: Glacier Bay Geologic Map.

**Ty - Yakataga Formation (Tertiary - Miocene to Pliocene)**

**Ty - Yakataga Formation (Tertiary, Pliocene and Miocene)**
More than 4,000 m of gray to dark-gray siltstone and mudstone, interbedded with massive subquartzose sandstone, diamictite (conglomeratic sandy mudstone or tillite), and conglomerate. Sandstone less than 25 to 30 percent of surface sections. Unit description from source map: MF009.

**Ttp - Topsy Formation (Tertiary, Miocene)**
Consists of about 75 percent hard calcareous or concretionary siltstone and about 25 percent fine- to medium-grained gray and greenish-gray clayey and carbonaceous sandstone. Thickness ranges from about 350 m in its type section to about 1,300 m at its southern outcrop limit (Brew and others, 1978; D.A. Brew, written commun., 2005). Exposed only south of Lituya Bay. Fossil evidence consists of a sparse middle Miocene molluscan fauna that indicates deposition in a shallow marine, cool water environment (Marinovich, 1980) in contrast with warm water environment of the contemporaneous Narrow Cape Formation of Kodiak Island. Description from source map: Glacier Bay Geologic Map.

**Tt - Topsy Formation (Tertiary - Oligocene to Miocene)**
Topsy Formation - concretionary marine siltstone and sandstone, moderately folded / faulted, in Lituya Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

**Tcv - Cenotaph Volcanics and similar volcanic and hypabyssal rocks (Tertiary, Oligocene to Miocene)**
Andesitic volcanic rocks, volcanic breccia and tuff, siltstone, sandstone, and conglomerate, found in the Mount Fairweather quadrangle (Brew, 1997). A hypabyssal dacite dike on the north side of Adams Inlet yielded a whole rock 40Ar/39Ar date of 44.0±0.4 Ma (S.M. Karl and J.A. Benowitz, unpublished data). Description from source map: Glacier Bay Geologic Map.

**Tc - Cenotaph Volcanics (Tertiary)**
Cenotaph Volcanics - andesitic, volcanic breccia and tuff, siltstone, sandstone, and conglomerate - found in Lituya Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

**Tavd - Felsic volcanic rocks (Tertiary)**

**Qta - Andesite and other intermediate extrusive rocks (Quaternary(?) and Tertiary)**
Icy Strait Belt: Described by Lathram and others (1959) as: "Flows, tuff and breccia-medium to light
gray, purple and green andesite, dacite, dacite obsidian, rhyodacite, aegirine augite soda trachyte, and less abundant dark gray basalt." Exposed on Pleasant Island. Unit description from source map: JU002.

**Tsan - Porphyritic andesite (Pliocene(?) and Miocene(?))**

Icy Strait Belt: Medium gray, phenocrysts of quartz feldspar, magnetite, and chloritized hornblende; age based on interpretation of unpublished K-Ar data; exposed on the north side of Adams Inlet, Glacier Bay. Unit description from source map: JU002.

**Tava - Andesite (Tertiary)**

Light to medium gray-weathering, commonly plagioclase porphyritic, locally hornblende or augite porphyritic, andesite flows and breccia form massive, bench-forming meter-scale cooling units, alternate with centimeter- to meter-scale lenses of water-laid gravel and conglomerate, forming distinctive topography on southeastern Admiralty Island. Andesite is dark gray fresh, green to maroon altered, blocky weathering, pyroxene and feldspar porphyritic, massive to vesicular and amygdaloidal flows 10-50 cm thick. On the Sisters Islands in Icy Strait, basalt and andesite flow breccia are dark greenish gray and locally altered to epidote. At the intersection of Icy Strait and Chatham Strait, Hanus Reef is composed of basalt, andesite, and dacite flows, agglomerates, and tuff. The Knob on Pleasant Island consists of undated augite basalt that overlies andesitic breccia and volcaniclastic rocks. Pyroclastic deposits and massive andesite of unknown age that range up to hundreds of feet in thickness are interlayered on Kupreanof Island. Unit also includes andesite stock in Chilkat Mountains. Unit description from source map: JU006.

**Tsan - Andesite stock (Tertiary)**


**Tavb - Basalt (Tertiary)**

On Kupreanof Island, basalt and other mafic extrusive rocks. Dense, dark gray aphanitic basalt. Flows as much as several meters thick. Commonly vesicular and amygdaloidal, containing fillings of calcite, epidote, chalcedony, chlorite, and zeolites. Flows may contain magnetite, pyroxene, olivine. Flows may be separated by lenses or cm- to meter-scale layers of tuff or flow breccia. Dark gray, rusty-weathering, platy, blocky, or columnar jointed flows 50 cm to several meters thick. Commonly vesicular and amygdaloidal; amygdole fillings include calcite, epidote, chalcedony, chlorite, and zeolites. In Bradfield Canal area, basalt and andesite(?) flows and breccia are cut by sharp-edged dikes of medium-grained, massive-appearing gabbro that is presumed to be cogenic with the basalt. Admiralty, Medium to dark gray basalt flows and breccia, with sparse plagioclase, augite, and olivine phenocrysts. Locally amygdaloidal. Massive, bench-forming meter-scale cooling units. Basal flows of the Admiralty volcanic pile are basalt, also late dikes that cut all volcanic phases are basalt. Medium to dark gray basalt flows and breccia, with sparse plagioclase, augite, and olivine phenocrysts. Gray, green, and brown massive flow breccia of intermediate to mafic composition at Whitewater Bay. Locally amygdaloidal. Massive, bench-forming meter-scale cooling units. Basal flows of the Admiralty volcanic pile are basalt, also late dikes that cut all volcanic phases are basalt. Unit description from source map: JU006.

**Tclp - Mt. Crillon-La Perouse suite ultramafic rocks (Tertiary, Oligocene to Miocene)**

Ultramafic rocks include “layered and locally zoned bodies of two-pyroxene ± olivine ± biotite ± hornblende ± quartz gabbro and subordinate troctolite, peridotite, leucogabbro, diorite, and tonalite” (Gehrels and Berg, 1992). This belt lies north of Cross Sound in the Fairweather Range (Brew and others, 1978). A large body (the La Perouse gabbro) northwest of Cross Sound yielded an 40Ar/39Ar apparent age of 28.0±6.0 Ma (Loney and Himmelberg, 1983). Description from source map: Glacier Bay Geologic Map.
Kbgb - Gabbro (Cretaceous)
Gabbro - layered pyroxene-hornblende gabbro, found in Muir and Chilkat Provinces (Brew, pers. comm., 1999). Brew renames this unit Tgbg. Unit description from source map: MF003.

gbc - Pyroxene gabbro? (Tertiary - Miocene to Pliocene)
Pyroxene gabbro? - fine-grained intrusive (?) rock locally at contact of layered pyroxene gabbro in Fairweather Province (Brew, pers. comm., 1999). Brew renames this unit Tgbc. Unit description from source map: MF003.

gbh - Layered hornblende and pyroxene gabbro (Tertiary)
Layered hornblende and pyroxene gabbro in Fairweather Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

gbm - Layered magnetite bearing pyroxene gabbro (Tertiary)
Layered magnetite bearing pyroxene gabbro - in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit Tgbm. Unit description from source map: MF003.

gbp - Layered pyroxene gabbro (Tertiary)
Layered pyroxene gabbro - In Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit Tgpb. Unit description from source map: MF009.

Tgbp - Layered gabbro and cumulate ultramafic rocks in Fairweather Range (Tertiary)
Layered gabbro and cumulate ultramafic rocks in Fairweather Range. Unit description from source map: MF009.

Kbgb - Gabbro (Cretaceous)
Gabbro - layered pyroxene-hornblende gabbro, found in Muir and Chilkat Provinces (Brew, pers. comm., 1999). Brew renames this unit Tgbg. Unit description from source map: SK010.

Tgn - Gabbronorite and norite (Tertiary (?))
Composed dominantly of medium to dark gray (C.I. 40-75), locally brown gray, medium to coarse grained, orthopyroxene + plagioclase + clinopyroxene gabbronorite and norite containing minor amounts of plagioclase bearing orthopyroxenite. Olivine is present in some norite, and postcumulus, brown hornblende is ubiquitous. Contains abundant sulfides and forms the host rock for the Bohemia Basin and Mirror Harbor nickel-sulfide ore bodies. Unit description from source map: MF002.

Tiy - Younger granitic rocks (Tertiary, early Miocene and Oligocene)
Largely consist of granite, quartz monzonite, and lesser granodiorite. Rocks tend to be light-gray, medium- to coarse-grained, leucocratic biotite granite and granodiorite. A small medium-grained, K-feldspar porphyritic, quartz monzonite body on the east side of Glacier Bay at Sandy Cove is included (Redman and others, 1984; Brew and Ford, 1985). Medium- to coarse-grained, equigranular, granodiorite to quartz diorite plutons and stocks that contain hornblende, biotite, and pyroxene as mafic minerals are typically surrounded by well-developed hornfels zones and sporadic hydrothermal alteration in country rocks. Unit includes garnet-biotite granodiorite west of Glacier Bay (Brew, 1997). Also includes intermediate composition plutons associated with Mt. Crillon-La Perouse mafic and ultramafic bodies. Radiometric dates range from 32.8±1.9 Ma to 21.2±2.8 Ma (Dodds and Campbell, 1988). Hornblende diorite in the Skagway quadrangle is undated but may be Oligocene in age (Gilbert and others, 1987). Description from source map: Glacier Bay Geologic Map.

Tqgm - Hornblende quartz monzonite (Miocene(?) and Oligocene(?))
Icy Strait Belt: Medium grained, K-feldspar porphyritic, quartz monzonite. Color index 5-10; accessory minerals are sphene, chlorite, and epidote; age based on interpretation of unpublished K-Ar data. Unit description from source map: JU002.
Tggr - Hornblende-biotite granite (Tertiary)
Hornblende-biotite granite. Unit description from source map: MF003 and SK010.

Togr - Granite and granodiorite (Tertiary)

Tgqp - Granite porphyry (Tertiary)
Granite porphyry - porphyritic granite and quartz monzonite in Muir Province, at Upper Casement Glacier (Brew, pers. comm., 1999). Unit description from source map: SK010.

Toet - Tonalite (Early Oligocene to Late Eocene)
Light gray medium-grained hornblende-biotite tonalite, gradational to subordinate granodiorite and trondhjemite. Color index ranges from 15 to 30. Tonalites are not magnetic. Biotite exceeds hornblende, and the pluton contains up to 5 per cent 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) report that “trondhjemite 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 describe 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 study. Unit includes the Vodopod pluton west of Nelson Bay and the small stock in the bay south of Nelson Bay. In Glacier Bay area includes intermediate composition plutons associated with Mt. Crillon- La Perouse mafic and ultramafic bodies. On Yakobi Island includes Yakobi Peak body associated with Bohemia Basin norite. Unit description from source map: SK021.

Tgt - Granite and tonalite (Granite) (Eocene)
Consists of Alsek River pluton of strongly foliate, medium-grained, equigranular, hypidiomorphic muscovite-biotite granite and the Novatak Glacier pluton of foliate, fine- to medium-grained, equigranular to seriate, hypidiomorphic hornblende-biotite tona. Unit description from source map: YA002.

Toegr - Granitic rocks (Tertiary, Oligocene and late Eocene)
This belt is composed of rocks that range in composition from biotite- and hornblende-bearing granodiorite to tonalite. Unit includes granite porphyry, porphyritic granite and quartz monzonite at upper Casement Glacier. Generally this younger belt occurs east of the Fairweather Fault and typically has K/Ar and 40Ar/39Ar dates that range from about 44.4±1.3 to 23.3±1.0 Ma (Berry and others, 1976; Brew and others, 2013). Description from source map: Glacier Bay Geologic Map.

TKgd - Hornblende-biotite and biotite-biotite hornblende granodiorite (Tertiary and (or) Cretaceous)
Alexander Belt: Unfoliated medium to coarse grained, very light gray to medium gray, color index 7-19; sphene and chlorite common; age based on regional considerations and interpretation of unpublished K-Ar data. Unit subdivided; outcrops on Admiralty Island. Unit description from source map: JU002.

Tggo - Garnet-biotite granodiorite (Tertiary)
Garnet-biotite granodiorite in Fairweather Province (Brew, pers., comm., 1999). Unit description from source map: MF003.

Tgss - Hornblende syenite (Tertiary)
Hornblende syenite - in Brew (1999; MGI map of Glacier Bay National Park) this unit symbol is discarded and polygons are relabeled part of Tgqp. Unit description from source map: MF003.

**Tegd - Biotite granodiorite (Tertiary (Miocene, Oligocene, and or Eocene))**
Unfoliated light to medium gray, medium-grained hornblende-biotite granodiorite, but ranging from fine- to coarse-grained in the Fairweather Range and east of the Border Ranges Fault zone. Composition ranges from tonalite to quartz monzonodiorite. Locally foliated. In the Skagway B-3 quadrangle (Gilbert and others, 1987) the unit includes igneous breccia that is mixed border phases of hornblende diorite, hornblendite, and fine-grained porphyritic diorite in a matrix of granodiorite. Unit description from source map: MF003 and SK012.

**Togd - Granodiorite (Miocene, Oligocene, and Eocene)**
Dominantly fine- to medium-grained, equigranular to seriate, locally slightly foliated, hypidiomorphic muscovite-biotite granodiorite and biotite granodiorite; the plutons are commonly zoned, with more mafic border zones that contain biotite-hornblende. Unit description from source map: MF010.

**Tqgv - Quartz diorite and granodiorite (Tertiary)**
Cataclastic hornblende-biotite quartz diorite and granodiorite. Medium-grained, subhedral, color index 20. Takhin block. Large andesitic roof pendants are andesitic, massive, usually porphyritic, gray-green. Unit description from source map: SK003.

**Tqd - Granodiorite (Tertiary)**
Medium-grained, equigranular hornblende-biotite granodiorite and quartz diorite. Unit description from source map: SK005.

**TKgg - Biotite-hornblende granodiorite (Cretaceous to Tertiary)**
Biotite-hornblende granodiorite found in Geikie and Chilkat Provinces (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew replaces this unit with: Tggd - biotite granodiorite in Fairweather Province and hornblende-biotite granodiorite in Fairweather Province and hornblende-biotite granodiorite in Geikie and Chilkat provinces; Kgdi - sheared diorite in Lituya Province; and Tgdq - biotite-hornblende quartz diorite in Fairweather Province. Unit description from source map: SK010.

**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 mineral near pluton margins. Plutons contains 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 study. Thin sections show cataclastic textures near contacts on the east side of the Crawfish pluton. The topographic expression of a strand of the Patterson Bay fault coincides with the contact between the plutons, falls within the area in which the plutons contain cataclastic textures, and the fault is therefore inferred to postdate emplacement of the Gut Bay pluton. In Haines area, hornblende-biotite quartz diorite and granodiorite. Medium-grained, subhedral, color index 20. Takhin block. Large andesitic roof pendants are andesitic, massive, usually porphyritic, gray-green. Unit description from source map: SK021.

**Tqg - Quartz diorite and subordinate granodiorite (Tertiary)**
Quartz diorite and subordinate granodiorite. Unit description from source map: SK022.

**Ti - Granodiorite (Miocene and Oligocene)**
Dominantly fine- to medium-grained, equigranular to seriate hypidiomorphic muscovite-biotite and biotite granodiorite and related rocks in 10 small, widely distributed bodies cut diverse older plutonic and metamorphic rocks. Unit description from source map: YA002.
TKgq - Biotite-hornblende quartz diorite (Cretaceous to Tertiary)
Biotite-hornblende quartz diorite - found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew replaces this unit with: Tgqd - in the Fairweather Province; and replaces all other TKgq polygons with Tgqd. Unit description from source map: MF003.

Tdi - Diorite (Tertiary)
Fine- to coarse-grained hornblende diorite. Border phase. Unit description from source map: SK005.

Tdf - Foliated diorite (Tertiary)
Medium-grained, equigranular hornblende diorite, shows flow foliation and compositional layering. Chilkat Lake area. Unit description from source map: SK005.

Tbr - Igneous breccia (Tertiary)
Mixed border phase of hornblende diorite, hornblendite, and fine-grained porphyritic diorite in a matrix of granodiorite. Unit description from source map: SK005.

Ted - Cataclastic diorite (Tertiary)
Fine- to medium-grained hornblende diorite that exhibits a strong cataclastic foliation. Unit description from source map: SK007.

Toet - Tonalite (Early Oligocene to Late Eocene)
Light gray medium-grained hornblende-biotite tonalite, gradational to subordinate granodiorite and trondhjemite. Color index ranges from 15 to 30. Tonalites are not magnetic. Biotite exceeds hornblende, and the pluton contains up to 5 per cent 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) report that “trondhjemite 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 describe 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 study.
Unit includes the Vodopod pluton west of Nelson Bay and the small stock in the bay south of Nelson Bay. In Glacier Bay area includes intermediate composition plutons associated with Mt. Crillon- La Perouse mafic and ultramafic bodies. On Yakobi Island includes Yakobi Peak body associated with Bohemia Basin norite. Unit description from source map: MF014.

Tegr - Tonalitic rocks (Tertiary, Eocene)
Rocks that range in composition from biotite- and hornblende-bearing granodiorite to tonalite, is distinguished by the almost ubiquitous presence of tonalite phases associated with the plutons. K/Ar and 40Ar/39Ar dates range from about 53 to as young 34 Ma in the vicinity of GLBA. These plutons intrude Chugach accretionary complex rocks (Kafl) and are mainly located west of the Fairweather Fault; however, a few bodies are located east of the Fairweather Fault and west of the Border Ranges Fault System (BRFS) in the vicinity of Johns Hopkins Inlet as well as one body in the northwest arm of Dundas Bay and east of the BRFS. Some of these plutons have associated migmatitic zones.
Description from source map: Glacier Bay Geologic Map.

Kgdi - Hornblende diorite (Cretaceous)
Hornblende diorite. Unit description from source map: MF003.

TKggs - Biotite-hornblende granodiorite (Cretaceous to Tertiary)
Biotite-hornblende granodiorite found in Geikie and Chilkat Provinces (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew replaces this unit with: Tggs - biotite granodiorite in Fairweather Province and hornblende-biotite granodiorite in Fairweather Province and hornblende-biotite granodiorite in Geikie and Chilkat provinces; Kgdi - sheared diorite in Lituya Province; and
Tgqd - biotite-hornblende quartz diorite in Fairweather Province. Unit description from source map: MF003.

Tgqd - Biotite granodiorite (Tertiary)
Biotite granodiorite found in Geikie and Muir Provinces (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew describes this unit as a hornblende-biotite granite and indicates that this unit will be partially changed (on new, unpublished map) to Tggr. Unit description from source maps: MF003 and SK010.

Tg - Granodiorite and granite (Tertiary, Eocene)
Chiefly light gray, fine- to coarse-grained, hypabyssal, muscovite-biotite granodiorite and granite that occur in four moderate-size stocks that chiefly intrude the Yakutat Group. Unit description from source map: YA002.

Tt - Tonalite (Tertiary (?))
A dominantly light to medium gray (C.I. 5-40), medium grained, biotite + or - hornblende + or - muscovite tonalite, having biotite generally more abundant than hornblende. Includes small zones of medium to dark gray, medium grained, hornblende + or - bi. Unit description from source map: MF002.

Tt+stipple - Hornblende(?)-biotite tonalite with abundant inclusions and septa (Tertiary (?))
Intrusive igneous rocks on Chichagof and Yakobi Islands. Hornblende(?)-biotite tonalite at Lake Elfenfeldahl and biotite(?)-hornblende tonalite in other bodies on northwest Chichagof Island. Areas of abundant inclusions and septa of metamorphic rock shown by stipple pattern. Unit description from source map: MF004.

Toet - 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, Indigo Lake, and on Kruzof Island. Tonalite in the core of the Crawfish Inlet pluton is relatively homogenous, inclusion-poor, medium-grained, and contains biotite 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 less than 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. Unit description from source map: MF014.

Tgt - Granite and tonalite (Tonalite) (Eocene)
Consists of Alsek River pluton of strongly foliate, medium-grained, equigranular, hypidiomorphic muscovite-biotite granite and the Novatak Glacier pluton of foliate, fine- to medium-grained, equigranular to seriate, hypidiomorphic hornblende-biotite tonalite. Unit description from source map: YA002.

TKmm - Migmatite associated with Cretaceous - Tertiary plutons (Cretaceous to Tertiary)
Migmatite in Fairweather and Geikie Provinces, associated with the following granitic units: TKgg, TKqq, Tggq, Tggg (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit Tmm. Unit description from source map: MF003.

Tmm - Migmatite associated with Tertiary plutons (Tertiary)
Migmatite associated with Tertiary plutons - in Brew (1999; MGI map of Glacier Bay National Park) unit TKmm changed to Tmm. Unit description from source maps: MF003 and SK010.
Togum - Mafic and ultramafic rocks of the Valdez and Orca Groups, undivided (Tertiary, Eocene to Paleocene)

Dark-gray, fine- to medium-grained locally porphyritic gabbro that occurs in distinct mafic-ultramafic complexes in the Prince William Sound region. The largest exposure is on Esther Island (Tysdal and Case, 1979). Several small intrusive bodies of gabbro occur on Knight Island, where they intrude sheeted dikes of unit Togb of Nelson and others (1985, included in unit Togum, here). On the Resurrection Peninsula in the Seward quadrangle, Miller (1984) described local occurrences of west-dipping magmatic mineral layering and cumulate textures within the gabbro. The gabbro grades into the sheeted dike map unit (Togb herein) and is generally elongate and parallel to the sheeted dikes, but it also crosscuts the dikes locally (Tysdal and Case, 1979; Miller, 1984). Tysdal and Case (1979) state that, on the Resurrection Peninsula, "The gabbro intrudes slate and sandstone of the Valdez Group, crosscuts the bedding, and forms aphanitic sills in other places. A blue-gray and whitish thermal aureole, at least 200 m wide, marks the contact zone with the sedimentary rocks." Nelson and others (1985) and Bradley and Miller (2006) instead interpreted the contacts between the gabbro and Valdez metasedimentary rocks on the Resurrection Peninsula as faults. On Knight Island, the gabbro intrudes rocks of the Orca Group. Nelson and others (1989) reported a 57 Ma U/Pb zircon age on a plagiogranite that intrudes the gabbro on the Resurrection Peninsula. The ultramafic rocks are primarily exposed in the Cordova quadrangle and in a small exposure associated with the Resurrection Peninsula ophiolite. The larger exposure is part of a compositionally and texturally variable unit that consists mainly of medium-grained gabbro, local diabase, hornblende gabbro, peridotite, and orthopyroxenite (Winkler and Plafker, 1993). Exposures associated with the ophiolite consist of dunite, locally with layers of chromite, moderately to mostly altered to serpentine, serpentine-talc, and talc schist (Tysdal and Case, 1979). "In most places enough relict texture and mineralogy remains to recognize original clinopyroxenite, dunite, and harzburgite" (Miller, 1984). Unit occurs as small pods in gabbro and fault-bounded slices within Valdez Group metasedimentary rocks (Miller, 1984; Nelson and others, 1985). On Knight Island, xenoliths of peridotite in sheeted dikes were observed by Richter (1965) but not by subsequent workers (Tysdal and Case, 1979; Nelson and others, 1985). Nelson and others (1985) mapped three peridotite bodies, including two that lie within or near a shear zone in their sheeted dikes unit Tod (unit Togb, here) and the other body occurs as a xenolith in the sheeted dikes unit. These ultramafic rocks weather orange-brown in color and form subdued rubble outcrops. Description from source map: Geologic Map of Alaska.

Toeg - Layered gabbro (Oligocene and Eocene)
Layered pyroxene and hornblende gabbro. Also includes olivine gabbro, norite, troctolite, anorthosite, pyroxenite, dunite. Contains magnetite, and locally ilmenite. Also contains copper and nickel sulfides, including the Brady Glacier Cu-Ni deposit. Unit description from source map: MF014.

Thi - Hypabyssal intrusions (Tertiary)
Consists of andesite dikes intruding volcanic rocks of the Chugach accretionary complex (unit Kaf and Kafv). Age is unresolved. Description from source map: Glacier Bay Geologic Map.

Tdan - Andesite dikes (Tertiary (Miocene?))
Andesite dikes in Fairweather Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

Ti - Felsic intrusive (Tertiary)
Felsic, intermediate and mafic dikes and hypabyssal intrusions. Swarms of dikes and also gray hornblende porphyritic andesite are mapped in Glacier Bay area (Brew, 1997); also in Skagway quad (Gilbert and others, 1987). Hypabyssal andesite contains hornblende, quartz, and magnetite phenocrysts, and hornblende is locally altered to chlorite. Proximal to Miocene to Eocene granitic intrusive rocks in Glacier Bay area and Skagway quadrangle. Unit description from source map:
SK021.

**Kvg - Valdez Group (Upper Cretaceous)**

Dark-gray, thin- to thick-bedded, moderately to poorly sorted sandstone, siltstone, and mudstone flysch. Rocks in the Glacier Bay region are regionally metamorphosed and range from subgreenschist facies to as high-grade as amphibolite facies, forming graywacke semischist, phyllite, slate, and layered schist, semischist, and gneiss (Brew and others, 1978). These metasedimentary rocks are correlated with strata in the Valdez Group to the northwest by lithologic similarity (Brew and Morrell, 1979a) and by stratigraphic continuity (Plafker and Campbell, 1979; Campbell and Dodds, 1983). The Valdez Group is part of a large unit in southern Alaska that extends from the western end of the Alaska Peninsula around the Gulf of Alaska to southeast Alaska, as far as GLBA. The Valdez Group as a whole is a thick sequence of rhythmically alternating, multiply-deformed, metamorphosed sandstone-siltstone turbidite in beds that generally range from a few centimeters to a few meters thick and, locally have massive beds as much as tens of meters thick (Winkler and Plafker, 1981; Nelson and others, 1985; Winkler and Plafker, 1993; Bradley and others, 1999). Point count analysis of sandstone from this unit in Prince William Sound by Dumoulin (1987) showed Valdez Group sandstone contains 6 to 30 percent quartz, 23 to 45 percent feldspar, and 28 to 68 percent lithic fragments; lithic fragments are dominantly volcanic rocks. Inoceramus kusiroensis, I. ulrichi, and I. concentrica, of Maastrichtian age, have been reported in areas to the west of GLBA (Tysdal and Plafker, 1978; Tysdal and Case, 1979; Nelson and others, 1985; Bradley and others, 1999). Bradley and others (2009) reported detrital zircon dates as young as 70 Ma from the unit near Anchorage. These fossils and detrital zircon dates provide a Late Cretaceous protolith age for this unit. More eastern exposures of the Valdez Group, such as in the Park, contain an increasing proportion of interbedded volcanic rocks; where these igneous rocks dominate, they are designated herein as unit Kafv. Description from source map: [Glacier Bay Geologic Map](#).

**mlg - Metagraywacke, slate, chlorite schist, and phyllite (Cretaceous)**

Metagraywacke, slate, chlorite schist, and phyllite - moderately folded / faulted, found in Fairweather Province and Tarr Inlet suture zone (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmlg. Unit description from source maps: MF003 and SK010.

**mlp - Muscovite schist and phyllite (Cretaceous)**

Muscovite schist and phyllite - highly folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmlp. Unit description from source map: MF003.

**msb - Biotite schist and semischist (Cretaceous)**

Biotite schist and semischist - moderately folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmsb. Unit description from source map: MF003.

**my - Biotite-hornblende schist and gneiss (Cretaceous)**

Biotite-hornblende schist and gneiss - undivided gneiss and schist - moderately folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmy. Unit description from source map: MF003.

**Kvs - Valdez Group, undivided metavolcanic and metasedimentary rocks (Cretaceous)**

Largely interbedded mafic to intermediate metavolcanic rocks and a metasedimentary sequence that locally includes metachert and thin lenses of marble. Locally includes melange of limy graphitic slate, phyllite, graywacke, chlorite schist and cherty lime. Unit description from source map: MF009.
Kvgv - Metavolcanic rocks of the Valdez Group (Cretaceous)

Moderately folded and faulted, hornblende augen gneiss, schist, and amphibolite found west of the BRFS in western GLBA (Brew, 1997). Protolith is thought to be basalt and basaltic tuff in western GLBA; rocks are deformed and regionally metamorphosed to as high as amphibolite facies (Gehrels and Berg, 1992, Dusel-Bacon and others, 1996). In Prince William Sound, this unit is generally described a tholeiitic metabasalt, massive greenstone, and basaltic metatuff, including local pillow lava, pillow breccia, and gabbroic dikes and sills (Winkler and Plafker, 1993) typically interbedded with flysch of the Valdez Group (unit Kaf). A Late Cretaceous protolith age assigned because of association with the metasedimentary part of the Valdez Group; K/Ar dates suggest an early Miocene metamorphic age (Hudson and others, 1977a). Description from source map: Glacier Bay Geologic Map.

mgg - Hornblende augen gneiss (Cretaceous)

Hornblende augen gneiss - moderately folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmgg. Unit description from source map: MF003.

Kvs - Valdez Group, undivided metavolcanic and metasedimentary rocks (Cretaceous)

Largely interbedded mafic to intermediate metavolcanic rocks and a metasedimentary sequence that locally includes metachert and thin lenses of marble. Locally includes melange of limy graphitic slate, phyllite, graywacke, chlorite schist and cherty lime. Unit description from source map: SK012.

mga - Hornblende gneiss and schist (Cretaceous)

Hornblende gneiss and schist - moderately folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmge. Unit description from source map: MF003.

Kvv - Valdez Group, amphibolite schist and minor gneiss (Cretaceous)

Dark-greenish black, fine-grained, partially segregated amphibolite schist and some gneiss. Unit description from source maps: MF009 and SK012.

Kvm - Valdez Group - Amphibolite schist (Late(?) Cretaceous)

Mostly massive, black to greenish-black fine- to medium-grained amphibolite schist. Probably derived from massive basalt and gabbro. Unit description from source map: YA002.

mgb - Biotite gneiss (Cretaceous)

Biotite gneiss - moderately folded / faulted, found in Fairweather Province (Brew, pers. comm., 1999; MGI map of Glacier Bay National Park). Brew renames this unit TKmgb. Unit description from source map: MF003.

Kvg - Valdez Group, gneiss and schist (Cretaceous)

Reddish-weathering, quartzofeldspathic pelitic gneiss and schist. Metasedimentary rocks having a well-developed gneissic foliation consisting of alternating quartz and feldspar-rich layers and biotite-rich layers. Locally contains porphyroblasts of euhedral garnet and poikilitic staurolite. Unit also contains up to 10 percent cream colored or light gray coarse-grained orthogneiss which locally grades into granitic rocks. Unit description from source map: SK012.

Kpm - Pelitic and quartzofeldspathic schist and gneiss (Cretaceous)

Pelitic and quartzofeldspathic schist and gneiss with abundant sills, dikes, and small intrusive bodies of felsic granitic rocks. Unit description from source map: YA002.

Ksm - Valdez Group - Pelitic and quartzofeldspathic schist and gneiss (Late Cretaceous)

Reddish weathering, variably banded, strongly schistose to granoblastic pelitic and quartzofeldspathic schist and gneiss. Typically a garnetiferous graphitic schist. Sedimentary clastic protolith. Unit description from source map: YA002.
Kvu - Volcanic rocks, undivided (Cretaceous)

Volcanic rocks that range in composition from rhyolite to olivine basalt flows, from dacitic to andesitic tuff and tuffaceous sandstone, and rhyolitic domes (Hoare and Coonrad, 1978; Patton and others, 1968, 1975; Box 1985; Box and others, 1993). Includes Tulip volcanic field rhyolite domes and flows; Swift Creek volcanic field lithic air-fall tuff; Kipchuk volcanic field andesite and basalt flows, tuff, tuffaceous sandstone; and rhyolite domes and flows in the Bethel quadrangle (Box and others, 1993). In Shungnak and Kateel River quadrangles, unit varies locally but generally consists of latite, quartz latite, and trachyte flows, crystal-lithic tuff, rhyolitic and rhyodacitic welded tuff and flows(?), and hypabyssal intrusive rocks (Patton and others, 1968). In the Tyonek quadrangle, unit is andesite, dacite, and rhyolite flows and tuff. Includes massive and crystal-rich tuff that contains either hornblende or plagioclase as phenocryst phases, as well as flow-banded rhyolite (Solie and others, 1991; Wilson and others, 2009, 2012). In the Healy quadrangle, small exposures of andesitic and basaltic subvolcanic rocks (Csetey and others, 1992) have yielded late Cretaceous radiometric ages of 97.3±2.9 Ma and 79.1±6.0 Ma, respectively. In the Tyonek and Nabesna quadrangles, unit consists of dominantly andesitic composition metamorphosed and altered volcanic tuff, breccia, or agglomerate. More mafic compositions are suggested by one outcrop of pillow lavas (small pillows, up to 30 cm in diameter) and lesser metasedimentary volcaniclastic turbidites and rare nonvolcaniclastic turbidites. Rocks are generally light green, indicative of alteration or low-grade metamorphism, but others are light-gray and fresh. Age best constrained at a locality near Hayes River Pass in the Tyonek quadrangle where the young-est detrital zircons in volcaniclastic sedimentary rocks were dated between 151 and 136 Ma, Late Jurassic to Early Cretaceous, indicating the sedimentary rocks are Hauterivian or younger (D.C. Bradley, written commun., 2008). Magoon and others (1976) included these rocks in their undivided metasedimentary rocks unit of Jurassic and (or) Cretaceous age. Other authors have included these rocks in the informally named Kahlitna assemblage (see, for example, Jones and others, 1981). In many other parts of western Alaska, unit consists of felsic dikes, sills, and hypabyssal rocks. In southeast Alaska, andesitic shallow intrusive rocks are found in the Juneau and Petersburg quadrangles thought to be Cretaceous in age (Brew and others, 1984; Brew and Ford, 1985). Locally subdivided into unit Kmvi. Description from source map: Geologic Map of Alaska

Kwan - Andesite (Cretaceous)

Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Described by Lathram and others (1959) as: "Andesite dikes and sills- altered hornblende basaltic andesite, hornblende pigeonite andesite, and hornblende andesite;" age inferred from Lathram and others (1959), but could be as young as Tertiary and therefore correlative with the Tertiary andesite unit (Tsan). Unit description from source map: JU002.

Kgb - Gabbro and diorite of southeast Alaska (Cretaceous)

Primarily gabbro, hornblende gabbro, hornblende, leucogabbro, and subordinate norite, syenite, and pyroxenite on Prince of Wales Island (Eberlein and others, 1983), Kuiu Island (Brew and others, 1984), and Chichagof Island (also described as the layered gabbro near the head of Tenakee Inlet by Loney and others(1975)), where it is associated with Early Cretaceous granodiorite and diorite (units Keg and KJse) (Loney and others, 1975; Johnson and Karl, 1985). Also includes hornblende diorite and gabbro in the Haines area that grades laterally into granodiorite and quartz diorite. Potassium-argon ages are Late Cretaceous (Redman and others, 1984). Hornblende and biotite diorite of the Juall Diorite (Knopf, 1911) along east shore of Lynn Canal in the northern Juneau quadrangle has produced a hornfels aureole in adjacent metasedimentary and metavolcanic rocks. Gehrels (2000) reported a U/Pb zircon age of 105 Ma on this pluton. At an unusual occurrence in the Craig quadrangle, epidote replaces the gabbro in irregular masses up to several meters in diameter or as veinlets cutting the rock (Herreid and others, 1978). In thin section, the replacement origin of the
epidote is clearly shown by gradational embayed contacts with gabbro. The gabbro, which is a small border phase of Cretaceous granodiorite, contains medium-sized subhedral crystals of sericitized labradorite and subordinate hornblende, pyroxene, ilmenite, sphene, and apatite (Herreid and others, 1978). On generalized map, included as part of unit KPzum. Description from source map: Geologic Map of Alaska

Kmdi - Hornblende diorite (Late Cretaceous)
Gravina Belt: Intrusive Rocks of Admiralty-Revillagigedo Plutonic Belt and Associated Migmatite: Hornblende diorite, quartz diorite, and minor gabbro; medium to very coarse grained; color index 15 to 50; weathers light to dark green; highly altered to epidote and chlorite rich rock. Crops out southeast of Berners Bay, south of Herbert River, and on Douglas and Lincoln Islands. Differs from other Cretaceous granitic rocks in the high degree of alteration and (or) metamorphism. Body on Lincoln Island described by Barker (1957) as: “Gabbro-Sericitized hornblende uralite gabbro.” Unit description from source map: JU002.

Kkhd - Hornblende diorite (Cretaceous)
Hornblende diorite, subhedral, seriate, medium-grained, color index 15-20. Inhomogeneous texture results form variations in color index. Orbicular texture at peak 4412, zoned orbicules 10-40 cm long. Hornblende is dominant mafic mineral, with rare augite, some hornblende is cored by augite. Hornblende is lined, trending 140 degrees, plunging moderately NW or SE. Quartz is 5-10%, 5% K feldspar, but locally as much as 30% K feldspar. Accessory sphene, magnetite, epidote. Unit description from source map: SK003.

Kfg - Foliated granitic rocks (Cretaceous)
Medium-grained, very light-gray to gray biotite-hornblende granodiorite that locally includes quartz diorite, quartz monzodiorite, tonalite, and granite phases. Foliation, defined by the alignment of mafic minerals, is usually present. These plutonic bodies are located mainly in the northeastern part of GLBA. Foliations generally parallel those in the host rocks except for local divergences near contacts. Contact aureoles in the host rocks generally consist of narrow zones of hornfels (D.A. Brew, written commun., 2002). Age control is generally lacking; one dated sample in the northern part of the Park yielded K/Ar biotite and hornblende dates of 114.5±3.4 and 112.5±3.4 Ma, respectively (Brew and others, 2013). A large pluton in the vicinity of Wachusett and Muir Inlets yielded three K/Ar hornblende dates between 107.5±3.2 and 111.6±3.4 Ma. Nonfoliated plutons of similar composition in the vicinity yielded cooling ages of about 120 to 110 Ma. Description from source map: Glacier Bay Geologic Map.

Kggd - Foliated biotite-hornblende granite, granodiorite, and tonalite (Cretaceous)

Kgdf - Foliated granodiorite (Cretaceous)
Weakly to strongly foliated, fine- to coarse-grained biotite-hornblende granodiorite. Subordinate granite, quartz monzodiorite, quartz diorite. Color index 10-30, biotite mostly less than hornblende in abundance. Equigranular, locally seriate. Locally abundant diabase xenoliths. Unit description from source map: SK007.

Kbg - Gabbro (Cretaceous)
Medium green, medium-grained hornblende gabbro. Poorly exposed and poorly documented small plugs of gabbro on Snow Dome, Glacier Bay (Brew and Ford, 1985). Description from source map: Glacier Bay Geologic Map.
**Kwdb - Diabase (Cretaceous)**
Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Described by Lathram and others (1959) as: "Diabase and basalt intrusions northwest of William Henry Bay are diabase, locally may contain fine grained diorite." Unit description from source map: JU002.

**Kwgb - Gabbro (Cretaceous)**
Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Poorly exposed and poorly documented small plugs on Snow Dome, Glacier Bay. Unit description from source map: JU002.

**Kmig - Migmatite and metaplutonic rocks (Cretaceous)**
Mixed intrusive rocks and inclusions of sedimentary rocks. Intrusive rocks tend to be of granodioritic to quartz dioritic composition (Brew and others, 1984; Brew and Ford, 1985; Karl, 1999; Karl and others, 1999; Brew, 1997). Migmatite textures range from agmatite (brecciated migmatite) to layered gneiss. Locally inclusions of schist, gneiss, and marble are present. Migmatitic rocks are exposed on either side of Glacier Bay where they are widespread and associated with Cretaceous or Cretaceous and Jurassic plutons that are tentatively assigned to the Saint Elias suite of Gordey and Makepeace (2003). Also includes garnet-hornblende (±quartz and feldspar) gneiss from the vicinity of Mount Merriam east of Queen Inlet as reported by Brew (1997). Description from source map: [Glacier Bay Geologic Map](#).

**Kwmg - Alexander belt, Intrusive rocks of the Chilkat-Prince of Wales plutonic province: Migmatite and biotite-quartz-feldspar gneiss (Cretaceous)**
Migmatite and gneiss associated with large body of biotite hornblende granodiorite north of the Casement Glacier in Glacier Bay National Park and Preserve; one other outcrop area south and east of Casement Glacier on Snow Dome. Unit description from source map: JU002.

**Kmm - Migmatite associated with Cretaceous plutons (Cretaceous)**
Migmatite - found in Geikie and Muir provinces, and associated with granitic units Kggd and Kgto (Brew, pers. comm., 1999). Unit description from source map: MF003.

**Kgm - Migmatite phase of the Chilkat Wales belt (Cretaceous)**
In Glacier Bay area, migmatitic granodiorite; light gray biotite hornblende granodiorite (Kgd) invader with mafic agmatite, plastically deformed schist, gneiss, and marble inclusions, and with felsic segregation and restite fabrics. Unit description from source map: MF006.

**Ksg - Sitka Graywacke, undivided (Cretaceous)**
Consists of sandstone and mudstone turbidites and subordinate conglomerate on Baranof, Chichagof, Kruzof, and Yakobi Islands (Loney and others, 1975; Decker, 1980; Johnson and Karl, 1985). Part of what is commonly called the Chugach accretionary complex, the Sitka Graywacke is lithologically similar to the Chugach flysch (see unit Kaf, above). Detrital zircon studies (Haeussler and others, 2006) suggest the unit includes two age-distinct subunits. The youngest and western part of the unit yields detrital zircons that have minimum age populations equivalent to the Late Cretaceous fossil ages of the Chugach flysch, which indicates a maximum depositional age of Campanian(?) or Maastrichtian. The eastern part of the unit yields an Albian maximum age on the basis of detrital zircon populations, suggesting the pre-ence of an earlier depositional system. As originally described, the Sitka Graywacke was thought to be Jurassic, in part; however, the detrital zircon data suggests this is unlikely. Strata represent deep-water marine trench, slope-basin, and fan deposits. Sitka Graywacke is moderately deformed and disrupted, regionally metamor-phosed to as high a grade as greenschist facies in some areas, and thermally upgraded to hornblende-hornfels facies
locally (Decker and others, 1979; Johnson and Karl, 1985). Common rock types in metamorphosed regions south of Cross Sound include metagraywacke and argillite. Early Cretaceous fossils were found in the Sitka Graywacke on Kruzof Island (Reed and Coats, 1941), and the detrital zircon data (Haussler and others, 2006) suggests a long depositional history for the Sitka Graywacke; minimum age of these strata is constrained by Eocene granodiorite (unit Toegr) on Baranof Island (Loney and others, 1975; Reifenstuhl, 1986; Bradley and others, 2003; S.M. Karl, unpub. data). On generalized map, included as part of unit Kchf. Description from source map: Geologic Map of Alaska

Ksh - Hornfelsed Sitka Graywacke (Cretaceous)
Regionally metamorphosed to prehnite-pumpellyte facies with prehnite typically occurring in veinlets or clots. In the vicinity of Tertiary (?) plutons, has been thermally metamorphosed to at least hornblende hornfels facies. Metamorphic mineral include biotite, garnet, and andalusite. On western Yakobi Island, banded quartz-feldspathic gneiss and migmatite occur at the contacts with Tertiary (?) tonalite and gabbronorite plutons. Unit description from source map: MF002.

Kmgr - Granitic rocks of central and southeast Alaska (Cretaceous, Albian to Coniacian)
Primarily granodiorite and lesser quartz diorite, granite, and quartz monzonite that is widely exposed in central and southeastern Alaska. Exposed primarily in four areas: (1) southern southeast Alaska west of the Coast plutonic complex; (2) in the Yukon-Tanana Upland of east-central Alaska and northern Alaska Range; (3) on Saint Lawrence Island in western Alaska; and (4) in southwest Alaska in the Bethel and Russian Mission quadrangles. In southeast Alaska, the plutons tend to be more mafic than other areas and consist of granodiorite and quartz diorite and lesser tonalite; most rocks are medium-grained and moderately foliated and lineated parallel to the fabric in country rocks. Some bodies are tabular and oriented parallel to the foliation; epidote is a common accessory mineral, and garnet is less common. Radiometric ages (K/Ar) are commonly discordant and range from 112 Ma to as young as 22.8 Ma, but most age determinations yielded Coniacian (~86 Ma) or older ages. Mid-Cretaceous plutons in the Yukon-Tanana Upland tend to be biotite granite and biotite-hornblende granodiorite with minor diorite phases and are relatively well dated. Some bodies are batholithic in size, like the Goodpaster and Mount Harper batholiths. Analyses, such as those by Wilson and others (1985), have demonstrated that emplacement of these plutons postdate regional metamorphism and reflect relatively slow cooling. Gold mineralization is commonly associated with these plutons, such as at the Fort Knox and Pogo deposits. In the Eagle and Tanacross quadrangles, radiometric dating is sparse and many of the plutons shown as part of this unit are undated. Limited dating in the adjacent northeastern Big Delta quadrangle suggests that at least some of these plutons may be of latest Cretaceous or earliest Tertiary age. A significant part of Saint Lawrence Island is made of these plutons, which consist of fine- to coarse-grained granite and subordinate granodiorite, monzonite, syenite, and alaskite (Patton and others, 2011). In southwest Alaska, this unit includes the Nyac and nearby plutons. Age control on these plutons is somewhat imprecise; K/Ar and 40Ar/39Ar ages vary between 120 and 101 Ma, and the only available U/Pb age was reported as an upper intercept on concordia described as between 129 and 104 Ma (Box and others, 1993). Atypical occurrences of the rocks of this unit are a granodiorite body associated with the Pebble copper deposit in southwest Alaska, dated to 90 Ma, and a coarse-grained biotite granite in the northern Tyonek quadrangle that was dated to 96.9 Ma (Wilson and others, 2009, 2012). Description from source map: Geologic Map of Alaska

Kg - Altered tonalite (Cretaceous)
Fine- to medium-grained, equigranular to seriate, hypidiomorphic and foliate hornblende-biotite tonalite. Mafic grains are oriented; most samples are pervasively sheared and altered along fractures. Intrudes Yakutat Group melange facies. Unit description from source map: YA002.
Keg - Granite to granodiorite (Early Cretaceous, Hauterivian to Aptian)
Small intrusions in eastern GLBA ranging in composition from hornblende biotite granite to granodiorite, including quartz monzonite, and locally diorite and quartz diorite. In Chilkat Mountains, quartz monzonite is medium-grained, locally K-feldspar porphyritic, and locally contains lineated hornblende which defines a magmatic foliation. Radiometric dating of the rocks in this unit is sparse and only one body within the Park has been dated, yielding a K/Ar date of 116.5±3.5 Ma on hornblende (Brew and others, 2013); rocks of this unit north of the Park boundary have yielded dates between 107.9±3 and 122.1±4 Ma. Description from source map: Glacier Bay Geologic Map.

Kwgr - Granite (Cretaceous)

Kwgd - Biotite-hornblende granodiorite (Cretaceous)
Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Also biotite hornblende granite, quartz, monzonite, quartz diorite, and diorite; most individual bodies are foliated; accessory minerals include pyrite, epidote, sphene, and chlorite; very light gray to dark gray, felsic types locally pinkish gray; color index 4-30, averaging 15; fine to coarse grained; dark fine grained inclusions common. Unit description from source map: JU002.

Kgd - Granodiorite (Cretaceous)
Fine- to coarse-grained biotite-hornblende granodiorite with biotite quartz monzonite, quartz diorite. color index 10-30, biotite mostly less than hornblende in abundance. Equigranular, locally seriate. Unit description from source map: SK007.

Kds - Dike swarm (Cretaceous)
Swarm of dikes and sills intruding Pzb, dark green basalt (60-70%) and white, green, and lavender chert (20-30%), and minor basaltic agglomerate and chert breccia. Unit description from source map: SK007.

Kqm - Quartz monzonite and quartz diorite (Cretaceous)
In Chilkat Mountains, quartz monzonite is medium-grained, locally K-feldspar porphyritic. Lineated hornblende defines magmatic foliation. On Kuiu Island, biotite-hornblende quartz monzodiorite, occurs with minor tonalite, granodiorite, quartz diorite, diorite, quartz monzonite, and monzodiorite, massive to foliated, equigranular to locally porphyritic, medium-grained. Secondary epidote locally present. (Kt on Baranof map). Unit description from source map: SK021.

Kwqd - Biotite-hornblende quartz diorite and tonalite (Cretaceous)
Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Also granodiorite and diorite; foliated, locally gneissic; fine to coarse grained; very light gray to dark, grayish green; color index 3-68, averaging 25; accessory minerals include pyrite, epidote, sphene, and chlorite; locally abundant dark fine grained inclusions. Unit description from source map: JU002.

Kwdi - Biotite-hornblende and hornblende-biotite diorite (Cretaceous)
Alexander Belt: Intrusive Rocks of the Chilkat-Prince of Wales Plutonic Province: Described by Lathram and others (1959) as: "Diorite and quartz diorite- Hornblende biotite diorite, hornblende biotite quartz diorite, lesser amounts quartz monzonite, quartz monzonite gneiss, granodiorite, and hornblende. Plutons west of William Henry Bay mostly sheared augite biotite diorite, augite diorite. Small pluton Central Chilkat Mountains augite diorite cut by diabase or andesite dikes. At Sullivan Island biotite quartz diorite gneiss, granodiorite gneiss, biotite diorite." Unit description from source map: JU002.

Ki - Diorite-granodiorite (Cretaceous)
Medium-grained, hornblende diorite and biotite-hornblende granodiorite with biotite quartz monzonite. Color index in diorite is 15-25. Granodiorite contains 15% biotite, 5% hornblende, 15-20% quartz. Unit
description from source map: SK004.

**Kdi - Diorite (Cretaceous)**
Medium-grained, equigranular hornblende diorite. Unit description from source map: SK005.

**Kd - Diorite (Cretaceous)**
Fine- to medium-grained hornblende diorite. Color index approximately 50. Unit description from source map: SK007.

**Kgqd - Biotite-hornblende quartz diorite (Cretaceous)**
Biotite-hornblende quartz diorite. Unit description from source map: SK010.

**Kmto - Hornblende tonalite, hornblende diorite, biotite-hornblende diorite, and biotite-hornblende tonalite (Cretaceous)**
Alexander Belt: Intrusive Rocks of the Muir-Chichaof Plutonic Belt I: Foliated, heterogeneous; exposed mainly southwest of Mud Bay River and Neka River, Chichagof Island. Unit description from source map: JU002.

**Kt - Biotite-hornblende tonalite (Late Cretaceous)**
Intrusive igneous rocks on Chichagof and Yakobi Islands. Biotite-hornblende tonalite and hornblende tonalite. Uralitic hornblende replaces pyroxene. Unit description from source map: MF004.

**KJmy - Mélange of the Yakutat Group (Cretaceous and Jurassic?)**
Mélange characteristically composed of blocks, as much as several kilometers in size, of a variety of rock types, enclosed in a pervasively sheared matrix of dark-gray to black mudstone, which may be cherty or tuffaceous (George Plafker, written commun, 2000). Plafker’s list of block compositions includes slaty argillite, tuff, graywacke, chert, greenstone, greenschist, limestone, and phyllite, which are incorporated into a chaotically deformed matrix that has both original soft sediment deformational features and later tectonic disruption features. Greenstone is generally massive, but locally has pillows, breccia, or agglomeratic textures, and commonly has epidote-rich pods and stringers. Some greenstone blocks are cut by diorite dikes, and are associated with limestone and marble. Other greenstone is associated with radiolarian-bearing ribbon chert. Poorly preserved fossils near Russell Fiord northeast of the Park indicate that some of the marble may be Late Triassic or Permain in age. Fine- to medium-grained hornblende biotite tonalite associated with greenstone and marble in a large block in the mélange at Marble Point in Russell Fiord northeast of the Park yielded a K/Ar hornblende date of 163.3±3.5 Ma (Hudson and others, 1977b). Description from source map: [Glacier Bay Geologic Map](https://www.nps.gov/glba/).  

**Kym - Yakutat Group Melange (Cretaceous)**
Melange - mixed chert, greenstone, and phyllite. Highly folded / faulted, found in Lituya Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

**Kym - Yakutat Group Melange (Cretaceous and Late Jurassic)**
Slaty argillite, tuff, graywacke, chert, greenstone, greenschist, limestone, and phyllite in a chaotically deformed melange with both original soft sediment deformational features and later tectonic disruption features. Unit description from source maps: MF009 and SK012.

**Kyx - Yakutat Group - melange facies (Cretaceous and Jurassic(?))**
Yakutat Group is a heterogeneous assemblage including clastic sedimentary rocks, altered volcanic rocks, chert, carbonate, and granitic rocks. Two major subdivisions that are commonly structurally juxtaposed, a flysch facies and a melange facies. Melange facies is characteristically composed of blocks of competent rocks of heterogeneous lithology as mush as several kilometers in size enclosed in a pervasively sheared matrix of dark-gray to black pelite, cherty pelite or tuffaceous pellite. Melange
blocks are predominantly greenstone, oolitic limestone, marble, granitic plutonic rocks, chert, and graywacke. Unit description from source map: YA002.

c - Conglomerate (Age not given)
Larger lenses and beds of well rounded and sorted pebble and cobble conglomerate to 200m thick that are locally developed within both the flysch and melange facies. Includes abundant angular blocks of gray oolitic limestone containing chert nodules in K. Unit description from source map: YA002.

g - Greenstone (Age not given)
Larger greenstone masses within the melange facies of the Yakutat Group, generally massive and structureless but locally with faint pillow forms and agglomeratic texture. Commonly with epidote-rich pods and stringers and cut by diorite dikes. Associate. Unit description from source map: YA002.

d - Tonalite (Jurassic)
Large bodies of foliate, fine- to medium-grained hornblende biotite tonalite associated with meta-greenstones. Interpreted as allochthonous blocks in the melange. Unit description from source map: YA002.

KJdg - Diorite and gabbro of southeast Alaska (Cretaceous? and Jurassic)
Extensively altered and sheared, green to gray-green, medium-grained, hornblende ± biotite diorite, gabbro, and minor quartz diorite that forms extensive sills and dikes within the Whistestripe Marble and along the contacts of the Whistestripe Marble and Goon Dip Greenstone southwest of the Peril Strait Fault. Mafic minerals are generally altered to chlorite and epidote or clinozoisite. Rocks are generally foliated and locally have extensive shear and cataclastic textures. Similar sheared dioritic rock intrudes marble and greenstone and also occurs as large blocks in the mélange facies of the Yakutat Group (unit KJyg here), which is thought to be correlative with the Kelp Bay Group (Johnson and Karl, 1985) (unit K*mg here). Unit spatially associated with rocks of unit KJse in southeast Alaska. On Halleck Island, unit has yielded several ages: a U/Pb zircon age of 192.8 ±2.4 Ma; 40Ar /39Ar hornblende ages of 191.9±1.2 and 185.4±3.8 Ma; and an 40Ar /39Ar white mica cooling age of 157.2 ±2.6 Ma (S.M. Karl, unpub. data). In the Juneau and Ketchikan quadrangles, unit also includes altered and (or) metamorphosed and undated diorite and quartz diorite that are exposed in small areas associated with rocks of the Gastineau Group (unit Kgsv) and the Gravina-Nutzotin unit (unit KJgn) (Gehrels and Berg, 1992; Karl, 1992; S.M. Karl, unpub. data). On generalized map, included as part of unit KPzum. Description from source map: Geologic Map of Alaska

KJd - Diorite (Cretaceous to Jurassic)
Dominantly a medium to dark gray green (C.I. 35-50), medium to coarse grained, foliated, hornblende diorite with minor clinopyroxene gabbro. Contains as much as 3 percent magnetite. Typically extensively altered so that only relicts of the primary minerals are identifiable. Areas with abundant inclusions and septa of metamorphic rock are shown by a stipple pattern. Unit description from source map: MF002.

KJgn - Gravina-Nuzotin unit (Lower Cretaceous and Upper Jurassic)
Marine graywacke and mudstone, subordinate conglomerate and andesitic to basaltic volcanic rocks, minor limestone, and regionally metamorphosed and deformed equivalents of these strata. Unit is exposed in southeast Alaska and in eastern Alaska near the Denali Fault System. Metamorphic grade varies regionally; in southeast Alaska, it generally increases from nonmeta-morphosed or subgreenschist facies in the southwest to greenschist and locally amphibolite facies in the north-east (Berg and others, 1972; Gehrels and Berg, 1992). Higher grade parts of unit are primarily phyllite, schist, and gneiss. Unit consists of the Gravina Island and Seymour Canal Formations and unnamed
strata in southeast Alaska (Berg and others, 1978, 1988; Eberlein and others, 1983; Lathram and others, 1965; Muffler, 1967). In south-central Alaska, includes the Nutzotin Mountain sequence of Lowe and others (1982) and other unnamed graywacke and mudstone rock units south of the Denali Fault System. In southwest Alaska, the Koksetna River sequence of Wallace and others (1989) is also included here. In southeast Alaska, the Gravina-Nutzotin unit is locally mapped as an undivided unit that includes several volcanic-rich parts. Where possible these volcanic-rich rocks are included here in unit KJgyv. Gehrels and Berg (1992) suggested that geologic and geochemical considerations indicate that some volcanic rocks in this unit are genetically related to Early Cretaceous ultramafic bodies of unit Kum here (Irvine, 1973, 1974) and possibly to Early Cretaceous and (or) Jurassic diorite and gabbro of unit KJdg here (Berg and others, 1978, 1988). Fossils in the widespread Gravina-Nutzotin unit range in age from Cenomanian to Late and possibly Middle Jurassic (Berg and others, 1972; Brew and others, 1984; Buddington and Chapin, 1929). Wallace and others (1989) reported four fossil localities in the Koksetna River sequence, which contain Buchia mosquensis of Late Jurassic (late Kimmeridgian) age and Buchia sublaevis of Early Cretaceous (Valanginian) age. Unit represents a thick deep-ocean trench, fossil-poor marine flysch sequence. Unit locally subdivided into unit KJgyv. Description from source map: Geologic Map of Alaska

KJss - Gravina belt, Stephens Passage Group, Seymour Canal Formation (Late Jurassic and Early Cretaceous)
Graywacke, slate, and minor conglomerate; composed largely of volcanic debris, except for the conglomerates, which are polymictic and contain granitic clasts; most graywacke and slate were turbidites, but nothing more is known of the depositional environment; weathers dark greenish gray, brownish gray, and very dark gray, graywacke and slate/argillite are locally calcareous and lighter colored; sedimentary structures common, although few directional features have been noted. On Douglas Island this unit encloses the Treadwell "albite diorite" sill which is the host rock for the Treadwell gold deposits. Unit description from source map: JU002.

KJyg - Yakutat Group, undivided (Lower Cretaceous and Upper Jurassic?)
Heterogeneous assemblage that includes clastic sedimentary rocks, volcanic rocks, chert, limestone, and granitic rocks. Yakutat Group consists of two major subdivisions that are commonly structurally juxtaposed: a flysch facies (sandstone and mudstone) and a mélangé facies (mudstone that contains meter- to kilometer-scale blocks of chert, sandstone, limestone, and volcanic rocks; unit KJmy). On this map, the undivided Yakutat Group and the flysch facies, which locally has been mapped separately (George Pfafker, written commun., 2000) are combined into one unit. Flysch facies is dominantly dense, hard, poorly sorted gray to brown feldspathic to lithofeldspathic graywacke, pebble-cobble conglomerate, and shale-chip conglomerate in thick channel deposits or rhythmically interbedded and graded with gray to black siltstone, and mudstone (recrystallized to argillite or slate). Locally these sedimentary rocks contain very sparse warm water molluscan fauna and abundant carbonized subtropical plant remains (George Pfafker, written commun., 2000). Also included in this unit is the schist of Nunatak Fiord of Pfafker (written commun., 2000), which is complexly deformed, interbedded mudstone and sandstone and minor volcaniclastic rocks and conglomerate metamorphosed to greenschist and epidote-amphibolite facies. At southern extent of outcrop area, unit includes volcanic rocks metamorphosed to higher grade amphibolite facies. Crops out between Boundary and Fairweather Fault Systems and intruded extensively by Tertiary granitic plutons (George Pfafker, written commun., 2000). Locally mélangé facies, unit KJmy, is mapped separately. Description from source map: Glacier Bay Geologic Map.

Kyg - Yakutat Group graywacke and argillite (Cretaceous)
Yakutat Group graywacke and argillite - medium-grained, moderately folded / faulted - found in Lituya Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

Kys - Yakutat Group limy graphitic shale, phyllite, graywacke, and cherty(?), limestone (Cretaceous)
Yakutat Group limy graphitic slate, phyllite, graywacke, and cherty(?) limestone in Lituya Province.
Unit description from source map: MF003.

**Kys - Yakutat Group - flysch facies (Cretaceous and Jurassic(?))**
Yakutat Group is a heterogeneous assemblage including clastic sedimentary rocks, altered volcanic rocks, chert, carbonate, and granitic rocks. Two major subdivisions that are commonly structurally juxtaposed, a flysch facies and a melange facies. Flysch facies is dominantly dense, hard, poorly sorted gray to brown feldspathic to lithofeldspathic sandstone (graywacke), pebble-cobble conglomerate, and shale-chip conglomerate in thick channel deposits or rhythmically interbedded and graded with gray to black siltstone, argillite, or slate. Unit description from source map: YA002.

**Kyb - Metamorphic rocks of the Brabazon Range (Cretaceous(?))**
Mainly amphibolite facies rocks more than 1,000 m thick. Grades over narrow interval into zeolite- and prehnite-pumpellyte-grade rocks of the Yakutat Group. Protolith mainly graywacke-carbonaceous pelite sequence recrystallized to quartzofeldspathic. Unit description from source map: YA002.

**Kyvm - Schist of Nunatak Fiord - Metavolcanic rocks of Novatak Glacier area (Cretaceous(?))**
Predominantly massive porphyritic mafic flow rocks interbedded with thinly laminated green to light-gray metatuff. Metamorphosed to fine-grained, schistose, partly segregated epidote-amphibolite and amphibolite-facies assemblages. Unit description from source map: YA002.

**Kyxm - Schist of Nunatak Fiord - Schist of Novatak Glacier area (Cretaceous(?))**
Lithologically diverse sequence of metasedimentary and metavolcanic rocks. Mainly thin-bedded metapelite, tuffaceous metapelite, pelitic schist, and quartzofeldspathic schist with subordinate stretched pebble conglomerate, metachert, gray-weathering marble, and thinly laminated tuffaceous greenschist. Unit description from source map: YA002.

**Kma - Amphibolite (and hornblende) with diorite (Cretaceous)**
Amphibolite / hornblende (metavolcanic rocks) with diorite - found in Lituya Province (Brew, pers. comm., 1999, 2002). Unit description from source map: MF003.

**Kyv - Yakutat Group Greenstone (Cretaceous)**
Yakutat Group Greenstone - moderately folded / faulted, found in Lituya Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

**KJse - Saint Elias suite of Gordey and Makepeace (2003) (Early Cretaceous and Late Jurassic)**
Chiefly quartz monzodiorite, but compositionally diverse; ranges from granite to diorite. Generally medium-grained but varies from fine- to coarse-grained and pegmatitic (Seitz, 1959; Rossman, 1963). Weakly foliated to nonfoliated in interior of plutons to strongly foliated and locally mylonitic near contacts. K/Ar and 40Ar/39Ar dates indicate plutonic ages as old as 162 Ma (Roeske and others, 1992; Brew and others, 2013) and possibly as young as 117 Ma (Dodds and Campbell, 1988); metamorphic dates are as young as 52 Ma (Roeske and others, 2003). Defined initially in Yukon and British Columbia, the suite extends from southern Alaska through Yukon and British Columbia (Gordey and Makepeace, 2003; Massey and others, 2005). A southern extension of this unit is tentatively mapped on the west side of Glacier Bay. These plutons, as yet not dated, are compositionally similar quartz diorite and granodiorite plutons. Muscovite-bearing leucotonalite and trondhjemite in a small, fault-bounded, lens-like stock on both sides of Johns Hopkins Inlet (Roeske and others, 1992) yielded an 40Ar/39Ar plateau date of 162±0.4 Ma and is included in this unit. As shown here, includes isolated small exposures of amphibolite as roof pendants along the west side of Glacier Bay. Brew (1997) interpreted these rocks as metavolcanic rocks of Paleozoic protolith age. Locally associated with rocks of units St and SI south of Johns Hopkins Inlet. Description from source map: [Glacier Bay Geologic Map](#).

**Kmdt - Uralitized biotite-pyroxene diorite, biotite-hornblende diorite, and biotite-hornblende...
melatonite (Cretaceous)
Alexander Belt: Intrusive Rocks of the Muir-Chichaof Plutonic Belt I: Foliated, heterogeneous; exposed only in body at head of Tenakee Inlet, Chichagof Island. Unit description from source map: JU002.

Kgqd - Biotite-hornblende quartz diorite (Cretaceous)
Biotite-hornblende quartz diorite. Unit description from source map: MF003.

Kd - Hornblende diorite (Late Cretaceous)
Intrusive igneous rocks on Chichagof and Yakobi Islands. Hornblende diorite and biotite-hornblende diorite. Unit description from source map: MF004.

Kqm - Quartz monzonite and quartz diorite (Cretaceous)
In Chilkat Mountains, quartz monzonite is medium-grained, locally K-feldspar porphyritic. Lineated hornblende defines magmatic foliation. On Kuiu Island, biotite-hornblende quartz monzodiorite, occurs with minor tonalite, granodiorite, quartz diorite, diorite, quartz monzonite, and monzodiorite, massive to foliated, equigranular to locally porphyritic, medium-grained. Secondary epidote locally present. Unit description from source map: MF006.

Kd - Syenite, monzonite, and diorite (Cretaceous)
In Skagway and Mount Fairweather quadrangles, hornblende biotite diorite, hornblende biotite quartz diorite, lesser amounts quartz monzonite, quartz monzonite gneiss, granodiorite, and hornblendite. Color index in diorite is 15-25. Granodiorite contains: 15% biotite, 5% hornblende, 15-20% quartz. Plutons west of William Henry Bay mostly sheared augite biotite diorite, augite diorite. At Sullivan Island biotite quartz diorite gneiss, granodiorite gneiss, biotite diorite. Unit includes diabase northwest of William Henry Bay. On Chichagof Island, gray, color index 25-35, fine- to medium-grained, hornblende diorite and biotite-hornblende quartz-diorite. The amphibole is called uralite by Loney and others, (1975), because it clearly surrounds and replaces pyroxene. The diorite also contains lighter colored, younger amphibole.includes uralitized biotite-augite diorite and uralitized biotite-hypersthene diorite, accessory sphene and apatite, very magnetic. On Admiralty Island, biotite-hornblende quartz diorite is inequigranular, hypidiomorphic. On Prince of Wales Island, includes massive, medium to coarse grained diorite,C1 15-40; contains chloritized brown biotite, 5-20 %diopsidic (?) augite, 10-25 % green hornblende, locally in a reaction relationship with augite, magnetite, tabular, zoned andesine plagioclase, interstitial anhedral K-feldspar and quartz, euhedral sphene, and up to 5% anhedral apatite. Unit description from source map: MF006.

KJd - Diorite (Jurassic(?) or Cretaceous)
Light gray to nearly white with a granitic texture. Main rock forming minerals are plagioclase, hornblende, biotite, and quartz. Includes granodiorite and quartz diorite phases believed to be the same age and genesis as the diorite. Unit description from source map: MF008.

KJqd - Quartz diorite (Jurassic(?) or Cretaceous)
Lighter colored and less well developed fabric than the diorite (KJd). Plagioclase ranges from albite to andesine. The rock contains more quartz and smaller amounts of ferromagnesian minerals than KJd. Contains as much as 5% orthoclase. Alteration consists of slight saussuritization of feldspar and local replacement of the hornblende by chlorite. Unit description from source map: MF008.

Kgqd - Biotite-hornblende quartz diorite (Cretaceous)
Biotite-hornblende quartz diorite. Unit description from source map: SK010.

Pzma - Amphibolite (Paleozoic)
Amphibolite found in Geikie Province (metavolcanic rocks) (Brew, 1999; MGI map of Glacier Bay National Park, unit symbol changed to Kma - and also used in Lituya Province; personal comm. 2002). Moderately folded / faulted. Unit description from source maps: MF003 and SK010.

Pzh? - Hornfels (Paleozoic)
Intensely folded interlayered hornfels, schist, and amphibolite. (S.M. Karl: Abundant thinly layered
calc-silicate hornfels, calcareous granofels, and marble. Probably derived from sedimentary and volcanic rocks of Silurian, Devonian, and possibly Mississippian age). Unit description from source map: MF004.

**Kkbm - Khaz Complex (Cretaceous and older)**

Formerly mapped as the Khaz Formation of the Kelp Bay Group, Karl and others (2015) renamed it the Khaz Complex, which reflects that the unit is a mélangé and does not have an internal stratigraphy, nor clear stratigraphic relation to surrounding unit. The Khaz Complex includes chaotically deformed rocks composed of blocks of greenstone, greenschist, tuff, graywacke, argillite, chert, limestone, and phyllite in a foliated argillaceous and tuffaceous matrix (Johnson and Karl, 1985). Unit is dominantly slaty argillite and tuff enclosing blocks of varying lithology, where the blocks and matrix are disrupted and displaced along thrust, strike-slip, and extensional-slip faults (Karl and others, 2015). As shown here, unit also includes the Freeburn assemblage of Johnson and Karl (1985), a collage composed of kilometer-scale, fault-bounded, lozenge-shaped blocks of metasedimentary and metavolcanic rocks, which form a continuous belt on Chichagof and Yakobi Islands immediately west of the Border Ranges Fault. The dominant lithologies include tuffaceous argillite, tuff, massive greenstone, and graywacke turbidite. Other common lithologies include chert, limestone, and phyllite. Age of formation of the mélangé is not well controlled; Brew and others (1988) reported late Tithonian (Late Jurassic) Buchia fischerina from argillite matrix, and Valanginian to Hauterivian radiolarians were reported from float near Sitka. Limestone blocks in the mélangé contain poorly preserved scleractinian corals, and sandstone blocks contain Buchia picchili(?) of Tithonian age and Buchia subokensis and Buchia okensis of Berriasian (earliest Cretaceous) age (Karl and others, 2015). Potassium-argon ages of 98 to 95 Ma (Decker and others, 1980), on sericite concentrated from phyllite, yielded an apparent metamorphic age for the Khaz Complex of early Late Cretaceous. On generalized map, included as part of unit KTrm. Description from source map: [Geologic Map of Alaska](#).

**Kd - Diorite (Cretaceous (?))**

An extensively altered and sheared, green to gray green (C.I. 15-25), medium grained, hornblende + or - biotite diorite with minor quartz diorite forms extensive sills and dikes within the Whistestripe Marble and along the contacts of the Whistestripe Marble and Goon Dip Greenstone with the Kelp Bay Group. Mafic minerals are generally altered to chlorite + epidote = or - clinozoisite. Generally foliated with locally extensive shearing and cataclasis. Similar sheared dioritic rock intrudes marble and greenstone and also occurs as large blocks in the melange facies of the Yakutat Group, which is thought to be correlative with the Kelp Bay Group. The diorite which intrudes the Whistestripe Marble and Goon Dip Greenstone along the Border Ranges fault may also be correlative. Unit description from source map: MF002.

**Kk - Khaz Formation (Cretaceous)**

A melange that includes chaotically deformed rocks composed of blocks of greenstone, greenschist, tuff, graywacke, argillite, chert, limestone, and phyllite in a foliated argillaceous and tuffaceous matrix. Correlates with other components of the melange facies of the upper Mesozoic accretionary terrane of Pfafker and others (1977), including parts of the Uyak Complex on Kodiak Island and the McHugh Complex of the Chugach Mountains. Fossils from the blocks. Member of the Kelp Bay Group. Unit description from source map: MF002.

**Kf - Freeburn assemblage (Cretaceous (?))**

A collage composed of kilometer scale, fault bounded, lozenge shaped blocks of metasedimentary and metavolcanic rocks which form a continuous belt on Chichagof and Yakobi Islands immediately west of the Border Ranges fault. The dominant lithologies include tuffaceous argillite, tuff, massive greenstone, and graywacke turbidite. Other common lithologies include chert, limestone, phyllite, and chert. Member of the Kelp Bay Group. Unit description from source map: MF002.

**KTrm - McHugh complex melange (Mesozoic)**
Metasedimentary and metavolcanic rocks with melange protolith west of Tarr Inlet SZ in Glacier Bay and east of Fairweather fault. Mapped only in Taylor Bay on this map; likely more of this unit is present east of the Fairweather fault in the Glacier Bay. Unit description from source map: MF006.

**Pmum - Marble (Permian)**
Marble from Tarr Inlet suture zone - moderately folded / faulted (Brew, pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmum. Unit description from source maps: MF003 and SK010.

**KJTRm - Kelp Bay Group, undivided (Triassic to Cretaceous)**
Consists of volcanic rocks, sandstone, chert, the mélange of the Khaz Complex (formerly Khaz Formation) of Karl and others (2015), the Pinnacle Peak Phyllite and the phyllite of Rodman Bay. Primarily exposed in the Sitka and Port Alexander quadrangles, also included here is an outlier of similar rocks associated with the Tarr Inlet Suture Zone in the Mount Fairweather and Skagway quadrangles. The undivided Kelp Bay Group consists of phyllite, quartzite, greenschist, greenstone, graywacke, and graywacke semischist and has been locally subdivided and mapped as two informal members, a sandstone member and a volcanic rocks and chert member, as well as the more formally defined members. The sandstone member consists of altered and recrystallized dull-green graywacke, volcanic wacke, turbiditic argillite, and subordinate polymeric conglomerate. Unit also includes gray and green, thin- to medium-bedded volcaniclastic-tic turbidites and interbedded tuff (Karl and others, 2015). The volcanic rocks and chert member consists of dark-green, fine-grained pillow basalt flows and breccia that has meter-scale lenses of ribbon chert, subordin-nate mudstone and sandstone, and massive greenstone that may be sills or may have a volcaniclastic protolith. Geochemical analysis of the volcanic rocks indicate that compositions range from alkali to tholeiitic, and trace elements plot in ocean floor, within plate, and island arc fields (Karl, 1982). The volcanic rocks and chert do not have a penetrative fabric, though locally the greenstone has a cataclastic or mylonitic texture (Karl and others, 2015). Karl and others (2015) reports that the volcanic rocks and chert member can be correlated with chert and volcanic rock units in the McHugh Complex in southern Alaska. Both the Kelp Bay Group and the McHugh Complex are considered part of the Chugach accretionary complex. Here we also include small slivers of serpentinite and partially serpentized peridotite on Baranof Island that were found enclosed in the phyllite unit. Description from source map: Geologic Map of Alaska

**Pmug - Greenstone, greenschist, and other metavolcanic rocks (Permian)**
Greenstone, greenschist, and other metavolcanic rocks, moderately folded / faulted. Found in Tarr Inlet suture zone. Brew (pers. comm., 1999, MGI map of Glacier Bay National Park) renames this unit Kmug. Unit description from source maps: MF003 and SK010.

**JTrm - Massive and schistose greenstone (Triassic and (or) Jurassic)**
Schist unit on northwestern Chichagof Island. Massive and schistose greenstone, graphitic schist, phyllite, and graywacke. (S.M. Karl: Unit is dominantly greenstone with interlayered graphitic schist or phyllite. Massive greenstone, greenschist, phyllite, limestone, graywacke, and chert are subordinate. Augite and labradorite are common minerals in the greenstone. Epidote, pyrite, magnetite, and chalcopyrite are common locally. Lenticular beds of limestone are similar in color and composition to the Whitestripe Marble. Intensely folded. Unit thickness exceeds 9000 feet) . Unit description from source map: MF004.

**Pmup - Phyllite, slate, conglomerate, and chert (Permian)**
Phyllite, slate, conglomerate, and chert from Tarr Inlet suture zone - moderately folded / faulted. Brew (pers. comm., 1999, MGI map of Glacier Bay National Park) renames this unit Kmup. Unit description from source maps: MF003 and SK010.

**Trsv - Metasedimentary and Metavolcanic rocks (Late Triassic)**
Gray and green volcanioclastic sandstone, mudstone, tuff, chert, limestone, and intermediate to mafic
volcanic rocks. 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 volcanioclastic 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 are not chaotically mixed like rocks in the Khaz Complex. Mafic volcanic rocks are more massive, form thicker sections, and lack interbedded chert that characterizes the volcanic rocks of the Kelp Bay Group. On Baranof Island, primary depositional textures are preserved in volcanioclastic rocks, pillowed greenstone, bedded limestone, argillaceous limestone turbidites, mudstone, and bedded chert. Limestone and chert commonly have stylolitic bed partings. Unit represents mostly deep water, basinal sedimentary deposits. Unit is folded, faulted, and locally sheared. Unit thickness is unknown due to faulting. Unit occupies a higher structural position than the Kelp Bay Group. 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 Vannucci (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 on in Nakwasina Sound and on northeastern Yakobi Island (Johnson and Karl, 1985). Unit description from source map: MF014.

Jise - Granitic rocks of southeast Alaska (Jurassic)

Consists of a variety of intrusive rocks including quartz monzonite, monzonite, tonalite, and quartz diorite on Chichagof and Baranof Islands generally west of or along the Peril Strait Fault (Loney and others, 1967; Karl, 1999). Dominant lithologies are white to medium-gray, medium- to coarse-grained, biotite-hornblende tonalite and garnet-muscovite-biotite tonalite, which have a wide range of quartz-to-plagioclase ratios (from approximately 1:4 to 1:1). Plagioclase-rich samples tend to contain hornblende and have a higher color index; quartz-rich samples tend to be hornblende free and leucocratic (Johnson and Karl, 1985). The tonalite contains local zones of fine-grained, rounded, mafic inclusions and occasional pink pegmatitic dikes. Subordinate to the tonalite is medium- to dark-gray-green, medium- to coarse-grained, foliated biotite-hornblende quartz diorite in which hornblende is always more abundant than biotite. Pyroxene-cored hornblende crystals are locally common (Johnson and Karl, 1985). K/Ar ages range from 182 to 143 Ma (Loney and others, 1967; Karl and others, 1988; S. M. Karl, unpub. data) and are commonly significantly discordant; the youngest ages are from samples collected close to the Peril Strait Fault. A single body is also found north of Tenakee Springs, east of the fault on Chichagof Island; it consists of buff to light-gray horn-blende-quartz monzonite, hornblende monzonite, and biotite alaskite (Karl, 1999) and yields a K/Ar hornblende age of 147±7 Ma. S.M. Karl (unpub. data) also reports the presence of small areas of Jurassic plutonic rocks in the Tracy Arm area of the Sumdum quadrangle. On generalized map, included as part of unit Jimgr. Description from source map: Geologic Map of Alaska

KJq - Quartz diorite (Cretaceous or Jurassic)

A medium to dark gray green (C.I. 25-50), medium to coarse grained, foliated hornblende + or - biotite quartz diorite, in which hornblende is always more abundant than biotite. One to 2 percent magnetite is common in these rocks, some samples contain as much as 5 percent. Pyroxene cored hornblende crystals are common locally. Unit description from source map: MF002.

Jqt - Tonalite (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. On Chichagof Island, medium to dark gray green (C.I. 25-50), medium to coarse-grained, foliated hornblende ±biotite quartz diorite, in which hornblende is always more abundant than biotite. One to 2 percent magnetite is common in these rocks, some samples contain as much as 5 percent. Pyroxene
cored hornblende crystals are common locally. Hornblende-biotite quartz diorite, mafic minerals locally altered to epidote and chlorite. Unit description from source map: MF006.

**Jqd - Quartz diorite and tonalite (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. On Chichagof Island, medium to dark gray green (C.I. 25-50), medium to coarse-grained, foliated hornblende ±biotite quartz diorite, in which hornblende is always more abundant than biotite. One to 2 percent magnetite is common in these rocks, some samples contain as much as 5 percent. Pyroxene cored hornblende crystals are common locally. Hornblende-biotite quartz diorite, mafic minerals locally altered to epidote and chlorite. Unit description from source map: MF014.

**TRb - Mafic volcanic rocks of Chilkat Peninsula (Late Triassic)**
Dark green, massive to pillowed and amygdaloidal mafic volcanic flows and minor tuff. Amygdules are undeformed and contain calcite and epidote. Massive, flow-banded, and locally pillowed or amygdaloidal metabasalt. Up to 3.4 km thick, unit also contains magnetite, traces of malachite, pods and veins of epidote and has associated tuffaceous metasediment. Metamorphosed to low greenschist facies and intruded by the Mount Kashagnak pluton of inferred mid-Cretaceous age (included in unit Kmqm here) (Redman and others, 1984). On generalized map, included as part of unit Trmb. Description from source map: Geologic Map of Alaska

**Kmb - Metabasalt (Cretaceous)**
Massive, flow-banded, and locally pillowed or amygdaloidal metabasalt. Contains magnetite, traces of malachite, pods and veins of epidote. Associated tuffaceous metasediments. Metamorphosed to low greenschist facies and intruded by the Mt. Kashagnak pluton. Up to 3.4 km thick. Unit description from source map: SK003.

**TRhgv - Hyd Group igneous rocks, undivided (Upper Triassic)**
Basaltic pillow flows, pillow breccia, flow-banded rhyolite, and rhyolitic tuff, which intertongue with calcareous interbeds, flow breccia, banded ash-flow tuff, and subordinate andesitic breccia and aquagene tuff. Locally, unit consists of massive greenstone, pillow green-stone, pillow breccia, and volcanic breccia that contain lenses of mafic to intermediate tuff, felsic tuff that has quartz crystals, as well as limestone, conglomerate, sandstone, argillite, and rare bedded chert. Amygdaloidal basalt flows that contain calcite-, chlorite-, and chalcedony-filled amygdules are locally present. Rocks in most areas are moderately metamorphosed and deformed and may be altered, bleached, or spilitic, and contain zones of hydrothermal alteration. Locally, greenstone is augite and (or) hornblende phyrir and commonly pyritic (Karl and others, 1999). Unit consists of rhyolite on Annette Island (Berg, 1982; Gehrels and others, 1987), rhyolite of the Puppets Formation and basalt of the Chapin Peak Formation on Gravina Island (Berg, 1982; Berg and others, 1978, 1986; Gehrels and others, 1986, 1987); and rhyolite and subordinate basalt of the Keku Volcanics and basalt and andesite of the Hound Island Volcanics in Keku Strait (Muffler, 1967; Brew and others, 1984). Unit also includes small metagabbro bodies in the Petersburg quadrangle (Karl and others, 1999). On generalized map, included as part of unit Trhg. Description from source map: Geologic Map of Alaska

**uPzbv - Basalt (Late Paleozoic)**
Basalt, rarely shows signs of metamorphism. Pillows, vesicles, calcite-filled amygdules. Aphanitic flows and agglomerate. Contains replacement pods of jasper and magnetite, and thin limestone beds. Glacier Creek area. Unit description from source map: SK004.

**Trhv - Mafic volcanic rocks of the Hyd Group (Triassic)**
Dark green fine-grained basalt with plagioclase and augite phenocrysts, locally in feldspar plagioclase
groundmass. Pillow forms are common and well-exposed in Windfall Harbor and Gambier Bay on Admiralty Island. Mafic volcanic rocks include interpillow limestone and volcanic breccia. Locally flows are amygdaloidal with calcite, chlorite, and chaledony amygdule fill. Locally altered, bleached, or spilitic. Locally as thick as 1000 m. In Glacier Creek area, pillow basalt, locally vesicular, locally has calcite-filled amygdules. Aphanitic, locally porphyritic. Includes flows, agglomerate, and volcanic breccia. Contains thin limestone beds, and hydrothermal deposits of jasper and magnetite. Massive, dark green, blocky andesite ranges to well-foliated andesitic tuff. Associated rhyolite or dacite tuff, and black argillaceous limestone and slate. In Keku Straits, Hound Island Volcanics consist of basaltic breccia and pillow lava flows, andesitic volcanic breccia, aquagene tuff, tuff breccia, minor thin-bedded limestone. In Duncan Canal includes massive greenstone, pillow greenstone, pillow breccia, and volcanic breccia, with lenses of mafic to intermediate tuff, felsic tuff with quartz crystals, limestone, conglomerate, sandstone, argillite, and rare bedded chert. Locally greenstone is augite and/or hornblende pyric. Commonly pyritic. Weather reddish brown. On Gravina Island, includes Chapin Peak Formation, which consists chiefly of marine basaltic volcanic rocks and subordinate intertonguing sedimentary rocks that crop out mainly on western Gravina Island. Characterized by basaltic pillow flows, calcareous agglomerate and volcanic breccia, and aquagene tuff. The volcanic and volcanioclastic rocks intertongue gradationally with limestone and calcareous clastic sedimentary rocks that are much less abundant and that occur mainly near the base of the formation. Basaltic volcanic rocks gradationally overlie sedimentary rocks. Sedimentary rocks range up to 3 feet thick; pillow flows average 10 feet thick. The volcanic rocks consist of deuterically altered basaltic and minor andesitic pillow flows, pillow breccia, and limestone and aquagene tuff-cemented volcanic breccia. The rocks weather dark green and dark brown; fresh surfaces are dark gray to purplish gray. Flows and clasts are fine-grained, and have relict intertental, trachytic, diabasic, and rarely, vitroclastic and porphyritic texture. Minerals include plagioclase, augite, calcite, chlorite, epidote, quartz, green hornblende, and prehnite(?). Sedimentary rocks include limestone-cemented granule to boulder conglomerate containing clasts of limestone, basalt, siltstone, argillite, and minor metamorphic rocks and amphibolite. Also dark gray siltstone, argillite, and brownish-gray silty limestone. Secondary minerals include chlorite and epidote. Mineralogy and textures suggest either widespread deuteric alteration or prehnite-pumpellyite facies metamorphism. The Chapin Peak Formation is at the top of the section, the base of the Triassic section is the Nehenta volcanic member (Berg, 1973), consisting of altered, partly spilitic, basaltic and minor andesitic massive flows, pillow flows, pillow breccia, and subordinate calcareous tuff and tuffaceous limestone. Pillow flows up to 8 feet in diameter, usually about 1 foot in diameter, with interpillow limestone. Dark green, fine-grained, with relict porphyritic, intertental, and trachytic textures. Phenocrysts are clinopyroxene and sericitized plagioclase, in a groundmass of altered plagioclase, epidote-clinozoisite, calcite, and potassium feldspar, with common amygdules filled with calcite-chlorite and quartz. Some tuff has sufficient K-feldspar to be classified as dacite. Locally includes thin beds of slate, siltstone, graywacke, calcareous grit, and conglomerate. Unconformably overlies Paleozoic rocks and underlies limestone with Norian Halobia. Unit description from source map: SK021.

**Trhf - Felsic volcanic rocks of the Hyd Group (Late Triassic)**

A band of felsic volcanic rocks southeast of the Jarvis Glacier The Keku Volcanics contain altered felsic flows and flow breccia; flow-banded, aphanitic, feldspar-microporphyritic; minor mafic flows and flow breccia, volcanic wacke, volcanic conglomerate, green aquagene tuff, and thick-bedded oolitic limestone; lenticular. Unconformably overlies Pybus Fm. On Admiralty Island, includes banded white to buff felsic volcanic rock with sparse to common euhehedral feldspar and anhedral quartz phenocrysts. Locally cm-scale banded, locally massive. Possibly as thick as 200 m. Southwest of Swan Cove, and west of Gambier Bay. Near Glacier Creek, includes massive rhyolite or dacite tuff. Includes the Puppets Formation on Gravina Island, which is divided into two intertonguing members: massive appearing, thinly layered recrystallized rhyolite; and recrystallized felsic tuff that varies in composition from latite to rhyolite. The tuff member occurs in discontinuous layers and lenses, generally at or near the base of the formation. Felsic metavolcanic rocks consisting of intertonguing metahyolite member and felsic metatuff member. Underlies Devonian limestone. Metatuff member estimated to be about 150 feet thick. Metatuff has microbreccia to coarse blocky fragmental texture, is locally massive and locally foliated, has variable content of potassium feldspar, and is deuterically and hydrothermally altered. Tuff is maroon, pink, purple, red, green, and brown and contains fragments of trondhjemite, metamorphic rocks, shard-shaped fragments, pumice, feldspar porphyry, quartz, and albite.
Groundmass is an aphanitic microclastic to microporphryitic aggregate of K-feldspar, quartz, albite, hematite, sericite, and dolomite. Chemistry suggests some of this tuff has mafic protolith. Silica-alkali-lime ratio indicates metamict and rhyodacite with subordinate rhyolite. Metarhyolite member is light gray, white, black, pink, purple, red, brown, and green. Mostly aphanitic and flowbanded, bands a fraction of an inch to about a foot; locally fragmental, with inch-size clasts that include exotic rock types; locally also spherulitic, with spherules to golf ball size; and locally aphanitic, resembling metachert. Rhyolite contains microphenocrysts of quartz, potassium feldspar, and albite or sodic oligoclase in a groundmass that includes the same minerals plus sericite, dolomite, chlorite, apatite, clinohumite-epidote, hematite, and pyrite. Sericitization is locally conspicuous. Quartz calcite veins containing dolomite, barite, and sulfide minerals are common. Local silification to red jasper, and deuteric and hydrothermal alteration is syngentic. Minimum unit thickness is 400 feet. On Annette Island the tuff unit includes massive crystal lithic tuff breccia several hundred meters thick, flow-laminated banded tuff, spherulitic, porphyritic, and vitriclastic tuff, and rhythmically bedded tuffaceous limestone and calcareous tuff that probably record marine deposition of rhyolitic ash and lapilli. Unit contains abundant disseminated hydrothermal hematite. Locally the hematite is accompanied by pyrite, chalcopyrite, and other sulfide minerals, partly in disseminated grains and partly in fissure veins with barite, calcite, and quartz. Many of these lodes have been prospected for gold, copper and other metals. A zircon age of 213 ± 5 Ma from a rhyolite flow on the Palmer property in the Skagway quadrangle is reported (Gehrels, in Green and Greg, 2004). In Keku volcanics, Late Triassic scleractinian corals and spiralifer brachiopods, and arceid and clydonitacid ammonites. Early or early Late Carnian Styrtes cf. S. tropiformis, Thibites cf. T. agricole, Pinacoceras cf. P. rex (Muffler, 1967.) On Gravina Island conodonts from dolomitic limestone lenses in felsic volcaniclastic rocks are Late Triassic, and rhyolite yielded a U/Pb zircon age of 225 ± 3 Ma (Berg and others, 1988). Conodonts Epigondolella primitive of latest Carnian and earliest Norian age from a 20 cm limestone layer near the base of the section on Annette Island (Savage and Gehrels, 1995). Unit description from source map: SK021.

TRhgs - Hyd Group sedimentary rocks, undivided (Upper Triassic)

Includes rocks locally mapped separately as the Burnt Island Conglomerate (Muffler, 1967), conglomerate and carbonate rocks of the Nehenta Formation, the Hamilton Island and Cornwallis Limestones, and argillite and limestone of the Hyd Group (Karl, 1992; Karl and others, 1999). Breccia and conglomerate of variable composition, locally called the Burnt Island Conglomerate, is as much as 200 m thick and clast composition reflects directly underlying units (S.M. Karl, unpub. data).

Locally, where the Hyd Group sedimentary rocks overlie limestone and dolostone of the Pybus Formation (unit Plps), breccia consists of unsorted angular blocks of limestone and dolostone in calcareous matrix, but where the Hyd Group sedimentary rocks overlie chert of the Pybus Formation, breccia is clast-supported chert pebble-cobble conglomerate in a calcareous matrix. Where it overlies the Canney Formation, the breccia is a matrix-supported debris flow deposit that has angular blocks of chert, argillite, graywacke, volcanic rocks, white vein quartz, and schist that are as large as 20 m. Breccia and conglomerate are commonly at or near base of Hyd Group, but the position is variable. At Keku Strait, the Hamilton Island Limestone consists of highly folded, generally very thin-bedded, aphanitic, dark-gray, locally dolomitic limestone that contains thin to medium beds of dark-green calcarenite and minor black claystone layers (Brew and others, 1984). Cornwallis Limestone, on Kuu Island, consists dominantly of medium- to very thick-bedded, medium-gray oolitic limestone and contains chert clasts derived from the underlying Pybus Formation (Brew and others, 1984). The Hamilton Island Limestone reflects a deep-water slope facies environment and is coeval with the shallow-water shelf facies of the Cornwallis Limestone. Other limestone in the Hyd Group varies from dark- to medium-gray, bluish-gray, or dark-brown, massive to medium-bedded limestone that may be graphitic, argillaceous, dolomitic, carbonaceous, or conglomeratic.Argillite of the Hyd Group is dark-gray to black, carbonaceous, locally siliceous or calcareous and rhythmically bedded. Subordinate chert, limestone, graywacke, and conglomerate are also present. Limestone may occur in lenses as much as 12 m thick. Carbonaceous beds and limestone locally contain well preserved Middle Triassic (Ladinian) ammonites and Daonella, Ladinian or Carnian conodonts, Late Triassic (late Carnian to early Norian) Halobia, crinoids, corals, mollusks, pelecypods, gastropods, ammonites, Monotis, early
Norian Halobia alaskana, middle Norian Halobia cf. H. fallax, H. lineata, and late Norian Heterastridium (Muffler, 1967; Berg and others, 1988). On generalized map, included as part of unit Trhb. Description from source map: Geologic Map of Alaska

**Trhb - Breccia and conglomerate of the Hyd Group (Late Triassic)**
Breccia and conglomerate of variable composition that reflects directly underlying units. On Pybus dolostone, Hyd breccia consists of unsorted angular blocks of limestone and dolostone in calcareous matrix. On Pybus chert, Hyd breccia is clast-supported chert pebble-cobble conglomerate with calcareous matrix. On Cannery Formation, Hyd breccia is a matrix-supported debris flow with angular clasts to 20 m blocks of chert, argillite, graywacke, volcanic rocks, white vein quartz, and schist. Variable thickness, maximum 200 m. Breccia and conglomerate are commonly, but not always, at or near base of Hyd Group. In Petersburg area, breccia and conglomerate consist mostly of matrix supported deposits representing debris flows. The most common breccia has calcareous matrix, and is matrix supported with argillite, limestone, and/or chert clasts. Matrix may also be argillaceous. Locally sericitic with disseminated sulfides. Hyd Group Burnt Island Conglomerate - conglomerate, calcarenite, and limestone; crudely bedded, poorly sorted calcite-matrix pebble conglomerate with clasts of either bluish-green and black argillite, graywacke, and chert derived from the Cannery Formation, or of chert and limestone from the Pybus Formation. On Gravina Island (Berg, 1973), orange-weathering, coarse, angular conglomerate containing granules to 8 foot boulders of light gray leucotrochondjemit, minor darker-hued metasedimentary and metavolcanic rocks, and locally clasts up to 3 feet across of limestone in a matrix of cream-colored ferruginous dolomite is interbedded with limestone, volcanic rocks, and locally unconformably overlies Paleozoic basement. Beds are a few feet thick to massive and greater than 10 feet thick. Associated rock types include orange-weathering carbonate-cemented sandstone and pebble- to cobble-grit in beds up to 6 feet thick, pebbly limestone, and very fine-grained limestone. Unit also includes salmon and green tuff containing clasts to 3 inches long of potassic metahyalite and other felsic volcanic rocks in a matrix of phylilitic sericite, quartz, albite, dolomite, and k-feldspar-rich lithic fragments. Polymeric conglomerate is olive-brown to gray and contains clasts of metachert, dolomite, limestone, siltstone, tuff, aplite, trondhjemite, greenstone, quartz, and plagioclase in a matrix of orange-weathering silty to gritty dolomitic limestone. Associated with dark gray slatey argillite. Unconformably overlain by Upper Triassic Nehenta Formation. In the Klehini-Tsirku River area, matrix-supported conglomerate forms the top of the exposed section, and overlies limestone and basalt units that contain Norian-Rhaetian conodonts (Green and others, 2003). On top of Mount Morlan, conglomerate beds are separated by a 2-3 m layer of mafic lapilli tuff and tuffaceous limestone that contains conodonts of undetermined age (Green and others, 2003). Elsewhere in southeast Alaska, conglomerate and breccia are found near base of Triassic section, unconformable on local basement, or at intervals between other members of the Hyd Group. The conglomerates in the Hyd Group do not occupy a consistent stratigraphic position with respect to other members of the Hyd Group. Unit description from source map: SK021.

**uPzvm - Marble (Late Paleozoic)**
Black, argillaceous marble, and gray massive marble, 2-20 m-thick beds. Minor volcanic and black slate layers. Glacier Creek area. Unit description from source map: SK004.

**Trha - Argillite of the Hyd Group (Middle and Late Triassic)**
On Admiralty Island consists of dark gray to black carbonaceous, rhythmically bedded argillite. Subordinate chert, limestone, graywacke, and conglomerate. Argillite is locally siliceous, locally calcareous. Chert is brownish gray radiolarian chert in cm-scale beds. Limestone is dark brown to black or light gray in lenses to 10 cm thick. Graywacke is carbonaceous, calcareous and graded or crossbedded, in layers up to 20 cm thick. Conglomerate on the argillite section in Pybus Bay contains 80 per cent chert pebbles, 15 per cent volcanic clasts, and 5 per cent limestone clasts in a calcareous matrix, unlike conglomerates of adjacent, younger map units. Argillite unit thickness estimated at 100 m. In Glacier Creek area includes black argillaceous limestone, slate, andesite, and basalt. Tuff layers pinch and swell over tens of meters. Rapid lateral facies variations. Locally foliated to schistose. On Kupreanof Island, consists mainly of carbonaceous black argillite, calcareous or siliceous, with ubiquitous disseminated pyrite. Calcareous argillite is very sooty and graphitic, and contains limestone lenses up to 12 meters thick. Siliceous argillite may have cherty layers, and grades to silty turbidites.
Unit also includes calcareous to volcanic wacke turbidites. Unit description from source map: SK021.

**TRhg - Hyd Group, undivided (Upper and Middle Triassic)**

Includes carbonaceous argillite, slate, and subphyllite, tuff, volcaniclastic wacke, conglomerate, mafic flows, and limestone. The volcanic rocks consist of basaltic pillow flows, pillow breccia, and breccia, rhyolitic tuff that has calcareous interbeds, flow breccia, banded ash-flow tuff, and subordinate andesitic breccia and aquagene tuff. Unit ranges from marine mafic volcanic and deep marine sedimentary rocks in northern southeast Alaska to more felsic volcanic rock and shallow-water limestone and conglomerate to the south (Taylor and others, 2008). On Admiralty Island, group includes volcanic breccia and deformed, locally metamorphosed, massive and thick-bedded mafic to intermediate flows that have pillows and columnar jointing (Latham and others, 1965; Brew and Ford, 1985). Volcanic flows are interbedded with, but mostly overlie, gray to black limestone, graywacke, slate or argillite, black chert, and conglomerate (Latham and others, 1965). In the Petersburg to Ketchikan area, group includes mafic volcanic rocks that generally overlie felsic volcanic rocks that consists of latite to rhyolite flows, aquagene tuff, and tuff breccia (Brew and others, 1984; Berg and others, 1988; Karl and others, 1999). The volcanic rocks are inter-bedded with, and commonly overlie, carbonaceous argillite, limestone, and volcaniclastic wacke; all overlie a basal conglomerate or breccia (Brew and others, 1984; Berg and others, 1988; Karl and others, 1999; Taylor and others, 2008). The Hyd Group is 200 to 800 m thick and is thought to have been deposited in a rift basin (Taylor and others, 2008). As shown here, the Hyd Group consists of the Nehenta Formation on Gravina Island near Ketchikan, the Barlow Cove Formation on Admiralty Island (Latham and others, 1965), basalt of the Chapin Peak Formation and rhyolite of the Puppets Formation (Berg and others, 1988), the Hound Island and Keku Volcanics (Brew and others, 1984) in southern southeast Alaska, and the Glacier Creek volcanic rocks of Redman and others (1985) in northern southeast Alaska. Age control is largely based on fossils, which are primarily late Carnian to Norian and there are local occurrences of younger Rhaetian fossils (Green and others, 2003). Karl and others (1999) report an occurrence of uppermost Anisian to Ladinian (?) (Middle Triassic) conodonts from the Duncan Canal area. Premo and others (2010) report a 210.3±0.3 Ma 40Ar/39Ar alteration age on fuchsite that they interpreted as age of intrusion of Hyd Group feeder plutons. Green and Greig (2004) reported a 213±5 Ma U/Pb zircon age on rhyolite from the northern part of the unit near the Canadian border. Gehrels and others (1987) reported a 225±3 Ma U/Pb zircon age from rhyolite on Gravina Island. Where possible, subdivided into the following two units, Trhgs and Trhgv. Description from source map: [Geologic Map of Alaska](#).

**uPzva - Andesite (Late Paleozoic)**

Massive, dark green, blocky andesite ranges to well-foliated andesitic tuff. locally pillowed, vesicular, porphyritic. Associated rhyolite or dacite tuff, and black argillaceous limestone and slate. Glacier Creek area. Unit description from source map: SK004.

**uPzvs - Volcanic and sedimentary rocks (Late Paleozoic)**

Andesite, black argillaceous limestone, slate, and basalt. Tuff layers pinch and swell over tens of meters. Rapid lateral facies variations. Locally foliated to schistose. Glacier Creek area. Unit description from source map: SK004.

**TRn - Nikolai and Goon Dip Greenstones and equivalent rocks (Late and Middle Triassic)**

Massive, dark-gray-green, dark-gray-brown, and maroon-gray, subaerial and submarine basalt flows and minor interbedded volcaniclastic sedimentary rocks, aquagene and epiclastic tuff, breccia, argillite, and radiolarian chert (Nokleberg and others, 1992a), commonly metamorphosed to lower greenschist facies. Widely distributed and several thousands of meters thick. Includes unnamed Triassic greenstone units in Talkeetna Mountains quadrangle (Csejtey and others, 1978). Commonly
associated with Late Triassic carbonate and cherty carbonate rocks. Together with Chitistone and Nizina Limestones, this is one of the diagnostic units of the Wrangellia terrane (Jones and others, 1977). Pfafker and others (1976) and Jones and others (1977) correlated the Goon Dip Greenstone of southeast Alaska with the Nikolai Greenstone based on similar lithology and stratigraphic position relative to the overlying Whitestripe Marble, which they correlated with the Upper Triassic Chitistone Limestone. Goon Dip Greenstone is dominantly massive greenstone and minor greenschist and marble. The greenstone also commonly contains sparsely distributed copper-bearing sulfides; the Nikolai was the host rock for the Kennecott group of mines. Similar and possibly correlative units, the Cottonwood Bay and Chilikradrotna Greenstones of the Alaska Peninsula, are described below as unit Trcb. On generalized map, included as part of unit Trmb. Description from source map: Geologic Map of Alaska

**Trg - Goon Dip Greenstone (Triassic (?))**
Dominantly massive greenstone with minor greenschist and marble. The greenstone also commonly contains sparsely distributed copper-bearing sulfides. Pfafker and others (1976) and Jones and others (1977) correlated the Goon Dip Greenstone with the Nikolai Greenstone of the Wrangell Mountains in Southern Alaska based on similar lithology and stratigraphic position relative to the overlying Whitestripe Marble which they correlated with the Upper Triassic Chitistone Limestone also of the Wrangell Mountains. The Goon Dip Greenstone is considered to be a part of Wrangellia by Jones and others (1977). Unit description from source map: MF002.

**Trgg - Goon Dip Greenstone (Triassic (?))**
Greenstone, volcanic breccia, greenschist, rare limestone, several thousand feet in thickness. Protoliths were basalt flows, sills, tuffs. Unit description from source map: MF004.

**TRqd - Quartz diorite and granodiorite (Triassic)**
Granodiorite and similar rocks of Triassic age occur primarily in three parts of Alaska. In southwest Alaska, the Afognak pluton is the largest exposure, but small exposures of rocks of similar age and composition are found in the Barren Islands of the Afognak quadrangle and in the Seldovia quadrangle of south-central Alaska. The Afognak pluton is exposed on the west side of the Kodiak Island archipelago in the Karluk, Kodiak, and Afognak quadrangles. It is a large, multiphase hornblende diorite, quartz diorite, and tonalite pluton that has a well-developed contact-metamorphic aureole in the Shuyak Formation; its boundary with the schist of Kodiak Island (unit Jsch) is apparently a fault (Roeske and others, 1989). In the Seldovia quadrangle, unit includes the diorite of Point Bede of Bradley and others (1999), which is a fine- to medium-grained quartz diorite, and the tonalite of Dogfish Bay of Bradley and others (1999), a medium-grained tonalite that shows chloritic alteration similar to that found in diorite of Point Bede and, hence, was assigned a similar age. Bradley and others (1999) originally assigned plusions in the Seldovia quadrangle a Jurassic age on the basis of correlation with the pluton in the Barren Islands that had yielded a K/Ar hornblende age of 191 ± 1.3 Ma (Cowan and Boss, 1978). A Triassic age of 227.7 ± 0.6 Ma was determined on zircon from the diorite of Point Bede (Bradley and Miller, 2006). Unit also includes diabasic hypabyssal intrusions in the Shuyak Formation (Connelly and Moore, 1979). A fission-track age determination on zircon yielded 153 ± 10 Ma (Clenedenen, 1991). K/Ar ages on hornblende from the Afognak pluton and associated migmatite range from 197 ± 5.8 to 187.5 ± 5.5 Ma (Roeske and others, 1989), which we interpret as a cooling age; a U/Pb age of 217 ± 10 Ma is interpreted as the emplacement age (Roeske and others, 1989). We infer a similar history for the plutons of the Barren Islands.

The second major area of exposure of Triassic plutonic rocks is the Taylor Mountain batholith in the Eagle and Tanacross quadrangles of east-central Alaska (Foster, 1970, 1976). The batholith is medium- to coarse-grained, subequigranular biotite–hornblende quartz monzodiorite, tonalite, granodiorite, and quartz diorite that ranges from slightly foliated in its interior to strongly foliated at its margins (Werdon and others, 2001). Contacts with surrounding rocks are complex; zones of intimately foliated quartz dioritic dikes and sills are locally present in the country rocks near the batholith, but sheared contacts apparently predominate: Jurassic deformation, and later high-angle faulting, has disrupted most of the original contacts (Werdon and others, 2001). Rocks of the Taylor
Mountain batholith have yielded a U/Pb (sphene) age of 214 Ma and zircon ages between 215.7±3.1 and 196±4 Ma (Aleinikoff and others, 1981; Dusel-Bacon and others, 2009; Day and others, 2014); K/Ar ages of 183 to 177 Ma (Wilson and others, 1985); and 40Ar/39Ar plateau ages of 209±3 Ma on hornblende and 204±9 Ma on biotite (Cushing and others, 1984a, b, written commun., 1992), and 210 Ma on biotite and 211 Ma on hornblende (P.W. Layer, University of Alaska-Fairbanks, unpub. data; see Werdon and others, 2001). The most likely magmatic age is about 214 Ma, with younger apparent ages caused by heating and deformation during the Early Jurassic (Werdon and others, 2001).

In southeast Alaska, the primary exposure of Triassic plutonic rocks is the Texas Creek granodiorite of Berg and others (1988) in the Ketchikan and Bradfield Canal quadrangles and adjacent British Columbia. The pluton consists mainly of recrystallized, locally cataastically deformed granodiorite and minor quartz diorite. In general, the unit is relatively massive and lacks pronounced primary or metamorphic foliation. Where present, the intensity of the catalastic texture generally is low, but locally the granodiorite is converted to mylonite (Berg and others, 1988). The Texas Creek granodiorite yields latest Triassic apparent ages, but discordant K/Ar dates on hornblende (Smith, 1977). U/Pb zircon age determinations by Aldrick and others (1987) on the pluton in adjacent British Columbia yield Early Jurassic apparent ages, which they interpreted to be metamorphic ages. Other small plutons, exposed on northern Admiralty Island, described as very light- to medium-gray, nonmag-netic, locally foliated, lineated, garnet-bearing granodiorite have reported U/Pb zircon ages of 227±2.0 and 221±3.0 Ma and an 40Ar/39Ar age of 236.3±3.8 Ma on hornblende; the plutons are locally migmatitic and some contacts are mylonitic (S.M. Karl, unpub. data). In the Skagway quadrangle, a number of dioritic dikes and small stocks mapped by Redman and others (1985) and Gilbert and others (1987) are of presumed Triassic age. Description from source map: Geologic Map of Alaska.

Mzd - Older diorite (Mesozoic)
Dike swarms in old fault zones, small stocks, scattered dikes. Altered to chlorite and epidote, and sheared. Pre-metamorphic. Jarvis Creek area. Unit description from source map: SK004.

TRwm - Whitestripe Marble of southeast Alaska (Triassic?)
A long narrow belt of nonfossiliferous, massive to thick-bedded, white to light-gray, fine-grained marble. Composed of nearly pure calcite, but locally contains accessory chlorite, sericite, graphite, quartz, albite, and pyrite (Johnson and Karl, 1985). Pfafker and others (1976) and Jones and others (1977) correlate the Whitestripe Marble with the Chitistone Limestone (unit Trnk) in the Wrangell Mountains and therefore considered it to be a part of the Wrangelia terrane along with the Goon Dip Greenstone (unit Trm). Unit was assigned a Triassic(?)/age by Loney and others (1975) on the basis of a fossil found in float. Unit also includes the informally defined marble of Nakwasina Sound (unit Trm of Karl and others, 2015), which consists of light-gray, medium- to thin-bedded metalimestone, which is locally fossilifer-ous and retains primary bedding structures as well as massive to banded white marble, locally interlayered with volcanic rocks. Unit ranges up to tens of meters in thickness and is associated with volcanic and volcanicanlastic rocks mapped in Nakwasina Sound (unit Trvs). On generalized map, included as part of unit Trmls. Description from source map: Geologic Map of Alaska.

Trwm - Whitestripe Marble (Triassic (?))
Marble, some interlayered greenstone. Light gray marble, pure calcite, conformably overlies Goon Dip Greenstone. Average thickness 100 feet, maximum thickness 1500 feet. Unit description from source map: MF004.

TRPZdb - Metamorphic rocks of Dundas Bay (Triassic or older)
Gray, greenish-gray, and brownish-gray gneiss and gray to white marble. Both gneiss and marble are banded to massive and medium- to coarse-grained. Gneiss includes varieties containing hornblende,
plagioclase, garnet, quartz, and pyroxene; also present is garnet-plagioclase-hornblende amphibolite. Unit primarily exposed in the west arm of Dundas Bay and east side of Taylor Bay (D.A. Brew, S.M. Karl, and George Plafker, unpublished data). Description from source map: Glacier Bay Geologic Map.

**MzPza - Amphibolite, gneiss, schist, and marble (Mesozoic or Paleozoic)**
High grade metamorphic rocks composed chiefly of amphibolite, gneiss, and schist, locally intercalated with thin units of marble and calc-silicate granofels, are faulted against metasedimentary and metavolcanic rocks to the west, and grade into dioritic rocks to the east. The most common lithology in this unit is a quartz-andesine-biotite-hornblende schist, typically containing almandine garnet; with alternating plagioclase-hornblende and quartzofeldspathic layers several centimeters thick. Common accessory minerals include apatite, epidote, pyrite, and sphene. The protolith of this unit, on the basis of bulk composition, was probably mafic volcanic rock and marine sediments. Unit description from source map: MF002.

**Pzmy - Garnet-biotite (-quartz-feldspar) gneiss (Paleozoic)**
Garnet-biotite (-quartz-feldspar) gneiss - moderately folded / faulted, found in Geikie Province (Brew pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmy. Unit description from source map: MF003.

**MzPzgc - Metamorphic rocks (Mesozoic? and Paleozoic)**
Gray, greenish-gray, and brownish-gray gneiss and gray to white marble. Gneiss and marble are banded to massive and medium- to coarse-grained. Metamorphic rocks include hornblende-plagioclase gneiss, garnet-hornblende-quartz-feldspar gneiss, hornblende-pyroxene-quartz-plagioclase gneiss, garnet-plagioclase-hornblende amphibolite, garnet-biotite-quartz-feldspar gneiss, and garnet-feldspar-quartz gneiss. Inian Peninsula of northwest Chichagof Island, Inian Islands, west arm of Dundas Bay. Unit description from source map: MF006.

**MzPzc - Metacarbonate rocks (Mesozoic? and Paleozoic)**

**Pzgc - Metamorphic rocks (Paleozoic)**
Gray, greenish-gray, and brownish-gray gneiss and gray to white marble. Gneiss and marble are banded to massive and medium- to coarse-grained. Metamorphic rocks include hornblende-plagioclase gneiss, garnet-hornblende-quartz-feldspar gneiss, hornblende-pyroxene-quartz-plagioclase gneiss, garnet-plagioclase-hornblende amphibolite, garnet-biotite-quartz-feldspar gneiss, and garnet-feldspar-quartz gneiss. Protoliths are inferred to be sedimentary and volcanic rocks associated with adjacent units Stg, Stl, Sv, and Svc on northeastern Chichagof Island and Glacier Bay, and could range slightly older, as these rocks occupy the west margin of a stratigraphic section that youngs eastward. Rocks are mapped on the northern Chichagof Island, the Inian Islands, and the west arm of Dundas Bay. Unit description from source map: MF014.

**Pzgcg - Metacarbonate rocks (Paleozoic)**
Gray to white massive to banded marble. Medium- to coarse-grained calcite and local lenses, pods, and strings of calc-silicate minerals, including garnet, epidote, and pyroxene. Associated with hornblende-plagioclase gneiss, garnet-hornblende-quartz-feldspar gneiss, hornblende-pyroxene-quartz-plagioclase gneiss, garnet-plagioclase-hornblende amphibolite, garnet-biotite-quartz-feldspar gneiss, and garnet-feldspar-quartz gneiss. Inian Peninsula of northwest Chichagof Island, Inian Islands, west arm of Dundas Bay. Unit description from source map: MF014.
**PZps - Porcupine slate of Redman and others (1985) (late Paleozoic)**

Limonite-stained black slate and dark-gray phyllite with subordinate black argillite and banded siltstone in the Skagway quadrangle (Gilbert and others, 1987). As originally described, includes gray bioclastic limestone and marble, but we show those rocks as part of unit Pzce herein. The Porcupine slate of Redman and others (1985) intertongues with rocks mapped here as part of the Hyd Group (unit Trhg) and, because of locally intense deformation, in many places workers could not distinguish a difference between the Porcupine slate, older rocks, and the Hyd Group (Green and others, 2003). The Porcupine slate contains Devonian to Triassic fossils and locally overlies marble (unit Pzce, here) that contains Devonian to Mississippian fossils (Gilbert and others, 1987). We suggest, however, that the Triassic fossils are more likely associated with the interleaved Hyd Group. The Porcupine slate has been correlated with the Cannery Formation (unit PDCF) (Karl and others, 2010). On generalized map, included as part of unit PDCF. Description from source map: Geologic Map of Alaska

**uPzs - Porcupine slate (Late Paleozoic)**

Black slate and phyllite, with banded siltstone, graywacke, chert, limestone, conglomerate, and volcanic layers. Gradational below Glacier Creek units and above marble limestone unit. Porcupine Creek area. Unit description from source map: SK004.

**Pzam - Siliceous argillite and marble (Paleozoic)**

White, gray, and black siliceous argillite interbedded with light gray to black marble. Alternating bands 1 mm to 10 cm thick. Marble locally crossbedded, up to 6 m thick. Unit description from source map: SK004.

**Pzam? - Siliceous argillite and marble? (Paleozoic)**

Light gray, very argillaceous schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (metatuff), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. Lacks schist in Tsirku River area. Unit description from source map: SK004.

**TrDs - Porcupine Slate (Triassic to Devonian)**

Limonite-stained black slate and dark-gray phyllite, with subordinate black argillite and banded siltstone. Includes gray bioclastic limestone and marble (TrDl). Unit description from source map: SK005.

**Pzc - Chert (Paleozoic)**

Light green, gray, and lavender argillaceous chert. Beds generally 0-10 cm thick, but may be up to 1 m thick. Locally calcareous, subordinate discontinuous lenses of marble, green metatuff, and chert breccia. Unit description from source map: SK007.

**Pzcm - Chert and marble (Paleozoic)**

Pzc grades to argillaceous chert and argillaceous marble, in beds 5-25 cm thick. Unit description from source map: SK007.

**Pzs - Slate (Paleozoic)**

Light gray to black slate. Locally iron-stained and very pyritic. Contains minor intercalations of volcaniclastic sandstone, greenstone, and marble. Unit description from source map: SK007.

**Pzsm - Slate and marble (Paleozoic)**

Approximately equal amounts of dark gray slate and discontinuous beds of dark gray marble. Tightly folded. Unit description from source map: SK007.
PZm - Marble (Paleozoic)
White to medium-gray marble in 3 to 15 m thick beds exposed along northern edge of Park, south of the Tsirku River (Redman and others, 1985; Gilbert, 1988). Unit is spatially associated with the Porcupine slate of Redman and others (1985). Description from source map: Glacier Bay Geologic Map.

Pzm - Marble (Paleozoic)
Marble. Unit description from source map: MF004.

Pzm - Marble (Paleozoic)
Dark gray argillaceous marble, with interbeds of massive gray marble. Poorly preserved fossil forms. Interlayered with Pzsh of Cheetdeekahyu Group. Unit description from source map: SK004.

uPzml - Limestone-marble (Late Paleozoic)
Black argillaceous limestone and medium-gray massive marble. Good slatey cleavage. Unit description from source map: SK004.

Pzmmw - White marble (Paleozoic)
Folded white marble. 3-15 m-thick beds. South of Tsirku River. Unit description from source map: SK004.

Pzmm - Massive marble (Paleozoic)
Massive light gray marble and marble breccia. Layer is 10 to 100's of meters thick. Very continuous. South of Tsirku River. Unit description from source map: SK004.

Pzmt - Thin-bedded marble (Paleozoic)
11-km long band of fine-grained, black to dark gray marble west of Takhin Glacier. Beds few cm to 10 m thick. Thin bands of light colored argillite up to 2 cm thick are common. Unit description from source map: SK004.

TrDI - Porcupine Limestone (Triassic to Devonian)
Medium gray bioclastic limestone and marble. Unit description from source map: SK005.

MDm - Porcupine marble (Mississippian or Devonian)
Massive medium-gray marble grades to thick-bedded medium-gray limestone. Unit description from source map: SK005.

MDd - Porcupine dolomitic limestone (Mississippian or Devonian)
Cream-colored dolomitic limestone gradational to MDm. Unit description from source map: SK005.

MDld - Dolomitic limestone (Mississippian or Devonian)
Gray dolomitic limestone, thin-bedded. Unit description from source map: SK005.

Pzm - Marble (Paleozoic)
Banded purple, gray, and tan marble. Locally contains argillite and greenstone. Unit description from source map: SK005.

Pzm - Marble (Paleozoic)
Light to medium gray impure marble. Unit description from source map: SK006.

Pzm - Marble (Paleozoic)
Light to medium gray impure marble. Commonly laminated, locally massive. Unit description from source map: SK007.

MDm - Marble (Mississippian? and Devonian)
Medium bedded gray marble, locally fossiliferous. Mapped along south side of Klehini River, underlies Porcupine Slate. Unit description from source map: SK021.

**MDcp - Carbonaceous phyllite (Mississippian? and Devonian)**
Black argillite in Tsirku River area, Skagway quadrangle. On Admiralty and Kupreanof Islands includes black, carbonaceous phyllite, with subordinate metagraywacke, greenstone, or marble. Phyllite contains graphite, chlorite, and pyrite. Greenstone is recrystallized to plagioclase, actinolite, chlorite, epidote, and calcite, sometimes with relic augite. In Saginaw Bay includes black chert member of the Saginaw Bay Formation, consisting of thin-bedded black chert and minor thin-bedded dense dark gray limestone (Muffler, 1967). With lenses of marble. Stratigraphically adjacent to or above Devonian Gambier Bay Formation. No fossils recovered. Black chert member of the Saginaw Bay Formation overlies Devonian volcanic member of the Saginaw Bay Formation. Black chert member limestone beds contain late Eifelian conodonts Tortodus kockelianus kockelianus (Bischoff and Ziegler), pb elements of Oulodus sp., pa element of Polygnathus aff. P. pseudofoliatus Wittekindt, and late Emsian to early Frasnian Polygnathus linguiformis linguiformis (A.G. Harris in www. alaskafossil.org). Inferred stratigraphic position and lithology correlate with black massive siltstone and marble of the Kaskawulsh Group. Unit description from source map: SK021.

**Psp - Pybus Formation and Limestone of Sith-gha-ee Peak formation of Brew (1997) (Permian)**
Consists of thin- to thick-bedded, locally cherty, light to dark gray limestone and siltstone (Brew and Ford, 1985). Overlies rocks of the Halleck and Sith-gha-ee Peak Formations. Megafossil collections from this unit were interpreted by Brew and Ford (1985) to be like those from the Pybus Formation elsewhere, which are middle Permian (Guadalupian) in age (Loney, 1964; Muffler, 1967; Brew and others, 1984); Brew and Ford (1985) informally extended the Pybus Formation to Glacier Bay National Park and Preserve (GLBA), exposed on the east side of Glacier Bay south of Adams Inlet. Subsequently, Brew (1997) defined the informal WiWilson memestone of Sith-gha-ee Peak formation consisting of light- and dark-gray, locally fossiliferous limestone for exposures north of Casement Glacier in the northeastern part of the Park. Description from source map: Glacier Bay Geologic Map.

**Pul - Limestone and siltstone (Early Permian)**
Alexander Belt: Unnamed Permian Formation(s) in Glacier Bay-Chilkat Mountains Area. Thin to thick bedded, locally cherty, light to dark gray. Described by Latham and others (1959) as: "Limestone-Light to medium brownish gray, fine to medium crystalline, contains sparse paper thin reddish brown separations, fossiliferous, 50(?) feet thick; overlain by limestone, nodular bedded, light brownish gray, fine to medium grained, interbedded with light greenish brown chert, which varies along strike from interbedded sequence to apparent limestone chert conglomerate; in turn overlain by dark gray slate, interbedded with very fine grained calcareous graywacke and silty calcareous graywacke." Unit description from source map: JU002.

**Pal - Argillite and limestone (Permian)**
Thick limestone section includes some phyllite, slate, shale, and graywacke; limestone is thin-bedded and depositionally interbedded with other rock types; Psl unit of Brew (1997) exposed north of Casement Glacier and south of Adams Inlet, Glacier Bay. Phyllite, slate, and metagraywacke facies of Sith-gha-ee Peak Formation. Shale, siltstone, and graywacke (?) found in Muir Province. In Chilkat Mountains area includes light to medium brownish gray, fine to medium crystalline limestone that contains sparse paper thin reddish brown separations, fossiliferous, up to 15 m thick; over lain by limestone, nodular bedded, light brownish gray, fine to medium-grained limestone, interbedded with light greenish brown chert, which varies along strike from interbedded sequence to apparent limestone chert conglomerate; in turn overlain by dark gray slate, interbedded with very fine grained calcareous graywacke and silty calcareous graywacke. Part of Sith-gha-ee Peak Formation includes light and dark gray, locally fossiliferous limestone. Includes Psl of Glacier Bay (Brew, 1997). In Chilkat Mountains, in the area between Boat Harbor and William Henry Bay, and in Glacier Bay, unit includes Early Permian limestones equivalent to Halleck Formation, and Late Permian limestones equivalent to...
the Pybus Formation, that contain the same Septacamera brachiopods typical of the Pybus Formation, but the rocks in this area have not been subdivided. Sith-Gha-Hee unit contains Early Permian fossils and includes lithologies that are similar to the Cannery Formation. In summary, this unit includes rocks that lithologically correspond to the Halleck, Cannery, and Pybus Formations, and fossils with ages that correlate with the Halleck and Pybus Formations and the upper part of the Cannery Formation. Unit description from source map: JU006.

**Psl - Sitth-gha-ee Peak Formation Limestone (Permian)**
Sitth-gha-ee Peak Formation light and dark gray, locally fossiliferous limestone - found in Muir Province (Brew, pers. comm., 1999). Unit description from source map: SK010.

**Ph - Sedimentary rocks of Sitth-gha-ee Peak formation of Brew (1997) (Permian)**
Phyllite, slate, shale, graywacke, and interbedded thin-bedded limestone, exposed north of Casement Glacier and south of Adams Inlet (Brew and Ford, 1985). Unit has been informally correlated with the Halleck Formation of Cisuralian (early Permian) age. The limestone has been locally subdivided, described as unit Psp here.: Description from source map: [Glacier Bay Geologic Map](#).

**Pua - Argillite and limestone (Early Permian)**
Alexander Belt: Unnamed Permian Formation(s) in Glacier Bay-Chilkat Mountains Area Includes some phyllite, slate, shale, and graywacke; limestone is thin-bedded and interbedded with other rock types; exposed north of Casement Glacier and south of Adams. Unit description from source map: JU002.

**Pss - Sitth-gha-ee Peak Formation phyllite, slate, metagraywacke (Permian)**
Sitth-gha-ee Peak Formation phyllite, slate, and metagraywacke. Also shale, siltstone, and graywacke (?) - found in Muir Province (Brew, pers. comm., 1999). Unit description from source map: SK010.

**Phb - Volcanic rocks of Sitth-gha-ee Peak formation of Brew (1997) (early Permian)**
Olivine-rich basalt, pillow flows, pillow breccia, greenstone, greenschist, and angular breccia, intercalated with the clastic sedimentary rocks of the informally named Sitth-gha-ee Peak formation of Brew (1997; unit Ph here) exposed north of Casement Glacier and south of Adams Inlet, Glacier Bay (Brew and Ford, 1985). Description from source map: [Glacier Bay Geologic Map](#).

**Puv - Amygdaloidal basalt or andesite (Early Permian)**
Alexander Belt: Unnamed Permian Formation(s) in Glacier Bay-Chilkat Mountains Area Includes some greenstone, greenschist, and phyllite; exposed north of Casement Glacier and south of Adams Inlet, Glacier Bay. Unit description from source map: JU002.

**Psv - Sitth-gha-ee Peak Formation greenstone, greenschist, and phyllite (Permian)**
Volcanics with phyllite and slate. Sitth-gha-ee Peak Formation greenstone, greenschist, and phyllite found in Muir Province (Brew, pers. comm., 1999). Unit description from source map: SK010.

**PPNgi - Granodiorite, syenite and other granitic rocks (early Permian and Pennsylvanian)**
Granodiorite, syenite, granite, monzonite, and other granitic rocks that form a discontinuous belt from southeast Alaska to south-central Alaska and typically yield Permian radiometric ages. The rocks are
fine- to coarse-grained, may be massive or schistose, and are locally porphyritic. Unit includes shoshonitic Ahtell pluton (Richter, 1966; W.J. Nokleberg, written commun., 1997), also called the Ahtell complex by Beard and Barker (1989) in the Gulkana quadrangle, which has been dated by K/Ar to between 291 and 288 Ma. Map unit also includes the granodiorite of Rainbow Mountain in the Mount Hayes quadrangle (unit grmr, Nokleberg and others, 1992a), which yielded a K/Ar age of 325.94±9.78 Ma and a U/Pb zircon age of 309±2 Ma (Nokleberg and others, 1992b). Richter and others (1975) and Richter (1976) defined a diorite complex to the east of the Ahtell pluton and considered it to be of Jurassic and Triassic age on the basis of K/Ar dates that range from 204 to 167 Ma (recalculated using constants of Steiger and Jager, 1977); subsequent U/Pb dating reported by Beard and Barker (1989) indicated that the diorite complex was mostly of Pennsylvanian age, between 311 and 290 Ma, and possibly older than the Ahtell pluton. The diorite complex includes a range of lithologies, from quartz diorite to gabbro, including minor anorthosite and gabbro cumulates and a small area of pink biotite-hornblende syenite-monzonite gneiss, gray hornblende diorite gneiss, minor dark biotite schist, and small syenite pegmatite dikes. In the McCarthy and Bering Glacier quadrangles, MacKevett (1978) and George Plafker (written commun., 2006) mapped a monzonitic to granitic complex that consists of “medium-grained, equigranular granitic rocks with fine- to coarse-grained variants. Abundant granite and quartz monzonite and some quartz syenite, syenite, and monzonite, with border zones of quartz monzodiorite, monzodiorite, and gabbror” (MacKevett, 1978). Radiometric ages for this complex range from 312 to 279 Ma, and most K/Ar ages are only slightly younger than the U/Pb age, unlike the dates on the diorite complex, which are highly discordant. Nokleberg and others (1992a), mapping in the Mount Hayes quadrangle, reported sparse to locally abundant andesite and lesser dacite and rhyolite stocks, sills, and dikes that intrude the Permian to Pennsylvanian Slana Spur Formation and Tetelina Volcanics but not the Permian Eagle Creek Formation. These igneous rocks have been metamorphosed to lower greenschist facies and have granoblastic overprint texture and local weak schistosity; their age is inferred from intrusive relations. The rocks of this unit, in the Bering Glacier, Gulkana, McCarthy, and Mount Haues quadrangles, are inferred to represent the plutonic root of the Skolai magmatic arc (Nokleberg and others, 1994). Small, undated, exposures of medium- to medium dark-gray, fine- to coarse-grained diorite appear to intrude the Totalanika Schist (unit MDts) in the Big Delta quadrangle (Weber and others, 1978). Distally associated with the rocks of this map unit are felsic to mafic rocks that intrude the Retreat Group in the Juneau and Sitka quadrangles, orthogneiss in the Sumdum and Petersburg quadrangles, and syenitic rocks in the Craig quadrangle of southeast Alaska. In the Craig quadrangle, syenite and leucogranite of the map unit locally grade to sodic diorite (Eberlein and others, 1983) and are compositionally similar to the other parts of this unit; they yield K/Ar and 40Ar/39Ar ages between 293 and 276 Ma, comparable to the K/Ar ages in south-central Alaska. Though included in this map unit on the basis of common age and lithology, these rocks may not all be genetically related. Description from source map: Geologic Map of Alaska

MzPzmi - Meta-intrusive rocks (Mesozoic to Paleozoic)
Metamorphosed intermediate to mafic volcanic flows, pillowd flows, tuff, and agglomerate, with subordinate pelitic and semipelitic flysch. Retains primary depositional textures. In Skagway quadrangle, North and east of Chilkat River near Haines and on Chilkat Peninsula, includes massive, flow-banded, and locally pillowd or amygdaloidal metabasalt. Contains magnetite, traces of malachite, pods and veins of epidote. Associated tuffaceous metasediments. Metamorphosed to low greenschist facies and intruded by the Mt. Kashagnak pluton, locally as thick as 3.4 km. Dark green and black metabasalt and meta-andesite. Flow units and intercalated metasedimentary rocks strike NW and dip steeply east. Greenschist facies metamorphic mineral assemblages include albite, quartz, chlorite, epidote, actinolite, calcite, pyrite, and sphene. Includes dark green, silvery green, and gray green phyllite and schist, with intercalated metachert and marble and carbonaceous gray phyllite. In Endicott Arm area, includes massive quartz-calcite-actinolite-epidote greenstone, massive plagioclase-actinolite-epidote-chlorite greenstone, and biotite-quartz-epidote-chlorite phyllite and schist. Minor amounts of slate, quartzite, and metalimestone are also present (Stowell and Hooper, 1990.) Taku terrane. Unit description from source map: SK021.
**PDCF - Cannery Formation and Porcupine slate of Redman and others (1985), undivided (Devonian to Permian)**

Cherty graywacke and argillite that contains subordinate conglomerate, limestone, and volcanic rock interbeds; locally metamorphosed to slate, phyllite, marble, greenstone, and hornfels; intensely folded (Loney, 1964; Lathram and others, 1965; Muffler, 1967; Brew and others, 1984; Redman and others, 1985; Karl and others, 2010). Includes the Porcupine slate of Redman and others (1985) and undifferentiated chert, marble, and argillite mapped by Gilbert (1988). Graywacke, tuff, and chert are commonly interbedded, deposited as turbidites. Graywacke beds are up to 5 m thick and dominantly consist of volcanic and calcareous rock fragments. Limestone occurs in beds up to 50 cm thick, and pillow basalt and tuff-breccia horizons are as thick as 100 m. Total thickness of the Cannery Formation is estimated to be greater than 500 m (Karl and others, 2010). Limestone of the Cannery Formation contains Permian bryozoans and crinoids on Admiralty Island (Lathram and others, 1965). Chert contains Mississippian to Permian radiolarians (Karl and others, 2010). On Kupreanof Island, chert and limestone contain Early Pennsylvanian to early Permian radiolarians, early Permian conodonts, and Upper Mississippian conodonts (Karl and others, 1999). Here, also includes calcareous schist and semischist on northwestern Admiralty Island that were previously mapped as part of the Retreat Group by Lathram and others (1965). The Cannery Formation is likely correlative with the Porcupine slate of Redman and others (1985). Also included here is a unit of siliceous phylite and metachert on Admiralty Island of similar age to rocks at the base of the defined Cannery Formation (Karl and others, 2010) of Late Devonian age. Co-author S.M. Karl considers these siliceous phylites and metacherts to be a separate unit, but we include them here. Description from source map: [Geologic Map of Alaska](#)

**PDc - Argillite, chert, and graywacke (Permian to Mississippian)**

Unit includes Cannery Formation, defined in Pybus Bay on Admiralty Island by Loney (1964) where it includes gray, brown, green, maroon, and tan argillite, chert, graywacke, tuff, conglomerate, limestone, and basalt. Graywacke and chert are dominant locally, sericitic cherty argillite is also locally dominant. Graywacke, tuff, and chert are commonly interbedded, deposited as turbidites. Graywacke beds are up to 5 m thick. Graywacke is dominated by volcanic and calcareous rock fragments. Chert contains radiolarians and is intercalated with graywacke, tuff, limestone, or volcanic flows. Limestone occurs in beds up to 50 cm thick. Pillow basalt and tuff-breccia form sections up to 100 m thick. Basalt contains clinopyroxene and plagioclase phenocrysts. Total unit thickness estimated to be greater than 500 m. On Kupreanof Island unit includes gray chert, green chert, red chert, black cherty argillite, gray and green slatey argillite, gray silicified limestone, black siltstone and chert turbidites, graywacke turbidites, minor conglomerate, conglomeratic debris flows, tuff, and volcanic rocks. Also thin-beded gray tuffaceous volcanic argillite and fine-grained gray tuffaceous volcanic graywacke; both weather bluish-green or reddish-brown and are intensely fractured; some very thin-beded dark gray chert, silicified argillite, pillow flows, and gray elastic limestone. On Admiralty Island, includes Green mafic to intermediate volcanic and volcaniclastic rocks, with rare metachert. Facies to Cannery Formation siliceous sedimentary rocks north of Gambier Bay. In Keku Strait, Halleck Formation volcanic rocks - olivine-rich basalt, pillow flows, pillow breccias, and angular breccias; intercalated with sedimentary rocks of above unit in Saginaw Bay. Unit description from source maps: JU006 and SK021.

**Staa - Argillite and graywacke (Late Silurian)**

Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Point Augusta Formation: Described by Lathram and others (1959) as: “Argillite- Dark gray, siliceous, weathers dark brownish red, contains large lenses of pebble to cobble conglomerate and layers of gray green graywacke in lower part. Includes thin bedded black, gray, and dark green chert near top. At least 3,000 feet thick. Unit description from source map: JU015.

**MDI - Limestone (Mississippian or Devonian)**

Laminated gray sooty limestone with bioclastic beds. Unit description from source map: SK005.
Pzgs - Cannery-Greenstone of Piledriver Cove (Paleozoic)
Medium to dark green, vuggy, calcareous schists and semischists on northwestern Admiralty Island were previously mapped as part of the Retreat Group by Lathram and others (1965). The greenschists are generally vuggy due to the dissolution of calcite. Some greenstone is albite porphyroblastic. Subordinate marble forms lenses as thick as 80 m, which is mapped separately as Pzmm when possible. Marble locally retains relict bedding and has stylolitic partings. Meter-scale lenses of metachert, carbonaceous phyllite, and felsic schist are interlayered with the greenstone schists in some places. Other rock types include minor amounts of white mica schists, chlorite-white mica schists, meta-peridotite, and meta-gabbro. The unit is gradational to Pzcs (7315) which contains a higher proportion of sericitic and graphitic schists relative to Pzgs. Protoliths of Pzgs are inferred to be dominantly volcanic and volcanoclastic rocks of intermediate to mafic composition, with an admixture of calcareous clasts and mafic intrusive rocks. Relict igneous textures are preserved in some semischists. Locally greenstone retains primary coarse clastic or layered sedimentary textures; vuggy texture appears to be related to high content of calcite lenses that may include an admixture of calcareous clasts. Common maximum-phase mineral associations in the greenschists include albite-chlorite-actinolite-epidote-calcite-muscovite; quartz-albite-chlorite-actinolite-epidote; quartz-albite-chlorite-epidote-calcite-white mica. White mica schists consist of quartz-albite-chlorite-calcite-white mica or some subset of that mineral association. The metaperidotite has the mineral association chlorite-actinolite-calcite-serpentine. Accessory minerals include opaque oxides, titanite, and pyrite. The mineral associations of the greenschists and semischists unit are indicative of regional metamorphism under conditions of the greenschist facies. Most of the schists are fine- to medium-grained with an S1 foliation. F2 folds and crenulations are commonly present with or without development of an S2 cleavage at a high angle to S1. Highly strained layers of greenstone semischist form bands 1-3 m thick; primary layer thickness is unknown. Best exposed on the west side of Piledriver Cove, and on the west side of Hawk Point. Unit description from source map: SK021.

MDcp - Cannery-Carbonaceous phyllite (Mississippian? and Devonian)
Dominantly black phyllite. Mapped in Tsirku River area, Chilkat Mountains, and Admiralty and Kupreanof Islands. Includes black, carbonaceous phyllite, with subordinate metagraywacke, greenstone, and marble. Phyllite contains graphite, chlorite, white mica, and pyrite. Greenstone is recrystallized to plagioclase, actinolite, chlorite, epidote, and calcite, sometimes has relict augite. Gradational to metavolcanic rocks and marble of the Gambier Bay Formation (Dg, Dgf, Dgm). Unit description from source map: JU006.

MDph - Black phyllite (Mississippian or Devonian)
Tightly folded black phyllite, black slate, and dark gray metasiltstone. Locally limonitic. Contains up to 25% calc siltstone and 25% thin-bedded sooty limestone. Includes units MDl and MDld. Unit description from source map: SK005.

PMcc - Slate and phyllite of Porcupine Creek (Permian to Mississippian)
In Porcupine Creek area of Skagway quadrangle, includes limonite-stained black slate and dark-gray phyllite, with subordinate black argillite and banded siltstone. Includes gray bioclastic limestone and marble, with banded siltstone, graywacke, chert, limestone, conglomerate, and volcanic layers. Gradational below Glacier Creek units and above marble limestone unit. In Eagle Peak and Gambier Bay areas on Admiralty Island, unit includes black pyritic phyllite, metachert, and metamorphic, of the Cannery Formation, with subordinate graywacke and mafic volcanic rocks. Carbonaceous facies of Cannery Formation. Unit description from source map: SK021.

PzZq - Siliceous and carbonaceous semischist (Paleozoic and Proterozoic)
North of Klehini River, includes interbedded black phyllite, felsic schist, metachert, and medium gray marble. On Four Winds Mountain includes dark gray to black graphitic schist, dark gray, locally rusty, pyritic quartzite; mafic and felsic schist, black phyllite, and calc schist. On Prince of Wales Island, includes siliceous black slate, carbonaceous phyllite, quartz-sericite schist, calc-chlorite schist of the Wales Group. Dark gray phyllite is fine-grained with quartz segregation layers, finely crenulated foliation, and common F2 folds. Commonly cleaves into 2-cm thick plates. Unit description from source map: SK021.
MDip - Iyoukeen and Peratrovich Formations (Mississippian and Devonian)

Iyoukeen Formation (Loney and others, 1963) consists of three informal members: lower member is 130 m of thin-bedded, dark-gray limestone that contains thin, dark-gray chert innerbeds; middle member is about 200 m of dark-gray, sparsely fossiliferous, partly calcareous shale; upper member is as much as 1,000 m of medium-bedded, dark-gray, fossiliferous limestone that contains dark-gray chert nodules. Fossils indicate shallow, warm, marine environment. Lower and middle members have Early Mississippian conodonts, corals, brachiopods and gastropods, whereas upper member contains conodonts of Late Mississippian age (Karl, 1999). Peratrovich Formation (Eberlein and Churkin, 1970) also has three informal members: lowest member consists of about 60 m of thin-bedded grayish-black chert that contains rare lenses of medium-dark-gray, aphanitic limestone, dolostone, and crinoidal limestone; middle member, about 120 m thick, is mainly medium- to thick-bedded, massive, medium-gray limestone and grayish-black chert nodules and lenses that may form up to 25 percent of the middle member; uppermost member is about 75 to 90 m of thick-bedded massive limestone and minor dolomitic limestone that is as much as 25 percent black chert nodules and lenses. Limestone is composed largely of echinoderm, bryozoan, and foraminiferal fragments and oolites (Churkin and Eberlein, 1975). Peratrovich Formation contains abundant shelly fossils, especially rugose corals (Eberlein and others, 1983), which indicate an age range of Middle to Late Mississippian for the Peratrovich Formation. Unit also includes the black chert and limestone member of the Saginaw Bay Formation, which consists of thin-bedded black chert and minor thin-bedded, dense, dark-gray limestone (Mufller, 1967). Mufller (1967) was uncertain about the nature of the contact between this unit and the other members of the Saginaw Bay Formation because outcrops are poor, and the rocks locally exhibit complex folds. The upper members of the Saginaw Bay Formation are of Pennsylvanian age (unit Psb), whereas the lower volcanic rocks are of Lower and Middle Devonian age. The age of the black chert is not known directly; volcanic rocks yielded earliest Late to latest Early Devonian conodonts (Dutro and others, 1981; Brew and others, 1984). Description from source map: Geologic Map of Alaska

Mi - Iyoukeen Formation (Mississippian)
Alexander Belt: Upper cherty fossiliferous limestone member and lower fossiliferous shale with minor limestone member; described and named by Loney and others (1963); exposed on northeastern Chichagof Island. Unit description from source map: JU002.

Dfr - Freshwater Bay and Port Refugio Formations (Late Devonian)

Freshwater Bay Formation on Chichagof Island is composed of green and red andesite and basalt flows, breccia, and tuff, pyroclastic rhyolite deposits, minor amounts of interbedded conglomeratic volcanic graywacke, grayish-black argillite, and dark-gray limestone (Loney and others, 1963). The correlative but more sedimentary-rock-rich Port Refugio Formation on Prince of Wales Island consists of km-thick sections of siltstone, shale, volcanogenic graywacke, conglomerate, and minor limestone that alternate with km-thick sections of pillow basalt intercalated with minor chert, shale, limestone and aquagene tuff (Eberlein and others, 1983). Unit also includes the Coronados Volcanics and the Saint Joseph Island Volcanics found on western Prince of Wales Island and adjacent islands (Eberlein and others, 1983). The Port Refugio Formation may be a distal facies of the Freshwater Bay Formation. Eberlein and Churkin (1970, p. 43) stated that “many of the graywackes are largely reworked basaltic lavas that contain euheadal crystals of plagioclase and pyroxene that resemble the phenocrysts in the basaltic flows of the formation,” and that many of the conglomerate clasts are andesitic or basaltic rocks. Volcanic flows are found throughout the unit and are up to a hundred meters thick (Eberlein and Churkin, 1970). Age control from the Freshwater Bay is derived from brachiopods, including Cyrtospirifer, mollusks, and corals of Frasnian (Late Devonian) age (Loney and others, 1975) and conodonts of Famennian (Late Devonian) age (Karl, 1999). Eberlein and Churkin (1970) reported Late Devonian “beautifully preserved” brachiopods that Savage and others
(1978) assigned a middle to late Famennian age and that are associated with vascular plant fossils. On generalized map, included as part of unit Dsv. Description from source map: Geologic Map of Alaska

**Df - Freshwater Bay Formation (Late Devonian)**

Alexander Belt: Andesite and basalt flows, volcanic breccia, tuff, minor graywacke, and limestone; described and named by Loney and others (1963); exposed on northeastern Chichagof Island. Unit description from source map: JU002.

**Dlse - Carbonate rocks of southeast Alaska (Devonian)**

Consists of thin-bedded to massive gray limestone of the Wadleigh and Black Cap Limestones; which locally contain minor shale and argillite interbeds, as well as the lime-stone members of the Cedar Cove and Karheen Formations, and the informal limestone of Kasaan Island. The Wadleigh Limestone on Prince of Wales Island is generally thick- to medium-bedded or massive limestone about 300 m thick composed of fragmented shelly fossils in a dark, lime mudstone matrix and minor argillaceous and calcareous shale. Massive stromatoporoids may form reefs and reef breccia; brachiopods, gastropods, ostracodes, pelecypods, and crinoids make up substantial quantities of the coarse fossil detritus (Eberlein and others, 1983) and indicate an age range of Emsian (late Early Devonian) to Famennian (Late Devonian) (Eberlein and Churkin, 1970; Eberlein and others, 1983; Savage and Funai, 1980; Soja, 1988a). The significantly thicker Black Cap Limestone, in the Glacier Bay area (Rossman, 1963), is a structurally com-plex thin-bedded black limestone about 210 m thick that grades upward to a lighter colored, thicker-bedded to massive limestone about 1,160 m thick. Numerous fossils including rugose and tabulate corals, brachiopods, gastropods, ostracodes, stromatoporoids, and conodonts suggest an Early to Middle Devonian age for the unit (Blodgett and others, 2012). Limestone member of the Cedar Cove Formation is as thick as 350 m and consists of massive to thin-bedded fossiliferous limestone that contains interbeds of argillite and tuff and is locally metamorphosed to marble (Loney and others, 1963). Rugose and tabulate corals, stromatoporoids, brachiopods, mollusks, and trilobites provide a Middle Devonian to lower Upper Devonian (Frasnian) age for this unit (Loney and others, 1975). Additional collections indicate an age no younger than early Middle Devonian (Eifelian) for the limestone member of the Cedar Cove Formation (R.B. Blodgett, written commun., 2014). The limestone of Kasaan Island (Eberlein and others, 1983) is part of the Karheen Formation near Prince of Wales Island and similar limestone along Duncan Canal on Kupreanof Island are thin-bedded to massive fossiliferous limestone a couple hundred meters thick (Eberlein and others, 1983; Karl and others, 1999). As with the other limestone units in this map unit, this limestone contains abundant fossil fragments of corals, stromatoporoids, brachiopods, conodonts, and crinoids, which here are of Emsian (late Early Devonian) to lower Eifelian (early Middle Devonian) age (Eberlein and others, 1983; Soja, 1988b; McClelland and Gehrels, 1990; Karl and others, 1999). Along Duncan Canal, the limestone also contains interbeds of argillite, sandstone, and volcanic rocks (Karl and others, 1999). Marble of the Gambier Bay Formation on Admiralty Island (Latham and others, 1965), which may be age correlative, is included in map unit Dgmb here. On generalized map, unit Dlse is included as part of unit DSsm. Description from source map: Geologic Map of Alaska

**mDI - Fossiliferous limestone (Late to late Early Devonian)**

Undivided fossiliferous, medium bedded gray limestone. In Glacier Bay area includes Black Cap limestone, named by Rossman (1963), including a light gray, thick-bedded upper member up to 1200 m thick, and a dark gray, thin-bedded lower member approximately 240 m thick. On Prince of Wales Island, includes limestone of Kasaan Island and Wadleigh Limestone. Kasaan limestone is dark gray, pelrolierous, medium-bedded, with abundant corals and megafossils. Wadleigh Limestone consists of thick- to medium-bedded or massive dark gray, locally pelrolierous, fossil fragmental limestone with interbeds of dark gray argillaceous limestone and calcareous shale. Rich in the stromatoporoid Amphipora, forming massive reefs and reef breccia. Fossil debris includes brachiopods, gastropods, crinoids, pelecypods, corals, ostracods, and trilobites. Conodonts are also common. Corals and massive stromatoporoids are the most abundant fossils, forming reef breccia deposits in places. Brachiopods, gastropods, pelecypods, ostracodes, and crinoids make up substantial quantities of the
coarse fossil detritus; thickness about 1000 feet (Churkin and Eberlein, 1975). In Hessa Inlet area, includes light to medium gray fossiliferous limestone breccia and subordinate massive to thin-bedded limestone. Thin layers of dark gray siliceous limestone are common in both breccia and bedded limestones. Two layers of limestone several meters thick, separated by sandstone apparently belong to a single horizon extending continuously through the Hessa Inlet area. Unit depositionally overlies Stanley Creek and Karchen limestone and sandstone. On Gravina Island (Berg, 1973), limestone, dolomite, and locally, metachert, phyllite, and conglomerate consists mainly of red-weathering, sandy to gritty dolomitic limestone. Limestone is in fault contact with Nehenta Formation and overlies recrystallized fragmental pre-Devonian rocks. Unit is thick-bedded to massive and up to 100 m in total thickness. Dolomitization is accompanied by silicification and sulfide minerals, so is probably hydrothermal. Unit includes mostly Lower Devonian limestones. Some Lower Devonian limestones, such as the Wadleigh Limestone on Prince of Wales Island, extend into the Middle Devonian, and contain fossils that range into the Upper Devonian. The Black Cap limestone in Glacier Bay contains Middle Devonian megafossils, including Amphipora, rugose corals, and tabulate corals Alveolites? sp., Aulocystis, Favosites, and Thamnoperella? sp. Wadleigh ranges from Emsian to Famennian. On Prince of Wales Island, basal black argillite in Wadleigh Limestone locally contains Early Devonian trilobites (species/genus) (Dr. Robert Blodgett, Oregon State Univ., written comm., 2002). Rich coral fauna below brachiopod Stringocephalus horizon include Acanthophyllum, Digonophyllum, Arcophyllum, Xystriphyllum, Australophyllum, Loyophyllum, and Yakutiophyllum, indicating a Middle Devonian (Eifelian) age. In the upper part of the formation, the corals Phillipiaspinea (Pachyphyllum), Sociophyllum, Thamnoperella, Seringporella, and Macgarea indicate a Late Devonian (Frasnian) age (Oliver and others, 1975; Tschudinova and others, 1974, in Churkin and Eberlein, 1975). Thicker bedded fossil fragmental limestone in the Wadleigh contains Famennian to Late Eifelian brachiopods (Camarotoechia, Cryptonella), corals (Xystriphyllum, Heliolites, Alveolites, Acanthophyllum, Phillipiaspinea, Sociophyllum, Seringporella, Dendrostella, Hexagonaria, Digonophyllum), gastropods (Naticopsis), cephalopods (Carloceras), and Frasnian conodonts (Polygnathus, Pandorinella) (Eberlein and others, 1983). Kasaan Limestone is Emsian (Soja, 1979) Middle Early Devonian conodonts from Max Cove, Tah Bay, Buschman Pass, Brownson Bay, Ingraham Bay, Cladopera and crinoid columnals from Hessa Inlet (Gehrels, 1992). On Gravina Island, limestone contains Cladopera and Coenites of Silurian to late Middle Devonian age and probable Middle Devonian fossils from Vallenar Bay (Chapin, 1918, p. 88; Buddington and Chapin, 1929, p. 94-98). Unit description from source map: JU006.

PCI - Limestone and marble (Permian? and Carboniferous?)
Alexander Belt: Unnamed Permian Formation(s) in Glacier Bay-Chilkat Mountains Area. Poorly defined unit; northern exposures of the unit described by Lathram and others (1959) as: "Limestone and marble- Light to medium gray, thick bedded, contains interbeds of phyllite and lenses and layers of basalt near top. Approximately 3,000 feet thick, thins rapidly northward. Unfossiliferous, except probable equivalent limestone,contains chain corals, brachiopods, giant cephalopods." Possibly correlates with Crinoidal limestone and/or limestone members of Saginaw Bay Formation. Unit description from source map: JU002.

Dbc - Black Cap Limestone (Devonian)
Thin-bedded black limestone, which becomes progressively lighter colored and thicker bedded upward, defined by Rossman (1963). It contains "fairly abundant marine invertebrate fauna of Middle Devonian age" (Rossman, 1963). Unit is exposed north and south of Adams Inlet (Brew and Ford, 1985). Unit may be correlative with the limestone of the Cedar Cove Formation on Chichagof Island. Description from source map: Glacier Bay Geologic Map.

Dcl - Limestone member (Late Devonian)
Alexander Belt: Cedar Cove Formation: Thin to medium bedded limestone, minor shale. Unit description from source map: JU002.
Dbcl - Black Cap limestone (Middle Devonian)
Alexander Belt: Light gray, thick-bedded upper member up to 1200 m thick, and dark gray, thin-bedded lower member approximately 240 m thick; described and named by Rossman (1963); exposed north and south of Adams Inlet, Glacier Bay. Unit description from source map: JU002.

Dlf - Fossiliferous limestone (Middle and Early Devonian)
Gray to black, fetid, medium-bedded fossiliferous limestone. In Glacier Bay area includes Black Cap limestone, named by Rossman (1963), which consists of a light gray, thick-bedded upper member up to 1200 m thick, and a dark gray, thin-bedded lower member approximately 240 m thick. The limestone member of the Cedar Cove Formation on Chichagof Island consists of approximately 400 m of light gray to black, medium-bedded fossiliferous limestone that alternates with meter-scale layers of crossbedded quartzite, and light gray to yellowish brown limestone-dolostone, capped by cm-bedded dolostone and greenish yellow siliceous tuff (Loney and others, 1963). In Duncan Canal, unnamed limestone is dark gray to black, thick-bedded to massive, and fossiliferous. On Prince of Wales Island, includes limestone of Kasaan Island and Wadleigh Limestone. Limestone of Kasaan Island is dark gray, fetid, medium-bedded, with abundant corals and megafossils. On Kasaan Island unit depositionally overlies rhyolite. Wadleigh Limestone consists of thick- to medium-bedded or massive dark gray, locally petrolierous, fossil fragmental limestone with interbeds of dark gray argillaceous limestone and calcareous shale; limestone is rich in the stromatoporoid Amphipora, forming massive reefs. Fossil debris includes brachiopods, gastropods, crinoids, pelecypods, corals, ostracods, and trilobites. Conodonts are also common and well-preserved. Corals and massive stromatoporoids are the most abundant fossils, forming reef breccia deposits in places. Limestone was deposited in shallow subtidal conditions in quiet water, in a lagoon or shelf open marine environment (Soja, 1988). The Wadleigh limestone is estimated to be 1000 m in maximum thickness, but is thinner locally (Savage, 1988). Wadleigh limestone depositionally overlies sandstone and conglomerate of the Karheen Formation and basalt of the Coronados Volcanics. The Wadleigh limestone is overlain by the black chert member of the Peratovich Formation on Wadleigh Island. In the Hess Inlet area, includes light to medium gray fossiliferous limestone breccia and subordinate massive to thin-bedded limestone. Thin layers of darker gray siliceous limestone are common in both breccia and bedded limestones. Two layers of limestone several meters thick, separated by sandstone apparently belong to a single horizon extending continuously through the Hess Inlet area on southern Prince of Wales Island. Unit depositionally overlies limestone and siliciastic rocks of the Stanley Creek Formation and sandstone and conglomerate of the Karheen Formation. On Gravina Island (Berg, 1973), limestone, dolomite, and locally, metachert, phylite, and conglomerate consists mainly of red-weathering, sandy to gritty dolomitic limestone. Limestone is in fault contact with the Triassic Nehenta Formation and overlies recrystallized fragmental pre-Devonian rocks. Locally dolomitization of the limestone is accompanied by silification and sulfide minerals, and inferred to be hydrothermal (Berg and others, 1988). Unit description from source map: JU006.

Dcbl - Black Cap Limestone (Middle Devonian)
Black Cap Limestone - found in Chilkat and Muir Provinces (Brew, pers. comm., 1999). Unit description from source maps: MF003 and SK010.

Dbcm - Marble derived from Black Cap limestone (Cretaceous)
Marble derived from Black Cap limestone in Geikie Province (Brew, 1999; pers. comm. renames this unit Kbcm). Unit description from source map: MF003.

Dcc - Karheen and Cedar Cove Formations (Devonian)
Karheen Formation has two facies: an upper shallow-water sandstone, shale and conglomerate facies, and a lower deep-water facies. According to R.B. Blodgett (written commun., 2014), the Karheen Formation, as used here, is much more complex than generally described. Much of it is Silurian in age and there is another unnamed unit likely included here. The shallow-water facies, about 1,800 m thick, contains minor well-bedded and penecontemporaneously deformed platy limestone in addition to its clastic components and is characterized by red beds, calcareous cement,
festoon crossbedding, ripple marks, and mud cracks. Clasts are mainly volcanic rocks and chert, but pebbles to boulders of sedimentary rocks and felsic to mafic plutonic rocks are also present (Eberlein and others, 1983). Locally the limestone contains abundant brachiopods. Unconformably overlies Staney Creek unit of Eberlein and others (1983) and the Descon Formation. Eberlein and others (1983) reported that abundant detrital K-feldspar and bronze-colored biotite in the sandstone distinguishes the Karheen from older sandstone, but S.M. Karl (unpub. data, 2013) noted that, upon thin-section examination, detrital K-feldspar is not abundant in this facies. The deep water facies consists of matrix-supported debris-flow deposits, which were described by Gehrels (1992) as a sedimentary breccia composed of unsorted clasts of plutonic rocks and highly deformed volcanic, sedimentary and intrusive rocks that are as large as 50 cm in diameter. The clasts are moderately flattened, tectonically brecciated, and locally semischistose (Gehrels, 1992). Eberlein and Churkin (1970) described the deep-water facies as green-gray, gray, and reddish-brown lithic wacke and graywacke and minor siltstone; red, red-brown, and green shale; thin-bedded sandy limestone; contorted platy limestone; pebble-to-cobble polymictic conglomerate; and biostromal limestone and reef breccia. Sandstone and shale is commonly graded and contains festoon cross bedding, ripple marks, and mud cracks (Eberlein and Churkin, 1970). Latest Lower Devonian or earliest Middle Devonian (Pragian or younger) graptolites Monograptus pacificus are reported (Churkin and others, 1970). Eberlein and others (1983) also describe “graptolite and plant-bearing shale interbedded with graywacke, sandstone, and conglomerate.” The vascular plants preserved in this unit are the oldest plant fossils known in North America (Churkin and others, 1969). Eberlein and others (1983) also report subordinate andesitic volcanic rocks and that “the youngest beds of the sequence appear to be a 200 m thick section of interbedded andesitic flows, broken pillow breccia, and tuff.” These volcanic rocks are included in unit Dmv here. The Cedar Cove Formation, on Chichagof Island, consists of up to 900 m of thin-bedded argillite and minor limestone, turbiditic graywacke, and conglomerate. Conglomerate clasts include “volcanic rock, granite, alaskite, syenite, graywacke, quartz, chert, and limestone” (Loney and others, 1975, p. 10). Graywacke contains large pink K-feldspar, plagioclase, quartz, pyrite grains, and volcanic rock fragments (Loney and others, 1975; Karl and others, 1999).

Locally, includes the limestone member of the Cedar Cove Formation (unit Dlse). Loney and others (1975) reported Middle Devonian to Frasian (lower Upper Devonian) corals, stromatoporoids, brachiopods, and a trilobite. Karl (1999) reported Emsian (lower Lower Devonian) conodonts from the lower member of the Cedar Cove Formation. Description from source map: Geologic Map of Alaska

Dc - Cedar Cove Formation (Devonian)
Alexander Belt: Cedar Cove Formation undivided. Unit description from source map: JU002.

Dcc - Clastic member (Late Devonian)
Alexander Belt: Cedar Cove Formation: Conglomerate, graywacke, argillite, and minor limestone. Unit description from source map: JU002.

Drl - Redbeds, conglomerate, limestone (Early Devonian)
On Chichagof Island, unit includes Cedar Cove Formation; lower member is a mixed argillite, tuff, limestone, and graywacke; upper member is dominantly limestone. Gradationally overlies Kennel Creek limestone, base is marked by first graywacke bed. Graywacke contains quartz, plagioclase, potassium feldspar, biogenic debris, limestone, volcanic rock fragments, and secondary pyrite, chlorite, and epidote. Graywacke forms turbidites, debris flows, and crossbeds, and is locally conglomeratic. Conglomerate contains pebbles and cobbles of granite, syenite, limestone, graywacke, chert, quartz and limestone. The upper member consists of medium to thick-bedded gray, feldspar, fossiliferous limestone, and black, organic calcareous mudstone. Red arkose and red polymictic conglomerate in Saginaw Bay overlie Kiulu Limestone, and contains quartz, plagioclase, and chert but no K-feldspar or detrital mica have been reported. On Prince of Wales Island unit includes Karheen Formation, composed of sandstone, shale, and pebble, cobble, and boulder conglomerate characterized by redbeds, calcareous cement, and crossbedding (commonly of festoon type). Locally contains thin- to medium-bedded gray limestone, calcareous pyritic siltstone, and thin-bedded platy limestone. Sandstone is green, green-gray, and reddish-brown lithic wacke and graywacke. Shale is silty and red or green. Conglomerate clasts vary in lithology: mainly mafic volcanic clasts and
greenish-gray chert, but graywacke, siltstone, red chert, quartzite, white quartz, and limestone are present. Granitoid clasts are generally rare. To the north the Karheen is mainly sandstone and shale that lie conformably on Heceta Limestone. In the south, Karheen is dominantly conglomerate and rests unconformably on Descon Formation. Thickness about 6000 feet. red sandstone, shale, and conglomerate, with subordinate platey thin-laminated limestone. Unit is characterized by redbeds with festoon crossbeds, ripple marks, and mudcracks. Conglomerate clasts include mainly volcanic rocks and chert, with subordinate arkose, graywacke, siltstone, quartz, limestone, and felsic to mafic intrusive rocks. Detrital K-feldspar and biotite distinguish Karheen sandstone from older sandstones. Mudstone locally contains ostracods, and contains Early Devonian plant fossils. Limestone is penecontemporaneously deformed. Unit conformably overlies Heceta limestone and gradationally overlies Stanyan Creek redbeds and limestone. Unit is laterally gradational to, and underlies Wadleigh limestone. Unit is locally as thick as 1800 m. In Hessa Inlet area, includes tan to reddish-brown-weathering sandstone, siltstone, and subordinate mudstone and pebbly conglomerate, interbedded locally with fossiliferous limestone and maroon and green shale. At Hessa Inlet-Bert Millar Cutoff area, unit includes tan- to reddish-brown-weathering pebble, cobble, and boulder conglomerate, pebbly sandstone, and subordinate sandstone, siltstone, and volcanic rocks. Massive to thick-bedded with channels and high angle crossbeds. Subaerial to shallow marine. Unit also includes plagioclase porphyritic volcanic rocks. Sandstone ranges from massive beds several meters in thickness to thin beds with high angle crossbeds and channels. Sandstone contains monocrystalline quartz and feldspar, and granitic and felsic to mafic volcanic lithic fragments. Unit gradationally overlies conglomerate. Shallow marine, stratigraphic thickness exceeds 1 km. Unit description from source map: JU006.

**Du - Conglomerate, volcanic rocks, and limestone undivided (Early Devonian)**

In Ketchikan quadrangle, consists primarily of massive and thinly bedded dolomitic marble and recrystallized limestone and greenschist facies, locally pyritic, phyllite and semischist derived from graywacke flysch. It also contains feldspathic to arkosic calcareous siltstone and sandstone, conglomerate, calcarenite and limestone breccia, and concretionary dolomite. On Prince of Wales Island consists of flyschlike tuffaceous banded mudstone, graywacke, quartzofeldspathic waacke, and subordinate grit. Gradationally overlain by tuffaceous marlstone, pillow breccia, volcanic conglomerate, carbonated cemented lithic lapilli aquagene tuff, subordinate basaltic to andesitic pillow flows, volcanic breccia, and polymictic conglomerate. In Keete Inlet, consists of volcanic breccia and massive clast- and matrix-supported volcaniclastic conglomerate, interbedded fossiliferous dark gray calcareous argillite and argillaceous limestone. Dark-gray siltstone and dark-gray argillite is the dominant unit. Unit is approximately 1800 m thick between Keete Inlet and KIakas Inlet. The lower 600 m contains subordinate but distinctive dolomitic concretions, usually 0.1 to 3 m thick and a few meters long. The concretions are faintly laminated, and usually parallel to siltstone beds. In KIakas Inlet, includes basal conglomerate or breccia, sandstone, siltstone and mudstone with intercalated basaltic and andesitic flows. Dark gray to black shale and subordinate slate and slatey argillite, with mm-scale laminations and cm-scale compositional layering. Layers of gray mudstone,, brown carbonate-rich siltstone, and leucogranoiorite-clast conglomerate up to tens of cm thick are found locally in the section. Graded beds and fine laminations record turbidite deposition. Large slide-block of leucogranoiorite suggest significant topographic relief. Stratigraphic thickness is at least 250 m. These clastic and volcanic rocks are over lain by limestone and the limestone is over lain by black graptolitic shale. Unit description from source map: JU006.

**Dgb - Gambier Bay Formation, undivided (Devonian)**

Medium-green actinolite schist, semischist, and dark-green garnet amphibolite that was first named by Loney (1964) on Admiralty Island. Unit also contains subordinate gray pelitic schist, calc-schist, chloritic quartzite, and felsic schist and marble. On Kupreanof Island, unit includes chlorite phyllite, schist, and semischist, graphitic schist, siliceous sericite schist, chloritic calc-schist, greenstone, marble, and meta-limestone. Subordinate light-tan to gray quartz-sericite semischist contains quartz porphyroblasts in a groundmass of feldspar, sericite, and pyrite and may have a quartz-porphyritic volcanic protolith. Greenstone semischist locally retains relict primary structures, including vuggy
volcaniclastic textures and marble lenses and clasts. Metamorphic mineral assemblages include chlorite-epidote-calcite, quartz-muscovite-chlorite-albite, quartz-talc-calcite, and quartz-albite-muscovite-chlorite, which indicate greenschist-grade metamorphism (S.M. Karl, unpub. data). Unit thickness is unknown. On Kupreanof Island, Karl and others (1999) report brachiopods from the late Emsian and Eifelian (latest Early to Middle Devonian), conodonts from the late Emsian to Late Devonian, and corals from the Silurian to Middle Devonian; together, the fossils have been interpreted to indicate a unit age of Middle Devonian. Unit yields Permian metamorphic ages (S.M. Karl, unpub. data). Locally, marble separated as map unit Dgbm. Description from source map: Geologic Map of Alaska.

**Dg - Greenstone of Gambier Bay Formation (Devonian)**
Greenstone semischist, with subordinate greenschist, talc schist, marble, sericite quartz semischist, and gray sericitic phyllite. Greenstone semischist retains relict primary structures, including vuggy volcaniclastic textures with marble lenses and clasts. Greenstones with igneous protoliths have relict augite, and clusters of euhehedral plagioclase. Metamorphic mineral assemblages include chlorite-epidote-calcite, quartz-muscovite-chlorite-albite, quartz-talc-calcite, quartz-albite-muscovite-chlorite. Tremolite, actinolite, and sodic amphibole have also been identified in some places. Associated with marbles with poorly preserved Devonian? corals. Unit description from source map: JU006.

**Pza - Amphibolite and schist (Paleozoic)**
Chiefly amphibolite and schist; some phyllite and minor gneiss, hornfels, and marble. Mainly amphibolite and greenschist-amphibolite transition-facies rocks. Unit description from source map: SK022.

**Dvs - Greenstone of Gambier Bay Formation (Devonian)**
Greenstone semischist, with subordinate greenschist, talc schist, marble, sericite quartz semischist, and gray sericitic phyllite. Medium-green actinolite schist. Greenstone semischist retains relict primary structures, including vuggy volcaniclastic textures with marble lenses and clasts. Greenstones with igneous protoliths have relict hornblende and augite, and clusters of euhehedral plagioclase. Immobile trace element chemistry plotted on the diagrams of Wood (1981) and Pearce (1982) indicate the metabasites have calc-alkaline and MORB compositions, and rare earth element/chondrite ratios range from depleted to slightly enriched at 100 times chondrite suggesting magmatic sources are arc-related (Karl, unpublished data). Metamorphic mineral assemblages include chlorite-epidote-calcite, quartz-muscovite-chlorite-albite, quartz-talc-calcite, quartz-albite-muscovite-chlorite. Tremolite, actinolite, and sodic amphibole have also been identified in some places. Unit also includes subordinate light tan to gray quartz-sericite semischist with quartz porphyroblasts and feldspar and sericite microlites and accessory pyrite. Discontinuous quartz segregations to 15 cm in thickness. Locally intercalated with up to 30% argillaceous marble and minor metachert. Locally contains gray pelitic schist and intervals of felsic schist to 3 m thick. Isoclinally folded. In Chilkat Mountains and Chilkat Lake area, includes amphibolite, greenschist, and greenstone. On Admiralty Island, includes subordinate black phyllite, graphitic metasiltstone, siliceous marble, metafelsite, and metacarbonate breccia. On Kupreanof Island, includes chlorite phyllite, schist, and semischist, graphitic schist, siliceous sericite schist, chloritic calc-schist, greenstone, marble, and meta-limestone. Pervasive isoclinally folded fabric; commonly crenulated, locally rodded. Unit description from source map: JU006.

**Dsv - Gambier Bay Formation (Devonian)**
In Chilkat Mountains, includes medium green actinolite schist to dark green garnet amphibolite. Discontinuous quartz segregations to 15 cm in thickness. Locally intercalated with up to 30% argillaceous marble and minor metachert. Locally contains gray pelitic schist and intervals of felsic schist to 3 m thick. Isoclinally folded. In Chilkat Lake area, includes amphibolite, greenschist, and greenstone. Includes subordinate black phyllite, graphitic metasiltstone, siliceous marble, metafelsite, and metacarbonate breccia. Unit description from source map: SK021.
Dgbm - Marble of the Gambier Bay Formation (Devonian)

Dark-gray to white, thin- to thick-bedded, fine- to medium-grained marble that is locally dolomitic, intercalated with greenstone and greenschist of the Gambier Bay Formation (S.M. Karl, unpub. data). On Admiralty Island, Lathram and others (1965) reported Middle Devonian(?) corals from the Gambier Bay Formation, but suggested that rocks older than Devonian may be included in the unit. On Kupreanof Island a possibly equivalent unit of schist and marble contains Silurian or Devonian crinoid, conodont, stromatoporoid, and rugose coral fossils, but age-diagnostic fossils suggested an age of Emsian (late Early Devonian) to Famennian (Late Devonian) (Karl and others, 1999). A Triassic age was inferred for this unit by Kelley (1990b), but the fossil of that age was most likely from the Triassic Hyd Group (unit Trhg). A probable correlation is with the limestone of map unit Dlse, which consists of the Wadleigh, Black Cap, and similar limestone units. On generalized map, included as part of unit Dgb. Description from source map: Geologic Map of Alaska.

Dgm - Marble of the Gambier Bay Formation (Devonian)

Light gray, argillaceous and schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (inferred metatuff protolith), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. The marbles are dominantly calcite but some also contain tremolite, phlogopite, epidote, talc and diopside. Calcite grains in marble contain deformed lamellae with sutured grain boundaries reflecting high pressure deformation. Minor interstitial quartz, albite, and tremolite grains. Contains poorly preserved amphibora and corals. In Chilkat Mountains in the Davidson and Rainbow glacier areas and southern Admiralty Island. Unit description from source map: JU006.

Dm - Marble (Devonian)

In Chilkat Mountains in Davidson and Rainbow glacier areas, includes light gray, very argillaceous schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (inferred metatuff protolith), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. Unit description from source map: SK021.

Dbcv - Volcanic rocks associated with Black Cap Limestone (Middle Devonian)

Gray-green to dark gray amygdaloidal andesitic volcanic rocks associated with the Black Cap Limestone in two small areas in the vicinity of Rendu and Muir Inlets (Brew, 1997). Description from source map: Glacier Bay Geologic Map.

Dcbv - Volcanic rocks associated with Black Cap Limestone (Middle Devonian)

Volcanic rocks associated with the Black Cap Limestone - andesitic - found in Muir and Chilkat Provinces (Brew, pers. comm., 1999). Unit description from source maps: MF003 and SK010.

DOgi - Syenite, trondhjemite and granite (Ordovician? to Early Devonian)

Exposed in southeast Alaska in three areas. On Chichagof Island in the Sitka quadrangle, the unit consists of a plutonic complex of trondhjemite and subordinate syenite, monzonite amd quartz monzonite. The trondhjemite is dominantly biotite trondhjemite and hornblende-biotite trondhjemite, but includes subordinate hornblende trondhjemite. Syenite is predominantly hornblende syenite, but includes subordinate sodalite syenite and sodalite-nepheline syenite. Also present on Chichagof Island is hornblende-bearing biotite monzonite, hornblende-bearing biotite syenodiorite, and biotite quartz monzonite (Loney and others, 1975). U/Pb TIMS-multigrain zircon dates range between 378 and 353 Ma (S.M. Karl, unpub. data), whereas existing K/Ar dates are significantly younger and discordant, at 121.9±5 and 253.1±10 Ma on biotite and hornblende, respectively (Lanphere and...
others, 1965). In the second area, in the Craig quadrangle, rocks mapped by Eberlein and others (1983) as Cretaceous diorite have yielded a 40Ar/39Ar age of 410 Ma (S.M. Karl, unpub. data) and are included here, presuming the age is a minimum age. In the Dixon Entrance quadrangle on southern Prince of Wales Island, leucocratic biotite ± aegirine ± arfvedsonite ± garnet syenite and subordinate leucodiorite yield a number of U/Pb TIMS-multigrain zircon upper intercept ages in the Ordovician (Gehrels and Saleeby, 1987). The plutons in the Craig and Dixon Entrance quadrangles are part of large igneous complex that consists of Ordovician granitic rocks (unit Ogi), the Bokan Mountain complex of Jurassic age (unit Jag), and these Early Devonian to possibly Ordovician plutons. Finally, in the Ketchikan and Prince Rupert quadrangles on Annette and Gravina Islands, rocks ranging from trondhjemite to granite to quartz diorite form another igneous complex (Loney and others, 1975; Berg and others, 1988; Karl, 1992; Brew, 1996) of Silurian age (Gehrels and others, 1987). Description from source map: Geologic Map of Alaska

Si - Intermediate composition intrusive rocks (Silurian)

Light- to medium -gray intrusive rocks are composed of plagioclase, quartz, minor to trace amounts of potassium feldspar, and variable amounts of biotite and hornblende. Tonalite, granodiorite, trondhjemite, and quartz diorite to diorite of various textures, commonly recrystallized, locally foliated, semischistose, or gneissic, and locally sheared. On Gravina Island, includes metagranodiorite with 65 per cent plagioclase and 30 per cent quartz; plagioclase is rimmed by albite (Berg, 1973). On Annette Island, the Annette pluton consists of metagranite, metatondhjemite, and metaquartz diorite that have ubiquitous cataclastic textures. On the Portland Peninsula, the Cape Fox pluton consists of metatondhjemite with mafic minerals altered to chlorite (Berg and others, 1988). Most outcrops of these bodies in southern southeast Alaska contain abundant metamorphic epidote and chlorite. Plagioclase is commonly altered to calcite and white mica. On southern Prince of Wales Island, the unit includes metaquartz diorite that also contains secondary epidote and massive, medium-to coarse-grained leucocratic diorite and subordinate monzodiorite and monzonite in Kassa Inlet area. One dated body cuts thrust faults at Shipwreck Point (Gehrels, 1992). A leucodiorite body that cuts thrust faults and deformational fabrics in Ordovician plutons in Kassa Inlet contains no quartz, less than 25 percent mafic minerals, and contains 1-6 mm long anhedral grains of arfvedsonite that locally contains cores of aegirine-augite, 4 mm in diameter grains of brown melanite (?) garnet, and euahedral titanite to 5 mm long, commonly intergrown with garnet and arfvedsonite, moderately zoned, tabular plagioclase grains to 7 mm long, interstitial microperthite, rare opaque minerals (Gehrels, 1992). In the Skagway quadrangle, the unit includes light to medium-gray, locally orthogneissic quartz diorite, composed of plagioclase, quartz, hornblende, and trace amounts of potassium feldspar. The unit locally contains metamorphic biotite, white mica, epidote, chlorite, calcite, quartz and rare garnet, apatite, and staurolite (MacKevett and others, 1974). The unit also locally contains pyrite or hematite, and is not magnetic. The quartz diorite is ubiquitously cataclastic and sheared at Mosquito Lake and on Four Winds Mountain. Unit description from source map: SK021.

SI - Limestone (upper Silurian)

Unit consists of limestone and marble representing the Willoughby Limestone, Tidal Formation limestone member, and Pyramid Peak Limestone, all of late Silurian age and defined by Rossman (1963). Willoughby is the stratigraphically lowest and consists of massive blue-gray to white limestone; bedding is difficult to discern and is “generally defined by slight differences in color rather than by variations in grain size” (Rossman, 1963, p. K11). It is fissilferous and the most distinctive fossil is a giant mollusk, Pycnodesma. Limestone member of the Tidal Formation constitutes about one quarter of the about 3,000 m thick, largely clastic unit, with the lowest limestone occurring about 1,670 m above the unit base. It is thin-bedded, light-gray and mostly lacks fossils, but the few reported are nondiagnostic Silurian or Devonian in age (Rossman, 1963). Pyramid Peak Limestone, stratigraphically the highest of these limestone units, overlies the Tidal Formation. It consists of light-colored thin- to moderately thick-bedded limestone that contains some argillaceous beds in its upper part. As no fossils are reported, its age is inferred from its position below the Rendu Formation (unit St) and Black Cap Limestone (unit Dbc). Description from source map: Glacier Bay Geologic Map.
Kch - Marble (Cretaceous)
Alexander Belt: Metamorphic Rocks in the Muir-Chichagof Plutonic Belt I and Chilkat-Prince of Wales Plutonic Province. Medium to coarse grained, white fresh, light gray weathering; original bedding and structures largely obliterated. Metamorphosed from adjacent limestone units. Unit description from source map: JU002.

Stal - Limestone (Late Silurian)
Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Point Augusta Formation: Thin to medium bedded light gray limestone and minor limestone turbidites. The limestone turbidites are probably interchannel and overbank deposits. The more massive limestones may represent slope facies deposits or carbonate banks like other carbonate units in the Glacier Bay sequence. Unit description from source map: JU002.

Stl - Limestone associated with Tidal formation (Silurian)
In Glacier Bay, includes thin to medium bedded light gray limestone and minor limestone turbidites; also limestone of the Tidal Formation of Rossman (1963). The limestone member of the Tidal Formation has a maximum thickness of 2,300 ft. (700 m.) , but is mostly less than 200 m thick (Rossman, 1963). The limestone turbidites are probably interchannel and overbank deposits. The more massive limestones may represent slope facies deposits or carbonate banks like other carbonate units in the Glacier Bay sequence. In Skagway quadrangle, includes 11-km long band of fine-grained, black to dark gray marble west of Takhin Glacier. Beds few cm to 10 m thick. Thin bands of light colored argillite up to 2 cm thick are common. On Chichagof Island, Limestone member of the Point Augusta Formation; dark gray, thin- to thick-bedded, medium-grained limestone, up to 100 m thick. On Kuiu and Prince of Wales Islands, includes limestone and limestone turbidites, thin- to medium- rhythmically bedded carbonateous light-gray limestone and limestone turbidites. These limestone turbidites are intercalated with Bay of Pillars graywackes, both as interbeds and as plastically deformed slump blocks. The limestone turbidites are interpreted as interchannel and overbank deposits, more massive limestones may represent slope facies deposits (Karl and Giffen, 1992). Unit description from source map: JU002.

Pzmm - Marble (Paleozoic)
Marble - derived from uncertain parent, found in Geikie and Muir Provinces (Brew, pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmb. Moderately folded / faulted. Unit description from source maps: MF003 and SK010.

Stl - Tidal Formation Limestone (Late Silurian)
Tidal Formation limestone - moderately folded / faulted, contains karst topography, found in Chilkat Province (Brew, pers. comm, 1999). Unit description from source map: MF003.

DScw - Willoughby limestone (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Carbonate Rocks- Interpreted to have formed as fringing reefs or carbonate banks in an island arc environment dominated by volcanic turbidites. Probably range in age and are not a single stratigraphic horizon. Massive, bluish gray to light gray limestone and marble; described and named by Rossman (1963); exposed north of Endicott River in Chilkat Mountains. Unit description from source map: JU002.

Sab - Massive limestone and algal boundstone (Early to Late Silurian)
In Chilkat Mountains and Glacier Bay includes the Willoughby Limestone, containing massive, bluish gray to light gray limestone and marble; also reefoid limestone with minor limestone breccia, mudstone, and polymictic conglomerate; described and named by Rossman (1963). Heceta Limestone on Prince of Wales Island named by Eberlein and Churchin (1970), is composed of massive limestone, mostly thick-bedded and sublithographic. Light to medium-dark gray, weathers light gray to buff. Bedding generally indistinct; richly fossiliferous, especially with corals, Dasycladacean algae, and brachiopods; contains intraformational limestone breccia. consists of light gray, massive,
sublithographic limestone, with abundant amphi-poroid corals, dasycladacean algae, oncoids, and brachiopods. Limestone also contains subordinate stromatoporoids, gastropods, pelecypods, bryozoans, trilobites, graptolites, conodonts, and aphrosalpingid sponges. Aphrosalpingid sponges form cores of stromatolithic mats. Skeletal wackestones, packstones, grainstones, and rudstones contain shelly faunas including corals and stromatoporoids in growth position (Soja, 1991). Algal, coralline, and microbial buildups are interpreted to represent platform margin reefs, with carbonate turbidites, debris flows, and slump deposits that accumulated in deeper water off the shelf margin (Soja, 1991). Bioherms range from 1 to 25 meters thick and 5 to 500 m wide (Soja, 1991). To the north, contains thick lenses of conglomerate and sandstone, with a variety of plutonic, volcanic, and sedimentary rock fragments. Contact with underlying Descon Formation is generally conformable, but limestone detritus resembling the Heceta in polymictic conglomerate that conformably underlies Heceta in several places indicates that carbonate sediments were deposited, lithified, and eroded in the Early Silurian prior to the main period of Heceta limestone deposition. Thickness varies widely due to pre-Karheen erosion but exceeds 3000 m on Heceta Island and thins eastward. Unit description from source maps: JU006, MF006, and MF014.

DSw - Willoughby Limestone (Late Silurian to Devonian)
Willoughby Limestone - contains karst topography, found in Chilkat Province (Brew, pers. comm., 1999). Unit description from source map: MF003.

DScp - Pyramid Peak Limestone (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Carbonate Rocks- Interpreted to have formed as fringing reefs or carbonate banks in an island arc environment dominated by volcanic turbidites. Probably range in age and are not a single stratigraphic horizon. Light gray, very thin to thick bedded nonfossiliferous limestone with some interbedded argillite near the top; lower part is thin bedded dark gray to black limestone; described and named by Rossman (1963); exposed south of Adams Inlet, Glacier Bay. Unit description from source map: JU002.

DSck - Kennel Creek limestone (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Carbonate Rocks- Interpreted to have formed as fringing reefs or carbonate banks in an island arc environment dominated by volcanic turbidites. Probably range in age and are not a single stratigraphic horizon. Light to medium gray, thin to very thick bedded limestone; minor dolomite, limestone breccia, shale, siltstone, and conglomerate; described and named by Loney and others (1963); the name extended by Loney and others (1975); exposed on northeastern Chichagof Island. Unit description from source map: JU002.

DSbl - Limestone associated with greenstone and greenschist (Devonian and (or) Silurian)

DSP? - Pyramid Peak Limestone? (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Volcanic and Associated Rocks. Limestone probably correlates with Pyramid Peak Limestone. Unit description from source map: JU002.

DSld - Limestone and dolostone (Early Devonian to Silurian)
In Glacier Bay includes Pyramid Peak Formation, consisting of light gray, very thin to thick bedded nonfossiliferous limestone with some interbedded argillite near the top; lower part is thin bedded dark gray to black limestone; described and named by Rossman (1963). South of the Tsirku River in the Skagway quadrangle, includes thin-bedded nonfossiliferous limestone and marble that overlies Silurian greywacke turbidites and underlies argillaceous limestone turbidites. In the Juneau quadrangle, includes the Kennel Creek Limestone includes gray, thin- to very thick-bedded limestone with few beds of dolostone and limestone breccia, minor shale and siltstone, and rare polymictic conglomerate described and named by Loney and others (1963); the name extended by Loney and others (1975). In Sitka quadrangle, includes gray, thin to thick-bedded limestone, with dolostone, limestone breccia, with minor shale, siltstone, and polymictic conglomerate in the lower part, and thin tuffaceous partings
in the upper part of the Kennel Creek Formation. Total unit thickness as much as 1600 meters. Unit includes marble where it is adjacent to younger plutons. On Kuiu Island limestone is massive, poorly bedded, dense, stylolitic, brownish-gray weathering with associated sedimentary breccia and polymictic conglomerate (Muffler, 1967). Associated limestone breccia with dolomitic + pyrite cement or interstitial red siltstone is inferred to represent paleokarstic textures. Approximately 800 m thick. The Pyramid Peak Formation is unfossiliferous, but overlies the Tidal Formation (Rossman, 1963), so occupies a similar stratigraphic position to the Kennel Creek Limestone, which overlies the tidal-correlative Point Augusta Formation. Kennel Creek Limestone contains amphipora, pycnidesma, Silurian corals, and Silurian and Early Devonian conodonts (Loney and others, 1963; 1975; Karl, 1999.) The Kuiu limestone contains Late Silurian megafossils, and Late Silurian to middle Early Devonian conodonts including Panderodus sp., (A.G. Harris in www.alaskafoossil.org). Limestone contains late Middle to Late Silurian ?Parachaetetes sp. algae, ?Striatopora tabulate corals, Microplasma sp., Entophyllum, and Zelophyllum sp. rugose corals, and brachiopods Conchidium alaskense Kirk and Amsden, Lissatrypa sp., Faardenia, sp., Obturamentella sp., and ?Coelospira sp. (C.W. Merriam in Muffler, 1967). Kuiu Limestone also contains Ludlovian to Pragian (Late Silurian to Early Devonian) Idiostroma? and Amphipora stromatoporoids, Cladopora tabulate corals, and Microplasma? sp., Holmophyllia? sp., Neostringophyllum sp., and Tryplasma sp.cf. T. pachyctem rugose corals (W.A. Oliver, Jr., in www.alaskafoossil.org). Megafossils from the Keku Islands area include stromatoporoids and corals Syringopora sp., Halyrites sp., Heliolites sp., Favosites sp., Cystiphyllum sp., Phaulactis sp., Zelophyllum sp., Petrozium cf. P. dewsari, and cephalopods Huroniella cf. H. inflect a Parks, of Silurian age, as old as early Wenlock and as young as Ludlovian (C.W. Merriam in Muffler, 1967). Another locality in the Keku Islands yielded ?Striatopora sp., Zelophyllum sp., Entophyllum sp., Faardenia sp., Obturamentella sp., ?Coelospira sp., and abundant Lissatrypa sp. brachiopods indicating a late Wenlock or early Ludlow age (C.W. Merriam, in Muffler, 1967). Unit description from source map: JU006.

DSI - Limestones associated with Rendu and Tidal Formations (Late Silurian to Devonian)

DSp - Pyramid Peak Formation limestone (Late Silurian to Devonian)
Pyramid Peak Formation limestone - composed of fine-grained clastics and limestone. Found in Geikie Province and Chilkat Province (Brew, 1999, pers. comm.). Unit description from source map: MF003.

DSpn - Marble from Pyramid Peak Formation (Paleozoic to Cretaceous (?))
Marble from Pyramid Peak Formation. Moderately folded / faulted, contains karst topography. May also be derived from Willoughby limestone - found in Geikie Province and Muir Province (Brew, pers. comm., 1999). Unit description from source map: MF003 and SK010.

DSbl - Berg Mountain Formation Limestone (with volcanics ) (Late Silurian to Devonian)
Berg Mountain Formation Limestone - moderately folded / faulted, contains karst topography. Associated with greenstone and greenschist volcanics, found in Muir Province and Chilkat Province (Brew, 1999, pers. comm.). Unit description from source map: SK010.

St - Clastic sedimentary rocks (upper Silurian)
Unit includes Tidal, Point Augusta, and Rendu Formations. Tidal Formation, defined by Rossman (1963) at Tidal Inlet, consists of primarily of well-indurated fine-grained argillite about 3,000 m thick and underlies the Pyramid Peak Limestone, which is included in unit SI here. A limestone member of the Tidal Formation is also included in unit SI here. Point Augusta Formation, extended into GLBA by Brew and Ford (1985), consists of grayish brown to gray, graywacke, mudstone, and calcareous mudstone. Graywacke typically grades to mudstone in rhythmic thin- to medium-bedded turbidites, and locally forms thicker and amalgamated sandstone beds, which commonly show soft sediment
deformation. Turbidite beds in this unit commonly have laminar, cross-bedded, graded, and load cast structures typical of full and partial Bouma sequences (Muffler, 1967; Karl and Giffen, 1992). Calcareous graywacke is dominant rock type; it contains carbonate clasts, fossil fragments, subordinate feldspar, quartz, and volcanic rock fragments, and has a patchy recrystallized carbonate matrix (Brew and Ford, 1985). Stratigraphic relationship of this unit with the Pyramid Peak Limestone is not reported. Rendu Formation, defined by Rossman (1963) at Rendu Inlet in the northern part of the Park, was described as argillaceous and calcareous sedimentary rocks; it is mainly thin-bedded limestone and argillite. Some argillaceous strata are limey, and some limestone strata contain argillaceous material. Rendu gradationally overlies Pyramid Peak Limestone and apparently unconformably underlies Black Cap Limestone (unit Dbc). Unit forms much of the eastern part of GLBA and is also exposed on the west side of Glacier Bay, east of the Tarr Inlet Suture zone and in the north central part of the Park north of Muir Inlet. Poorly preserved Early Jurassic radiolarians (C.D. Blome, written commun., 1996), were reported by D.A. Brew, written commun., 2004), in argillite and chert overlying this unit just east of GLBA in the northwestern Juneau quadrangle, are unique in southeast Alaska. Description from source map: [Glacier Bay Geologic Map](#).

**Kth - Biotite-quartz-feldspar hornfels (Cretaceous)**
Alexander Belt: Metamorphic Rocks in the Muir-Chichagof Plutonic Belt I and Chilkat-Prince of Wales Plutonic Province: Fine to medium grained, brownish gray; original sedimentary structures and bedding of graywacke and mudstone turbidite sequence locally preserved; metamorphosed from graywacke and mudstone of adjacent units. Unit description from source map: JU002.

**Stag - Graywacke, mudstone, turbidites, and limestone (Late Silurian)**
Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Point Augusta Formation: Grayish brown to gray fresh, tan to gray weathering graywacke, mudstone and calcareous mudstone; graywackes typically very thin to medium bedded, with some thicker and amalgamated beds. Soft sediment deformation is common. The dominant rock type is calcareous graywacke with carbonate clasts, fossil fragments, subordinate feldspar, quartz, and volcanic rock fragments, and patchy recrystallized carbonate matrix. Unit description from source map: JU002.

**Stg - Graywacke and calcareous wacke turbidites (Silurian)**
Thin bedded calcareous argillite, limestone, calcareous graywacke turbidites, and graywacke matrix conglomerate. The graywacke contains chert, volcanic rock fragments, feldspar, monocrystalline quartz, rare polycrystalline quartz, detrital epidote, white mica, biotite, chlorite, and amphibole. The graywacke is similar to, but generally contains more monocrystalline quartz than, the calcareous volcaniclastic graywacke of the Point Augusta and Bay of Pillars Formations (Karl and Giffen, 1992). The base of the unit is not exposed. The graywacke turbidites are gradationally over lain by limestone turbidites, bedded limestone, and reef breccia of Carroll Island. Unit thickness is not known, but exposures in the area between Murder Cove and Carroll Island suggest a thickness greater than 1500 meters. Unit description from source maps: JU006 and MF006.

**Pzmh - Biotite-quartz-feldspar hornfels, schist, and semischist (Paleozoic)**
Biotite-quartz-feldspar hornfels, schist, and semischist - moderately folded / faulted, found in Muir and Geikie Provinces (Brew, pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmh. Unit description from source maps: MF003 and SK010.

**Sag - Point Augusta Formation graywacke and argillite (Late Silurian)**
Point Augusta Formation graywacke and argillite - medium-grained clastic, moderately folded / faulted, found in Muir and Chilkat Provinces (Brew, pers. comm., 1999). Unit description from source map: MF003 and SK010.

**Stg - Tidal Formation (Late Silurian)**
Tidal Formation - medium-grained clastics, mudstone / siltstone, graywacke. Moderately folded / faulted, found in Chilkat Province (Brew, pers. comm., 1999). Unit description from source map:
**Pzh - Hornfels (Paleozoic)**
Intensely folded interlayered hornfels, schist, and amphibolite. These rocks probably were mainly derived from the slate, graywacke, and limestone of the Point Augusta Formation. The abundant hornfels and amphibolite were possibly derived from volcanic flows and sediments of the Freshwater Bay Formation. Possible contact metamorphosed equivalents
(S.M. Karl: Abundant thinly layered calc-silicate hornfels, calcareous granofels, and marble. Probably derived from sedimentary and volcanic rocks of Silurian, Devonian, and possibly Mississippian age). Unit description from source map: MF004.

**Stg - Graywacke and calcareous wacke turbidites (Silurian)**
In Glacier Bay, Rendu and Tidal Formations include thin bedded argillite, limestone, and limy mudstone; carbonates and fine-grained clastics, graywacke, described and named by Rossman (1963); exposed south of Adams Inlet. In Chilkat Mountains and Chichagof Island, includes Point Augusta Formation, containing grayish brown to gray fresh, tan to gray weathering graywacke, mudstone and calcareous mudstone; graywackes typically very thin to medium bedded, with some thicker and amalgamated beds. Soft sediment deformation is common. The dominant rock type is calcareous graywacke with carbonate clasts, fossil fragments, subordinate feldspar, quartz, and volcanic rock fragments, and patchy recrystallized carbonate matrix. Interbedded gray graywacke, calcareous wacke and dark gray argillite; massive conglomeritic debris flows, massive amalgamated sandstone beds, and turbidites consisting of graded beds with full Bouma sequences, and ungraded rhythmic beds with sharp contacts; isolated beds of thin-bedded, light gray, medium-grained limestone intercalated with argillite and graywacke. On southern Admiralty Island, unit includes gray calcareous graywacke and argillite turbidites with interbedded limestone. Graywacke beds commonly grade up to limestone tops. The graywacke contains chert, volcanic rock fragments, feldspar, monocrystalline quartz, rare polycrystalline quartz, detrital epidote, white mica, biotite, chlorite, and amphibole. On Kuiu and Prince of Wales Islands, includes Bay of Pillars Formation graywacke, mudstone, turbidites, and limestone - buff, green, or gray, tan to maroon weathering graywacke, mudstone and calcareous mudstone; graywackes typically medium- to thick-bedded or massive, with amalgamated beds as well as full Bouma sequences (Muffler, 1967). Unit description from source map: MF014.

**Stg - Point Augusta Formation (Silurian)**
Thin bedded calcareous argillite, limestone, calcareous graywacke turbidites, and graywacke matrix conglomerate. The graywacke contains chert, volcanic rock fragments, feldspar, monocrystalline quartz, rare polycrystalline quartz, detrital epidote, white mica, biotite, chlorite, and amphibole. The graywacke is similar to, but generally contains more monocrystalline quartz than, the calcareous volcaniclastic graywacke of the Point Augusta and Bay of Pillars Formations (Karl and Giffen, 1992). The base of the unit is not exposed. The graywacke turbidites are gradationally overlain by limestone turbidites, bedded limestone, and reef breccia of Carroll Island. Unit thickness is not known, but exposures in the area between Murder Cove and Carroll Island suggest a thickness greater than 1500 meters. There are no fossils from this unit, but it underlies the limestone of Carroll Island that contains Devonian-Silurian corals and Late Devonian conodonts. The graywacke may correlate with similar calcareous graywacke of the Rendu, Tidal, Point Augusta and Bay of Pillars Formations of Glacier Bay area, Chichagof Island, and Kuiu Island, respectively. The Point Augusta and Bay of Pillars Formations contain Silurian graptolites. Graptolites from the Bay of Pillars Formation include Monograptus sp. cf. M. dubius and Monograptus sp. cf. M. vulgaris, late Llandovery to early Ludlovian in age; Monograptus sp. similar to M. micropoma micropoma, Silurian, possibly early Ludlovian in age; and M. nilssonii, early Ludlovian in age (W.B.N. Berry, written communication in Muffler, 1967). Unit description from source map: SK021.

**Staa - Argillite and graywacke (Late Silurian)**
Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Point Augusta Formation: Described by Lathram and others (1959) as: "Argillite- Dark gray, siliceous, weathers dark brownish
red, contains large lenses of pebble to cobble conglomerate and layers of gray green graywacke in lower part. Includes thin bedded black, gray, and dark green chert near top. At least 3,000 feet thick. Unit description from source map: JU002.

**Jac - Argillite and chert (Early Jurassic)**
Dark gray siliceous argillite and dark gray, bedded chert, white-weathering medium-gray and green chert associated with subordinate evenly bedded (10-20 cm) lithic sandstone and dark gray limestone. Chert beds are 2-6 cm thick in sections are as much as 30 m in thickness, total thickness of the section is estimated to be a few hundred meters (Brew and Plafker, Glacier Bay map, in review). Argillite and chert section overlies argillite and graywacke of the Silurian Point Augusta Formation in apparent unconformity in the Chilkat Mountains. Unit description from source map: JU010.

**DSr - Rendu Formation (Devonian to (or) Silurian)**
Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Thin bedded argillite, limestone, and limy mudstone; described and named by Rossman (1963); exposed south of Adams Inlet, Glacier Bay. Unit description from source map: JU002.

**DSal - Calcareous mudstone, wacke, and limestone (Devonian and Silurian)**
Light tan to gray, thin to medium bedded, calcareous mudstone and siltstone turbidites, with subordinate green and tan calcareous graywacke turbidites, siliceous turbidites, and limestone. In Glacier Bay area, includes thin-bedded argillaceous and calcareous sedimentary rocks of the Rendu Formation, named by Rossman, (1963), which overlies the Pyramid Peak Formation. Rendu contains more limestone than the Tidal Formation, and is locally silicified to cherty brown, red, yellow, green, blue, black, and white ‘hornstone’ (Rossman, 1963). South of Tsirku River, unit includes white, gray, and black siliceous argillite interbedded with light gray to black marble, locally with alternating bands of argillite and marble, 1 mm to 10 cm thick, locally crossbedded, and light gray, very argillaceous schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (metatuff), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. Thin-bedded, fine-grained, rhythmically bedded, purple and tan marble. Gray and black marble also common, with argillite and greenstone locally present. Also includes 11-km long band of fine-grained, black to dark gray marble west of Takhin Glacier, consisting of limestone beds a few cm to 10 m in thickness, with thin bands of light colored argillite up to 2 cm in thickness, alternating with carbonate bands 1 mm to 10 cm thick. Marble locally retains primary crossbedding. On southern Admiralty Island, unit includes calcareous turbidites, transitional between Silurian turbidites and Upper Devonian limestones at Carroll Island. On Prince of Wales Island, unit includes the Staney Creek Formation of Eberlein and others (1983), consisting of light gray to pale yellow and pink laminated limestone, buff, light gray or tan mudstone, and gray, green, and tan calcareous sandstone. Locally includes fossiliferous limestone, forming meter-scale bioherms that are laterally and vertically gradational to thin-bedded brown calcareous, locally fossiliferous mudstone and green, rhythmically bedded fossiliferous volcaniclastic sandstone that has turbidite structures. Limestone contains brachiopods, corals, gastropods, dasycladacean algae. Subordinate clast-supported and matrix-supported conglomerate contain rounded clasts of dominantly intermediate volcanic rocks, with a few percent each of limestone, brown chert, green chert, and intermediate to mafic intrusive rocks. Only the limestone clasts are angular; some limestone clasts show soft-sediment deformation. In some places there are cm to m scale. Unit description from source map: JU006.

**DSr - Rendu Formation (Devonian to Late Silurian)**
Rendu Formation - composed of fine-grained clastic material. Moderately folded / faulted. Found in Chilkat and Geikie Provinces (Brew, pers. comm., 1999). Unit description from source map: MF003 and SK010.
DSrt - Rendu and Tidal Formation rocks (Late Silurian to Devonian)

Pzmb - Banded marble (Paleozoic)
Thin-bedded, fine-grained, rhythmically bedded, purple and tan marble. Gray and black marble also common, with argillite and greenstone locally present. Unit description from source map: SK004.

DSal - Calcareous, mudstone, wacke, and limestone turbidites (Devonian and Silurian)
Light tan to gray, thin to medium bedded, calcareous mudstone and siltstone turbidites, with subordinate graywacke turbidites, siliceous turbidites, and limestone. In Glacier Bay area, includes thin-bedded argillaceous and calcareous sedimentary rocks of the Rendu Formation, named by Rossman, (1963), which overlies the Pyramid Peak Formation. Rendu contains more limestone than the Tidal Formation, and is locally silicified to cherty brown, red, yellow, green, blue, black, and white 'hornstone' (Rossman, 1963). In Skagway quad, south of Tsirku River, white, gray, and black siliceous argillite interbedded with light gray to black marble, locally with alternating bands of argillite and marble, 1 mm to 10 cm thick. Marble locally crossbedded, up to 6 m thick. Light gray, very argillaceous schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (metatuff), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. Lacks schist in Tsirku River area. Thin-bedded, fine-grained, rhythmically bedded, purple and tan marble. Gray and black marble also common, with argillite and greenstone locally present. Also includes 11-km long band of fine-grained, black to dark gray marble west of Takhin Glacier. Beds few cm to 10 m thick. Thin bands of light colored argillite up to 2 cm thick are common. Alternating bands 1 mm to 10 cm thick. Marble locally crossbedded, beds up to 6 m thick. Unit description from source map: SK021.

Sv - Volcanic rocks (Silurian)
Dark green, weakly metamorphosed basalt and subordinate white, green, and lavender chert and minor basaltic agglomerate, chert breccia, graywacke, argillite, and limestone (Gilbert, 1988). Basalt commonly displays pillow structures. Includes volcanic rocks associated with the Point Augusta Rendu, and Tidal Formations and mapped as part of the informal Berg Mountain formation of Brew (1997). It is most common east of Adams Inlet, but has smaller exposures in the vicinity of Geikie Inlet. Description from source map: Glacier Bay Geologic Map.

DSbv - Greenstone and greenschist (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Volcanic and Associated Rocks. Described by Lathram and others (1959) as part of their "Siliceous argillite and volcanic rocks" unit: "Basalt and andesite flows, agglomerates, and tuff, increase in abundance laterally and predominate in north central Chilkat Range;" and west of Casement Glacier, Glacier Bay. Unit description from source map: JU002.

DSbb - Basal graywacke and volcanic rock unit (Devonian and (or) Silurian)
Alexander Belt: Glacier Bay Sequence: Volcanic and Associated Rocks: Poorly documented basal conglomerate part of the thick volcanic pile; exposed only in central part of Chilkat Mountains. Unit description from source map: JU002.

DSv - Volcanic and sedimentary rocks, undivided (Devonian and Silurian)
Dark green basalt (60-70%) and white, green, and lavender chert (20-30%), with minor amounts of basaltic agglomerate, chert breccia, graywacke, argillite, and limestone in Tsirku River area of Skagway quadrangle (Gilbert, 1988). Basalt is weakly metamorphosed and commonly displays pillow structures. In Skagway quadrangle, dark green basalt (60-70%) and white, green, and lavender chert (20-30%), with minor amounts of basaltic agglomerate and chert breccia. Basalt is weakly metamorphosed and commonly displays pillow structures. Unit description from source map: JU006.
DSv - Mafic volcanic rocks associated with Rendu and Tidal Formations (Late Silurian to Devonian)
Unnamed mafic volcanic rocks associated with Rendu and Tidal Formations - andesitic - moderately folded / faulted, found in Chilkat and Muir Provinces (Brew, pers. comm., 1999). Unit description from source map: MF003.

Pzmv - Greenstone and greenschist (Paleozoic)
Greenstone and greenschist - moderately folded / faulted, found in Geikie Province (Brew, pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmv. Unit description from source map: MF003.

DSbv - Volcanics at Berg Mountain (Early Silurian to Devonian)
Volcanics at Berg Mountain - Berg Mountain Formation greenstone and greenschist, found in Chilkat Province and Muir Province (Brew, 1999, pers. comm.). Moderately folded / faulted. Unit description from source map: SK010.

SZfw - Four Winds complex of Gilbert and others (1987) and similar rocks (Neoproterozoic to Silurian)
Consists of a variety of rocks, including interbedded black phyllite, mafic and felsic schist, metachert and medium-gray marble, amphibolite, greenschist, and greenstone; also includes sheared metabasalt and orthogneiss along the west side of Chilkat Inlet and the Chilkat River. Gilbert and others (1987) divided these rocks into four informal units that consist of intercalated metasedimentary and metavolcanic rocks, metabasite, metavolcanic rocks, and gneiss. For partially contiguous rocks to the south in the Skagway quadrangle, Redman and others (1985) used the informal term Cheetdeakahyu group. According to Gilbert and others (1987), metamorphic grade of the Four Winds complex increases to the northeast from greenschist to amphibolite facies. Gilbert and others (1987) suggested that the Four Winds complex is overlain by Mississippian to Devonian age rocks, and hence assigned a pre-Devonian age. Karl and others (2006) report a U/Pb TIMS age of 455±5 Ma from zircon in a metamorphosed (?) felsic dike within the complex on Mount Cheetdeakahyu. They also dated a xenocrystic zircon from the dike that yielded a concordant age of 544±9 Ma, which is similar to the age of orthogneiss that intrudes the Retreat Group at False Point Retreat on Admiralty Island, as well as other orthogneiss bodies that intrude schist of the Wales Group on Prince of Wales Island. Description from source map: Geologic Map of Alaska.

Pzn - Gneiss (Paleozoic)
Foliated granodioritic orthogneiss. Unit description from source map: SK006.

St - Tonalite, quartz diorite, and trondjhemite (Silurian)
Light gray granodiorite composed of plagioclase, quartz, and minor to trace amounts of biotite, hornblende and potassium feldspar. On Gravina Island, includes metagranodiorite with 65 per cent plagioclase and 30 per cent quartz; plagioclase is rimmed by albite (Berg, 1973). Annette pluton consists of metagranite, metatondhjemite, and metaquartz diorite with ubiquitous cataclastic textures on Annette Island. On Portland Peninsula, Cape Fox pluton consists of metatondhjemite with mafic minerals altered to chlorite Berg and others, 1988). Most outcrops contain abundant metamorphic epidote. Contains secondary chlorite and epidote. Extensive recrystallization has reduced almost all the primary biotite to chlorite. Plagioclase is altered to calcite and white mica On southern Prince of Wales Island, unit includes metaquartz diorite with secondary epidote. On southwestern Prince of Wales Island, includes massive, medium-to coarse-grained leucocratic diorite and subordinate monzodiorite and monzonite in Kassa Inlet area. Unit cuts Shipwreck Point thrust faults (Gehrels, 1992). Diorite contains no quartz, Cl less than 25, and contains 1-6 mm long anhedral grains of arfvedsonite that locally contains cores of aegirine-augite, 4 mm in diameter grains of brown melanite (?) garnet, and euahedral sphen to 5 mm long, commonly intergrown with garnet and arfvedsonite, moderately zoned, tabular plagioclase grains to 7 mm long, interstitial microperthite, rare opaque minerals (Gehrels, 1992). Unit description from source map: SK021.
**Pzsp - Schist and phyllite (Paleozoic)**  
Alexander Belt: Glacier Bay Sequence: Described by Lathram and others (1959) as: "Schist, phyllite, and slate- Reddish brown weathering chlorite schist, sericite schist, phyllite, and black slate. Upper 200 to 300 feet medium dark gray weathering slate and phyllite, thin limestone layers near top. Unfossiliferous." May be metamorphosed equivalent of the Argillite and Graywacke unit (Staa) described above. Unit description from source map: JU002.

**Stag - Graywacke, mudstone, turbidites, and limestone (Late Silurian)**  
Alexander Belt: Glacier Bay Sequence: Turbidites and Associated Rocks- Interpreted to be the dominant feature of a long lived island arc environment. The limestones that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Point Augusta Formation: Grayish brown to gray fresh, tan to gray weathering graywacke, mudstone and calcareous mudstone; graywackes typically very thin to medium bedded, with some thicker and amalgamated beds. Soft sediment deformation is common. The dominant rock type is calcareous graywacke with carbonate clasts, fossil fragments, subordinate feldspar, quartz, and volcanic rock fragments, and patchy recrystallized carbonate matrix. Unit description from source map: JU006.

**Pzp - Cheetdeekahyu phyllite (Paleozoic)**  
Chlorite-feldspar schist, chlorite phyllite, and slate. Unit description from source map: SK004.

**Pzsh - Gneiss, amphibolite and schist (Paleozoic)**  

**Pzsv - Intercalated metasedimentary and metavolcanic rocks of the Four Winds Complex (Paleozoic)**  
Interbedded black phyllite, felsic schist, metachert, and medium gray marble. Unit description from source map: SK005.

**Pzsv - Metasedimentary and metavolcanic rocks (Paleozoic)**  
Biotite-quartz schist, actinolite greenschist, graphitic schist, felsic schist, feldspathic quartz gneiss, calc-schist, and impure marble. Unit description from source map: SK006.

**Pzsv - Metavolcanic and metasedimentary rocks (Paleozoic)**  
Variable assemblage of schistose metavolcaniclastic rock, dark gray slate, metabasite, and marble. Locally contains minor amounts of gneiss, felsic schist, or chert. Unit description from source map: SK007.

**Pzam - Argillaceous marble (Paleozoic)**  
Light gray, very argillaceous schistose marble, and buff weathering, tan calc-schist and calc-phyllite. Commonly contains quartz segregations up to 15 cm thick. Contains minor intervals of muscovite schist (metatuff), and metabasite, argillaceous marble, and black phyllite, in intervals up to 3 m thick. Unit description from source map: SK007.

**Pzmm - Marble (Paleozoic)**  
Use SEAK compilation description, but correlates with Admiralty Island Pzmm. Description will be more detailed in the future. Folded white marble. 3-15 m-thick beds. Light to medium gray marble. Commonly laminated, locally massive. On Admiralty Island, Bedded or massive, coarse-grained, light gray marble. Contains orthopyroxene and forsterite, and in one locality, molybdenite. South of Greens Creek, associated with Pzgs on Admiralty Island. Unit description from source map: SK021.

**Pzcs - Calcareous mica schists (Paleozoic)**  
Light to dark, green and gray, mixed calcareous chlorite-epidote-albite schists and semischists, white to light gray sericitic quartzite, green chlorite schist, pale yellow felsic schist, dark gray graphitic schist, and subordinate micaceous marble. Unit description from source map: SK021.
PzZc - Marble of Four Winds Mountain (Paleozoic and Proterozoic)
North of Klehini River, includes dark gray argillaceous marble, with interbeds of massive gray marble. Poorly preserved fossil forms. Interlayered with Pzsh of Cheeteekahyu Group. On northern Admiralty Island includes marble, limestone and minor shale; weathers light to medium gray, light gray fresh; poorly bedded at 10-50 cm scale in a few places; most is fine to medium grained and most is recrystallized. On Prince of Wales Island, includes medium to light gray, thin bedded sericitic marble with algal laminaions, medium bedded marble with intercalated greenschist and greenstone, and massive marble, locally dolomitic, up to 300 m thick. Thin marble beds are interbedded with the Wales Group throughout the map area. Most of the marble is very light- to medium-grain, fine-grained crystalline rock. In some areas it has thin color or compositional bands parallel to bedding. Elsewhere it is massive with no hint of bedding. Minor folds within marble beds are common. In some areas, marble is gradational to medium-grain fine-grained marble that contains dolomitic nodules and abundant crosscutting calcite veinlets. Solution pits up to 30 m in diameter and 10 m deep are common. Dolomitic marble forms thick, planar, fine-grained, medium- to light-gray beds that stand out in relief above the interlayered marble. Near the contact with Wales Group greenschist, tabular dolomite bodies in the marble have been deformed into boudins 10 to 30 m long and up to 10 m thick. Usually, irregular, folded dolomite bodies have marble beds draped around them, suggesting deformation of the rocks after deposition of the dolomite. On the north shore of Divide Head, dolomite in marble forms thin partings parallel to bedding and small subangular lumps several cm across. In a few places, there are many dolomite veinlets crosscutting the marble. At Lime Point there is a significant barite deposit in this marble. Unit also includes thin-beded, medium- to dark-gray, fine- to medium-grained limestone, interbanded with dark gray slaty phyllite, crenulated greenish-gray phyllite, and greenish-gray graywacke. Macroscopic folds are locally abundant. Similar to Wales Group in Prince of Wales. Unit description from source map: SK021.

PzZsv - Metasedimentary and metaigneous rocks of Four Winds Mountain, undivided (Paleozoic and Proterozoic)
Heterogenous unit consisting of greenish- to dark-gray phyllite, greenish-gray, limy, sericitic tuffaceous schist with twinned albite crystals, and marble. North of Klehini River includes biotite-quartz schist, actinolite grenschist, graphitic schist, felsic schist, feldspathic quartz gneiss, calc-schist, and impure marble. On Prince of Wales Island, includes intercalated metabasite, metagfelsite, metaclastic rocks, marble, and phyllite of the Wales Group. Greenschist to amphibolite facies metavolcanic and metasedimentary rocks. Complex assemblage of predominantly andesitic to basaltic marine fragmental volcanic rocks and flows, graywacke, mudstone, and shale, with locally interlayered marble regionally deformed and metamorphosed to greenschist and locally amphibolite facies. The most abundant and widely distributed lithology is greenish-gray, thinly foliated, commonly crenulated albite-epidote ± quartz ± actinolite schist that is compositionally layered parallel to schistosity, probably derived from tuffaceous mudstone, siltstone, and graywacke. Transitions to quartz-sericite schist associated with quartz-albite metakeratophyre up to 3 m thick are common. Metakeratophyre typically contains rounded blue quartz eyes and phenocrysts or glomeroporphyrithic clots of twinned albite set in a chert-like microscopic groundmass of quartz and albite. Chemically the rock is silica and soda-rich. These rocks are most abundant in Hetta Inlet, and around Eek Point where they are in fault contact with SOs. Light to dark green, fine-grained greenschist and greenstone. Pillows and cm-scale pyroclastic fragments are locally preserved. Metasedimentary rocks locally show relict rhythmic layering, graded bedding, and crossbedding. Protolith features are mostly obscured by metamorphic recrystallization, penetrative foliation, high degree of flattening, and moderate elongation. Metagraywacke protolith is inferred for rocks with 10- to 50-cm layering. Unit also includes subordinate black phyllite and schist, meter-thick layers of silicic metavolcanic rocks, and light-colored, coarsely recrystallized marble. Metamorphic mineral assemblage includes chlorite, actinolite, albite, epidote, and opaque minerals, greenschist facies, increasing eastward to amphibolite facies with brown biotite, hornblende, plagioclase, and almandine garnet. Rocks on southern Dall Island are amphibolite facies and include hornblende schist. Penetrative foliation parallel to compositional layering and flattening of protolith features. Most rocks also have a strong linear fabric defined by elongation of protolith features and strong mineral elongation on foliation surfaces. Isoclinal folds have axes parallel to mineral elongation. Superimposed on metamorphic foliation and lineation are several sets of folds that do not have axial planar foliation. Asymmetric ‘s’ and ‘z’ folds with shallow-plunging,
northeast-trending axes are common, with wavelengths of tens to hundreds of meters. Unit is folded, crenulated, and lineated (preferred orientation of minerals such as actinolite), with quartz and carbonate boudins up to 5 m thick and 20 m long. Quartz segregation layers parallel and crosscut the foliation, and are concentrated in the crestal regions of folds. There is evidence for at least 2, and as many as 4 deformation events in these rocks. Unit believed to be at least several thousand meters thick. K/Ar hornblende age of 483 Ma (Turner and others, 1977) suggests deformation and metamorphism prior to the end of Early Ordovician. Available constraints indicate that rocks in the Wales Group were deposited prior to Late Cambrian time and regionally metamorphosed and deformed during Middle Cambrian to Early Ordovician time. Corresponds to Wales Group on Prince of Wales. Unit description from source map: SK021.

**Pzs - Chlorite-biotite schist and phyllite (Paleozoic)**

**Pzmg - Garnet-hornblende (-quartz-feldspar) gneiss (Paleozoic)**
Garnet-hornblende (-quartz-feldspar) gneiss found in Geikie and Muir Provinces (Brew, pers. comm., 1999, MGI map of Glacier Bay National Park). Brew renames this unit Kmgb and Kmg. Moderately folded / faulted. Unit description from source map: MF003.

**Pzmb - Metabasite (Paleozoic)**
Amphibolite, greenschist, and greenstone. Includes subordinate black phyllite, graphitic metasiltstone, siliceous marble, metasiltite, and metavolcanic breccia. Four Winds Mountain. Unit description from source map: SK005.

**Pzmv - Metavolcanic rocks (Paleozoic)**
Mafic and felsic schist, black phyllite, and calc schist. Four Winds Mountain. Unit description from source map: SK005.

**Pzv - Metavolcanic rocks (Paleozoic)**
Medium green actinolite schist to dark green garnet amphibolite. Discontinuous quartz segregations to 15 cm. Locally intercalated with up to 30% argillaceous marble. Locally contains gray pelitic schist and intervals of felsic schist to 3 m thick. Isoclinally folded. Unit description from source map: SK007.

**Pzgs - Greenstone (Paleozoic)**
Greenstone retains primary textures. Unit description from source map: SK021.

**PzZa - Amphibolite of Four Winds Mountain (Paleozoic and Proterozoic)**
Dark green to black amphibolite and biotite-hornblende schist and semischist. Subordinate garnet-biotite hornblende-quartz schist, biotite sericite quartz schist, biotite-actinolite-quartz schist, graphitic schist, and rare white marble exposed on the west side of Admiralty Island between Ward Creek and the ridge south of Fishery Creek. Most of the rocks are hornblende bearing; maximum-phase mineral associations are: quartz-plagioclase-chlorite-hornblende-epidote-garnet-biotite-calcite; quartz-plagioclase-chlorite-hornblende-epidote-biotite-calcite-muscovite; quartz-plagioclase-hornblende-epidote-garnet-biotite-muscovite; quartz-plagioclase-hornblende-epidote-clino.pyroxene-calcite-Kfeldspar; and plagioclase-hornblende-clino.pyroxene. Other hornblende-bearing mineral associations are subsets of the above associations. Non hornblende-bearing assemblages in schists and quartzites include quartz-plagioclase-garnet-biotite-muscovite; quartz-plagioclase-chlorite-muscovite; quartz-plagioclase-garnet-biotite-muscovite-staurolite; quartz-plagioclase-garnet-cummingtonite-biotite, and quartz-plagioclase-cummingtonite-biotite-muscovite. Marble mineral associations include quartz-tremolite-calcite and quartz-clino.pyroxene-garnet-calcite. Amphibolite-marble contact zones contain the mineral associations epidote-clino.pyroxene-grossular-calcite and clino.pyroxene-grossular-biotite. Accessory minerals generally include opaque oxides and titanite, and tourmaline in the micaceous schists. Amphibolite facies metamorphism predates greenschist facies metamorphism. Mineral associations indicate that the amphibolite unit, for the most part, was metamorphosed under conditions of the lower amphibolite, or epidote amphibolite, facies. Spacial distribution of mineral
associations suggest that the metamorphic grade may increase to upper amphibolite facies (greenish-brown hornblende with clinopyroxene) in the southwest area of exposure of the unit. The higher grade rocks are near the contact with a large diorite-tonalite intrusion (Kqd) but the fabric of the metamorphic rocks indicates regional metamorphism rather than recrystallization by heat from the intrusion. The amphibolites and schists are generally well recrystallized, medium-grained rocks with a moderately to well developed S1 foliation. An S2 crenulation cleavage is present in some rocks but it is not common. In some areas, especially in the southeast area of exposure of the unit, a shear induced foliation is prominent with no evidence of an aligned S1 mineral foliation. Where shearing is prominent, the amphibolite facies minerals have been partly to completely recrystallized to greenschist facies associations. Protolith age unknown. Metamorphic ages not well-documented. A 40Ar/39Ar biotite cooling age of 121.8 +/- 1.0 Ma (table 1) predates Cretaceous plutonism in the map area. This may be the age of peak amphibolite facies metamorphism, however, it may also represent a Cretaceous heating event with the peak metamorphism having occurred during the Permian similar to the metamorphic history of the units Pzcs and PzZq. Similar metamorphic textures and mineral assemblages, and proximity to PzZq suggest a similar metamorphic history for PzZq and PzZa. Unit may correlate with amphibolite schist and gneiss unit in the Four Winds Mountain area northwest of Haines. Unit description from source map: SK021.

**um - Unmapped (age unknown)**

Area not mapped. Unit present on source map: [Geologic Map of Alaska](https://example.com/geologic-map)
Ancillary Source Map Information

The following section(s) present ancillary source map information associated with source(s) used for this project.

USGS Source Map References

USGS geologic-GIS data for the Alaska region maintains geologic source information as an attribute attached to each geologic feature. Although the GRI considers the USGS to be the mapping source for this project, sources used and referenced by the USGS have been preserved in the GRI digital geologic-GIS data. Geologic features in the GRI digital geologic-GIS data and the unit descriptions listed in this document have references to the sources listed here.

Several attribute fields present in the USGS source GIS data were retained in the GRI digital geologic-GIS data to provide users with the ability to relate back to the USGS source data. To view source publications used in the creation of this dataset refer to the References sections of this document and visit the USGS Alaska Science Center at: http://alaska.usgs.gov to obtain USGS source GIS data files.


MF005 Brew, D.A., Johnson, B.R., Grybeck, Donald, Griscom, Andrew, Barnes, D.B., Kimball, A.L.,


MF009 Plafker, George, 2002, Unpublished data.

MF010 Brew, D.B., and Plafker, George, unpublished data.


MF014 Karl, S.M., 2013, Unpublished data.


SK012 Pfaffer, George, 2002, Unpublished data.


33 p., 1 sheet, scale 1:63,360.


SK024 Brew, D.B., and Plafker, George, unpublished data.


YA002 Plafker, George, 2002, Unpublished data.


YA007 Brew, D.B., and Plafker, George, unpublished data.
Geologic Map of Alaska

The formal citation for this source.


Prominent text and web links associated with this source.

Pamphlet

The pamphlet associated with the source map is available online at: https://pubs.usgs.gov/sim/3340/sim3340_pamphlet.pdf.

Data

The digital data and map associated with the source map is available online at: https://pubs.usgs.gov/sim/3340/sim3340_gdb.zip.

Glacier Bay Geologic Map

The formal citation for this source.


Prominent text associated with this source.

Report

Glacier Bay National Park and Preserve, Alaska: A geologic map for the National Park Service

Compiled by Frederic H. Wilson and Susan M. Karl

Prepared in cooperation with the National Park Service

INTRODUCTION

This map of Glacier Bay National Park and Preserve (GLBA) is derived from the Geologic Map of Alaska (Wilson and others, 2015). The unit descriptions included here are from the state map and are only those that apply to GLBA. They have been revised as appropriate to reflect features directly related to the Park. The geology shown here is primarily derived from the mapping of Seitz (1959), Rossman (1963), Brew (1997), and unpublished mapping of George Plafker.

The Park is located about 100 km west-northwest of Juneau, Alaska and is centered around Glacier Bay, which is a major fjord indenting the southern coast of Alaska. It includes the mountains of the Fairweather Range, several smaller mountain ranges and fjords, and locally extensive low-relief areas of glacial outwash. The region was established as a National Monument in 1925 and in 1980 designated as a National Park and Preserve under the Alaska National Interest Lands Conservation
Act (ANILCA). Glacier Bay National Park and Preserve covers 13,286 km$^2$ of which 10,757 km$^2$ or about 80 percent is classified as Wilderness.

Glacier Bay itself is a geologically young feature; as recently as 1794 a tidewater glacier largely filled the bay and extended as far south as the Beardslee Islands (Cooper, 1923). This glacier represented a readvance subsequent to retreat of the late Pleistocene glacial maximum. It over-rode forests that had developed since the late Pleistocene and this readvance is most likely associated with the Little Ice Age advances around Prince William Sound. A number of the Prince William Sound glaciers apparently achieved their maximum Holocene extent about 1900 (Grant and Higgins, 1913). However, by 1900 the glaciers in Glacier Bay had retreated up Tarr Inlet past Russell Island and up Muir Inlet to Adams Inlet (Cooper, 1923). A recent surficial geologic map by Becker and others (2012) provides a detailed presentation of the surficial deposits within the Park.

The map accompanying this report shows the bedrock geology of the Park, much of which has been exposed with the retreat of the glaciers; yet much remains covered, particularly under Brady Glacier in the western part of the Park and in extensive ice fields along the Park boundary with Canada. Glaciers cover about 27 percent of the Park area. Bedrock in the Park ranges in age from Silurian volcanic rocks, sandstone, and limestone to sedimentary rocks as young as Quaternary, overlain by Quaternary unconsolidated deposits. A small exposure of gneiss in the vicinity of Mount Merriam east of Queen Inlet and three exposures of amphibolite roof pendants west of Glacier Bay are of indeterminate age. Much of the eastern area of the Park is underlain by Silurian sandstone and argillite deposits of (unit St, ~443 to ~420 Ma) that represent a number of formal stratigraphic units and largely consist of argillite and graywacke and, locally, thin-bedded limestone. Closely associated with these rocks is Silurian age limestone (unit Sl), which on this map also represents a number of formal stratigraphic units. Some of these limestone bodies these are quite fissilferous and have well controlled ages; others are dated by association. Many of the rocks on the west side of Glacier Bay and east of the Border Ranges Fault are plutonic rocks of various ages. Around Dundas Bay, these plutons are of Eocene age, in common with other plutons west of the Border Ranges Fault. Among the other plutons on the west side of the Bay, many have yet to be dated though some have yielded middle Cretaceous dates. The plutons of the Saint Elias Suite of Late Jurassic and Early Cretaceous age (unit KJse here) are known just north of the Park in British Columbia and Yukon and it is likely that this belt extends into the west side of Glacier Bay, where we have tentatively been assigned some plutons to this suite.

West of the Border Ranges Fault and east of the Fairweather Fault, the bedrock consists largely of rocks of the Valdez Group, a latest Cretaceous unit of sandstone and shale that is intruded by Eocene and Oligocene plutons and metamorphosed to greenschist facies resulting in crystallization of metamorphic minerals and development of metamorphic foliation. This area of the Park is extensively ice-covered and access is difficult. Finally, west of the Fairweather Fault rocks of the Yakutat Group, consisting of Jurassic and Cretaceous flysch and mélange (units KJyg and KJmy) are exposed and overlain by the latest Tertiary and Quaternary Yakataga Formation (unit QTf) in the vicinity of Lituya Bay and along the coast of the Gulf of Alaska within the Park. A number of plutons (unit Tegr) intrude the Yakutat Group, one of which has been dated and yielded an early Eocene age.

Text from source map: [Glacier Bay Geologic Map](#)

References


Dusel-Bacon, Cynthia, Brew, D.A., and Douglass, S.L., 1996, Metamorphic facies map of


References from source map: Glacier Bay Geologic Map
Alaska Resource Data Files

Ancillary information regarding Alaska Resource Data Files (ARDF) data for four 1’ x 3’ quadrangles that define the extent of the GRI digital geologic-GIS data is presented below. This information, as well as additional information, tables and metadata can be found online at: https://ardf.wr.usgs.gov/index.php. Note that as only a portion of each ARDF 1’ x 3’ quadrangle was used in the GRI digital geologic-GIS data, and therefore not all mineral occurrence localities displayed on each source’s mineral occurrence map are present in the GRI digital geologic-GIS data.

ARDF, 1’ x 3’ Skagway Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Report


Data


Index Map

Graphic from source map: ARDF, 1’ x 3’ Skagway Quadrangle
Mineral Occurrence Map

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

Graphic from source map: ARDF, 1' x 3' Skagway Quadrangle

References


**Additional References**


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References from source map: ARDF, 1’ x 3’ Skagway Quadrangle
ARDF, 1' x 3' Yakutat Quadrangle

The formal citation for this source.


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Report


Data

The Alaska Resource Data File (ARDF) data for the Yakutat Quadrangle, Alaska (OF-99-333) are available online at: https://ardf.wr.usgs.gov/ardf_data/YA.csv.

Index Map

Graphic from source map: ARDF, 1' x 3' Yakutat Quadrangle
Mineral Occurrence Map

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

Graphic from source map: ARDF, 1' x 3' Yakutat Quadrangle

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Tarr, R.S., 1909, Physiography and glacial geology, in Tarr, R.S. and Butler, B.S, The Yakutat Bay


References from source map: ARDF, 1’ x 3’ Yakutat Quadrangle
**ARDF, 1' x 3' Juneau Quadrangle**

The formal citation for this source.


Prominent graphics and text associated with this source.

**Report**


**Data**


**Index Map**

[Graphic from source map: ARDF, 1' x 3' Juneau Quadrangle](https://ardf.wr.usgs.gov/ardf_data/Juneau.pdf)
Mineral Occurrence Map

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

Graphic from source map: ARDF, 1' x 3' Juneau Quadrangle

References


Cheney, E.S., 1981, Geology of the Jualin gold property, Berners Bay District of the Juneau Gold Belt:
Unpublished report for B-T Enterprises, Seattle, WA.


Holt, S.P., and Moss, J.M., 1946, Exploration of a nickel-copper-cobalt deposit at Funter Bay,


Roehm, J.C., 1940, Preliminary report on the McGinnis Creek Mining group of claims, McGinnis Creek, Juneau Precinct, Alaska, 1938: Alaska Territorial Department of Mines Property Examination, PE 112-17, 2 p.


References from source map: ARDF, 1’ x 3’ Juneau Quadrangle
**ARDF, 1' x 3' Mount Fairweather Quadrangle**

The formal citation for this source.


Prominent graphics and text associated with this source.

**Report**


**Data**


**Index Map**

Graphic from source map: [ARDF, 1' x 3' Mount Fairweather Quadrangle](https://ardf.wr.usgs.gov/ardf_data/MountFairweather.pdf)
Mineral Occurrence Map

Distribution of mineral occurrences in the Mount Fairweather 1:250,000-scale quadrangle, southeastern Alaska

Graphic from source map: ARDF, 1' x 3' Mount Fairweather Quadrangle

References


Ellett, R.D., 1975, Statement and discussion: Adverse effects of proposed legislation upon Alaska nickel mining, in The regulation of mining activities within areas of the National Park System: U.S. Congressional Senate Committee hearing before the Committee on Internal and Insular Affairs, Oct. 7, 1975, 94th Congress, 1st Session, p. 311-316.


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References from source map: ARDF, 1’ x 3’ Mount Fairweather Quadrangle
ARDF, New and Revised Records Version 1.6

The formal citation for this source.


Prominent graphics and text associated with this source.

Report


Data

The Alaska Resource Data File (ARDF) data for the New and Revised Records Version 1.6 (OF-2008-1225) are available online at: https://ardf.wr.usgs.gov/ardf_data/1225.csv.

References

References for this document are available in the https://ardf.wr.usgs.gov/ardf_data/1225.pdf.
GRI Digital Data Credits

This document was developed and completed by Jake Suri and Ron Karpilo (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Ron Karpilo, Jim Chappell and Stephanie O'Meara (Colorado State University).

The information in this document was compiled from GRI source maps, and intended to accompany the digital geologic-GIS map(s) and other digital data for Glacier Bay National Park and Preserve, Alaska (GLBA) developed by Ron Karpilo with quality control assistance by Stephanie O'Meara. See the GRI Digital Map and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map.

GRI finalization by James Chappell.

GRI program coordination and scoping provided by Jason Kenworthy and Tim Connors (NPS GRD, Lakewood, Colorado).