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GEOLOGICAL SURVEY

Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska

By

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INTRODUCTION

This report consists of three main items: (1) the geologic map (sheet 1 of 2), (2) the correlation of map units (sheet 2 of 2), which includes an inset map relating different parts of the map to the correlation of map units and to (3) the description of map units (this pamphlet).

The inset map on sheet 2 shows the major geological elements of the map area. They are, from west to east, (1) the Alexander belt, consisting of generally unmetamorphosed Lower Paleozoic through Upper Triassic rocks intruded by scattered mid-Cretaceous plutons, (2) the Gravina belt, consisting of unmetamorphosed to highly metamorphosed, variably deformed Upper Jurassic(?) through mid-Cretaceous flysch and volcanic rocks intruded by both mid- and Upper Cretaceous plutons, and (3) the Mainland belt, consisting of metamorphic rocks intruded by Upper Cretaceous, lower Tertiary, and mid-Tertiary plutons. Younger than almost all parts of all of these belts, and extending from the Alexander belt across the Gravina and onto the mainland belt, is the lower to middle Tertiary Kuiu-Etolin belt that consists largely of varied volcanic rocks, associated plutons, and minor sedimentary rocks. This pamphlet describes these belts in this order: Kuiu-Etolin, Alexander, Gravina (including the Duncan Canal-Zarembo Island-Screen Islands sub-belt), and Mainland.

The Alexander belt corresponds more or less to the Alexander terrane of Berg and others (1978), the Gravina belt is a refined interpretation of their Gravina belt, and the Mainland belt corresponds to their Taku and Tracy Arm terranes which are not considered to be tectonostratigraphic terranes, but are instead the metamorphosed equivalents of the upper and lower parts of the Alexander belt rocks, respectively (Brew and Ford, 1983, 1984a; Brew, 1983a).

The mineral deposits and occurrences in the map area, as known through 1979, were described by Karl and others (1980). A bibliography of geologic reports pertinent to the map area was prepared by Burrell and others (1982) and a telegeologic analysis was made by Le Compte (1981). A series of reports on the stream-sediment and panned-concentrate geochemistry have also been released (Cathrall and others, 1983a-w). Several short reports dealing with specific geologic and(or) mineral resource topics have been published; they are referred to where appropriate in the description of map units. Additional supporting material for this map, including detailed descriptions of different intrusive suites, compilation of fossil information, compilation of major element chemical and geochronological data, and compilation of available bedrock geochemical data, is currently in preparation.

A compilation of the geology of the Craig quadrangle to the south recently became available (Eberlein and others, 1983); the remaining parts of the Port Alexander quadrangle to the west were mapped by Loney and others (1975); the geology of Admiralty Island to the north was described by Lathram

and others (1965); and the geology of the Bradfield Canal quadrangle to the east is currently being studied by R. L. Elliott and R. D. Koch of the U.S. Geological Survey, Menlo Park, California. The stratigraphic and structural studies done by Muffler (1967) in the Keku Islets and neighboring parts of Kuiu and Kupreanof Islands have been incorporated in the map and description of map units without modification, except for the inclusion of some new lithologic, paleontologic, and interpretative information.

This map and description of map units incorporates the results of some special studies of granitic and other units: Peter D. Burrell prepared the descriptions of the intrusive rocks of the Admiralty-Revillagigedo Plutonic Belt; Susan J. Hunt those of the intrusive rocks of the Kuiu-Etolin Belt; John H. Webster those of the granitic rocks of the Mainland Belt, incorporating some earlier work by Robert B. Trumbull; and R. A. Loney those of the Ultramafic Complex at Blashke Islands and Related Rocks. Susan L. Douglass contributed petrographic information on metamorphic rocks in the Gravina and Mainland Belts. H. C. Berg mapped the shorelines of Zarembo, Shrubby, Bushy, Vank, and Sokolof Islands.

We thank Eugene Tobey of Bushwalker Exploration for alerting us to the occurrence of post-glacial-till basalt flows at Kah Sheets Bay on Kupreanof Island and thus in turn to the recognition of 1) the extensive Quaternary flows and locally associated underlying sandstones and conglomerates, 2) the Quaternary(?) and Tertiary age of the remainder of the volcanic rocks on southwestern Kupreanof, and 3) the implications for the plutonic and volcanic history of the Kuiu-Etolin belt. We also thank Tobey and Norm Comer (also of Bushwalker Exploration), William Zelinski of Amoco Minerals Company, and Ed Chipp of Resource Associates of Alaska for providing fossil collections from the Duncan Canal area.

Finally, like all present day geologic workers in southeastern Alaska, we acknowledge our debt to the late A. F. Buddington, who, during 13 months in the field in 1921 through 1925, learned more of the regional geology than seems possible and who went on to write the only comprehensive description and synthesis available for the region (Buddington and Chapin, 1929).

DESCRIPTION OF MAP UNITS

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.

KUIU-ETOLIN BELT

Belt informally named by Brew and others (1979) and redefined by Brew and Morrell (1983).

EXTRUSIVE AND INTRUSIVE VOLCANIC ROCKS OF KUIU-ETOLIN VOLCANIC-PLUTONIC BELT (Quaternary and Tertiary)--Diverse volcanic rocks exposed in a broad area extending from northeastern Kuiu southeastward through Kupreanof and Zarembo Islands; as mapped, divided into:

Qb Extrusive Basaltic Rocks and Underlying Sediments (Holocene and(or) Pleistocene)--Fresh, locally polygonally jointed, dark greenish gray, dense, very fine-grained to aphanitic magnetite-bearing olivine basalt and minor pyroxene basalt; individual flows are as much as 10 m thick and are columnar jointed; most flows are less than 1 m thick. Underlain locally by aa flows and mafic volcanic breccia in layers up to 0.5 m thick and by locally derived, poorly sorted, well-bedded brown- to gray-weathering conglomerate, pebbly sandstone, sandstone and minor siltstone deposited in fluvial or beach environment. Quarry on peninsula in Kah Sheets Bay exposes polymitic glacial till that is mapped with this unit in small lens under dense aphanitic basalt; whole unit is interpreted to be Pleistocene or younger. Three whole-rock K-Ar ages on basalts from a few miles south of Kah Sheets Bay gave ages of 0.272±0.085, 0.262±087, and 4.04±6.95 Ma (M. A. Lanphere, written commun., 1972). Exposed along south shore of Kupreanof Island from Kah Sheets Bay to Douglas Bay and from west of Totem Bay to beyond Point Barrie and at Indian Point and on High Castle Island in Duncan Canal. Equivalent rocks may be included with Basalt and Other Mafic Extrusive rocks unit (QTb), particularly along Rocky Pass and near the mouth of Irish Creek.

Extrusive and Intrusive Volcanics and Volcaniclastic Rocks (Quaternary(?) and Tertiary)--Complicated intrusive and extrusive volcanic pile best exposed on southwestern Kupreanof Island, may include rocks that should be assigned to Extrusive Basaltic Rocks and Underlying Sediments unit (Qb) but which cannot be distinguished in the field from older basalts. Originally considered to be the southeastern, and more varied extension of Admiralty Island Volcanics unit named by Loney (1964) and assigned a late Eocene to Oligocene age on Admiralty Island; that age revised to Eocene to Miocene(?) by Lathram and others (1965); recent K-Ar dating (G. E. Plafker, oral commun., 1982) of volcanic rocks there indicates a Miocene age. However, the Admiralty volcanics are now considered to be a different but possibly time-equivalent unit. Time- and litho-stratigraphic relations are uncertain, but dominant rhyolites and basalts appear to have erupted at undetermined times and in no obvious or simple sequence from Paleocene (as indicated by the age of the locally underlying Kootznahoo Formation) to Holocene (as inferred from the possible inclusion of Quaternary volcanic rocks in the unit). The unit may include rocks erupted throughout the Tertiary and Quaternary, but it is believed likely to have a significant Oligocene break. Stratigraphically complicated with major lithologic types

occurring repeatedly throughout the section. Some suggestion that Altered Dellenite, etc. unit (QTf), and Gabbro and Microgabbro unit (Tmgb) occurs only low in the section. Siliceous Volcaniclastic Rock unit (QTc) occurs in and around Rhyolite, Rhyodacite, etc. unit (QTr); see also Muffler (1967); as mapped, divided into:

QTv — Vent Breccia--Angular to subangular blocks of fine-grained light gray silicic volcanic rock ranging from 5 mm to 15 cm with either no matrix or little (less than 15 percent) matrix of very fine grained dark gray volcanic rock or chalcedony; crops out on southeast shore of Zarembo Island southwest of Round Point, and in Kadake Creek drainage, west of Kadake Bay and north of Washington Bay, all on Kuiu Island.

QTr — Rhyolite, Rhyodacite, and Related Siliceous Extrusive and Intrusive Rocks--Aphanitic to finely crystalline, generally quartz and feldspar porphyritic; C.I. less than 1. Locally layered, spherulitic, and(or) miarolitic; light gray fresh; buff, white, green lavendar, maroon, or pink where altered; generally rusty weathering. Pyrite and zeolites common. Many exposures are texturally complicated mixtures of discontinuous mm scale flow layered, brecciated, spherulitic, and phenocrystic rocks. Heterogeneous stratigraphy includes lava flows, obsidian flows, lahars, welded and nonwelded ash, tuff, and lapilli, all cut locally by porphyritic rhyolite and rhyodacite dikes. Extreme alteration, brecciation, attitudes of layering, and diking identify vents and domes; massive structureless isolated rhyolite bodies suggest plugs; columnar-jointed cliff exposures in excess of 100 m thick are interpreted as cooling units. Exposed west of Port Camden and Kuiu Island, on southwest and south central Kupreanof Island, southwest Zarembo Island, and northwest Etolin Island. Probably in part related to Altered Dellenite (Quartz Latite) Flows unit (QTf).

QTf — Altered Dellenite (Quartz Latite) Extrusive Rocks--Medium to light gray, flaggy weathering, generally altered, felsic flow rock. Contains microphenocrystic clinopyroxene in plagioclase groundmass, with quartz, K-feldspar, green biotite, and plagioclase-quartz myrmekite. Subordinate weathered intraformational pebble conglomerate and locally overlying breccia suggest alteration was deuteric (Muffler, 1967). Intercalated with basalt and with plant-bearing sandstone of Kootznahoo Formation; cut by gabbro, basalt, andesite, and rhyolite dikes. Exposed near Port Camden, Big John Bay, Rocky Pass and Keku Strait on eastern Kuiu and western Kupreanof Islands.

QTa — Andesite and Other Intermediate Extrusive Rocks--Dark gray fresh, green to maroon altered, blocky weathering, pyroxene and feldspar porphyritic, massive to vesicular and amygdaloidal flows 10-50 cm thick. Apparently intercalated with basalts in southern Rocky Pass area between Kuiu and Kupreanof Islands, also occurs in south central Kupreanof Island, and near exposures of Rhyolite, Rhyodacite, etc., map unit (QTr) near Kah Sheets Lake, and on southwestern Zarembo Island.

QTb — Basalt and Other Mafic Extrusive Rocks--Dark gray, rusty weathering, platy, blocky, or columnar jointed flows 50 cm to several meters thick. Commonly vesicular and amygdaloidal; amygdule fillings include calcite, epidote, chalcedony, chlorite, and zeolites, in order of decreasing abundance. Platy flows are pyroxene microporphyritic; massive flows may contain magnetite, pyroxene,

and olivine. Intercalated mafic tuff and flow breccia of uneven thickness, less than 1 meter thick. Section of gently east-dipping flows greater than 500m thick extends from Port Camden on Kuiu Island, across Rocky Pass to western Kupreanof Island; also exposed on northwestern Zarembo Island. Most extensive volcanic unit in the Kuiu-Etolin belt; may also underlie much of exposed extrusive volcanic section on Kuiu, Kupreanof and Zarembo Islands. Mafic dikes and small localized flows occur higher in the section.

QTc — Volcaniclastic Deposits--Includes unsorted and sorted pyroclastic deposits, felsic to mafic tuff, lapilli tuff, tuff breccia, and block and ash deposits. Also includes felsic to mafic lahars and oligomictic conglomerates. Deposits range from massive, matrix supported, and 10's of meters thick, to well-bedded on a cm scale, with graded beds, and thinning and fining upwards cycles. Tuffaceous deposits are generally altered to pale green clay; ashy horizons are locally silicified. Coaly plant material is rare, but present where bedding is well-developed. Mafic material subordinate to felsic material, quartz subordinate to feldspar, and pyrite is spare but ubiquitous. Deposits lap onto volcanic centers in the vicinity of Tunehean, Lovelace, and Kushneahin Creeks, and are intercalated with extrusive rocks at several horizons.

QTd — Dikes, Sills, and Extrusive Rocks--Mutually cross cutting network of dikes, flows, sills, and breccias ranging in composition from basalt to rhyolite. Extremely complicated, heterogenous, outcrops; may include xenoliths of metamorphic country rock. Best exposures associated with granitic intrusion west of Threemile Arm on Kuiu Island, and on Conclusion and Zarembo Islands. Interpreted to be feeder system of volcanics in these areas.

QTx — Breccia and Agglomerate--Poorly exposed enigmatic light and dark gray interlayered volcanic graywacke and mafic tuff breccia of basaltic (?) composition; crops out on isolated reefs in Kashevarof Passage off northeast Prince of Wales Island.

INTRUSIVE GRANITIC AND OTHER ROCKS OF KUIU-ETOLIN VOLCANIC PLUTONIC BELT (Miocene and(or) Oligocene--Preliminary K-Ar determinations of about 20-22 Ma obtained on rocks from the Granite of Central and Northern Etolin Island (Tmge) (M. A. Lanphere, written communs., 1981, 1982); preliminary descriptions given by Hunt (1984); as mapped, divided into:

Tmae — Alkali Granite Satellitic to Granite of Central Etolin Island--Biotite-amphibole alkali granite, granite, and alkali quartz syenite with minor amounts of quartz syenite to syenite. Massive, nonfoliated; allotriomorphic to hypidiomorphic; equigranular to seriate; medium- to very coarse-grained; C.I. 01 to 13; weathers to a distinctive pale orange to white; generally homogeneous at outcrop scale. Feldspar mineralogy consists of well developed perthitic alkali feldspar, commonly intergrown with quartz in a coarse graphic texture, and general absence of plagioclase as a separate feldspar phase; distinctive mafic mineralogy includes blue-green to blue (sodic) amphibole (hornblende and riebeckite), dark brown, often reddish-brown, biotite, and locally abundant green (iron-rich) pyroxene which may also be associated with rare iron-rich olivine (fayalite); accessory minerals are fresh and coarse-grained and include sphene, allanite, rare fluorite, and magnetite which is locally either rare or abundant. Unit is exposed in several bodies and numerous unmapped dikes and small

plugs satellitic to the Granite of Central Etolin Island (Tmge). Similar to that same body in general appearance, but is coarser-grained, more granular, lacks miarolitic cavities, and has an unusual mafic mineralogy.

Tmge — Granite of Central and Northern Etolin Island--Hornblende-biotite granite, alkali granite, quartz syenite, and alkali quartz syenite; massive, nonfoliated; allotriomorphic to hypidiomorphic; equigranular to seriate; medium- to coarse-grained; C.I. 01 to 07; weathers to a distinctive pale orange to white; miarolitic cavities common, often rusty weathering; generally quite homogeneous at outcrop scale. Feldspar mineralogy consists of common, but only rarely pervasive, graphic and micrographic intergrowths of quartz and well-developed microperthitic alkali feldspar; mafic mineralogy consists of dark brown to greenish-brown biotite and generally subordinate green to blue-green hornblende, both of which are often partially altered to chlorite; accessories include sphene, allanite, and locally abundant magnetite; epidote fills miarolitic cavities in several places. Minor amounts of fine- to medium grained, porphyritic biotite-hornblende quartz monzonite, quartz syenite, and granite (C.I. 03-10), frequently containing up to 10 percent rounded, very fine grained mafic (about C.I. 40) inclusions occur, generally near the margins. Unit forms the core of the large composite pluton on central Etolin Island, and is best exposed there along Burnett Inlet; also exposed as small bodies on Brownson Island, near Fisherman's Chuck, in the Niblack Islands, and in numerous small unmapped plugs and dikes within the migmatitic rocks surrounding the core; on northern Etolin Island, it forms the pluton at Bessie Peak as well as several small plugs and dikes which invade the adjacent country rocks and the migmatite at Anita Bay. The body at Bessie Peak has a more homogeneous composition and carries more fine-grained mafic inclusions than does the body at Burnett Inlet.

Tmme — Migmatitic Granitic Rocks of Central and Northern Etolin Island--Hornblende-biotite-pyroxene quartz monzodiorite, quartz monzonite, granodiorite, quartz diorite, and diorite paleosomes invaded by neosomes of these same compositions as well as of granite, alkali granite, and quartz syenite. Massive, extremely heterogeneous, and generally nonfoliated; hypidiomorphic to allotriomorphic; equigranular to seriate to porphyritic; generally fine- to medium-grained; C.I. 10 to 50 (paleosomes), 03 to 25 (neosomes). Feldspar mineralogy consists of zoned plagioclase, in places rimmed by potassium feldspar, abundant "clots" of interstitial potassium feldspar, and generally rare micrographic intergrowths; highly intergrown and generally subophitic mafic minerals in the more dioritic phases consist of abundant pale clinopyroxene, local additional orthopyroxene, both occurring as cores in green-brown hornblende, associated pale-green fibrous secondary amphibole, brown biotite, and very rare olivine; accessories include sphene, apatite, magnetite, and rare allanite. Unit makes up the outer portion of the large composite pluton on central Etolin Island at Burnett Inlet, as well as a smaller body at Anita Bay associated with the granite at Bessie Peak, and an irregular zone associated with the granite on the Niblack Islands in Ernest Sound. Dioritic phases resemble rocks within the outer portions of the pluton at Washington Bay on northwestern Kuiu Island, and rocks comparable to other phases can also be found associated with the granitic plutons on Zarembo, Kupreanof and northeastern Kuiu Islands.

Tmaz — Alkali Granite of Northwestern Etolin and Southeastern Zarembo Islands--Amphibole-biotite alkali granite and subordinate granite. Massive,

nonfoliated; allotriomorphic to hypidiomorphic; equigranular to seriate, some porphyritic; medium- to coarse-grained; C.I. averages 04; miarolitic cavities common and locally abundant; quite homogeneous at outcrop scale, but with locally abundant hornfels inclusions. Feldspar mineralogy consists of perthitic alkali feldspar, a variety of exotic (and in places pervasive) graphic and micrographic textures, and rare occurrence of plagioclase as a separate feldspar phase; mafic mineralogy is distinctive and includes green, blue-green, and blue (sodic) amphibole (hornblende to riebeckite), dark brown to reddish-brown biotite, and locally abundant green (iron-rich) pyroxene; mafic minerals altered and partially replaced by chlorite; accessories include locally abundant sphene, allanite, apatite(?), magnetite, and minor hematite; epidote fills some miarolitic cavities. Unit on Zarembo Island includes minor coarse-grained, subophitic, hornblende-biotite-pyroxene diorite (C.I. 40-45) that resembles diorites within the Migmatitic Granitic Rocks of Central and Northern Etolin Island (Tmme) as well as the diorites associated with the granites of Kupreanof and Kuiu Islands (see Tmqk). Unit exposed in two possibly interconnected bodies at Quiet Harbor on northwestern Etolin Island and at Round Point on southeastern Zarembo Island, as well as in several small plugs and dikes that invade the adjacent country rocks on Zarembo Island. Resembles the Granite of Central and Northern Etolin Island (Tmge) in composition and texture, while the mafic mineralogy is similar to the Alkali Granite Satellitic to Granite of Central Etolin Island (Tmae).

Tmqk Heterogeneous Granitic Rocks of Central Kupreanof and Northeastern Kuiu Islands--Biotite-hornblende granite, quartz syenite, quartz monzonite, and quartz monzodiorite. Poorly exposed, nonfoliated; hypidiomorphic, inequigranular to porphyritic; fine- to medium-grained; C.I. 02 to 20; miarolitic cavities common and locally abundant, as are fine-grained mafic inclusions. Feldspar mineralogy consists of microperthitic alkali feldspar which commonly rims plagioclase grains, common and locally pervasive micrographic intergrowths, and some potassic alteration of plagioclase; mafic mineralogy consists of brown biotite (often partially replaced by chlorite), green-brown to blue-green hornblende (commonly associated with a pale-green fibrous secondary amphibole), and rare pale pyroxene; accessories include locally abundant sphene, magnetite, and rare allanite; epidote occurs as miarolitic cavity fillings. Includes minor amounts of pyroxene-rich coarse- to medium-grained quartz monzodiorite (C.I. 25-35), and of medium-grained, subophitic, pyroxene-biotite diorite (C.I. 40-50) similar to diorites associated with the granitic rocks on northwestern Kuiu (Tmdk) and Zarembo Islands (Tmaz). Unit is exposed in small plutons in central Kupreanof Island south of Castle River, on northwestern Kuiu Island southwest of Threemile Arm (where it also forms dikes which invade the adjacent country rocks) and as small plugs on Horseshoe and Monte Carlo Islands in Keku Strait; various phases of these plutons have counterparts among all of the other coeval plutons in the quadrangle; they differ from various granitic units on Etolin Island in generally lower quartz and greater plagioclase content, finer grain size, and generally higher C.I.

Tmgk Granite of Northwestern Kuiu Island--Hornblende-biotite granite and granodiorite. Massive, nonfoliated; hypidiomorphic; equigranular to seriate, locally porphyritic; fine-medium- to coarse-medium-grained; C.I. 04 to 09; generally quite homogeneous at outcrop scale; local miarolitic cavities and minor fine-grained mafic inclusions. Feldspar

mineralogy consists of microperthitic alkali feldspar, poorly developed graphic and micrographic intergrowths, and local potassic alteration of plagioclase; mafic mineralogy consists of dark brown to reddish-brown biotite (often partially replaced by chlorite) and dark brownish-green to blue-green hornblende; accessories include common, locally abundant sphene, magnetite, and rare allanite. Unit exposed in the core of the pluton on northwestern Kuiu Island near Washington Bay, and as small plugs and dikes cutting the surrounding Heterogeneous Dioritic Rocks of Northern Kuiu Island (Tmdk); differs from the Heterogeneous Granitic Rocks of Northeastern Kuiu Island (Tmqk) in its homogeneity, generally lower C.I., higher quartz content, and coarser grain size; similar to the Granite of Central and Northern Etolin Island (Tmge), and differs from it mainly in its higher plagioclase content and poorer graphic textures.

Tmdk — Heterogeneous Dioritic Rocks of Northern Kuiu Island--Biotite-hornblende-pyroxene diorite, quartz diorite, quartz monzodiorite, and gabbro; massive, nonfoliated; allotriomorphic to hypidiomorphic; seriate; medium- to coarse-medium-grained; C.I. 17 to 50; extensively diked and locally migmatitic with granitic to dioritic neosomes invading dioritic paleosomes. Feldspar mineralogy includes zoned plagioclase with local potassic alteration, locally abundant "clots" of interstitial potassium-feldspar, rare micrographic intergrowths, and abundant subophitic mafics; mafic minerals are generally intergrown and consist of pale clinopyroxene, some orthopyroxene, green-brown hornblende (associated with a pale-green, fibrous secondary amphibole), minor brown biotite, and rare olivine; accessory minerals include sphene, apatite, magnetite, and rare allanite. Unit exposed in the outer portion of the pluton at Washington Bay on northwestern Kuiu Island and as a small plug at the head of Threemile Arm on northeastern Kuiu; resembles the more dioritic phases of the Migmatitic Granitic Rocks of Central and Northern Etolin Island (Tmme).

Tmgb — Gabbro and microgabbro--Medium-grained, dark gray fresh and weathered, olivine- and clinopyroxene-bearing, locally deuterically altered;forms now-gently-dipping sills up to about 500 m thick; cuts Kootznahoo Formation and older rocks; well exposed on Hamilton Island, on Kuiu Island north of Kadak Bay and at Saginaw Bay in the Keku Islets, and at Big John Bay on Kupreanof Island; inferred by Muffler (1967) to be genetically related to the Basalt and Other Mafic Extrusive rocks unit (QTb) to the south.

Tsh — HORNFELSED SEYMOUR CANAL FORMATION ROCKS (Miocene and(or) Oligocene)--Albite-epidote hornfels facies rocks, generally preserving both original structures and textures and(or) the metamorphic effects of Cretaceous metamorphic events, in aureoles on Etolin Island. The limits are, as described under the heading "Metamorphosed Stephens Passage Rocks" in the section on the Gravina belt, poorly defined and the unit may not be as extensive as presently shown. Age of protoliths is Late Jurassic to middle Cretaceous, based on on an ammonite of Albian age (D. L. Jones, written commun., 1979) collected on the northwest shore of Etolin Island and on obvious derivation from the Seymour Canal Formation (KJss).

Tbh — HORNFELSED BAY OF PILLARS FORMATION ROCKS (Miocene and(or) Oligocene)--Albite-epidote- to hornblende hornfels facies metamorphic rocks; dominantly biotite-quartz-feldspar hornfels, fine- to medium-grained, brownish-gray; original sedimentary structures and bedding of graywacke and mudstone turbidite sequence locally preserved; includes minor metaconglomerate. Metamorphosed from the Graywacke and Mudstone Turbidite Unit in Bay of Pillars Formation.

Tk

KOOTZNAHOO FORMATION(?) (Paleogene)--Nonmarine arkosic sandstone, sandstone, shale, and conglomerate; medium- to very thick-bedded; locally cross-bedded; dominant rock type is medium- to very coarse-grained lithic feldspathic quartz arenite; conglomerate contains clasts up to 10 cm of granitic rock, slate, schist, chert, felsic volcanics; minor shale is locally carbonaceous and contains plant fossils; rare thin coal beds; greater than 300 m thick near Dakaneek Bay on Kupreanof Island (K. A. Dickenson, oral commun., 1980). Available fossil evidence suggests that all of this unit in the northern part of this map area near Keku Strait is Paleocene in age and that in the southern part on Zarembo Island is early Eocene, whereas the type Kootznahoo Formation on Admiralty Island (Lathram and others, 1965) is now considered latest Eocene through early Miocene age (Wolfe, 1966; written communs., 1979, 1983); the similarities in depositional environment, stratigraphic position, and lithology suggest that the name Kootznahoo Formation is appropriate although the depositional basins may not have been connected. Unit is inferred to underlie most, if not all, of the Extrusive and Intrusive Volcanic Rocks of Kuiu-Etolin Volcanic-Plutonic Belt units in this map area and locally intertongues with at least the lower part of that unit. The largest outcrop area is south and southeast of Hamilton Bay on Kupreanof Island, another large area is on the southwest side of Zarembo Island and Bushy Island, small outcrops are at California Bay on Prince of Wales Island, east of Point Nesbitt on Zarembo Island, in the divide between Port Camden and Threemile Arm on Kuiu Island, at Kadake Bay on Kuiu Island, and in the upper drainage of Hamilton Creek on Kupreanof Island; Buddington and Chapin (1929) report an occurrence at Kah Sheets Bay on Kupreanof Island which we did not find. See Muffler (1967), Dickinson (1979), Dickinson and Campbell (1982), Wright and Wright (1908), and Loney (1964) for further information.

ALEXANDER BELT

Belt informally named here to denote those rocks that form a coherent stratigraphic section (and including the pre-Cenozoic granitic and other rocks intrusive into that section) in the western part of the map area, ranging in age from Ordovician up to Cretaceous. Because it includes one stratigraphic unit of limited extent that is of Cretaceous age, it does not correspond exactly to the Alexander terrane of Berg and others (1978).

INTRUSIVE ROCKS OF THE CHILKAT-PRINCE OF WALES PLUTONIC PROVINCE (Cretaceous); Province informally named by Sonnevil (1981); preliminary K-Ar determinations on hornblende from the Hornblende Quartz Monzodiorite, etc. unit on Kosciusko and Prince of Wales Islands by M. A. Lanphere (written communs., 1981, 1982) give 98.7 and 100.0 Ma, respectively; as mapped, divided into:

Kwgd

Hornblende Granodiorite and Diorite--Fine- to medium-grained, C.I. about 10-25; some biotite-hornblende monzodiorite. Crops out west of Security Bay on Kuiu Island.

Kwqo

Hornblende Quartz Monzodiorite with Minor Tonalite, Granodiorite, Quartz Diorite, Diorite, Quartz Monzonite, and Monzodiorite--Massive to foliated, equigranular to locally porphyritic; medium-grained; C.I. 2 to 48, average (approx.) 15; locally hornblende porphyritic; local rounded fine-grained mafic inclusions; includes common aplite, less common pegmatite, and several mafic dikes. Typical petrographic features are: seriate twinned and zoned plagioclase with minor alteration; K-feldspar interstitial to plagioclase and occasionally in poikilitic clots; hornblende anhedral to subhedral with some plagioclase inclusions and ubiquitous opaque inclusions; pyroxene and

biotite locally present and subordinate to hornblende; pyroxene altering to hornblende and biotite to chlorite; accessories are apatite and sphene. Unit differs in general from the Upper Cretaceous plutons of the Admiralty-Revillagigedo plutonic belt in the Gravina and Mainland Belts to the east by lack of epidote and garnet, lower color index, and by lack of local plagioclase porphyry phase. Unit differs from the Biotite-Pyroxene-(Hornblende-)Monzodiorite, etc. Unit (Kqo) on northeastern Kupreanof Island in having ubiquitous hornblende. Exposed on Prince of Wales, Kosciusko, and Kuiu Islands.

Kwan — Andesitic Intrusive Rocks--Grayish-green weathering feldspar-porphyroaphanitic andesite, with local prehnite and zeolite(?) filled amygdules. Age not known directly, but inferred from field relations, which suggest that the body is a high-level equivalent to the Hornblende Quartz Monzodiorite, etc. Unit (Kwqo) at Devilfish Bay. Crops out only on Kosciusko Island west of Davidson Inlet.

METAMORPHIC ROCKS IN THE CHILKAT-PRINCE OF WALES PLUTONIC PROVINCE (Cretaceous)--Aureoles around plutons of the Chilkat-Prince of Wales plutonic province on Kosciusko and northern Prince of Wales Islands; age is that of the plutons (about 100 Ma) based on preliminary K-Ar dating (M. A. Lanphere, written commun., 1982); as mapped, divided into:

Khh — Marble--Medium- to coarse-grained, white fresh, light gray weathering; original bedding and structures largely obliterated. Metamorphosed from Heceta Limestone.

Kch — Biotite-Quartz-Feldspar Hornfels--Metapolymictic conglomerate with 1 to 35 cm diameter rounded clasts of syenite(?), granodiorite, feldspar porphyry, chert, intermediate volcanic rock, and mudstone in 1 to 10 m thick beds. Metamorphosed from Polymictic Conglomerate Unit of Bay of Pillars Formation.

Kbh — Biotite-Quartz-Feldspar Hornfels--Fine- to medium-grained, brownish-gray; original sedimentary structures and bedding of graywacke and mudstone turbidite sequence locally preserved; includes minor metaconglomerate like that described above. Metamorphosed from the Graywacke and Mudstone Turbidite Unit in Bay of Pillars Formation.

Koh — Biotite-Quartz-Feldspar Hornfels--Metapolymictic conglomerate like that described previously; cannot be differentiated from that unit except by stratigraphic position between the Heceta Limestone and Bay of Pillars Formation. Metamorphosed from Polymictic Conglomerate Unit in that position.

Kdh — Biotite-Feldspar-Quartz Hornfels--Fine- to coarse-grained, brown and gray; original textures and structures obliterated; includes minor calc-silicate hornfels layers. Metamorphosed Graywacke Unit of the Descon Formation near Coffman Cove.

ULTRAMAFIC COMPLEX AT BLASHKE ISLANDS AND RELATED ROCKS (Cretaceous)--Preliminary K-Ar dating (Lanphere and Eberlein, 1966) suggests an age of 110 Ma for this complex (Kennedy and Walton, 1946; Walton, 1951a,b), which is considered to be a westward outlier of the Klukwan-Duke plutonic belt informally named by Brew and Morrell (1983) (see Gravina belt); as mapped, divided into:

Kbdu — Dunite--Massive, partially (25 to 100 percent) serpentinized; medium-grained; C.I. 100; fresh surfaces gray to dark gray; weathers yellowish-brown; forms smooth, rounded outcrops; consists of 98 to 99 percent olivine and 1 to 2 percent chromite in very sparse, thin streaks, except near Wehrlite (Kbwh) contact where clinopyroxene increases to as much as 5 percent; primary fabric generally preserved.

Kbwh — Wehrlite--Massive; medium-grained; C.I. 100; xenomorphic granular; fresh surfaces dark green, weathers to rough yellowish-brown to dark gray with yellowish-brown patches; clinopyroxene increases outward from Dunite Unit (Kbdu) contact near which the wehrlite grades to olivine clinopyroxenite.

Kbgb — Clinopyroxene-Hornblende Gabbro--Massive to locally flow banded on cm scale; medium-grained; C.I. 65-75; hypidiomorphic granular; medium gray fresh; weathers dark gray; locally 5 percent mafic inclusions 2 to 3 cm maximum dimension, fine grained mafic dikes common; grades from clinopyroxene gabbro at sharp contact with Wehrlite unit contact to hornblende gabbro at country rock contact.

Kbqd — Magnetite-Bearing Chlorite-Hornblende-Pyroxene Monzodiorite--Massive, well-jointed, medium- to coarse-grained; C.I. 30-35, weathers grayish-green and gray; up to 20 percent subangular mafic inclusions, generally altered appearance; abundant diorite and gabbro(?) dikes. Unit crops out only on Rose Rock, Rose Island, and Seal Rock in Kashevarof Passage. Inferred from aeromagnetic anomaly pattern (U.S. Geological Survey, 1979) to be related to the ultramafic complex described above but could be related to the granodiorite of inferred Cretaceous age (Kwqo) at Coffman Cove on Prince of Wales Island to the south.

METAMORPHIC ROCKS ADJACENT TO COMPLEX AT BLASHKE ISLANDS (Cretaceous)--Aureole around ultramafic complex at Blashke Islands; age is that inferred for the complex on the basis of preliminary K-Ar dating (Lanphere and Eberlein, 1966); as mapped, includes:

Kph — (Garnet-) (Pyroxene-)Biotite-Quartz-Feldspar Hornfels--Fine- to medium-grained, grayish-brown; forms ragged outcrops; original sedimentary structures and 2-cm to 15-cm-thick alternating graywacke and mudstone turbidite beds preserved; includes minor metapolymictic conglomerate with 3-30 cm diameter rounded cobbles of volcanic and granitic rock. Metamorphosed from the Graywacke, Slate, and Limestone Unit of Bay of Pillars Formation on northeastern Prince of Wales Island.

Kpch — Biotite-Quartz-Feldspar Hornfels--Metapolymictic conglomerate and agglomerate with 3 to 50 cm diameter subrounded to rounded clasts of volcanic and granitic rock, and of volcanic rock, respectively, in 50 cm to 2 m thick beds. Metamorphosed from the Conglomerate, Agglomerate, and Volcanic Breccia Unit of Bay of Pillars Formation on northeastern Prince of Wales Island.

Ksm — LITHIC SANDSTONE AND MUDSTONE TURBIDITES (Lower Cretaceous/Berriasian)--Calcareous lithic wacke and arenite; light gray, thin-bedded, fine- to very fine-grained, with interbeds of dark gray mudstone; interpreted here to be a facies of the turbidite complex of the Gravina Belt; greater than 330 m thick (Muffler, 1967); age based on fossils from two localities (Muffler, 1967); crops out near Pt. Hamilton on Kupreanof Island and north of Kadake Bay on Kuiu Island. The latter locality is important because (assuming that this unit is part of the Gravina belt sequence) the relations there suggest a disconformable contact of this unit over the Upper Triassic Hound Island Volcanics.

HYD GROUP (Upper Triassic)--Named by Loney (1964) from exposures in Gambier and Pybus Bays on Admiralty Island; extended to the Keku Islets area and redefined by Muffler (1967); as mapped, divided into:

Trhh — Hound Island Volcanics--Basaltic pillow breccia and pillow lava flows, andesitic volcanic breccia, aquagene tuff, tuff breccia, minor thin-bedded limestone; unit thickness ranges from a few 100's of m to more than 650 m; basaltic flows are massive and range from 70 cm to 15 m

thick and are polygonally jointed with vesicular tops. Age is late Karnian to late Norian based on 22 fossil collections (Muffler, 1967). Most outcrops are on the Keku Islets and nearby shores of Keku Strait. Paleomagnetic determinations from the unit were reported by Hillhouse and Grommé (1980).

[Trhl] Hamilton Island Limestone--Limestone, mudstone, and calcarenite; generally very thin-bedded (1-30 cm) dark-gray aphanitic limestone (locally dolomitic), minor black claystone layers and thin to medium beds of dark-green calcarenite; highly folded, but probably a few 100 m thick. Age is late Karnian to perhaps earliest Norian based on 16 fossil collections (Muffler, 1967). Most outcrops are on Hamilton Island, the north side of Hamilton Bay, or on the northeastern Keku Islets. Coeval with the Cornwallis Limestone.

[Trhc] Cornwallis Limestone--Limestone and calcarenite; dominantly medium- to very thick-bedded (10 cm-1 m) medium gray oolitic limestone, minor pebble calcarenite with clasts of chert and limestone from the Pybus Formation; at least 60 m thick. Age is late Karnian to earliest Norian based on 3 fossil collections (Muffler, 1967). Crops out on northeast side Cornwallis Peninsula on Kuiu Island. Coeval with Hamilton Limestone.

[Trhb] 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, depending on which unit it overlies; minor interbedded medium- to very thick-bedded light-brown-weathering medium-gray-fresh, calcarenite and fossil fragmental limestone with abundant terrigenous debris; also minor light-brown-weathering limestone and dark-gray fetid sandy and silty limestone similar to that in the overlying Hamilton Limestone; up to 50 m thick. Age is early to perhaps early late Karnian based on 2 fossil collections (Muffler, 1967). Crops out on the northwestern Keku Islets, near Cape Bendel on Kupreanof Island, and in the Hamilton Bay/Hamilton Island area.

[Trk] KEKU VOLCANICS (Upper Triassic)--Altered felsic flows and flow breccia; flow-banded, aphanitic, feldspar-microporphyritic; minor mafic flows and flow breccia, volcanic wacke, volcanic conglomerate, gray medium-grained sandstone, polymictic pebble conglomerate, green aquagene tuff, and thick-bedded gray oolitic limestone; lenticular, but as much as 330 m thick; forms extensive beaches and inland outcrops. Age is Late Triassic, probably early to late Karnian, based on 3 fossil collections (Muffler, 1967). Named by Muffler (1967) for the outcrops on the Cornwallis Peninsula and adjacent Keku Islets.

[Pp] PYBUS FORMATION (Lower Permian)--Limestone, dolomite, and chert; conspicuous cliff-forming medium-bedded to massive non-bedded coarsely crystalline white to very light gray dolomitic limestone with light gray replacement chert as thin beds, nodules, fragments, and crosscutting masses; minor coarse-grained light gray limestone, fetid medium-gray dolomite near top of unit; 80 to 160 m thick; abundant silicified brachiopod fauna has been studied extensively (Buddington and Chapin, 1929; R. E. Grant, written commun., 1968; Grant, 1971); collections noted by Muffler (1967) indicate a Leonardian age as do 4 collections made during our study (J. T. Dutro, Jr., written commun., 1983). Named by Loney (1964) and redefined by Muffler (1967). Crops out on Cornwallis Peninsula of Kuiu Island south to head of Saginaw Bay, on Keku Islets, in Hamilton Bay area and adjacent part of Kupreanof Island, and near Cape Bendel on Kupreanof Island.

HALLECK FORMATION (Lower Permian)--Named by Muffler (1967) from exposures in Halleck Harbor, Saginaw Bay, Kuiu Island; as mapped, divided into:

Phl — Siltstone, Sandstone, Limestone, and Conglomerate--At Saginaw Bay, dominantly dark-gray very calcareous siltstone that grades into silty limestone, minor intercalated thin beds of fossil fragmental limestone, and very fossiliferous medium-bedded crossbedded medium-gray weathering calcareous sandstone, some small bioherms; in Keku Islets, dominantly thick-bedded polymictic pebble and cobble conglomerate with rounded clasts of chert, felsic volcanic rock, and minor limestone derived mostly from Cannery Formation (Jones and others, 1981); minor dark-gray calcareous siltstone and thin- to medium-bedded medium gray fine- to coarse-grained crossbedded sandstone; complexly folded locally, but probably 220 m thick at Saginaw Bay. Age is Leonardian based on collections discussed by Muffler (1967) and(or) late Wolfcampian based on two collections made during our study (R. G. Douglass, written commun., 1980; J. T. Dutro, Jr., written commun., 1983)

Phb — Volcanic Rocks--Olivine-rich basalt, pillow flows, pillow breccias, and angular breccias; masses up to a few 100 m thick intercalated with sedimentary rocks of above unit in Saginaw Bay.

Cl — CRINOIDAL LIMESTONE (Pennsylvanian)--Medium-bedded to massive, white or medium gray fresh, weathers white, contains crinoids, brachiopods, corals, and (locally) fusulinids; at least a few hundred meters thick. Age considered Mississippian or Pennsylvanian by Muffler (1967) on the basis of three fossil collections; reexamination of those collections, one other old collection, and examination of two new collections (J. T. Dutro, Jr., written communs., 1983) now indicates a late Early to Middle Pennsylvanian age and no Mississippian age fossils are recognized. Informally named by Muffler (1967).

CDs — SAGINAW BAY FORMATION (Pennsylvanian and Devonian)--Basaltic(?) aquagene tuff and pillow breccia, black chert, chert and limestone, and silty limestone; considered Carboniferous by Muffler (1967), but new fossil evidence supports the revised age. Four members are exposed in Saginaw Bay and the northeast side of Cornwallis Peninsula, Kuiu Island, and on one Keku Islet; mapped here as one unit, but described separately below from youngest to oldest with the revised age information: Silty limestone member--thin- to medium-bedded brown-weathering, medium-gray fossil fragmental and clastic limestone with chert debris, minor light-gray weathering bioherms, conglomerate near the base; about 90 m thick. Age is early Middle Pennsylvanian based on Muffler's (1967) discussion. Chert and limestone member--Thin- to medium-bedded light-brown-weathering calcareous chert and minor, locally dolomitic medium-gray cherty fossil fragmental limestone, some light-gray-weathering, tan-fresh biostromal limestone; about 120 m thick. Age is late Early to Middle Pennsylvanian based on unspecified fossils in two collections (J. T. Dutro, Jr., written commun., 1983). Black chert member--Thin-bedded black chert, minor thin-bedded dense dark-gray limestone; thickness not known. Age is not known directly. Volcanic member--massive light-greenish-gray medium- to coarse-grained aquagene tuff and subordinate broken and isolated-pillow breccia; some thin-bedded limestone, tuffaceous sandstone; thickness locally about 160 m. Age considered probably Mississippian by Muffler (1967) on the basis of fossils from Keku Islets, but conodonts from the Saginaw Bay exposures give a latest Early through earliest Late Devonian age (A. G. Harris, written commun., 1980). This member may correlate with the Volcanic Graywacke and Argillite Unit (DSvg) described below. Thus, as shown on the map the formation ranges in age from Early Devonian to Middle Pennsylvanian and probably includes a significant hiatus. Named by Muffler (1967) from exposures at the head of Saginaw Bay.

MDc CANNERY FORMATION (Mississippian and Devonian)--Thin-bedded 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-bedded dark gray chert, silicified argillite, pillow flows, and gray clastic limestone; at least 600 m, and possibly 1,200 to 1,500 m thick. Age considered Permian by Muffler (1967) based on two fossil localities; one of which is Permian in age but is from rocks now mapped as Pybus Formation, and on the original age assigned by Loney (1964). More recent studies (Jones and others, 1981) have shown that the Cannery Formation in this map area is Late Devonian to Early Mississippian in age. Four collections made during this study contain Late Devonian to Mississippian radiolarians (D. L. Jones, written communs., 1981, 1982). One new collection from rocks mapped as Cannery Formation on upper Hamilton Creek, Kupreanof Island, contains Upper Triassic conodonts (B. Wardlaw and A. G. Harris, written commun., 1983) and those rocks probably should be mapped as the Greenschist, Chert, Limestone, and Argillite Unit (Mzm) of the Gravina Belt; however, they lack the structural features that typify that unit. Named by Loney (1964) for exposures at Cannery Bay on Admiralty Island. As mapped, includes:

MDcv Volcanic rocks--Altered pillow flows and greenstone, probably andesitic composition, gray to greenish-gray-weathering, fine-grained.

D1 LIMESTONE (Upper Devonian)--Thin-bedded dark-gray fetid limestone, weathers brownish-gray, locally cherty; minor laminae of gray calcareous siltstone, weathers dark brown. Age is Upper Devonian based on two fossil collections (Muffler, 1967).

PRINCE OF WALES ISLAND SEQUENCE (Devonian to Ordovician)--Informally named here to emphasize the island-arc depositional situation that persisted from Ordovician through Early Devonian time; as mapped, divided into:

Volcanic and Associated Rocks, divided into:

DSva Red Arkose (Devonian(?))--Medium- to thick-bedded, medium-grained, red weathering; some interbedded siltstone; extensively intruded by dikes and irregular masses of distinctive altered red-or dark-green-weathering feldspar porphyry that is confined to this unit. Age is unknown and the unit is probably entirely fault bounded. Muffler (1967) suggested a Late Silurian age based on general field relations; we suggest that it correlates lithologically with part of the Karheen Formation (Eberlein and Churkin, 1970; Eberlein and others, 1983) of Early Devonian age.

DSvg Volcanic Graywacke and Argillite (Devonian(?))--Medium- to thick-bedded dark-gray calcareous feldspathic volcanic graywacke, grades locally into pebble and cobble conglomerate with altered red porphyritic volcanic rock and argillite clasts; some calcareous volcanic argillite. Age is Late Silurian according to Muffler (1967), based on two collections, one a graptolite locality of probably early Ludlow age and the other a mollusk collection of probable Middle Devonian age; two collections made in the course of this study suggest a Devonian age (S. H. Mamay, written commun., 1980) and a possible middle Early Devonian age (E. L. Yochelson and J. T. Dutro, Jr., written commun., 1980). Most of the evidence now favors an Early Devonian age and this unit and the (lowest) volcanic member of the Saginaw Bay Formation (CDs) may be facies equivalents.

DSvb Volcanic Breccia (Silurian(?))--Massive, dark-reddish-gray-weathering, altered porphyritic andesitic(?) breccia; some agglomerate or volcanic cobble conglomerate; minor altered gray

and greenish-gray flows of probable intermediate composition; rare thick-bedded volcanic graywacke. Age is unknown and outcrop is fault-bounded; Muffler (1967) suggested a Silurian or Devonian age based on general field relations. We suggest that the unit may be a fault slice of a local volcanic unit such as the Volcanic Breccia and Agglomerate Unit (Stbv) associated with the Upper to Lower Silurian Bay of Pillars Formation.

Carbonate Rocks and Associated Conglomerates (Upper to Lower Silurian): These extensive carbonate units--the Kuiu Limestone and the Heceta Limestone--are interpreted to have formed as fringing reefs or carbonate banks in an island-arc environment dominated by volcanic turbidites. They probably range in age and are not a single stratigraphic horizon. The associated polymictic conglomerates probably represent several separate channels at different horizons carrying material from distant sources. Divided into:

Sck — Kuiu Limestone--Massive, poorly bedded, dense, brownish-gray weathering limestone; some sedimentary breccia; probably 750 m thick southwest of Saginaw Bay; age is Late Silurian, based on Muffler's (1967) discussion of four fossil localities; two new localities (A. G. Harris, written commun., 1980; W. A. Oliver, Jr., written commun., 1980) contain forms that range in age from Late Silurian to middle Early Devonian. Named by Muffler (1967) from the exposures southwest of Saginaw Bay; as mapped, also includes:

Sckc — Polymictic Conglomerate, Thin-Bedded Limestone, and Massive Limestone--Polymictic conglomerate interbedded with thin-bedded limestone and massive limestone; rounded clasts to 15 cm maximum dimension of gray and green chert, gray limestone, red feldspar porphyry, red siltstone, and--locally--of limestone, coral masses, arkose, pebble conglomerate, and green volcanic rock. Age inferred by Muffler (1967) to be Late Silurian; two new collections range from Late Silurian to as young as middle Devonian in age (W. A. Oliver, written commun., 1980).

Sch — Heceta Limestone--Massive or thick-bedded, fine-grained limestone, minor limestone breccia, sandstone, mudstone, and pods of polymictic conglomerate; commonly fractured, locally fossiliferous, light- to medium-dark gray fresh, buff weathered, forms rough pockety surfaces in tidal zone and karst topography inland; thickness probably greater than 4,000 m in some exposures. Age is Middle and Late Silurian according to Eberlein and Churkin (1970) based on discussion of several collections; Eberlein and others (1983) extended the lower age limit to include late Early Silurian; several new collections confirm this assignment. Named by Eberlein and Churkin (1970) for exposures on Heceta Island in the Craig map-area to the south; other exposures discussed in detail by Ovenshine and Webster (1970); as mapped, also includes:

Schc — Polymictic Conglomerate Intercalated with Heceta Limestone--Pebble and cobble conglomerate, sedimentary breccia, fine- to coarse-grained graywacke, siltstone, and mudstone; in discontinuous lenses and large pod like bodies; some

oligomictic chert pebble or limestone pebble conglomerate, but commonly polymictic, with clasts to 20 cm of porphyritic andesite, gray-green and black chert, limestone, vein quartz, graywacke, granitic and gabbroic composition; thickness highly variable but must be in excess of 2,000 m in places. Age is inferred through the age of the related Heceta Limestone.

Scp — Polymictic Conglomerate--Pebble and cobble conglomerate and other clastic rocks like those described above the Polymictic Conglomerate Intercalated with Heceta Limestone Unit (Schc), but which occur between the Heceta Limestone (Sch) and the Graywacke Mudstone, Turbidites, and Limestone Unit (DStbg) of the Bay of Pillars Formation; thickness probably greater than several thousand m locally. Age is not known directly, but is inferred from the age of the adjacent units noted above.

Turbidites and associated rocks (Upper Silurian to Lower Ordovician): These very extensive turbidite, conglomerate, and volcanic units--the Bay of Pillars and Descon Formations--are interpreted to be the dominant feature of a long-lived island-arc environment. The two formations probably grade into one another. The limestones, conglomerates, and volcanic units that are mapped separately probably vary in age and do not represent persistent stratigraphic horizons. Divided into:

Bay of Pillars Formation on Kuiu and western Prince of Wales Islands (Upper to Lower Silurian)--Dominantly graywacke, mudstone, and calcareous mudstone turbidites, with subordinate conglomerate, limestone, and intermediate to mafic volcanic flows, breccia, and tuff. Sedimentary features in sandstone turbidites include massive, amalgamated beds, channelized beds, graded beds with Bouma sequences, and chaotically deformed slump deposits. Associated polymictic conglomerates are massive to channelized and cross-bedded. Ubiquitous limestone turbidites are rhythmically bedded with carbonaceous partings. Isolated exposures of volcanic rocks are massive and generally brecciated. Sandstones are extremely variable in composition. Three dominant varieties include calcareous graywacke, volcaniclastic graywacke, and quartzofeldspathic graywacke. Sediment immaturity and rapid local changes in sandstone composition suggest local sources. Proximal turbidite facies and cross-bedding in conglomerates suggest shallow to moderate water depths; map pattern suggests local volcanic centers with associated carbonate reefs, and a dominant regime of graywacke turbidite deposition, with calcareous turbidites occupying interchannel areas. The Bay of Pillars Formation was named and defined by Muffler (1967) from exposures on Kuiu Island. It is mapped on Kuiu, Kosciusko, and northern Prince of Wales Islands. Stratigraphic intercalation as well as incorporation of large angular boulders of limestone similar to the Heceta suggests a facies relationship with that unit. Well rounded syenite porphyry cobbles indicate a distinctive source terrane for the conglomerates. Preliminary structural and paleocurrent data suggests deposition of Bay of Pillars sediments in basins between a syenite-bearing landmass to the west and volcanic/carbonate centers to the east. Unit thickness probably exceeds a few thousand meters. Bay of Pillars rocks are locally hornfelsed by Mesozoic and Tertiary plutons. Graptolite

collections made during this study range in age from middle Llandoverian to early Ludlovian (Claire Carter, written commun., 1980). Differs from the Descon Formation because it has significantly less volcanic debris, both as units and as individual clastic grains. It also is mostly younger than the Descon. As mapped, divided into:

Stbg — 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. Mutti and Ricchi-Lucci turbidite facies represented are dominantly B and C "inner fan" channel facies, with associated A conglomerates and E overbank deposits. Soft sediment deformation is common. The graywackes are immature, consisting of poorly sorted angular clasts with extreme compositional variability over short distances laterally and vertically. The three dominant varieties are: 1) calcareous graywacke with carbonate clasts, fossil fragments, subordinate feldspar, quartz, and volcanic rock fragments, and patchy recrystallized carbonate matrix; 2) volcaniclastic graywacke consisting mainly of felted intermediate to mafic volcanic rock fragments, with subordinate grains of feldspar, monocrystalline, embayed quartz, occasional fossil fragments, and chloritic or clayey matrix; and 3) quartzofeldspathic graywacke with detrital biotite and potassium feldspar, and with locally calcareous or clayey matrix. In all three types rare grains of microcrystalline quartz, epidote, volcanic shards, and felsite may be found. No white mica or metamorphic rock fragments were seen. Calcareous graywackes are ubiquitous, and often grade to limestone interbeds. The volcaniclastic graywackes are most characteristic around northernmost Affleck Canal, Port Malmesbury, Bay of Pillars, and Security Bay on Kuiu Island. Quartzofeldspathic graywackes occur in the vicinity of Table Bay and Explorer Basin on the west side of Kuiu Island.

Stbc — Polymictic Conglomerate--Polymictic conglomerate, typically massive or thick-bedded and channelized; occasionally cross-bedded. Clast populations vary as do the graywacke compositions, but generally include, in order of decreasing abundance, graywacke, mudstone, volcanic rock, limestone, and syenitic to dioritic intrusive rock. Well-rounded syenite cobbles are distinctively pink and K-feldspar porphyritic. Graywacke and mudstone clasts vary in degree of roundness. Volcanic and carbonate clasts are generally large and angular relative to other clasts. Conglomerates tend to map as NNW-SSE trending belts, such as from the head of the Bay of Pillars to Alvin Bay on Kuiu Island, suggesting paleochannels.

Stbo — Olistostrome Blocks of Heceta Limestone in Turbidite Matrix--Disrupted blocks of Heceta(?) limestone in massive calcareous sandstone matrix, and intraformational limestone conglomerate, interpreted as olistostromes (Ovenshine and Webster, 1970). Best exposed south of Alvin Bay on Kuiu Island and on islands in Sumner Strait.

Stbl — Limestone and Limestone Turbidites--Thin- to medium-

rhythmically bedded carbonaceous 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, particularly well-exposed on Windfall Islands west of Explorer Basin on Kuiu Island. The limestone turbidites are interpreted as interchannel and overbank deposits based on their map distribution and fine texture. More massive limestones may represent slope facies deposits. Occasionally limestone layers contain sorted algal or fossil fragments.

Stbv — Volcanic Breccia and Agglomerate--Massive, dull green volcanic breccia, agglomerate, and flows. Compositions of volcanic rock range from intermediate to mafic, hypocrystalline to augite and feldspar porphyritic greenstone, with a felted plagioclase-epidote-chlorite groundmass. Discrete occurrences are mapped south Port Beauclerc and near Alvin Bay on Kuiu Island.

Bay of Pillars Formation on Northeastern Prince of Wales Island (Upper(?) to Lower Silurian)--Graywacke and siliceous mudstone turbidites. Amalgamated beds, full Bouma sequences, and high sand/shale ratios suggest a proximal turbidite facies association. Rhythmically bedded limestones, polymictic conglomerate, and volcanic agglomerate and breccia are intercalated with the graywackes. Sandstones and conglomerates are volcaniclastic, immature, and probably reflect local sources (Claire Carter, written commun., 1980). All graptolite collections to date are of Early Silurian age. The unit is distinguished from Bay of Pillars rocks on Kuiu and western Prince of Wales Islands by a more volcaniclastic and less calcareous composition. As mapped, divided into:

Stpg — Graywacke, Slate, and Limestone--Greenish gray, buff weathering, volcaniclastic graywacke and argillite turbidites. Massive to amalgamated, graded, and rhythmic beds corresponding to Mutti and Ricchi-Lucci A, B, C, and E turbidite facies, suggest a proximal depositional environment in moderate water depths. Graptolites may be found on argillaceous bed parting surfaces. Local soft sediment deformation is typically associated with calcareous layers or lenses. Andesite dikes cut this unit east of Salmon Bay.

Stpc — Conglomerate, Agglomerate, and Volcanic Breccia--Predominantly volcaniclastic polymictic conglomerate, and volcanic breccia and agglomerate of intermediate to mafic, feldspar and dinopyroxene porphyritic composition. Massive occurrences of coarse volcaniclastic rock may be found on some of the Islands in Clarence Strait north and west of the Blashke Islands.

Descon Formation (Lower Silurian to Lower Ordovician)--Massive graywacke, graywacke and argillite turbidites, siliceous graptolitic shale, polymitcic conglomerate, bedded limestone and limestone breccia, and mafic volcanic sills, flows, and tuffs. Sandstone and conglomerates range from predominantly volcaniclastic to polymictic, including graywacke, shale, chert, limestone, and felsic to gabbroic lithic fragments together with the volcanic grains. The Descon Formation crops out on

northeastern and northwestern Prince of Wales Island and in the vicinity of Davidson Inlet, Kosciusko Island. These rocks are locally metamorphosed to greenschist facies. Thickness exceeds 3,000 meters. Graptolites from the Descon Formation yield ages ranging from Tremodocian (Early Ordovician) to Llandoverian (late Early Silurian) (Claire Carter, written commun., 1980; Eberlein and others, 1983). This unit is more siliceous and contains more volcanic material than the Bay of Pillars Formation. Named by Eberlein and Churkin (1970). As mapped, divided into:

SOtdg — Graywacke--Grayish green, buff weathering, volcaniclastic graywacke and siliceous shale. Massive amalgamated beds, graded beds, and full Bouma sequences, thin rhythmic beds, slump deposits, sedimentary breccia and conglomerate suggest a proximal depositional environment. Sandstones and conglomerates include mainly mafic volcanic rock fragments, with feldspar, quartz, graywacke, mudstone, chert, limestone, and plutonic rock fragments in a chloritic matrix. Graptolites are found on siliceous argillite bed partings. Some greenschist facies sandstones are pyritic.

SOtdl — Limestone--Intraformational calcareous breccia and conglomerate, including fossil hash, occurs stratigraphically above polymictic conglomerate at Port Protection on northwestern Prince of Wales Island.

GRAVINA BELT

The term Gravina belt is used here to denote sedimentary and volcanic rocks of Late Jurassic and Early Cretaceous age (and the pre-Cenozoic granitic and other rocks intrusive into that section) in the east-central part of the map area. As used here, the term also includes rocks of indeterminate Mesozoic age in a broad zone to the west of and adjoining the Jurassic and Cretaceous rocks. This zone is called the Duncan Canal-Zarembo Island-Screen Island sub-belt and it has within it blocks of Paleozoic and Mesozoic rocks unlike any elsewhere in the Gravina belt, but similar to some in the Alexander belt. The Gravina belt as used here more or less corresponds to the Gravina belt as defined by Berg and others (1978), but the map distribution does not correspond because of newer information and differing interpretations.

INTRUSIVE ROCKS OF ADMIRALTY-REVILLAGIGEDO PLUTONIC BELT AND ASSOCIATED MIGMATITE (Upper Cretaceous)--Belt informally named by Brew and Morrell (1983); preliminary K-Ar determinations by M. A. Lanphere (written communs., 1981, 1982) interpreted to be applicable to the whole suite are as follows:

Map unit	General location	Biotite age	Hornblende age
Ktif	Wrangell Is.	83.2 Ma	91.6 Ma
"	Mitkof Is.	-	89.1 Ma
Ktef	Zarembo Is.	90.4 Ma	93.0 Ma

Similarly dated rocks occur in lithically correlative units to the east in the Bradfield Canal quadrangle (R. L. Elliott and R. D. Koch, oral commun., 1982). The Biotite-Pyroxene-(Hornblende-) Monzodiorite, etc. Unit (Kqo) mapped in the Missionary Range somewhat resembles the Hornblende Quartz Monzodiorite, etc. Unit (Kwqo) on northwestern Prince of Wales Island and may be part of the Chilkat-Prince of Wales plutonic province and slightly older than the other plutonic rocks in this belt. The rocks in these units are described also by Burrell (1984a, b, c). As mapped, divided into:

Ktef — Hornblende-Biotite Tonalite and Granodiorite, Quartz Monzodiorite, and Quartz Diorite--Foliated to massive equigranular; average grain size is medium, fine-grained near some margins; C.I. 17 to 50; light to medium

gray fresh, weathers brownish to dark gray. Foliation varies both in direction and development: moderately developed in west to very well developed on east side of Wrangell Island; locally semischistose and cataclastic. Contains aplite dikes, pegmatite dikes and veins, rounded very fine-grained hornblende diorite inclusions. Generally concordant intrusions as sills with country rock and screens of country rock in margin of body. Mineralogy includes zoned, complexly twinned plagioclase with minor alteration to sericite; mafic minerals usually biotite greater than hornblende; subhedral epidote; and local garnet and pyroxene. Accessory minerals are sphene, apatite, opaque minerals and allanite. Unit differs from Hornblende-Biotite Tonalite, Granodiorite, etc. unit (Ktif) by presence of pyroxene and garnet, and biotite as the dominant mafic phase. Unit is exposed on Etolin, Wrangell, Dry, Farm and Sergief Islands (Burrell, 1984b).

Ktif — Hornblende-Biotite Tonalite, Granodiorite, Quartz Monzodiorite, and Quartz Diorite--Equigranular to sparsely porphyritic, massive to weakly foliated; medium-grained; C.I. 14 to 52; light gray fresh, weathers yellowish-gray. Rounded, elongate very fine-grained dioritic and local ultramafic inclusions. Mineralogic features include oscillatory zoned seriate plagioclase, both discrete and small clumps of biotite and hornblende, subhedral epidote and clinozoisite (mutually exclusive), rare garnet, and accessory sphene, allanite, and apatite. Alteration includes plagioclase to sericite and mafic minerals to epidote. Unit differs from Hornblende-Biotite Tonalite and Granodiorite, etc., unit (Ktef) by lack of pyroxene and garnet and better development of seriate plagioclase. Hornblende-Biotite Tonalite unit (Ktop) is a porphyritic variation of this unit. Exposed on Mitkof, Zarembo, and Woronkofski Islands (Burrell, 1984a, b).

Ktop — Hornblende-Biotite Tonalite--Porphyritic, locally foliated; medium- to coarse-grained; C.I. 15 to 40; medium to dark gray fresh, brownish-gray weathered; local alignment of plagioclase laths defines foliation; rare hornfels inclusions; aplitic granite dikes, pegmatite veins, and tonalite dikes into country rock at margins produce interfingering contacts. Plagioclase porphyritic with local reddish-brown garnet phenocrysts; garnet-rich and -poor zones locally define layers. Mineralogic features include zoned seriate plagioclase with minor alteration to sericite; mafic minerals mostly in clumps; epidote and zoned garnet present; accessory sphene, apatite, and allanite, some biotite alteration to chlorite. Body on southwestern Mitkof is quartz monzodiorite in composition. Unit is gradational with Hornblende-Biotite Tonalite, Granodiorite, etc. unit (Ktif), but differs in its porphyritic texture and ubiquitous garnet. Unit differs from Biotite-Epidote-Hornblende Quartz Monzodiorite Unit (Kqop) by the dominance of biotite over hornblende, larger hornblendes with poorer crystal form and (locally) abundant inclusions, presence of garnet, and clumps of mafics as opposed to discrete mafics. Unit differs from Biotite Tonalite, Quartz Diorite and Granodiorite unit (Ktgp) in abundance of hornblende and a higher color index. Exposed on Lindenberg Peninsula, Mitkof, Rynda, Kadin, Woronkofski, and Wrangell Islands (Burrell, 1984b), and in Ernest Sound.

Ktoc — Garnet-Biotite Tonalite and Minor Granodiorite--Nonfoliated crowded plagioclase rock; inequigranular to porphyritic; very fine- to medium-grained; C.I. 14 to 29; medium gray fresh; weathers light gray; forms small elongate bodies less than 3 square km in area; also makes up one larger body on northern Wrangell Island. Mineralogy includes reddish-brown garnet, clinozoisite (or rarely epidote) and local muscovite.

Biotite and quartz commonly interstitial to closely spaced plagioclase laths. Unit is similar to Biotite Tonalite, Quartz Diorite, and Granodiorite unit (Ktgp) mineralogically, but differs texturally by its finer grain size and lack of large phenocrysts. Exposed on northern Wrangell, Mitkof, Woronkofski and Etolin Islands (Burrell, 1984b).

Kqop — Biotite-Epidote-Hornblende Quartz Monzodiorite--Locally foliated; plagioclase porphyritic with medium- and coarse-grained phenocrysts (to 12 mm), fine- to medium-grained groundmass (to 3 mm) and a C.I. range of 17 to 48; weathers brownish-gray, gray and white fresh; body margins are commonly more mafic and have a very fine- to fine-grained groundmass; also common are muscovite-biotite garnet-epidote aplite dikes of granitic and granodioritic composition. Mineralogical features include oscillatory zoned plagioclase with sericite alteration of the cores; interstitial quartz and K-feldspar, euhedral fine-grained hornblende, minor biotite, and primary (occasionally twinned and zoned) and secondary epidote. Unit is exposed on the Lindenberg Peninsula, Kupreanof Island, and on southwestern Mitkof, Woronofski and northern Zarembo Islands. Where mapped on northern Dry Island and eastern Mitkof Island, the compositions range from quartz monzodiorite to tonalite (Burrell, 1984a, b).

Ktgp — Biotite Tonalite, Quartz Diorite, and Granodiorite--Porphyritic and foliated; medium- to coarse-grained; C.I. 11 to 35; cut by pegmatite and basalt dikes; local cataclastic texture; inclusions of country rock. Mineralogical features include zoned, complexly twinned plagioclase, quartz, interstitial K-feldspar, partly chloritized biotite, epidote, minor local hornblende; and garnet, sphene, apatite and allanite as accessories. The unit on Etolin Island lacks K-feldspar and shows moderate to extreme alteration of plagioclase, biotite, and garnet. Unit differs from Biotite-Epidote-Hornblende Quartz Monzonite unit (Kqop) by lack of hornblende and presence of garnet.

Kqo — Pyroxene-Biotite-Hornblende-Quartz Monzodiorite, Quartz Diorite, Monzodiorite, and Diorite--Locally foliated; equigranular; medium-grained, fine- to medium-grained near margins; C.I. 20 to 61; black and white to medium gray fresh, weathers brownish-gray to orangish-gray. Mafic inclusions, quartz and pegmatite veins and diabase dikes present. Mineralogical characteristics include anhedral, commonly poikilitic hornblende with pyroxene, biotite and plagioclase inclusions, anhedral biotite, and pyroxene. Plagioclase is twinned, zoned,and very closely packed. Plagioclase, K-feldspar, and quartz form the groundmass. On Northern Lindenberg Peninsula biotite, opaques and clinopyroxene are common in the northern part of the Missionary Range body. Hornblende appears and increases in abundance as pyroxene and opaque minerals decrease in abundance to the south. Hornblende, when present, is usually the dominant mafic mineral. Unit is exposed on northern Lindenberg Peninsula and central Mitkof Island (Burrell, 1984a).

Kdi — Hornblende Diorite--Hornblende diorite, quartz diorite, and minor tonalite; medium- to very-coarse-grained; C.I. 15 to 50; equigranular, except for local crowded plagioclase porphyry like the Hornblende-Biotite Tonalite unit (Ktop); weathers light to dark green; highly altered to epidote- and chlorite-rich rock. Crops out on Woewodski Island. Differs from other Cretaceous granitic rocks in the high degree of alteration.

Kmgf — MIGMATITE (UPPER CRETACEOUS)--Varied migmatitic rocks, mainly agmatite and irregular banded gneiss, in zones between the Hornblende-Biotite

Tonalite and Granodiorite, etc. unit (Ktef) and the Metamorphosed Stephens Passage Group Rocks (see below); the granitic leucosomes generally resemble the main rock types in the above-mentioned (Ktef) unit; the metamorphic melasomes are fine- to medium-grained (garnet-) (sillimanite-) biotite hornfels, schist, and semischist. Crops out only on southwestern Wrangell, southeastern Etolin, and nearby small islands.

METAMORPHOSED STEPHENS PASSAGE GROUP ROCKS (Upper Cretaceous)--In general, these units are associated with the Upper Cretaceous and Tertiary plutons (of the Kuiu-Etolin Belt) in the Gravina Belt, but the eastern parts of these units adjoin the metamorphic rocks of the Mainland Belt. The rocks have been rather arbitrarily assigned an Upper Cretaceous age and are described here or assigned a Tertiary age and described elsewhere as "Hornfelsed Seymour Canal Formation Rocks (Tsh) based on the known or inferred age of the pluton(s) nearby; this results in a potentially misleading map pattern, however, because the metamorphic rocks adjacent to Tertiary plutons may have undergone Upper Cretaceous metamorphism as well and the units that are based on Tertiary metamorphic effects are poorly defined. The Cretaceous age assignment used here is also not entirely satisfactory from either a field mapping or petrographic study viewpoint; this is due to both the complexity of spatial overlapping metamorphic effects and the apparent lack of an unmetamorphosed equivalent of the Phyllite, Etc. Unit (Ksp) in the Stephens Passage Group. In addition, the present scheme combines into one unit (Schist and Hornfels (Kss)) rocks whose present make-up is dominantly the result of essentially static metamorphism associated with the intrusion of the rocks of the Admiralty-Revillagigedo Plutonic Belt at about 90 Ma and those that record the dynamic regional metamorphism that preceded the intrusion of the rocks of the Klukwan-Duke Plutonic Belt at about 100-110 Ma (Brew and Ford, 1984a, b; Brew, 1983b). As mapped, divided into:

Ksg — Greenstone and Greenschist--Subgreenschist to greenschist facies rocks within the Phyllite Unit (Ksp) on Lindenberg Peninsula, Kupreanof Island; dominantly fine- to medium-grained, relict pyroxene-phenocryst-bearing epidote-albite-chlorite greenstone; poorly foliated, weathers dark greenish gray, grayish-green fresh; probably derived from intermediate composition volcanic breccias; forms poor rounded outcrops. Some greenschist and green phyllite, although most of the latter has been mapped with the Phyllite Unit (Ksp). Age inferred from relation to that same unit.

Kss — Schist and Hornfels--Greenschist and albite-epidote to hornblende-hornfels facies metamorphic rocks derived from Seymour Canal Formation turbidites and related rocks (KJss); original textures and structures generally preserved; dominantly fine- to medium-grained, grayish-brown and reddish-brown weathering, locally foliated, commonly compositionally layered chlorite-biotite-quartz-feldspar schist and semischist; minor phyllite; some strongly hornfelsed rocks close to plutons; clear-cut aureoles around Upper Cretaceous plutons are (garnet-andalusite-staurolite-) biotite-quartz-feldspar hornfels and schistose hornfels; some calc-silicate and intermediate composition layers and lenses locally. Age of metamorphism varies as described in headnote above; age of protolith is Late Jurassic to middle Cretaceous based on derivation of this unit from the Seymour Canal Formation.

Ksp — Phyllite--Subgreenschist and greenschist facies metamorphic rocks inferred to be derived from fine-grained sediments associated with the turbidites of the Seymour Canal Formation (KJss); original textures and

structures generally obscure; dominantly very-fine-grained, dark-gray weathering, carbonaceous chlorite-quartz-feldspar phyllite; some interlayered graywacke and graywacke semischist; locally extensive layers and lenses of very-fine-grained, light to dark-green weathering chlorite-rich phyllite interpreted to have been metamorphosed from fine-grained volcanic sediments such as tuffs or from highly transposed and tectonized coarser grained intermediate composition rocks. Age interpretation is the same as that given above for the Schist and Hornfels Unit (Kss).

INTRUSIVE ROCKS OF KLUKWAN-DUKE PLUTONIC BELT (Cretaceous): Belt informally named by Brew and Morrell (1983); rocks interpreted to be 100-110 Ma on the basis of their similarity to dated rocks elsewhere (Lanphere and Eberlein, 1966) and on a preliminary K-Ar age of 107 Ma from the pluton at Turn Mountain on Kupreanof Island (M. A. Lanphere, oral commun., 1983). See also Taylor and Noble (1960) and Taylor (1967). As mapped, divided into:

Kuk — Ultramafic Complex at Kane Peak--Complex (Kennedy and Walton, 1946; Walton, 1951a, b) not dated but probably similar in age to Blashke Islands complex; consists of undivided wehrlite, dunite, and clinopyroxenite. Wehrlite--most abundant, massive to locally layered on 1 to 10 cm scale; medium-grained; C.I. 100; weathers brown, greenish-gray to dark gray on fresh surfaces; partially serpentinized; scattered inclusions of clinopyroxenite and sparse hornblendite dikes. Dunite--next most abundant rock type, grades from wehrlite; massive, partially serpentinized; medium-grained; C.I. 100; weathers yellowish-brown, fresh surface gray to dark gray. Olivine pyroxenite--massive to locally layered on 1 to 5 scale; medium-grained; C.I. 100; weathers dark green, greenish-gray on fresh surface; tends to form narrow discontinuous zone around margin, interrupted by massive, hornblendite along northern contact. Zonation poorly developed, no evidence of homogeneous dunite core or gabbro margin; above major rock types gradational. Intruded by Upper Cretaceous granitic body adjacent to north.

Khb — Hornblendite--Hornblendite and hornblende gabbro; locally compositionally layered, fine- to medium-grained, weathers dark grayish-green to black, C.I. 70 to 100; locally cut by granitic rocks like those of nearby Upper Cretaceous plutons, but on Sukoi Islets appears to cut some granitic bodies. Also exposed on northeast shore Mitkof Island, southeast side Woronkofski Island, on islets in Zimovia Strait, and in a large body on northwestern Kupreanof Island at Turn Mountain that is interpreted to be the outer envelope of an Alaska-type mafic/ultramafic pluton (Taylor, 1967).

STEPHENS PASSAGE GROUP (Upper Cretaceous/Cenomanian to Upper Jurassic(?))--Name proposed by Lathram and others (1965) for the "...sequence of slate, graywacke, conglomerate, and augite-bearing volcanic flow breccia, Late Jurassic and Early Cretaceous in age, which forms a well-defined northwest-trending belt of rocks exposed along the eastern slopes and shores of Admiralty Island...". This sequence also occurs south and east of Admiralty Island (Souther and others, 1979) and extends southward into the map-area described here. New information presented here shows that the Group is as young as Albian or Cenomanian, i.e., late Early and early Late Cretaceous, in this area. The Brother's Volcanics/Douglas Island unit probably intertongues with the Seymour Canal Formation, probably near the top of the latter (Loney, 1964). As mapped, includes:

KJsv — Brothers Volcanics/Douglas Island Volcanics--Augite-bearing flows,

volcanic breccia, and intercalated tuff, volcanic graywacke, phyllite and slate. Andesitic to probably basaltic composition; weathers dark greenish-gray, gray, and green; generally lighter colored where fresh; relict augite phenocrysts conspicuous in most outcrops; probably a few thousand meters thick; individual flow or breccia units as much as a few hundred meters thick and graywacke, tuff, and slate lenses may also be that thick. No fossils have been found in this unit in this map area; its age is based on its close association with the locally fossiliferous Seymour Canal Formation. The Brothers Volcanics named by Loney (1964) from exposures just north of this map area; the Douglas Island Volcanics named by Lathram and others(1965) on Admiralty Island from exposures on Douglas Island to the north. Exposed on Kupreanof, Zarembo, Etolin, and Mitkof Islands; the best and least deformed or metamorphosed outcrops are on southwestern Mitkof Island and near Steamer Bay on Etolin Island. See also Berg and others (1972); Ford and Brew (1977a, 1978) and Page and others (1977).

KJss Seymour Canal Formation--Graywacke, slate, and minor conglomerate. Composed largely of volcanic debris, except for the conglomerates, which are polymictic and contain granitic clasts; most are 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; probably a few thousand meters thick; some individual graywacke units are massive and 10's of meters thick, but most are 1 to 20 cm thick. Numerous fossil collections by Loney (1964) established a Late Jurassic and Early Cretaceous age for the unit on Admiralty Island; that age has been confirmed by subsequent collections (Berg and others, 1972), who collected an Albian ammonite, a Valanginian(?) pelecypod, and Berriasian pelecypods from the western Etolin Island area and by collections made during the present study, including an Albian or Cenomanian ammonite (D. L. Jones and J. W. Miller, written commun., 1979) from hornfelsed Seymour Canal Formation and by Kimmeridgian to Tithonian pelecypods from the western Etolin Island area (R. W. Imlay, written commun., 1982). The Seymour Canal Formation was named by Loney (1964) from exposures at the mouth of Seymour Canal on Admiralty Island; the name was extended to the rest of Admiralty Island by Lathram and others (1965) and to northern Kupreanof Island by Muffler (1967). Probably grades into the more deformed and generally finer grained Semischist and Phyllite, Etc., unit (Mzs) and the Phyllite and Slate, Etc. unit (Mzp) to the west. Exposed on Kupreanof, Zarembo, Etolin, and Wrangell Islands.

DUNCAN CANAL-ZAREMBO ISLAND-SCREEN ISLAND SUB-BELT

See "Gravina belt" heading for background information. Most detailed information on Screen Islands is given by Karl (1984). The first group of units described here appear to enclose, with fault contacts, the second group, of Triassic, Permian, and Devonian units, all of which have affinities with units in the Alexander Belt.

METAMORPHOSED STEPHENS PASSAGE GROUP AND OTHER ROCKS (Upper(?) Mesozoic)--Currently interpreted to be mostly metamorphic equivalents of the Stephens Passage Group, but some may be derived from Cannery Formation, some from a different facies of the Stephens Passage Group, and some from a previously unrecognized facies of Triassic rocks. As mapped, includes:

Mzm Greenschist, Chert, Limestone, and Argillite-- Greenstone, greenschist,

pelitic and quartzofeldspathic phyllite, and marble. Locally very folded and internally faulted; dominantly light- to medium-green fresh, grayish-green to reddish-gray weathered; probably several thousand meters thick; depositional environment uncertain but may have been in part a chaotic slope facies sequence adjacent to a volcanic arc; now metamorphosed to albite-muscovite chlorite-subfacies of the greenschist facies according to Muffler (1967). Greenstone and greenschist probably derived from porphyritic basalt and basaltic tuff. Mapped as Gambier Bay Formation of Devonian age by Muffler (1967) on the basis of the fossiliferous limestone-marble lenses within the unit. Those lenses are mapped here as the Fossiliferous Limestone unit (Dls) and are interpreted to be exotic blocks within this unit. A collection of conodonts from thin marble layers in north-central Kupreanof Island indicates that the unit is at least in part Upper Triassic (B. R. Wardlaw and A. G. Harris, written commun., 1983). The relation of the unit to the Cannery Formation to the west and south is obscure; in most places the two units have been differentiated by the contrasting degrees of metamorphism and folding. Similar criteria, together with lithologic contrast, have been used to separate this unit from the Phyllite and Slate Metamorphosed From Mudstone and Minor Graywacke unit (Mzp), exposed near Pinta Point on northwestern Kupreanof Island, south of the Bohemia Range, and on Hamilton Creek. See also (Loney, 1964; Muffler, 1967)

Mzs — Semischist and phyllite. Metamorphosed From Graywacke and Siltstone--Low grade (probably sub-greenschist facies) metamorphic rocks; locally highly folded; generally poorly foliated but finer-grained phases have good cleavage; brownish-gray fresh, gray to brown weathered; relict textures and sedimentary structures indicate derivation from a graywacke and siltstone or mudstone turbidite sequence. Unit encloses several large lenses of Fossiliferous Limestone unit (Dls) of Devonian age, but there is no direct indication of the age. Proximity to Seymour Canal Formation (KJss) outcrops and compatibility of the protoliths with that formation suggest that this unit is a metamorphic and deformed equivalent of that formation. Unit contrasts with the Phyllite and Slate Metamorphosed From Mudstone and Minor Graywacke unit (Mzp) in the proportion of originally coarse-grained sediments, and in the general absence of volcanic(?) protolith phyllite in this unit, and the two units probably intertongue much more complexly than is shown on the map. Exposed on Duncan Canal, and on Woewodski, Zarembo, and Etolin Islands.

Mzl — Massive Limestone--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 much may be recrystallized. No fossils (including conodonts) found, so age assigned is Upper(?) Mesozoic based on association with the enclosing units; it is equally likely that (as predicted from analogy with the other limestone lenses) these lenses are somehow related to the Fossiliferous Limestone unit (Dls) of Devonian age. Unit crops out near Duncan Canal on Kupreanof Island and at Mosman Inlet on Etolin Island, where it is medium-grained marble.

Mzv — Greenschist and Greenstone Metamorphosed From Intermediate to Mafic Volcanic Rocks--Greenschist, greenstone, phyllite, minor semischist; weathers light to dark green, locally brownish pillow breccia, agglomerate flows, and possible tuffs; appears less deformed and less metamorphosed than other nearby rock units; probably several thousand meters thick. Locally abundant relict pyroxene phenocrysts suggest a

close link to the Douglas Island Volcanics (KJsm). Inferred upper Mesozoic age based on association with other units. Unit contrasts with the Phyllite and Slate Metamorphosed From Mudstone and Minor Graywacke unit (Mzp) in its apparent lesser metatuff and its higher proportion of rocks of volcanic origin. Exposed along and near Duncan Canal and on Woewodski and Zarembo Islands, and on Key Reef in Clarence Strait.

Mzc — Quartzite Metamorphosed From Chert--Quartzite and minor phyllite; white or light gray fresh and weathered, fine-grained, "ribbon" appearance common with relict beds 0.5 to 3.0 cm thick with very thin phyllitic partings; individual outcrops are highly folded, but some lenses must have been at least several 10's of m thick originally, others may have been only a few m thick. No direct evidence of age; no Radiolaria recovered from several samples collected for that purpose. Crops out in Little Duncan Bay and in central Kupreanof Island.

Mzr — Schist and Semischist Metamorphosed From Felsic Volcanic Rocks--Quartz-feldspar schist and semischist, minor phyllite and greenstone; fine-grained; light grayish green fresh, orangish-brown weathered; thickness unknown; relations to adjacent units uncertain. Age not known directly, but inferred from spatial association with other units. Exposed on Woewodski Island and nearby in Duncan Canal.

Mzp — Phyllite and Slate Metamorphosed From Tuff, Mudstone and Minor Graywacke --Chlorite phyllite, slate and semischist, minor conglomerate, limestone and quartzite; fine- to very fine-grained; highly folded, especially in northern Kupreanof Island; some phyllite is light green fresh and medium green weathered and is inferred to have been derived from intermediate composition tuffaceous rocks, other is dark gray fresh and weathered and is inferred to have been derived from fine-grained clastic sediments, as are the dark gray fresh and weathered slates; dark gray rocks are locally graphitic; locally polymictic conglomerate layers less than 1 m thick on northwestern Kupreanof Island only; thickness unknown, but probably great. One collection of conodonts from the limestone layers in west-central Kupreanof Island indicates that the unit is at least in part Upper Triassic (B. R. Wardlaw and A. G. Harris, written commun., 1983). Unit contrasts with the Cannery Formation (MDc) because the unit contains less chert and is more deformed and with the Greenschist, Chert, Limestone, and Argillite unit (Mzm) because the unit is of lower metamorphic grade and contains no limestone. Unit probably grades into the Phyllite unit (Ksp) to the east. Muffler (1967) mapped the exposures of this unit on northwestern Kupreanof Island as Seymour Canal Formation (KJss on this map) on the basis of lithologic correlation with that unit on Admiralty Island to the north. We have lumped those rocks in with this unit because of difficulty in mapping them southward as a separate unit. Exposed very widely as the most common unit in the northern part of the Duncan Canal-Zarembo Island-Screen Island sub-belt.

Mzg — Metamorphosed Gabbro--Chlorite-amphibole-plagioclase rock interpreted to have been gabbro bodies, but could be more highly metamorphosed mafic volcanic rocks; dark grayish-green fresh and weathered; medium- to fine-grained; thickness uncertain. Some local suggestion of relict layering. No direct evidence of age. Crops out at Indian Point in Duncan Canal and on Woewodski Island.

Mzum — Ultramafic Rock--Serpentinized peridotite and dunite; fine- to medium-grained; greenish-gray fresh organgish-brown weathered; two small bodies several meters across in upper Duncan Canal intruded into the Semischist and Phyllite, Etc. unit (Mzs).

Mzgb — Gabbro--Hornblende gabbro and pyroxene-hornblende gabbro; medium to very coarse grained, C.I. 60 to 80, weathers dark greenish black and very dark green, some interstitial indeterminate sulfide noted; cut by numerous dikes of medium-grained C.I. 05 to 25 quartz diorite like that in adjacent pluton. Crops out on northeast shore of Zarembo Island.

HYD GROUP(?) (Upper Triassic)--See write-up under Alexander Belt for background; as mapped, divided into:

Rhp — Conglomerate, Calcarenite, and Calcisiltite--Conglomerate is massive to cross-bedded, bimodal and polymictic; clasts include well-rounded green or white chert cobbles and angular to plastically deformed masses of limestone, locally brachiopod-bearing sandstone, and siltstone, as well as angular to subrounded felsic to mafic volcanic clasts; no plutonic or metamorphic clasts have been recognized in the conglomerates or sandstones. Cross-bedded to massive, amalgamated buff-colored sandstones overly the conglomerate, and are overlain by thin to medium (4-30 cm) bedded, calcisiltite and limestone, along with intraformational limestone conglomerate and sedimentary breccia. The shallow water sedimentary facies deposits overlain by calcareous-lithic graywacke turbidites suggest an increase in water depth (Buddington and Chapin, 1929). Numerous fossil collections (Karl, 1984) have yielded a Late Triassic (late Karnian to early Norian) age for this unit. On the Screen Islands Permian brachiopods occur in the cobbles in the conglomerates. The term Hyd Group (Loney, 1964; Muffler, 1967) was extended to include this conglomerate, sandstone and limestone on the Screen Islands in Clarence Strait (Karl, 1984), and the name Burnt Island conglomerate applied.

Rhv — Felsic and Intermediate Volcanic Flows and Breccia, Limestone, and Argillite--Dominantly very-fine to fine-grained, chlorite-quartz-muscovite-feldspar phyllite; light to dark green fresh, rusty and green weathered; locally chertlike; interpreted by Berg and Grybeck (1980) and Berg (1981) to be felsic metatuff. Also thinly layered to laminated quartz-feldspar phyllite or semischist interpreted by the same workers to be metarhyolite. Associated with dark gray thin bedded carbonaceous mudstone, siltstone, and limestone. Thickness unknown, but probably several hundred meters at least. Age Late Triassic-early Karnian for the unit inferred from one collection of halobiid pelecypods from exposures on the west side of Duncan Canal (N. J. Silberling, written commun., 1980). Host unit for massive sulfide deposits. Exposed along and near Duncan Canal, on the Castle Islands, Woewodski Island, and on Zarembo Island. The exposures on Rookery Island in Duncan Canal and on the northeast side of East Island in the Kachevarof Islands are well-bedded silty limestone of different and more uniform aspect.

Pp — PYBUS FORMATION (Lower Permian)--Limestone, dolomite, and chert; conspicuous cliff-forming medium-bedded to massive non-bedded coarsely crystalline white to very light gray dolomitic limestone with light gray replacement chert as thin beds, nodules, fragments, and crosscutting masses; minor coarse-grained light gray limestone, fetid medium-gray dolomite near top of unit; 50(?) m thick; scrappy silicified brachiopod fauna and lithologies support correlation with the type Pybus Formation (see Alexander Belt). Crops out only on northeast side of East Island, Kashevarof Islands, Clarence Strait.

Dls — FOSSILIFEROUS LIMESTONE (Lower and Middle Devonian)--Medium-bedded to massive, fine- to medium-grained; light to medium gray fresh and weathered; locally fetid; individual lenses up to several hundred m thick; contains brachiopods, corals, crinoids, and (locally) fusulinids. Northwesternmost exposures (mapped by Muffler, 1967, as part of the Gambier Bay Formation) contain corals or stromatoporoids of Middle Devonian or possibly Late Silurian age (Muffler, 1967). Abundant old and new collections from the several fossiliferous lenses at and near the head of Duncan Canal contain Lower and Middle Devonian corals, brachiopods, and conodonts (Buddington and Chapin, 1929); A. G. Harris, written communs., 1979, 1980, 1983; W. A. Oliver, Jr., written commun., 1979; J. T. Dutro, Jr., written communs., 1979, 1980) and the smaller lenses in Clarence Strait (Key Reef and Abraham Island) contain Lower(?) Devonian corals (W. A. Oliver, Jr., written communs., 1978, 1983). Part of large exposure at Castle Islands in Duncan Canal was the host for a sulfide-barite deposit of significant size (Burchard, 1914).

MAINLAND BELT

This belt is informally named to facilitate discussion of 1) rocks that have been metamorphosed to the extent that the age and nature of their protoliths is highly uncertain, and 2) the granitic and other rocks that intrude them. The belt occupies the northeastern corner of the map-area. The rocks in this belt, as well as some of those to the west in the Gravina belt, make up the Coast plutonic-metamorphic complex as defined by Brew and Ford (1983a,b,c).

Qi — PERMANENT SNOW AND ICE (Holocene)

INTRUSIVE ROCKS OF BEHM CANAL PLUTONIC BELT (Miocene and(or) Oligocene)--Belt informally named by Brew and Morrell (1983); As mapped, includes:

Tdr — Rhyolite and Related Rocks--Generally flow banded, locally quartz porphyritic; light brown and yellowish-brown weathering, light gray fresh; occurs in broad swarm of dikes from 0.5 to a few m wide with little included country rock more or less centered on the granite stock at Groundhog Basin (see below); a few small isolated plugs occur along strike. Several exposures within the unit of vent breccia similar to the Vent Breccia unit (QTv) in the Kuiu-Etolin belt; the breccias consist of dominant 5-20 cm angular rhyolite and some granitic and metamorphic rock fragments with essentially no matrix of any kind; see Gault (1954) and Gault and others (1953) for some further information. Age of the rhyolites is inferred from that of the closely associated granite stock at Groundhog Basin. The dike swarm has been prospected for both molybdenite and base metals, but no economic occurrences are known within it.

Tag — Chlorite Granite--Homogeneous, fine- to medium-grained, C.I. 03 to 06; very light gray to yellow fresh, yellow to yellowish-gray weathered; chlorite replaces biotite, generally seriate texture, but some samples are distinctly bimodal with a very fine-grained mosaic interstitial to larger biotite/chlorite, quartz, plagioclase, and K-feldspar grains. Age is based on a 17 Ma K-Ar determination on chlorite (Ken Fink, oral commun., 1978). Exposed only on the north side of Groundhog Basin (Gault and others, 1953) and in a possible small plug (not shown on map) that outcrops along Porterfield Creek about 1 km downstream from where the Groundhog Basin creek joins it. The body on the north side of Groundhog Basin has been the target of exploratory drilling for molybdenite.

GRANODIORITE OF CENTRAL COAST METAMORPHIC-PLUTONIC COMPLEX AND ASSOCIATED

MIGMATITES (Eocene)--Age is based on preliminary K-Ar age determinations by M. A. Lanphere (written commun., 1984) interpreted to be applicable to the whole suite, as follows:

Map unit	General location	Biotite age	Hornblende age
Tgdb	Mount Pratt	51.3	49.3
Tgdb	Castle Mountain	50.9	-

These units are similar in petrographic and field characteristics to similarly dated units in the Sumdum, Taku River, Bradfield Canal and Ketchikan quadrangles (Webster, 1984). As mapped, divided into:

Tgdb — Sphene-Bearing Biotite-Hornblende Granodiorite--Homogeneous, nonfoliated; medium- to coarse-grained; C.I. 4 to 20; light gray to buff fresh, weathers darker gray; euhedral sphene crystals (to 4 mm) common. Petrographic features include slightly inequigranular, hypidiomorphic-granular texture; biotite more abundant than hornblende, and always chloritized, abundant zoned (An_{38}-An_{28}) subhedral plagioclase, myrmekite intergrowths are ubiquitous. Unit differs from nearby Porphyritic Biotite-Hornblende Granodiorite Unit (Tgdp) in the lack of K-feldspar phenocrysts. Unit is exposed adjacent to the International Boundary near Mount Pratt and Castle Mountain in the Petersburg D-1 quadrangle.

Tgdp — Porphyritic Biotite-Hornblende Granodiorite--Homogeneous to slightly foliated; medium-grained; C.I. 9 to 22; gray to buff fresh, weathers to darker gray; faint foliation defined by biotite and hornblende; rare mafic inclusions. Petrographic features include slightly inequigranular, hypidiomorphic-granular texture; biotite more abundant than hornblende and always chloritized; euhedral to subhedral K-spar phenocrysts up to 3.5 cm normally constitute a small percentage of the rock; myrmekite common. Unit differs from nearby Sphene-bearing Biotite-Hornblende Granodiorite Unit (Tgdb) by the presence of phenocrysts and slight foliation. Unit is exposed southwest of the International Boundary in the Petersburg D-1 quadrangle.

Tgrg — Gneissic Biotite Granite and Granodiorite--Foliated, generally leucocratic, locally porphyritic and banded; medium-grained; C.I. 3 to 30; light gray fresh, weathers darker gray; K-spar phenocrysts or porphyroblasts up to 3x5 cm, locally augen-like; locally has inclusions of quartz and hornblende. Petrographic features include inequigranular, hypidiomorphic-granular texture; biotite more abundant than hornblende and shows only slight alteration to chlorite; sphene found locally; myrmekite intergrowths are common. Unit differs from nearby Sphene-bearing Biotite-Hornblende Granodiorite Unit (Tgdb) and Porphyritic Biotite-Hornblende Granodiorite Unit (Tgdp) units by gneissic structure. Unit exposed in the Petersburg C-1 and D-1 quadrangles.

Tmgz — Migmatite Consisting of Schist, Gneiss, Tonalite, and Granodiorite Invaded by Biotite Granodiorite-- Amphibolite facies hornblende-biotite quartzofeldspathic schist and gneiss, calc-silicates, mafic agmatite, tonalitic gneiss, tonalite, and K-feldspar megacrystic biotite granodiorite invaded and deformed by leucocratic (C.I. 1-8) biotite granite, granodiorite, and granodiorite gneiss. Deformation is intense and shows no structural trends. The neosome is heterogeneous in texture and composition and is gradational to the homogeneous Sphene-Bearing Biotite-Hornblende Granodiorite Unit (Tgdb). It is mapped along the western margins of these granodiorites, and to the east of the family of tonalite sill plutons. It usually, but not always, occurs to the

east of the K-feldspar megacrystic migmatite described below. Inclusions of both the migmatite unit described below (Tmgx) and the K-feldspar megacrystic-neosome (Tmgy) can be recognized within the leucocratic granite-granodiorite neosome. Schist and gneiss portions of some outcrops are conspicuously iron-stained, some portions of most other outcrops are visibly iron-stained; most outcrops have an extremely heterogeneous appearance. See Karl and Brew (1983, 1984) for further information.

Tmgy — Migmatite Consisting of Tonalite, and Gneiss Invaded by Megacrystic Biotite Granodiorite--Amphibolite facies hornblende-biotite quartzofeldspathic schist and gneiss with calc-silicates, marbles, and mafic agmatites, tonalitic gneiss, and tonalite of the sill belt (see below), invaded and deformed by texturally heterogeneous K-feldspar megacrystic biotite granodiorite. This neosome engulfs a previous migmatite with a tonalite neosome; megacrysts contain inclusions of biotite, feldspar, plutonic and volcanic rock fragments. Accessory minerals in the granodiorite include hornblende, epidote, and sphene (C.I. is 20-20). The quartzofeldspathic schist and gneiss characteristically weathers rusty. The tonalitic gneiss is fine grained and of homogeneous intermediate composition, with common augen, porphyroblastic, and segregation textures. This migmatite unit invades the eastern margin of the tonalite-neosome migmatite unit described below (Tmgx) and is in turn invaded on its own eastern margin by the homogeneous Sphene-Bearing Biotite-Hornblende Granodiorite Unit (Tgdb). Deformation produced structures more or less parallel to regional trends. Most outcrops weather a uniform medium gray and are poorly jointed. See Karl and Brew (1983, 1984) for further information.

INTRUSIVE ROCKS OF COAST PLUTONIC COMPLEX SILL BELT AND ASSOCIATED MIGMATITE (Upper Cretaceous and(or) Paleocene)--Belt informally named by Brew and Morrell (1983); located northeast of Coast Range megalineament (Brew and Ford, 1978). Regional aspects of this belt discussed by Brew and others (1976); Brew and Ford (1981); Ford and Brew (1981); belt is currently interpreted to be 62-69 Ma old on the basis of Pb-U determinations on zircons from rocks in the Sumdum and Juneau map areas to the northwest (Gehrels and others, 1983, 1984). The one attempt at K-Ar dating of the belt in this map area west of the headwaters of Aaron Creek (M. A. Lanphere, written commun., 1984) resulted in a biotite age of 50.4 Ma and a hornblende age of 49.1. These are interpreted to be the result of complete thermal resetting of the K-Ar system by the thermal effects of the Eocene granodiorites (Tgdb, Tgdp, and Tgrg). As mapped, divided into:

Ttos — Biotite-Hornblende and Hornblende-Biotite Tonalite, Quartz Diorite, and Minor Granodiorite--Homogeneous, foliated, non-layered; medium- to coarse-grained; C.I. averages 29, range 16 to 40; gray fresh, weathers darker gray; locally hornblende porphyritic with phenocrysts up to 2 cm; inclusions and schlieren of dioritic composition common; gneiss inclusions occur locally. Petrographic features include equigranular to seriate texture, hornblende dominant mafic, biotite replaces hornblende and is chloritized, plagioclase (An_{35}-An_{50}) subhedral to euhedral and rarely zoned, poikilitic hornblende with inclusions of quartz and plagioclase common, epidote minerals rare. Unit is broken out into four different units. Unit trends northwest through the northeast corner of the Petersburg map-area.

Tgdg — Gneissic Biotite Granodiorite and Quartz Monzodiorite--Homogeneous at outcrop scale, foliated; fine- to medium-grained; C.I. 5 to 25, light

gray to gray fresh, weathers darker gray; local K-spar augen and K-spar phenocrysts up to 2.5 cm, locally banded. Petrographic features include inequigranular texture; local disseminated garnet; subhedral plagioclase, unzoned and usually altered; local myrmekite; biotite is usually unaltered. Exposed at Thomas Bay in the Petersburg D-3 quadrangle and possibly along the Stikine River in the C-1 quadrangle.

Tmgx — Migmatite Consisting of Schist and Gneiss Invaded by Tonalite--Amphibolite facies (hornblende-) biotite-quartz-feldspar schist and gneiss invaded and deformed by tonalite. The schist and gneiss are fine grained, thinly layered (1-30 cm), may include calc-silicate layers (calcite, epidote, diopside, tremolite, garnet), and typically weathers rusty. The tonalite invader is the Biotite-Hornblende- and Hornblende-Biotite Tonalite characterized by its uniform (C.I. 20-35), medium grain size, and local aligned hornblende phenocrysts. Biotite, sphene, epidote, and magnetite are common accessory minerals. This migmatite includes wavy deformed gneisses and raft structures, but on a large scale conform to regional structural trends. It is mapped on the eastern margin of the Coast Plutonic Complex Sill Belt of tonalitic plutons and extends several kilometers to the east. It is successively invaded by younger neosomes to the east and can be recognized as paleosomes in almost all migmatites west of the homogeneous Sphene-Bearing Biotite-Hornblende-Granodiorite Unit (Tgdb). Schist and gneiss portions of small outcrops are conspicuously iron-stained, some portions of most other outcrops are visibly iron-stained. See Karl and Brew (1983, 1984) for further information.

METAMORPHIC ROCKS OF COAST METAMORPHIC-PLUTONIC COMPLEX (Upper Cretaceous and(or) Paleocene)--The progressively metamorphosed belt that forms the western edge of the Coast plutonic-metamorphic complex; the western part adjoins the metamorphic rocks of the Gravina Belt. The rocks are in general sufficiently metamorphosed that no original textures or structures remain. The protoliths must have included a variety of clastic rocks, dominantly fine-grained, but including some sandstones and conglomerates. The fine-grained sediments probably occurred in thicker units than the coarser-grained. Other protoliths were limestones 10's to 100's of m thick, sediments and volcanic rocks of intermediate to mafic composition, and probably some intermediate to mafic sill-like intrusions. No fossils have been found in any of these rocks in this map area, but proximity to the Gravina belt suggests that some of the protoliths may have been of Jura-Cretaceous age; fossils collected in somewhat similar rocks to the northwest in the Tracy Arm area (Brew and Grybeck, 1984) and in the Juneau area (Ford and Brew, 1977b; Brew and Ford, 1977) suggest that Lower Permian and Upper Triassic rocks may also be involved. Brew (1983a) and Brew and Ford (1983, 1984a) argue that these rocks are the metamorphosed equivalent of rocks in the upper part (Permian and Triassic) of the Alexander Belt section, rather than a separate tectonostratigraphic terrane (or terranes) as espoused by Berg and others (1978). The age of metamorphism is interpreted to be Late Cretaceous and(or) Early Tertiary (Brew and Ford, 1984a, b; Gehrels and others (1983, 1984). No significant contrast, other than metamorphic grade, is inferred to exist between the metamorphic rocks west of the Coast Range megalineament and those engulfed in the plutons between there and the International Boundary. As mapped, divided into:

TKp — Phyllite--Dominantly well foliated and commonly lineated dark gray very fine- to fine-grained phyllite with minor thin dark gray semischist interlayers, weathers medium- to dark gray; some extensive areas of interlayered green phyllite that weathers light green. The former are

probably derived from a fine grained clastic section; the latter from either tuffs or fine-grained volcanogenic sediments. Both form alternately rounded and serrated ridge tops and cliffy slopes. Metamorphic grade generally increases from prehnite-pumpellyite/low greenschist facies in the southwest to upper greenschist facies in the northeast. Common prehnite pumpellyite/greenschist facies mineral assemblage of the semischist is (epidote-) albite-white mica-chlorite-quartz. Presence of foliation and spatial relationship to the well defined Barrovian metamorphic sequence, together with lack of actinolite or biotite, support the prehnite pumpellyite facies assignment. Typical greenschist metamorphic facies mineral assemblages in the dark gray semischists and phyllites are (garnet-) muscovite-chlorite-biotite-albite-quartz and in the green phyllites (biotite-) (actinolite-) (sphene-) clinozoisite-albite-quartz-chlorite-calcite-muscovite. With increase in grade, clastic and other relict textures disappear, grain size increases, and crenulation cleavage and transposition become well developed. Foliation in general is defined by parallel, intergrown laths of actinolite, biotite, chlorite, or white mica. Garnet is porphyroblastic, epidote and clinozoisite subidioblastic, calcite xenomorphic interstitial, and quartz and albite form a subgranoblastic matrix. This unit is enigmatic in that its distribution pattern includes semi-isolated areas almost surrounded by the Biotite Schist and Semischist ((TKbs) unit; this is currently interpreted to mean that this unit (TKp) actually records two metamorphic episodes that are difficult to distinguish from each other. The first is a post-Early Cretaceous pre-Late Cretaceous (110 to 90 Ma) low grade regional event, the second overprints the first and is part of the low- to high-grade Late Cretaceous-Early Tertiary metamorphic and deformational event that is closely related to the emplacement of the Coast Plutonic-Metamorphic Complex Sill Belt rocks (Ttos, Tgdg). Commonly observed polydeformation textures such as multidirection crenulation cleavage and nearly complete transposition are compatible with this interpretation. Where the 90 Ma Admiralty-Revillagagedo Belt pluton intruded the unit, staurolite, biotite, garnet hornblende hornfels facies thermal aureoles formed. Porphyroblasts of staurolite and garnet, and decussate biotite laths have been rotated and realigned by development of the post-aureole foliation. Only rarely can an early foliation be detected through the superposed thermal and later dynamic-thermal metamorphic effects. Exposed along the eastern shore of Frederick Sound and east of Eastern Passage.

TKbs Biotite Schist--Dominantly well foliated and lineated biotite schist, lesser amounts of interlayered biotite semischist and hornblende schist and semischist; fine- to medium-grained; weathers grayish-brown, brownish-gray fresh; forms craggy ridges and steep slopes. Metamorphic mineral assemblages suggest derivation from the same protoliths as the Phyllite, Slate, and Semischist unit (TKp) above. Metamorphic grade generally increases from southwest to northeast, in a Barrovian facies series, from greenschist facies to upper amphibolite facies. Mineral isograds marking the first occurrence of biotite, garnet, staurolite, and kyanite trend north-northwest and appear to steepen northeastward towards the Coast Range megalineament which coincidentally locally marks the sillimanite isograd. Typical greenschist mineral assemblages are (epidote-) (clinozoisite-) (calcite-) (garnet-) biotite-muscovite-chlorite-albite-quartz and (actinolite-) epidote-calcite-sphene-chlorite-muscovite-albite-quartz. Higher grade pelitic assemblages

include (kyanite-) quartz-muscovite-plagioclase (oligoclase to andesine)-biotite-garnet-staurolite. More mafic assemblages include (clinopyroxene-) hornblende-biotite-quartz-garnet-plagioclase. East of the Coast Range megalineament sillimanite-potassium feldspar-muscovite-biotite-garnet-quartz-plagioclase assemblages represent the highest grade of regional metamorphism. The above assemblages may or may not contain the following accessory minerals: graphite, magnetite, ilmenite, apatite, and tourmaline. There may actually be four different metamorphic episodes recorded in different parts of this map unit: 1) a higher grade phase of the post-Early Cretaceous, pre-Late Cretaceous regional metamorphism discussed above, 2) the superposed thermal effects of the 90 Ma Admiralty-Revillagigedo Belt intrusions on those previously deformed rocks, 3) the "main" Late Cretaceous to Early Tertiary event that is the most likely cause of the features in this unit, and 4) thermal effects of the Eocene age Granodiorite of Central Coast Plutonic-Metamorphic Complex units (Tgdb, Tgdp, Tgrg). Textural and mineralogical evidence of the post-Early Cretaceous, pre-Late Cretaceous regional metamorphism have for the most part been obscured by local amphibolite facies porphyroblastic, dicussate, and granoblastic recrystallization caused by 2) above, and the effects of 3) above, both of which caused deformation-crenulations, shattered porphyroblasts with fragment trains, and in places totally disrupted foliation. Foliation is defined primarily by alignment of mica laths and amphibole prisms that wrap around pre-existing garnet, biotite, staurolite, and/or kyanite grains. Recrystallized quartz and plagioclase are most commonly subgranoblastic, polygonal, and slightly elongate parallel to the foliation. Local zones of cataclasis in rocks exposed along the Coast Range megalineament include blastomylonites, rare mylonites, and exhibit late greenschist facies recrystallization. Exposed along the eastern shores of Frederick Sound and Eastern Passage east to the Sill Belt and in a few screens and pendants between there and the International Boundary.

TKhs Hornblende Schist and Semischist--Poorly to well foliated, locally lineated interlayered hornblende schist, semischist, and lesser amounts of biotite schist; fine- to coarse-grained; weathers greenish-gray, dark greenish-gray fresh. Probably derived from intermediate to mafic volcanic flows, tuffs, or volcanic sediments, but some may be from fine-grained sills. Metamorphic grade increases towards the northeast from upper greenschist facies to amphibolite facies and is compatible with metamorphic facies of nearby Biotite Schist and Semischist unit (TKbs). Typical mineral assemblages are (garnet-) (zoisite-) (epidote-) plagioclase (albite-oligoclase)-hornblende-quartz-biotite-chlorite-sphene, and (clinopyroxene-) (garnet-) (potassium feldspar-) plagioclase (andesine)-hornblende-quartz-biotite in greenschist and amphibolite facies respectively. In outcrops east of the Coast Range megalineament chlorite-actinolite-calcite-epidote-white mica retrograde/alteration has commonly occurred. Petrographic features include poikiloblastic hornblende and garnet. Hornblende and biotite laths define foliation with leucocratic and mafic minerals commonly segregated into bands. Within the Coast Range megalineament zone, protoclastic, quartz-ribbon, and augen textures have developed. Exposed only in relatively small elongate masses more or less on either side of and close to the Coast Range megalineament.

TKmb Marble and Calc-Silicate Granofels--Poorly foliated, rarely lineated marble, calc-silicate granofels and schist interlayered with highly variable amounts of biotite and hornblende schist; fine- to coarse-

grained; weathers white and light gray or yellowish-gray, white, and light gray fresh; commonly forms distinctive, poorly vegetated outcrops. Derived from limestone and varying amounts of intercalated sediments; some marble masses are several hundreds of m thick and may have been reefoid limestones (or alternatively may simply be large detached fold hinges or a combination of the two); others consist of 1-cm to 10-cm scale interlayered with equal amounts of marble and biotite schist; in the latter case they are mapped as this unit to emphasize the presence of the metacarbonates. Typical greenschist and amphibolite facies mineral assemblages are (quartz-) (white mica-) calcite-tremolite-chlorite, and (diopside-) (scapolite-) calcite-wollastonite-quartz. These are compatible with metamorphic facies assignments of nearby Biotite-Schist (TKbs) and Hornblende Schist and Semischist (TKhs). The assemblages are also typical of thermal aureoles formed adjacent to 90 Ma Admiralty-Revillagigedo Belt plutons. Commonly lower temperature recrystallization has introduced tremolite and chlorite into these hornblende hornfels or amphibolite facies assemblages. Petrographic features include abundant lamellar twinned xenoblastic calcite, interstitial xenoblastic quartz, subidioblastic tabs of white mica, and decussate clusters, blades, and needles of tremolite and wollastonite. Mapped as elongate lenses within Phyllite (TKp), Biotite Schist (TKbs), and Hornblende Schist and Semischist (TKhs) units and as screens within the intrusive bodies to the northeast of the megalineament. Several outcrops were sampled for conodonts, but none were recovered.

TKbg Biotite Gneiss--Dominantly well-foliated, well-layered, locally lineated fine- to coarse-grained quartz-biotite-feldspar gneiss with lesser amounts of garnet-quartz-biotite-plagioclase schist and still less hornblende-plagioclase schist and gneiss; weathers grayish-brown, gray fresh. Probably derived from the same protoliths as the Phyllite, Slate, and Semischist (TKp) and Biotite Schist and Semischist (TKbs) units; generally, but not exclusively, lies to the northeast of those units. Metamorphic characteristics are spatially dependent. Near the Coast Range megalineament the unit is well foliated; commonly exhibits protomylonitic to phyllonitic, quartz-ribbon, and myrmekitic textures. Epidote-amphibolite facies synkinematic assemblages are (hornblende-) plagioclase-chlorite-biotite-epidote-quartz and (garnet-) biotite-muscovite-quartz-plagioclase-chlorite. Typically these 'sheared' rocks are strongly altered with abundant late chlorite, white mica, and calcite. East of and locally to the west of the Coast Range megalineament unit exhibits less cataclasis, foliation becomes poorer as grain size increases. Metamorphic mineral assemblages indicate the kyanite and sillimanite zones of the amphibolite facies. Typical mineral assemblages are (kyanite-) (staurolite-) biotite-muscovite-plagioclase-quartz-garnet and (sillimanite-) (potassium feldspar-) plagioclase-quartz-biotite-garnet. To the west of the Coast Range megalineament sillimanite (fibrolitic) rarely occurs in kyanite-bearing gneisses. "Regional" prismatic sillimanite occurs only east of the megalineament. Segregation is well developed between mafic biotite-rich and leucocratic layers; garnet, kyanite, and staurolite are poikiloblastic. An anastomosing foliation is defined by sub-equant-stubby laths of biotite outlining partially recrystallized porphyroblasts of plagioclase. Exposed both as elongate masses within the Biotite Schist and Semischist (TKbs) unit and as isolated screens within the granitic rocks northeast of the Coast Range megalineament.

TKhg Hornblende Gneiss--Moderately to poorly foliated and layered medium- to

coarse-grained hornblende gneiss with lesser amounts of hornblende and biotite schist; weathers greenish-gray or grayish-green, dark greenish-gray fresh. Probably derived from same protolith as Hornblende Schist and Semischist unit (TKhs). Metamorphic mineral assemblages are consistent with Barrovian facies series increase in grade towards the northeast: epidote-amphibolite facies assemblages such as hornblende-biotite-plagioclase-epidote and hornblende-biotite-garnet-plagioclase-quartz typify the lower grade portion of unit while (clinopyroxene-) garnet-hornblende-biotite-plagioclase-quartz and (potassium feldspar-) (hornblende-) clinopyroxene-biotite-plagioclase-quartz assemblages represent the northeastern higher grade portions. The accessory minerals magnetite, sphene, zircon, and apatite occur in most assemblages. Foliation is commonly anastomosing or lenticular and is defined by parallel schlieren of biotite and sparse hornblende. Intergrown biotite hornblende, garnet, and(or) pyroxene also occurs in sparse patches, clusters, and swirls which show minor chlorite and rarely calcite alteration. Where poikiloblastic, hornblende includes biotite, apatite, and quartz. Porphyroblastic garnet has xenomorphic, partially resorbed, outlines. Clinopyroxene is subidioblastic. Subidioblastic plagioclase and xenomorphic interstitial potassium feldspar show minor sericite alteration. Quartz is xenomorphic to subidioblastic and commonly exhibits undulose extinction. Crops out as elongate masses in the same general area as that same unit, i.e., on either side of and close to the Coast Range megalineament.

INTRUSIVE ROCKS OF ADMIRALTY-REVILLAGIGEDO PLUTONIC BELT AND ASSOCIATED MIGMATITE (Upper Cretaceous)--General age relations are described previously under Gravina Belt. As discussed in that section, these plutons are about 90 Ma; in general, they have narrow thermal metamorphic aureoles that are superposed on deformed and low-grade regionally metamorphosed country rocks. Here in the Mainland Belt a further complication is present: parts of some of this same family of plutons have been involved in the deformation and progressive low- to high-grade metamorphism in latest Cretaceous and earliest Tertiary time that gave rise to the Metamorphic Rocks of the Coast Plutonic-Metamorphic Complex super unit described above. Thus, the metamorphic age given for those rocks differs from with the emplacement age given for this family of plutons. The alternative was to assign the same metamorphic age to these plutons, but that is equally inadequate because not all of them show metamorphic features. As mapped, divided into:

Ktef — Hornblende-Biotite Tonalite and Granodiorite, Quartz Monzodiorite, and Quartz Diorite--Foliated to massive equigranular; average grain size is medium, locally fine-grained near some margins; C.I. 17 to 50; light to medium gray fresh, weathers brownish to dark gray. Foliation varies both in direction and development; locally semischistose and cataclastic; contains granite aplite dikes, pegmatite dikes and veins, rounded very fine grained hornblende diorite inclusions. Mineralogy includes zoned, complexly twinned plagioclase with minor alteration to sericite; mafic minerals usually biotite greater than hornblende; subhedral epidote; and local garnet and pyroxene. Accessory minerals are sphene, apatite, opaque minerals, and allanite. Unit differs from Hornblende-Biotite Tonalite Granodiorite, etc. unit (Ktif) by presence of pyroxene and garnet, and biotite as the dominant mafic phase. Unit is exposed on Dry, Farm and Sergief Islands, and on the mainland south of the Stikine River (Burrell, 1984b).

Ktoc — Garnet-Biotite Tonalite and Minor Granodiorite--Nonfoliated; crowded plagioclase rock; inequigranular to porphyritic; very fine- to medium-

grained; C.I. 14 to 29; medium gray fresh; weathers light gray; forms small elongate bodies less than 2 square km in area. Mineralogy includes reddish-brown garnet, clinozoisite (or rarely epidote) and local muscovite. Biotite and quartz commonly interstitial to closely spaced plagioclase laths. Unit is similar to Biotite Tonalite, Quartz Diorite, and Granodiorite unit (Ktgp) mineralogically, but differs texturally by its finer grain size and lack of coarse-grained phenocrysts. Exposed on the eastern shore of Frederick Sound.

Kgop — Biotite-Epidote-Hornblende Quartz Monzodiorite--Compositions here range from quartz monzodiorite to tonalite (Burrell, 1984a, b, c). Locally foliated plagioclase porphyritic with medium- to coarse-grained phenocrysts (to 12 mm), fine- to medium-grained groundmass (to 3 mm) and a C.I. range of 17 to 48; weathers brownish-gray, gray and white fresh; body margins are commonly more mafic and have a very fine- to fine-grained groundmass; also common are muscovite-biotite-garnet-epidote aplite dikes of granitic and granodioritic composition. Mineralogical features include oscillatory zoned plagioclase with sericite alteration of the cores; interstitial quartz and K-feldspar, euhedral fine-grained hornblende, minor biotite, and primary (occasionally twinned and zoned) and secondary epidote. Exposed on northern Dry Island, McDonald Island, and at Horn Mountain.

Ktgp — Biotite Tonalite, Quartz Diorite, and Granodiorite--Porphyritic and foliated; medium- to coarse-grained; C.I. 11 to 35; cut by pegmatite and basalt dikes; local cataclastic texture; inclusions of country rock; foliation parallels that of the country rock; petrographic features include zoned, complexly twinned plagioclase, quartz, interstitial K-feldspar, portly chloritized biotite, epidote, minor local hornblende; and garnet, sphene, apatite and allanite as accessories. Unit differs from Biotite-Epidote-Hornblende Quartz Monzonite unit (Kgop) by lack of hornblende and presence of garnet. Unit occurs on the mainland south of the Stikine River.

Kgb — Metagabbro--Biotite-plagioclase-hornblende granofels or semischist; fine- to medium-grained; C.I. 70; dark green fresh, grayish-green weathered; crops out as a small plug on the ridge above the headwaters of Government Creek south of the Stikine River.

Kmgf — Migmatite (Upper Cretaceous)--Varied migmatitic rocks, mainly agmatite and irregular banded gneiss, in zones between the Hornblende-Biotite Tonalite and Granodiorite, etc, (Ktef) and Biotite Tonalite, Quartz Diorite, etc. (Ktgp) units and the Biotite Schist unit (TKbs); the granitic leucosomes generally resemble the main rock types in the above-mentioned units (Ktef and Ktsp); the metamorphic melasomes are fine- to medium-grained (garnet-) (sillimanite-) biotite hornfels, schist, and semischist. Crops out only south of the Stikine River, between Government Creek and South Fork (of Andrews Creek), on the ridge southeast of Porterfield Creek, and northeast of Blake Channel.

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