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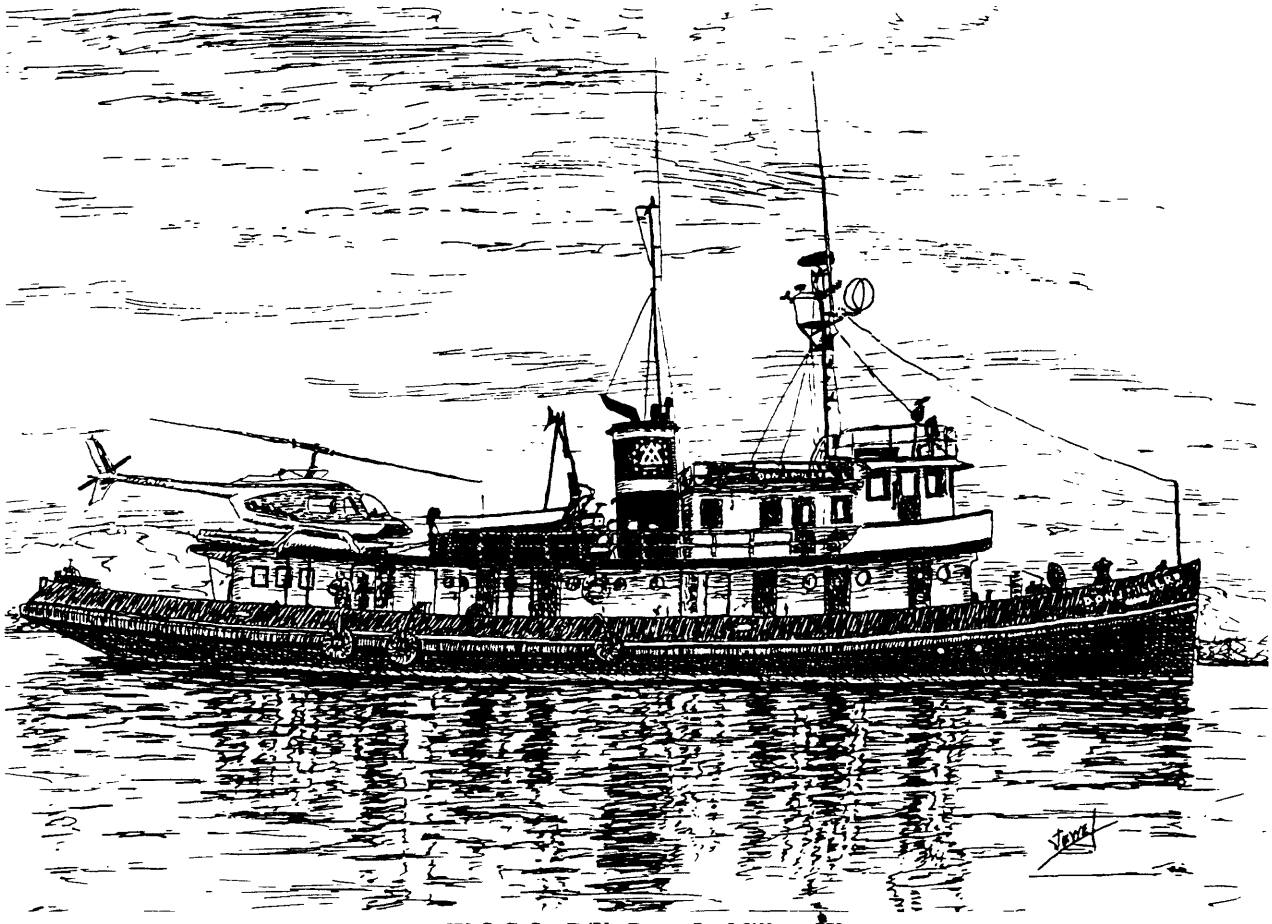

[U.S.G.S. R/V Don J. Miller II]

RECONNAISSANCE GEOLOGIC MAP OF THE BRADFIELD CANAL B-6 QUADRANGLE, SOUTHEASTERN ALASKA

Open-File Report 97-156-N

By David A. Brew and Richard D. Koch

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Reconnaissance Geologic Map of the Bradfield Canal B-6 Quadrangle, Southeastern Alaska

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INTRODUCTION

This map and its accompanying information were prepared specifically as a U.S. Geological Survey contribution to the joint State of Alaska Division of Geological and Geophysical Surveys and the U.S. Department of Interior Bureau of Land Management Alaska Minerals Section (Juneau, Alaska) mineral-resource studies of part of the Petersburg and Bradfield Canal, Alaska 1:250,000-scale quadrangles. Those studies are a direct follow-up to geological, geochemical, and geophysical studies done in the region by the U.S. Geological Survey in the 1970's and 1980's that are cited below.

The geologic information presented on this map has been released previously in generalized form (Koch and Berg, 1996); the information is based on reconnaissance field mapping and thus does not have the density of field-station control, samples, or field observations that are expected in published U.S. Geological Survey 1:63,360-scale geologic maps. This map is one of a series that share the same format and general information (Brew, 1997a-m; Brew and Koch, 1997). There are both a combined description and a combined correlation of the map units for this whole series of maps (Brew and Grybeck, 1997).

The available information on known mineral deposits in the whole Petersburg/Wrangell area was released previously (Grybeck and others, 1984) and Brew and others (1989, 1991, 1996). Bedrock, stream-sediment, and other geochemical data were interpreted and released by Karl and others (1985), Karl and Koch (1990), Cathrall and others (1983a-w), and Tripp and Cathrall (1984). Aeromagnetic and aeroradioactivity surveys information was released by the U.S. Geological Survey (1978, 1979b) and Bouguer gravity information by Barnes and others (1989). Remotely-sensed features were described by LeCompte (1981b). Burrell and others (1982) released a preliminary bibliography of Petersburg and Port Alexander quadrangles-related items. Douglass and others (1989) reported major-element chemical and other data for rocks from the Wrangell-Petersburg area.

The available information on known mineral deposits in the Bradfield Canal quadrangle was released previously (Elliott and Koch, 1982) and Brew and others (1991). Bedrock, stream-sediment, and other geochemical data were released and interpreted by Koch and Elliott (1981a-i) and Koch and others (1976, 1980ab, 1981a). Aeromagnetic and aeroradioactivity surveys information was released by the U.S. Geological Survey (1976, 1979a) and total gamma ray intensities at ground stations by Koch and others (1981b). Remotely-sensed features were described by LeCompte (1981a).

Assessments of the undiscovered mineral resources for the whole Petersburg/Wrangell area are also available (Brew and others, 1989, 1991; Brew and Drinkwater, 1991). Some of the mineral-resource-assessment tract information in neighboring areas was revised by Brew and others (1996). Brew (1993) presented a generalized view of metallogenic belts that includes this area. The final mineral-resource assessment of the Bradfield Canal 1:250,000-scale quadrangle is reported to be currently in preparation.

Detailed information on the Late Cretaceous plutonic rocks in the Petersburg 1:250,000-scale quadrangle is found in Burrell (1984abc); some of the information applies to this quadrangle also.

The index map on the over-size sheet shows the major geological elements of the Petersburg/Wrangell and adjacent areas. 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. The Alexander belt corresponds more or less to the Alexander terrane of Berg and others (1972, 1978), the Gravina belt is a refined interpretation of their Gravina belt. This quadrangle includes only rocks of the Mainland belt (see Correlation of Map Units diagram on the oversize sheet).

DESCRIPTION OF MAP UNITS

[Note: All formational and descriptive map-unit names in the text of the following descriptions are set off with quotation marks to make them easier to identify.]

MAINLAND BELT

This belt was informally named by Brew and others (1984) 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 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 (1984abc), which has been redefined as the Coast Mountains Complex by Brew and others (1995).

Qs SURFICIAL DEPOSITS (Holocene and(or) Pleistocene)--Includes alluvium, colluvium, tidal mudflat deposits, and glacial drift, till, moraine, and fluvial deposits. The distribution of some large areas of surficial deposits was mapped in the field, others were inferred from topography and drainage; many small areas are not shown.

Qi GLACIAL ICE AND PERMANENT SNOWFIELDS (Holocene)--Limits are taken from the topographic map and may not be correct now

GRANODIORITE OF CENTRAL COAST METAMORPHIC-PLUTONIC COMPLEX (Eocene)--Age is based on K-Ar age determinations by M. A. Lanphere (U.S. Geological Survey, written commun., 1984) on a unit that occurs in the Petersburg quadrangle but is interpreted to be part of and 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	-

Age is also based on a K-Ar age determination from the Bradfield Canal quadrangle near the International Boundary (J.G. Smith, U.S. Geological Survey, unpub. data, cited by Koch and Berg, 1996):

Map unit	General location	Biotite age	Hornblende age
Tlg1	Unknown	51.0	53.5

The following three units are interpreted in this report to be closely related, and the second two are revised from the interpretation given by Koch and Berg (1996). This reinterpretation was done on the basis of the field relations and compositional similarities and on the available geochronologic information. The original unit names and map symbols used by Koch and Berg (1996) are cited to facilitate evaluation of our reinterpretation. As mapped, divided into:

Tgdb Hornblende-Biotite Granodiorite and Quartz Diorite in this quadrangle (mapped as Sphene-Bearing Biotite-Hornblende Granodiorite in the adjoining Petersburg C-1 quadrangle)--

In this quadrangle, includes three massive, medium-grained, C.I. 10 to 20, hypidiomorphic-granular phases: (1) nonfoliated, equigranular hornblende-biotite quartz diorite with 2- to 4-mm anhedral biotite grains; (2) K-spar porphyritic granodiorite with phenocrysts up to 1.5 cm in maximum dimensions; and (3) slightly foliated hornblende-biotite granodiorite characterized by conspicuous 3 to 6-mm-diameter books of fresh blackish-brown biotite. In the Petersburg C-1 quadrangle, correlative rocks are homogeneous, nonfoliated; medium- to coarse-grained; and have a C.I. 4 to 20. They are light gray to buff on fresh surfaces and weather darker gray. Euhedral sphene crystals to 4 mm are common. Petrographic features in the Petersburg C-1 quadrangle include a slightly inequigranular, hypidiomorphic-granular texture; biotite more abundant than hornblende, and invariably chloritized, abundant zoned (An_{38}-An_{28}) subhedral plagioclase; and myrmekite intergrowths are ubiquitous. Unit is exposed, as part of the Mount Fawcett body, in the northeastern corner of this quadrangle. Mapped by Koch and Berg (1996) as "Granodiorite and Quartz Diorite" (their Tgq).

Tlg1 Leucocratic Porphyritic Biotite Granodiorite and Adamellite [or Granite]--

Homogeneous to slightly foliated; K-feldspar porphyritic, and medium-grained; C.I. 0-5. Faint foliation defined by biotite. Petrographic features include slightly inequigranular, hypidiomorphic-granular texture. Euhedral to subhedral K-spar phenocrysts up to 7 cm normally constitute a significant percentage of the rock. Unit is exposed in an irregular-shaped body immediately southwest of the Coast Range Megalineament in the central part of this quadrangle. Mapped by Koch and Berg (1996) as "Leucocratic Granodiorite and Adamellite" (their Tlg); which grades into the "Leucocratic Granodiorite" (Tlg2) described below.

Tlg2 Leucocratic Granodiorite--

Hornblende-biotite granodiorite; compositionally, texturally, and structurally heterogeneous. Locally massive, foliated, schlieric, and gneissic. Light tan to light gray on weathered surfaces. Mafic minerals and K-spar grains generally irregularly distributed; locally K-spar porphyritic. Differentiated from unit described above by being more foliated and less porphyritic. Mapped by Koch and Berg (1996) as "Leucocratic Granodiorite" (their TKlg); which grades into the "Leucocratic Porphyritic Biotite Granodiorite and Adamellite" (Tlg1) described previously.

Tlgm Migmatite associated with Leucocratic Granodiorite--

Dark gray on weathered surfaces; consists of mostly "Garnet- Biotite Gneiss and Schist, and Amphibolite" (TKgn) rocks invaded by magnetite-bearing hornblende quartz monzonite and granodiorite like the "Leucocratic Granodiorite" (Tlg2) and by rhyolite dikes and sills that may be like those mapped in the Petersburg C-1 quadrangle to the northwest (Brew, 1997h).

INTRUSIVE ROCKS OF THE GREAT TONALITE SILL BELT (Upper Cretaceous and(or) Paleocene)--Belt informally named the Coast Complex Sill Belt by Brew and Morrell (1983) but now re-named. 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), and Brew (1994). 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, 1991; Brew, 1994). The one attempt at K-Ar dating of the belt in this map area west of the headwaters of Aaron Creek in the Petersburg B-1 quadrangle resulted in a biotite age of 50.4 Ma and a hornblende age of 49.1 Ma (M. A. Lanphere, U.S. Geological Survey, written commun., 1984). These are interpreted to be the result of complete thermal resetting of the K-Ar system by the thermal effects of the Eocene granodiorites. In this quadrangle:

Ttos Biotite-Hornblende and Hornblende-Biotite Tonalite, Quartz Diorite, and Minor Granodiorite--Homogeneous, foliated, non-layered; medium- to coarse-grained; C.I. averages 29, with a range of 16 to 40. Gray on fresh surfaces, 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 is the 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 occurs as two separate main bodies that trend northwest through the central part of this quadrangle. Mapped by Koch and Berg (1996) as "Quartz Diorite" (their TKq).

METAMORPHIC ROCKS OF COAST MOUNTAINS COMPLEX (Upper Cretaceous and(or) Paleocene)--The progressively metamorphosed belt that forms the western edge of the Coast Mountains 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 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, 1977a) suggest that Lower Permian and Upper Triassic rocks may also be involved. Brew (1983a) and Brew and Ford (1983, 1984a) argued 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). Nevertheless, isotopic evidence summarized by Brew and Ford (1994) and Brew and others (1994) indicates the some of the protoliths are Late Proterozoic or Early Paleozoic in age and belong to the Nisling assemblage, or lithotectonic terrane, of Wheeler and McFeely (1991). The age of metamorphism is interpreted to be Late Cretaceous and(or) Early Tertiary (Brew and Ford, 1984ab; Gehrels and others, 1983, 1984). No obvious contrast, other than metamorphic grade, exists between the metamorphic rocks west of the Coast Range megalineament and those engulfed in the plutons between there and the International Boundary, even though more than one lithotectonic terrane may be present. Divided into:

TKbs Biotite Schist--

Dominantly well foliated and lineated (muscovite-)(garnet-)biotite schist, lesser amounts of interlayered biotite semischist and hornblende schist and semischist; fine- to medium-grained; grayish-brown where weathered, brownish-gray on fresh surfaces Locally layered; forms craggy ridges and steep slopes. Metamorphic mineral assemblages suggest derivation from the psammitic, semipelitic, and pelitic protoliths. Typical greenschist mineral assemblages in the belt as a whole 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 previously, 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 granodiorites of the central Coast Mountains Complex units (Tgdb, etc.). 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 shore of Blake Channel in this quadrangle east to the Great Tonalite Sill Belt. Mapped by Koch and Berg (1996) as "Schist and Paragneiss" (their MzPzsp).

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 on fresh surfaces. Commonly forms distinctive, poorly vegetated outcrops. Derived from limestone, some dolomite, 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 lenses 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) units. 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 lenses within "Garnet- Biotite Gneiss and Schist, and Amphibolite" (TKgn) in east-central part of quadrangle. Several outcrops were sampled for conodonts, but none were recovered. Mapped by Koch and Berg (1996) as "Marble" (their MzPzmb).

TKgn Garnet- Biotite Gneiss and Schist, and Amphibolite--

A belt of heterogeneous gneiss and schist, most of the gneisses of which were developed from older and undated intrusive silicic to intermediate plutonic units. The schist components are like the rocks of the "Biotite Schist" (TKbs). The belt is approximately parallel to the Coast Range Megalineament and to the the Great Tonalite Sill (Ttos). Metamorphic mineral assemblages including sillimanite and cordierite indicate higher temperatures than in the "Biotite Schist" (TKbs) to the west. Mapped by Koch and Berg (1996) as "Paragneiss and Orthogneiss" (their MzPzpo).

INTRUSIVE ROCKS OF ADMIRALTY-REVILLAGIGEDO PLUTONIC BELT (Upper Cretaceous)--General age relations are described for the Peterburg B-2 quadrangle (Brew, 1997d) 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 Mountains 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. The belt was informally named by Brew and Morrell (1983) and is described by Burrell (1984abc); K-Ar determinations by M. A. Lanphere (U.S. Geological Survey, written communs., 1981, 1982), interpreted to be applicable to the whole suite in the Petersburg-Wrangell area, including the rocks in this quadrangle, are as follows:

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

Similar rocks occur in lithically correlative units to the east in this part of the Bradfield Canal quadrangle (R. L. Elliott and R. D. Koch, U.S. Geological Survey, oral commun., 1982; Koch and Berg, 1996), but some, like the Marten Lake body in this quadrangle, and other bodies, are interpreted to have had their K-Ar systems reset by younger intrusive events.

Map unit	General location	Biotite age	Hornblende age
Ktef unit	Marten Lake body	58.6 Ma	83.2 Ma
"	Elsewhere in Bradfield Canal quadrangle	67.8 Ma	71.8 Ma
"	"	71.8 Ma	80.0 Ma

In this quadrangle:

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 on fresh surfaces, 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, which is in this quadrangle; 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 the margins of the bodies. 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." (Ktif) mapped in other quadrangles by presence of pyroxene and garnet, and biotite as the dominant mafic phase. Unit is exposed in the western part of this quadrangle on Wrangell Island and the mainland. Mapped by Koch and Berg (1996) as "Biotite-Hornblende Quartz Diorite" (their Kqd).

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. Garnet-bearing crowded plagioclase porphyry with magmatic epidote is common in the eastern part of the body at Marten Lake and well-developed foliation and hornblende are more common in the western part; an internal contact separating these two phases is shown on the map. Petrographic 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. Unit differs from "Biotite-Epidote-Hornblende Quartz Monzonite" (Kgop) mapped in other quadrangles by lack of hornblende and presence of garnet. Unit occurs on the mainland in the vicinity of Marten Lake, in the southwestern part of this quadrangle. Mapped by Koch and Berg (1996) as "Porphyritic Granodiorite" (their Kgp in text on p. 20, their Kgd on map, so one or the other is an unintended mistake).

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