GEOLOGIC MAP OF SOUTHERN PRINCE OF WALES ISLAND, SOUTHEASTERN ALASKA

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INTRODUCTION

Southern Prince of Wales Island is underlain by pre-Ordovician to Cretaceous stratified, intrusive, and metamorphic rocks and by surficial deposits. The rocks in the area were mapped initially along shorelines by Buddington and Chapin (1929) and subsequently, with the use of aerial photographs, by W.H. Condon and I.L. Tailleur (written commun., 1960). More recently (1) MacKevett (1963) studied the geology of the Bokan Mountain-Stone Rock Bay area; (2) Herreid and others (1978), Eberlein and others (1983), and G.D. Eberlein, Michael Churkin Jr., and Walter Vennum (unpub. data, 1949-1979) mapped Kassa and Klakas Inlets and regions to the north; and (3) Thompson and others (1982), Bernard Collot (*in* Saint-André and others, 1983), and Armstrong (1985) studied the Bokan Mountain Granite. This report describes the results of geologic studies of southern Prince of Wales Island in the Dixon Entrance D-1, D-2, and C-1 quadrangles and the Prince Rupert D-6 quadrangle.

The rocks of southern Prince of Wales Island are classified into three principle categories: (1) Sedimentary and (or) Volcanic Rocks, (2) Regionally Metamorphosed and (or) Deformed Rocks, and (3) Intrusive Rocks. The categories of units are defined as follows:

Units of the Sedimentary and (or) Volcanic Rocks category consist of stratified rocks, and in some areas their moderately deformed and (or) metamorphosed equivalents, that obey the Law of Superposition (North American Commission on Stratigraphic Nomenclature, 1983). These units consist of sedimentary and (or) volcanic rocks belonging to the Karheen Formation (Lower Devonian) and the Descon Formation (Ordovician and Lower Silurian?).

Units of the Regionally Metamorphosed and (or) Deformed Rocks category consist of metasedimentary, metavolcanic, and metaplutonic rocks that do not obey the Law of Superposition. These rocks consist of the Wales Group (pOw) (informally designated Wales metamorphic suite of Gehrels and Saleeby, 1987) and rocks assigned to the Klakas Inlet assemblage (DSk), the Kendrick Bay assemblage (SOk), and the Ruth Bay assemblage (Or).

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Units of the Intrusive Rocks category consist of plutonic and hypabyssal rocks that are subdivided on the basis of their composition and emplacement age. Compositional terms follow recommendations by the International Union of Geological Sciences Subcommission on Systematics of Igneous Rocks (Streckeisen, 1976). All radiometric ages were calculated or recalculated with the decay constants and abundances recommended by the International Union of Geological Sciences Subcommission on Geochronology (Steiger and Jäger, 1977). These radiometric ages are correlated to the Decade of North American Geology Geologic Time Scale (Palmer, 1983).

The rocks belonging to each map unit are described below in the Description of Map Units. Unmapped geologic units include surficial deposits and widespread basaltic to dacitic(?) dikes that are described in the Surficial Deposits and Dikes section. Major faults in the area are described in the following Structural Geology section. Paleontologic and geochronologic samples analyzed during this and previous studies are compiled in tables 1 and 2. Gehrels and Saleeby (1987) discuss the geologic and tectonic history of the region, the U-Pb geochronologic data listed in table 2, and geochemical data determined from samples of volcanic and intrusive rocks in the study area. Devonian conodonts from samples collected during this study were described by Savage and Gehrels (1984).

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DESCRIPTION OF MAP UNITS

SEDIMENTARY AND (OR) VOLCANIC ROCKS

[May include metamorphosed and (or) deformed rocks]

Karheen Formation (Early Devonian)—Strata belonging to the Karheen Formation comprise a fining-upward sequence of clastic sedimentary rocks interbedded with subordinate volcanic rocks and limestone. These strata unconformably overlie the Ordovician and Lower Silurian Descon Formation and are youngest stratified rocks in map area. Stratigraphic sequence generally consists of coarse conglomeratic rocks (Dkcg) or breccia (Dkbx) in basal part; sandstone (Dks), mudstone and siltstone (Dkms), and limestone (Dkl) in middle part; and laminated black graptolitic shale (Dksh) in upper part. Plagioclase-porphyritic and basaltic to andesitic volcanic rocks (Dkpv and Dkbv) are interlayered with coarser clastic strata in lower part of section in southern part of map area.

Conodonts in limestone layers in unit Dkl (Savage and Gehrels, 1984) and graptolites in black shale in unit Dksh (Churkin and others, 1970) suggest a middle Early Devonian age for rocks in upper and middle parts of formation. Coarser clastic rocks in lower part of section grade into these strata and are interpreted as Early Devonian in age (Gehrels and Saleeby, 1987). These strata are here assigned to the Karheen Formation on basis of similarity of lithic types, stratigraphic position, and depositional age with exposures of the Karheen Formation on west-central Prince of Wales Island (Eberlein and Churkin, 1970; Eberlein and others, 1983; Gehrels and Saleeby, 1987). Thickness of section in study area ranges from several hundred meters to more than 2 km. Divided into:

Dksh **Shale**—Dark-gray to black shale and subordinate slate and slaty argillite with millimeter-scale laminations and slight centimeter-scale compositional layering. These strata are distinguished from the argillite and shale unit of the underlying Descon Formation (SOda) by being less siliceous and more fissile. Layers as thick as several tens of centimeters of gray mudstone, brown carbonate-rich siltstone, and leucogranodiorite-clast conglomerate are locally found in section. Fine laminations and slight fining-upward in individual shale layers record transportation by turbidite flows and deposition in distal reaches of a submarine fan system. Conglomeratic horizons and a large slide(?) block of leucogranodiorite in section suggest significant topographic relief within or adjacent to unit's depositional basin.

In most areas this unit grades downsection into the tan to gray mudstone and siltstone unit (Dkms) over a stratigraphic thickness of several meters; contact is drawn where shale dominates over mudstone and siltstone. Observed stratigraphic thickness is at least 250 m along east shore of Klakas Inlet but could be considerably greater along west shore. North of study area, this unit and the underlying mudstone and siltstone unit (Dkms) were mapped together as a section of dark-gray siltstone (about 600 m thick) and dark-gray argillite (about 1200 m thick) by Herreid and others (1978)

Dkms **Mudstone and siltstone**—Tan, dark- to light-gray, and bluish-gray mudstone and siltstone beds ranging from 2 to 20 cm in thickness. Individual beds commonly show a slight size gradation from silty to more shaly detritus upsection. Low-angle cross-stratification is common. These characteristics and stratigraphic relations with adjacent units indicate transportation of detritus by turbidity currents and deposition in distal marine environments—probably in a submarine fan. Orange- to brown-weathering beds as thick as 10 cm constitute about 10 percent of section and consist of sandy siltstone containing a carbonate-rich matrix. These beds commonly weather more rapidly than adjacent mudstone and siltstone, forming recessed horizons. In some layers sandy siltstone changes along strike from this orange-brown, deeply recessed character to a gray siltstone with weathering characteristics similar to that in adjacent mudstone and siltstone. Cobbles and lenses of sandy siltstone found within the mudstone and siltstone unit also show this style of weathering. This difference in weathering characteristics may result from greater amounts of carbonate matrix material in sandy siltstone layers.

These strata grade downsection into coarser grained siltstone and locally into sandstone. Basal contact is drawn where mudstone becomes subordinate to sandstone. In Max Cove and west of Klakas Inlet, the underlying sandstone unit (Dks) is too thin to distinguish on map and is included within this unit. Thickness of the mudstone and siltstone unit is approximately 400 m between Max Cove and Klakas Inlet; to south and on west side of Klakas Inlet, unit thickness may be considerably greater. North of study area, these strata and the overlying shale unit (Dksh) are included in an argillite and siltstone map unit consisting of about 600 m of dark-gray siltstone overlain by about 1,200 m of dark-gray argillite (Herreid and others, 1978)

Dks **Sandstone**—Tan- to reddish-brown-weathering sandstone, siltstone, and subordinate mudstone and pebbly conglomerate interbedded locally with fossiliferous limestone (Dkl). The sandstone ranges from massive beds several meters in thickness to thin-bedded sandstone and siltstone containing ripple marks and high-angle crossbeds and channels. Along southern shoreline of Prince of Wales Island, plagioclase-porphyritic volcanic rocks are widespread, but are not mapped separately from clastic strata within this unit. North of Tah Bay, sandstone contains predominantly monocrystalline quartz and plagioclase and subordinate lithic fragments of fine-grained quartz and plagioclase (leucogranodiorite?) and of cryptocrystalline rock containing trachytic feldspar microphenocrysts (volcanic rock?). To south, lithic grains and matrix are more highly altered to carbonate and clay minerals. Lithic fragments from southern part of study area consist of feldspar phenocrysts in an altered cryptocrystalline matrix (hypabyssal or volcanic rock?) or highly altered cryptocrystalline volcanic(?) rock of intermediate to mafic composition. Monocrystalline quartz and plagioclase grains are subordinate. Dominant sources for detritus varied from pre-Devonian intrusive and stratified rocks in northern part of study area to intraformational volcanic rocks along southern shoreline of island.

In most of study area, this unit contains, or is interbedded with, a thin horizon of fossiliferous limestone (Dkl). Interbedded maroon and green shale and chert-pebble conglomerate are associated with limestone in a few localities. Megafossils in limestone, interbedded maroon and green shale, and sedimentary structures in the sandstone all suggest that these strata were deposited in shallow-marine environments.

Strata generally coarsen downsection, grading through pebbly sandstone into cobble and boulder conglomerate. Basal contact of the sandstone unit is drawn where conglomerate becomes dominant lithology. Thickness of unit ranges from more than 1 km at south end of island to several meters or less in Max Cove region (Gehrels and Saleeby, 1987). Much of this thinning is observed near Klinkwan Cove

Dkl **Limestone**—Light- to medium-gray fossiliferous limestone breccia and subordinate massive to thin-bedded limestone. Thin layers of darker gray siliceous limestone are common in both breccia and bedded limestone lithologies. North of Tah Bay, the limestone forms a single bed 1 to 3 m in thickness. In Max Cove it is underlain by, and locally interbedded with, chert-pebble conglomerate containing centimeter-scale rounded clasts of black to dark-gray chert. Strata above and below the limestone in Max Cove consist of sandstone and siltstone. South of Tah Bay, two layers of limestone as thick as several meters are interbedded with, and separated by, sandstone and siltstone. The limestone apparently belongs to a single horizon that extends continuously throughout study area. Conodont ages (Savage and Gehrels, 1984) indicate that the limestone may be younger in southern part of study area than it is in northern part

Dkpv **Plagioclase-porphyritic volcanic rocks**—Volcanic and subordinate hypabyssal rocks that consist of tan, red, and gray plagioclase-porphyritic dacite(?). These rocks are present as porphyritic tuff, tuff breccia, and flows interbedded with the conglomerate unit (Dkcg) and the sandstone unit (Dks) and as hypabyssal dikes, sills, and small intrusive bodies. Dominant minerals include subhedral altered grains of andesine in a matrix of altered plagioclase microlites, opaque minerals, calcite, iron oxides, and other secondary minerals. Small, highly altered ferromagnesian grains with cores of pigeonite are preserved in a few samples

Dkbv **Basaltic to andesitic volcanic rocks**—Basaltic to andesitic rocks present as flows, breccia, dikes, and small intrusive bodies in Tah Bay region and as a thin pillow flow just west of Bert Millar Cutoff. In both regions, these volcanic rocks are interbedded with, and overlain by, clastic strata of the lower part of the Karheen Formation (Dks and Dkcg). In thin section, rocks consist of highly altered, millimeter-scale plagioclase phenocrysts in a matrix of very fine grained opaque minerals, chlorite, calcite, epidote, and other secondary minerals. These rocks resemble andesitic breccia and flows present in uppermost part of the Karheen Formation north of study area (Herreid and others, 1978; Gehrels and Saleeby, 1987)

Dkcg **Conglomeratic rocks**—Tan- to reddish-brown-weathering pebble, cobble, and boulder conglomerate, conglomeratic sandstone, and subordinate sandstone, siltstone, and volcanic rocks. Unit varies considerably in thickness and in clast composition from north to south. On west shore of Klakas Inlet and in Max Cove, the conglomeratic rocks unit is several meters thick and consists of well-rounded cobbles of intrusive, volcanic, and hypabyssal rocks in a sandstone matrix. In both areas, the conglomeratic rocks unit is massive and overlies brecciated leucogranodiorite (Ogd). Basal contact of unit can be located to within 1 m at its northern extent in Max Cove, but it is not actually exposed. In Klinkwan Cove region, the conglomeratic rocks unit thickens rapidly southward to a thickness of more than 500 m on northeast side of Klinkwan Cove fault. Clasts of unit in this area are well rounded and consist of approximately equal proportions of intrusive and volcanic rocks. High-angle crossbeds and channels and presence of clasts more than 1 m in diameter suggest that these strata were deposited in subaerial to shallow marine environments within or adjacent to an area of significant topographic relief.

South of Hunter Bay, volcanic clasts become predominant within unit, unit increases in thickness to more than 1,500 m, and plagioclase-porphyritic volcanic rocks (Dkpv) are interbedded with the conglomeratic rocks unit. Composition of volcanic clasts within unit changes southward also, from aphyric basalt-andesite in north, to plagioclase-porphyritic andesite-dacite in south. Volcanic and plutonic clasts within unit in north were apparently derived from underlying Ordovician and Lower Silurian rocks, whereas porphyritic clasts in south were derived from intraformational volcanic rocks (Dkpv and Dkbv). Basal contact of the conglomeratic rocks unit with underlying pre-Devonian rocks is exposed just east of Seagull Island (southern Buschmann Pass), along west shore of Brownson Bay, and near Bert Millar Cutoff

Dkbx **Sedimentary breccia**—Basal unit of the Karheen Formation in southern Klakas Inlet is a sedimentary breccia consisting of nonsorted angular clasts (as much as 50 cm across) of brecciated leucogranodiorite (Ogd) and diorite (Od) and highly deformed volcanic, sedimentary, and intrusive rocks derived from the subjacent Klakas Inlet assemblage (DSk). The sedimentary breccia is moderately flattened, tectonically brecciated, and locally semischistose, but is not as strongly deformed or altered as rocks in underlying structural assemblage. Basal contact of the sedimentary breccia unit is exposed in several areas on islands in southern Klakas Inlet, but degree of deformation in overlying and underlying rocks makes recognition difficult. The sedimentary breccia unit is locally overlain unconformably by as much as 1 m of crossbedded sandstone that grades upsection into the black mudstone and siltstone unit (Dkms). These overlying strata are only slightly deformed, which demonstrates that deformation in the sedimentary breccia unit and underlying structural assemblage occurred prior to middle Early Devonian time. The sedimentary breccia unit is interpreted to be Early Devonian in age because it grades laterally into the conglomeratic rocks unit (Dkcg), which is locally interbedded with fossiliferous limestone (Dkl)

Descon Formation (Early Silurian? and Ordovician)—Strata here assigned to the Descon Formation on southern Prince of Wales Island are similar in lithic types, stratigraphic position, and approximate age to Lower Silurian and Ordovician rocks of the Descon Formation on central and northern Prince of Wales Island (Eberlein and Churkin, 1970; Eberlein and others, 1983; Gehrels and Saleeby, 1987). Volcanic rocks dominate unit in most of study area and consist of basaltic to andesitic pillow flows, pillow breccia, and tuff breccia (SOdbv) and subordinate intermediate composition and silicic tuff and tuff breccia (SOdiv, SOdsv). These rocks locally interfinger with marine clastic strata south of the Frederick Cove thrust fault; north of fault strata consist primarily of interbedded argillite and shale (SOda), banded mudstone and siltstone (SOdms), and graywacke (SOdgw). Limestone (SOdl) is a minor component of the Descon Formation in study area.

Sedimentary and volcanic rocks of the Descon Formation are overlain unconformably by Lower Devonian clastic strata of the Karheen Formation and are in fault contact with pre-Middle Ordovician rocks of the Wales Group. Age of clastic strata south of Frederick Cove thrust fault is indicated by early Middle Ordovician conodonts and latest Early Ordovician graptolites recovered from unit SOda on east shore of Klakas Inlet (Eberlein and others, 1983). Middle Ordovician graptolites were also recovered from argillite (SOda) interbedded with basaltic to andesitic volcanic rocks (SOdbv) in Moira Sound (Eberlein and others, 1983). Consists of:

SOda **Argillite and shale**—Black, well-bedded, siliceous argillite and dark-gray to black shale. North of Frederick Cove thrust fault, black shale and argillite with millimeter-scale laminations and 1- to 3-cm-scale layering are dominant lithic types. Interbedded with these strata are layers of dark-gray mudstone and siltstone and several beds of gray laminated limestone as thick as 1 m. Along strike to northwest, the argillite and shale unit is interbedded with dark-gray and brownish-gray banded mudstone and siltstone (SOdms). Contact between two units is drawn where shale and argillite dominate over mudstone. Rhythmically bedded nature of these strata and graded beds in adjacent mudstone and siltstone indicate that they were deposited in a basin plain to distal submarine fan environment. Sedimentary structures indicate that these strata become younger to southwest.

South of Frederick Cove thrust fault, siliceous argillite is interbedded with volcanic rocks in many areas. Between Klakas Inlet and West Arm (Moira Sound), thick sections of argillite and shale are interlayered with basaltic to andesitic and minor silicic volcanic rocks. Thin beds of siliceous (locally cherty) argillite are common in volcanic rocks at Winter Bay, Johnson Cove, South Arm (Moira Sound), and on Barrier Islands. On Barrier Islands and at Winter Bay, these beds commonly contain disseminated pyrite and are stained with red- and orange-weathering iron oxides (Gehrels and others, 1983a)

SOdms **Banded mudstone and siltstone**—Rhythmically bedded, gray, greenish-gray, light-green, and locally tan mudstone and siltstone turbidites with well-developed size grading. Graywacke and argillite are also found in unit in some areas. Individual beds generally range from 2 to 6 cm in thickness and are finely laminated and laterally continuous. These stratigraphic characteristics are typical both in thick sections north of Frederick Cove thrust fault and in thin layers interbedded with other clastic strata or volcanic rocks to south. Greenish color, strong compositional layering, and lack of tan-weathering carbonate-rich layers distinguish these strata from the mudstone and siltstone unit (Dkms) of the Karheen Formation. Size grading, low-angle cross-stratification, and rhythmically bedded nature of these strata suggest deposition by turbidity currents in a submarine fan system.

These strata are interlayered with, and grade into, the argillite and shale unit (SOda) north of West Arm (Moira Sound) and along east shore of Klakas Inlet. Contact between these two units is drawn where banded mudstone and siltstone become dominant lithology. At Hunter Bay and south of Nichols Bay, the mudstone and siltstone unit is interbedded with layers of light-colored limestone (SOdl) in a section of predominantly basaltic to andesitic volcanic rocks. At north end of Nichols Bay, this unit is interbedded with gray, carbonate-rich mudstone (part of unit SOdl) and silicic volcanic rocks (SOdsv). Thin sulfide-rich layers are found in this unit and in adjacent volcanic rocks at Nichols Bay (Gehrels and others, 1983a). Strata at Hunter Bay and to south are moderately deformed and are metamorphosed to low greenschist facies. Metamorphism and deformation occurred prior to deposition of the overlying Karheen Formation. In most locales, strata display meter-scale open folds with shallow-plunging, northwest-trending axes

SOdgw **Graywacke**—Gray and greenish-gray graywacke consisting of silt-, sand-, and pebble-size grains of volcanic lithic fragments and subordinate feldspar. Individual beds range from several centimeters to more than 1 m in thickness and commonly are size graded. These strata are interbedded with, and grade into, banded mudstone, siltstone, argillite, and shale (SOdms, SOda) north of Frederick Cove thrust fault and are interbedded with the basaltic to andesitic volcanic rocks unit (SOdbv) in Moira Sound

SOdl **Limestone**—Limestone is a subordinate component of formation in study area and is quite variable in character. Along north shore of West Arm (Moira Sound), light- to dark-gray beds (as much as 1 m in thickness) of cross-laminated sandy limestone are interbedded with shale, argillite, and subordinate mudstone and siltstone (SOda, SOdms). Sedimentary structures in these beds and in adjacent clastic strata suggest that they were deposited by turbidity flows. Limestone along south shore of West Arm (Moira Sound) and east shore of Klakas Inlet consists of thin layers of massive, dark-gray limestone interbedded with siliceous black argillite of the argillite and shale unit (SOda). At Hunter Bay and southern Nichols Bay, massive, light-colored layers of recrystallized limestone (as thick as several meters) are interlayered with volcanic and subordinate volcaniclastic rocks. Limestone along north shore of Nichols Bay consists of gray limestone to calcareous mudstone interbedded with the banded mudstone and siltstone unit (SOdms) and the silicic volcanic rocks unit (SOdsv)

SOdbv **Basaltic to andesitic volcanic rocks**—Dark- to light-green basaltic to andesitic pillow flows, pillow breccia, and tuff breccia with subordinate tuff, volcaniclastic strata, and volcanic rocks of more silicic composition. Pillow lavas (P) display variably deformed pillows that average 30 cm across (ranging from 10 cm to as much as 1 m). Interpillow carbonate rocks and chert are quite rare. Of approximately equal abundance is volcanic breccia locally distinguished as pillow breccia (PB) or tuff breccia (TB) on map sheet. Bedding in breccia is well developed and is commonly parallel to a slight flattening of protolith features. Thin layers of tuff (T), volcaniclastic graywacke (SOdgw), and banded mudstone and siltstone (SOdms) are interbedded with volcanic breccia throughout study area. Also present are layers of silicic volcanic rocks (SOdsv) and siliceous argillite (SOda) that contain disseminated and locally massive sulfides.

Rocks of this unit generally consist of spilitic basalt to andesite containing highly altered plagioclase phenocrysts. Plagioclase grains are of andesine composition, have variable albitic and sericitic alteration, and may be as long as 4 mm. Millimeter-scale clots of chlorite, epidote, and opaque minerals are probably alteration products of ferromagnesian phenocrysts. Matrix minerals consist of plagioclase microlites, chlorite, epidote, leucoxene, and opaque minerals that formed during lower greenschist- to sub-greenschist-facies metamorphism. Adjacent to Ordovician and Early Silurian intrusive bodies, rocks are locally metamorphosed to biotite- or hornblende-bearing hornfels. Degree of deformation of volcanic rocks is quite variable; in many areas protolith features such as pillows and breccia fragments are only slightly flattened, rocks do not have a foliation, and plagioclase microlites in matrix are randomly oriented. In other areas, particularly along trace of Anchor Island thrust fault, volcanic rocks are brecciated and semischistose, and protolith features are obscured.

Features that distinguish these rocks from metavolcanic rocks of the Wales Group (pOw) include (1) lack of both schistosity and outcrop-scale, asymmetric folds; (2) abundance of well-preserved protolith features such as pillows or breccia fragments; and (3) tendancy for pillows and breccia fragments to weather differentially from their matrix

SOdiv **Intermediate (andesitic to dacitic) volcanic rocks**—Gray, greenish-gray, greenish-white, and tan plagioclase- and quartz-porphyritic tuff and subordinate tuff breccia. Volcanic rocks of basaltic to andesitic and more silicic composition and hypabyssal bodies of intermediate composition are common in this unit; as mapped, also locally includes some banded mudstone and siltstone. Widespread centimeter-scale layering in tuff is locally due to flow banding, but more commonly is due to variations in grain size and slight variations in composition within individual layers. Compositionally these volcanic rocks probably fall within andesite to dacite range. They are distinguished from lithic types of generally coeval basaltic to andesitic volcanic rocks unit (SOdbv) on basis of their more silicic composition, abundant plagioclase and quartz phenocrysts, and characteristic centimeter-scale layering. Lithologies of the silicic volcanic rocks unit (SOdsv) are more silicic and commonly fragmental. Volcanic rocks of intermediate composition constitute a major component of formation in northeastern part of study area and are present as thin layers within volcanic sections exposed in other parts of study area.

Most rocks belonging to this unit are plagioclase- and quartz-porphyritic keratophyre. Plagioclase phenocrysts constitute 5 percent to 15 percent of rock and commonly occur as glomerocrysts of large plagioclase and smaller opaque crystals. Individual plagioclase grains as long as 6 mm are generally tabular, unzoned, albitized, and moderately sericitized. Subrounded quartz phenocrysts as much as 5 mm in diameter are subordinate to plagioclase. Anhedral opaque grains as long as 3 mm constitute as much as several percent of the rock. Matrix minerals comprise microcrystalline quartz, plagioclase, and alteration products including chlorite, leucoxene, epidote, opaque minerals, and calcite

SOdsv **Silicic (dacitic to rhyolitic) volcanic rocks**—Light-green, light-gray, tan, and white plagioclase-porphyritic silicic tuff, tuff breccia, and breccia. Tuffaceous strata commonly have millimeter-scale laminations formed by slight changes in composition and probably grain size. Tuff breccia is found both as meter-scale layers throughout volcanic sections exposed in study area and as kilometer-thick layers in northeastern part of study area. Clasts in breccia range from several centimeters to 50 cm in length and consist of massive to finely laminated silicic and subordinate intermediate-composition volcanic rock. Clasts are supported in a matrix of laminated tuff and locally argillaceous strata. Silicic breccia also present as lenses as long as several hundred meters on Barrier Islands and in Ingraham Bay region. These breccias consist entirely of 10- to 50-cm-scale angular blocks of laminated silicic volcanic rock and are interpreted to represent extrusive domes. As mapped, common layers of intermediate and basaltic to andesitic volcanic rocks (SOdiv, SOdbv) are included as part of this map unit, as are sedimentary interbeds of argillite and shale (SOda) and banded mudstone and siltstone (SOdms).

Sulfide-rich horizons are common in this unit and in adjacent sedimentary and volcanic strata (Gehrels and others, 1983a). On Barrier Islands, several thin sulfide-rich layers are found at or near contacts between silicic breccia and either basaltic to andesitic volcanic rocks or argillaceous strata. Sulfides concentrate in thin rinds around pillows or breccia fragments or in thin layers in argillaceous strata. These relations and an outcrop at Nichols Bay where massive sulfide minerals show sedimentary layering and lamination similar to that in their banded siltstone host-rock indicate that mineralization was syn-volcanic and presumably volcanogenic.

Most of this unit consists of plagioclase-porphyritic quartz keratophyre. Plagioclase phenocrysts as long as 8 mm are andesine in composition, and commonly are present as glomerocrysts containing smaller opaque grains. Phenocrysts are generally tabular, nonzoned, and have thin albitic rims and variable secondary alteration. Phenocrysts constitute as much as 20 percent of some rock samples, but are more commonly less than 10 percent. Matrix minerals include primary microcrystalline quartz and albitized plagioclase and secondary chlorite, epidote, leucoxene, calcite, sericite, and opaque minerals. Although these volcanic rocks are more silicic and leucocratic than the intermediate volcanic rocks (SOdiv) with which they are interbedded, quartz phenocrysts are not recognized in more silicic rocks

REGIONALLY METAMORPHOSED AND (OR) DEFORMED ROCKS

DSk **Klakas Inlet assemblage (Early Devonian and Silurian)**—Highly altered and brecciated intermediate-composition semischist, greenstone, silicic semischist, and leucogranodiorite derived from stratified and intrusive rocks of Ordovician and Early Silurian(?) age. Assemblage is found in southern Klakas Inlet region and is here referred to informally as the Klakas Inlet assemblage. Much of unit consists of orange- to gray-weathering, green to tan semischist surrounding centimeter-scale elongate blocks of fractured greenstone. Relict volcanic or sedimentary structures and textures in some blocks indicate protoliths of the basaltic to andesitic volcanic rocks (SOdbv), mudstone and siltstone (SOdms), and graywacke units (SOdgw) of the Descon Formation. Iintermediate-composition semischist and greenstone were intruded by dikes of brecciated leucogranodiorite (Ogd). Foliation is only rarely developed in various rock types due to cataclastic style of deformation and to pervasive orange-weathering dolomitic alteration. These rocks are mapped as an assemblage because original depositional and intrusive relations between constituent rock types are obliterated by penetrative deformation and alteration.

Age of deformation is constrained by Ordovician age of intrusive and stratified rocks included and by nondeformed middle Lower Devonian sandstone and mudstone (Dkms) of the Karheen Formation that overlies assemblage. Deformation of rocks in assemblage may be result of Silurian to earliest Devonian movement on Anchor Island and associated thrust faults (Gehrels and Saleeby, 1987)

SOk **Kendrick Bay assemblage (Early Silurian and Ordovician)**—A heterogeneous assemblage of dark- to medium-brown and gray schistose gneiss in Kendrick Bay-McLean Arm area (MacKevett, 1963) here referred to informally as the Kendrick Bay assemblage. Layering in gneiss ranges from several millimeters to 50 cm in thickness and is defined by variations in abundance of ferromagnesian minerals versus quartz and plagioclase. Ferromagnesian minerals consist of green hornblende and brown biotite, which record amphibolite-facies metamorphism. Composition of gneiss, combined with rare exposures of deformed pillows, volcanic breccia fragments, rhythmic sedimentary layering, and plutonic textures indicate that these metamorphic rocks were derived from basaltic to andesitic volcanic rocks (SOdbv) and volcaniclastic strata (SOdgw, SOdms) of the Descon Formation and subordinate dioritic to quartz dioritic intrusive rocks (Od, Oqd).

As mapped, sills of variably layered and foliated quartz monzonite (SOqm) and quartz diorite (Oqd) are also common in this unit. Layering and foliation in sills and in adjacent quartz monzonite and granite (SOqm), quartz diorite (Oqd), and granite (SOgr) bodies are nearly everywhere parallel to compositional layering and foliation in assemblage. These relations and gradational contacts between metadiorite belonging to this unit and adjacent quartz dioritic and dioritic rocks (Oqd) indicate that metamorphism and deformation occurred during, and probably as a result of, emplacement of Ordovician and Early Silurian intrusive bodies. Regional relations and relict protolith features indicate that metasedimentary and metavolcanic components of assemblage were derived from rocks of the Descon Formation rather than the Wales Group

Or **Ruth Bay assemblage (Ordovician)**—A distinctive assemblage of metagabbro-metadiorite bodies intruded by metagranodiorite sills (approximately 20 percent) and containing screens of amphibolite-facies metavolcanic and metasedimentary rocks (<5 percent). This assemblage is found in Ruth Bay region west of Klakas Inlet and is here referred to informally as the Ruth Bay assemblage. Relative proportions of various rock types are quite consistent between Keete Inlet fault and Bird Rocks thrust fault and on southern Klakas Island. On small islands south of Klakas Island, however, this assemblage consists almost entirely of 10- to 50-cm-thick layers of foliated gabbro, diorite, and quartz diorite. Assemblage is juxtaposed to east along Keete Inlet fault against brecciated and deformed Ordovician (Og, Ogd), Ordovician and Early Silurian(?) (SOdbv), and Silurian and Early Devonian (DSk) rocks and to west along Bird Rocks thrust fault against amphibolite-facies rocks of the Wales Group (pOw).

Metavolcanic and metasedimentary rocks of this assemblage are several-meter-thick, lens-shaped screens enveloped in metagabbro, metadiorite, and metagranodiorite. These metamorphic rocks are recognized by their compositional layering, relict pyroclastic fragments, and, in Clam Cove, existence of a thin marble layer. Best exposures of protolith features are found near narrow part of large island in Ruth Bay. In most areas, metasedimentary and metavolcanic rocks consist of medium-grained green hornblende, brown biotite, plagioclase, opaque minerals, and minor quartz. Lack of penetrative deformation of protolith features in metavolcanic rocks suggests that they were derived from the Descon Formation rather than the Wales Group.

Metagabbro-metadiorite components generally consist of dark-gray to black, highly foliated and locally schistose amphibolite with a color index ranging from 40 to 70. Most rocks contain green hornblende, plagioclase, sphene, opaque minerals, and minor quartz. Rocks are more highly altered to east and are overprinted by secondary chlorite, epidote, calcite, and white mica. Contacts between various intrusive components in assemblage are generally parallel to pervasive regional foliation, which is defined by elongation and alignment of metamorphic minerals and by slight centimeter-scale variations in relative proportions of hornblende and plagioclase. Degree to which ferromagnesian minerals are elongated and aligned varies, and in some rocks a plutonic texture is well preserved.

Both metasedimentary-metavolcanic rocks and metagabbro-metadiorite are intruded by sills and dikes of metagranodiorite generally 10 to 40 cm in thickness and as long as several tens of meters. Sills commonly taper out along strike, but locally have abrupt, angular terminations or are truncated by ductile shear zones. Contacts of sills are commonly parallel to foliation in both country rocks and granodiorite. In some cases, however, metagranodiorite sills cut across foliation in adjacent rocks and have a foliation that is parallel to, but not as strongly developed as foliation in their country rocks. Granodioritic rocks consist predominantly of quartz, plagioclase, K-feldspar, 5 to 15 percent brown biotite, up to 5 percent green hornblende (found in long narrow grains), sphene, and trains of opaque grains—all of which are elongated and aligned parallel to foliation. Although most rocks have a penetrative foliation defined by alignment of ferromagnesian minerals and elongation of quartz and plagioclase, a relict plutonic texture is preserved in most areas. To east, these rocks are moderately altered—chlorite and epidote replace ferromagnesian minerals, and calcite, white mica, and epidote replace plagioclase.

Intrusive and structural relations described above suggest that emplacement of metaplutonic rocks caused deformation and amphibolite facies metamorphism of metasedimentary and metavolcanic rocks. Age of deformation, metamorphism, and formation of assemblage is constrained by a U-Pb apparent age of 465±7 Ma (Middle Ordovician) on a metagranodiorite sill (loc. 5, table 2) that cuts across foliation in metagabbro-metadiorite yet exhibits regional foliation. Similarities in age and composition suggest that foliated intrusive rocks in this assemblage may be deeper level equivalents of Ordovician diorite (Od) and leucogranodiorite (Ogd) east of Keete Inlet fault (Gehrels and Saleeby, 1987)

pOw **Wales Group (pre-Middle Ordovician)**—A metamorphic sequence of greenschist- to amphibolite-facies metavolcanic and metasedimentary rocks (named the Wales Group by Buddington and Chapin, 1929; informally called the Wales metamorphic suite by Gehrels and Saleeby, 1987). In most of study area, unit consists of light- to dark-green, fine-grained greenschist and greenstone derived from basaltic to andesitic volcanic rocks and volcaniclastic strata. Pillows and centimeter-scale pyroclastic fragments are locally preserved in metavolcanic rocks. Metasedimentary rocks locally show relicts of rhythmic and graded bedding. Metavolcanic and metasedimentary rocks are interlayered over structural thicknesses of tens of meters. In most locales, protolith features are obscured by metamorphic recrystallization, penetrative foliation, a high degree of flattening, and moderate elongation. Black phyllite and schist derived from argillaceous strata (A) are interlayered with greenschist and greenstone along shoreline between Kassa Inlet and Mabel Bay. Meter-thick layers of silicic metavolcanic rocks (S) and light-colored, coarsely recrystallized marble (L) constitute a minor part of this unit.

The Wales Group is metamorphosed to greenschist facies north of study area (Eberlein and others, 1983; Herreid and others, 1978) and north and west of Kassa Inlet. Dominant metamorphic mineral assemblage in greenschist-facies rocks includes chlorite, actinolite, albite, epidote, and opaque minerals. South of Kassa Inlet, metamorphic grade increases eastward from greenschist to amphibolite facies. Along Ship Island Passage, rocks are similar in metamorphic grade and structural style to rocks north and west of Kassa Inlet. To east, rocks become progressively higher in metamorphic grade, with brown biotite replacing chlorite and almandine garnet present just west of Shipwreck Point thrust fault. Between Shipwreck Point and Bird Rocks thrust faults, rocks are amphibolite facies and consist of fine- to medium-grained garnet, plagioclase, and hornblende and (or) biotite. In addition to this regional metamorphism, rocks in this unit were metamorphosed to hornblende-hornfels facies adjacent to the Silurian leucodiorite body (Sd) in Kassa Inlet.

Rocks in the Wales Group have a penetrative metamorphic foliation generally parallel to compositional layering and to flattening of protolith features. Most rocks also have a strong linear fabric defined by elongation of protolith features and by strong mineral lineation along foliation surfaces. Isoclinal folds in protolith layering are found in some outcrops and have axes that are parallel to mineral lineation and elongation direction. Regional foliation generally forms axial surface of these folds. Relations between dominant fabric elements and these isoclinal folds, combined with a high degree of flattening of protolith features, indicate that primary stratigraphic relations in these rocks were transposed into metamorphic foliation.

Superimposed on metamorphic foliation and lineation are several sets of folds that do not have an axial planar foliation and are interpreted to have formed after main phase of deformation and metamorphism. Outcrop-scale folds generally plunge less than 30°, have wavelengths of 10 cm to several meters, and are highly asymmetric. Along shoreline northwest of Shipwreck Point, metamorphic foliation dips to either southeast or northwest in domains that define a synform-antiform pair with shallow-plunging, northeast-trending axes (see map sheet). Asymmetric folds along this shoreline are coaxial with synform-antiform pair and show both "s" and "z" asymmetry, with direction of overturning in up-dip direction of foliation. This suggests that outcrop-scale "s" and "z" folds along this shoreline, which are common throughout the Wales Group, may be parasitic to a series of shallow-plunging, upright antiforms and synforms with wavelengths of several tens to several hundreds of meters. These preliminary observations indicate that outcrop-scale asymmetric folds common throughout the Wales Group may not have direct regional kinematic significance.

Relations north of study area indicate that rocks in the Wales Group were metamorphosed and deformed during Middle Cambrian to Early Ordovician time and that their protoliths are pre-Late Cambrian in age. Maximum age of metamorphism and deformation was determined north of study area (in Cholmondeley Sound), where Middle and Late Cambrian metaplutonic rocks were metamorphosed and deformed along with rocks in the Wales Group (J.B. Saleeby and G.E. Gehrels, unpub. data, 1984; Gehrels and Saleeby, 1987). These relations also demonstrate that protoliths of rocks in the Wales Group must be pre-Late Cambrian in age. An Early Ordovician age of metamorphism was proposed by Turner and others (1977) on basis of an 40Ar-40K isochron apparent age of 483 Ma determined from hornblende with tremolite overgrowths. Presence of relatively nondeformed uppermost Lower Ordovician and younger strata in the Descon Formation in many areas of southern Prince of Wales Island suggests that metamorphism and deformation occurred prior to end of Early Ordovician time. Thus, available constraints indicate that rocks in the Wales Group were deposited prior to Late Cambrian time and were regionally deformed and metamorphosed during Middle Cambrian to Early Ordovician time.

Eberlein and others (1983) reported that the Wales Group may be overlain by a several-kilometer-thick section of south-dipping strata near head of South Arm (Cholmondeley Sound) and in Klakas Inlet (approximately 15 km north of study area). They argue that these strata are Cambrian in age and that the Wales Group may be at least in part Precambrian because late Early to Middle Ordovician fossils were recovered from uppermost part of section in southern Klakas Inlet (loc. 3, table 1). My mapping in Klakas Inlet has shown, however, that Ordovician strata at sample locality 3 (table 1) are separated from rocks to the north by Frederick Cove thrust fault and that strata north of fault are moderately deformed, highly folded, and cut by many high- and low-angle faults. In addition, Herreid and others (1978) reported that these strata are separated from the Wales Group near head of Klakas Inlet by Keete Inlet fault. Thus, a Precambrian age for rocks in the Wales Group is not demonstrated by stratigraphic relations or geochronometric determinations

INTRUSIVE ROCKS

Kgd **Granodiorite (Cretaceous)**—Massive, medium-grained granodiorite that intrudes Devonian and older rocks and several thrust faults west of Klakas Inlet. Color index of these rocks ranges from 5 to 25. Ferromagnesian minerals consist of green hornblende and subordinate light-green augite and chloritized brown biotite. Anhedral opaque minerals (generally magnetite) constitute several percent of some samples, are commonly anhedral, and may be as much as 1 mm in diameter. Sphene is ubiquitous and locally over 1 mm in length. Plagioclase forms 2- to 5-mm-long, tabular, strongly zoned grains with moderately altered cores. Outer parts of grains are oligoclase in composition. Potassium feldspar commonly grows in large (locally more than 1 cm in diameter) anhedral grains around plagioclase and also as small grains intergrown with quartz in interstices of larger plagioclase grains. Locally associated with bodies are small unmapped masses of Cretaceous gabbro (Kgb).

These granodioritic rocks are readily distinguished from Ordovician and Silurian plutonic rocks by their tabular and strongly zoned plagioclase, large anhedral potassium feldspar, and abundant magnetite and sphene. These rocks are correlated with mid-Cretaceous intrusive rocks north of study area (Herreid and others, 1978) on basis of their similar mineralogy and texture

Kd **Diorite (Cretaceous)**—Massive, medium- to coarse-grained diorite of presumed Cretaceous age east of Klakas Inlet. Color index ranges from 15 to 40; ferromagnesian minerals include moderately chloritized brown biotite (as much as 15 percent), diopsidic(?) augite (5 to 20 percent) grains as long as 5 mm, and green hornblende (10 to 25 percent) locally in a reaction relation with clinopyroxene. Large euhedral grains of sphene, anhedral and irregular opaque grains (primarily magnetite), and a minor proportion of small anhedral apatite constitute as much as 5 percent of rock. Quartz is a minor constituent, plagioclase forms euhedral to subhedral, tabular, strongly zoned grains of andesine composition, and potassium feldspar forms large interstitial grains around other minerals. This intrusive body is similar in mineralogy, texture, weathering characteristics, and aeromagnetic signature to mid-Cretaceous granodiorite and diorite bodies north of study area (Eberlein and others, 1983; Rossman and others, 1956; Herreid and others, 1978) and is accordingly interpreted as Cretaceous in age

Kgb **Gabbro (Cretaceous)**—A small body of medium- to coarse-grained gabbro that intrudes Shipwreck Point thrust fault and rocks belonging to the Wales Group (pOw) west of Ruth Bay. Green hornblende, moderately altered plagioclase, and chloritized brown biotite constitute most of rock. Subordinate granodiorite pods are associated with intrusive body. Dikes of granodiorite and gabbro cut metamorphic foliation in the Wales Group and also cut cataclastic fabrics in rocks along trace of Shipwreck Point thrust fault. This intrusive body is probably Cretaceous in age on basis of mineralogical and textural similarities with gabbroic phases of mid-Cretaceous intrusive bodies north of study area (Herreid and others, 1978; Eberlein and others, 1983)

Bokan Mountain Granite (Jurassic)—A fine- to coarse-grained stock of peralkaline granite exposed between Kendrick Bay and South Arm (Moira Sound). A considerable amount of research has been conducted on petrology and geochemistry of this body because of its unusual composition and close association with uranium, thorium, and rare-earth-element deposits. MacKevett (1963) originally mapped stock as silica-rich, riebekite- and aegirine-bearing peralkaline granite. Thompson and others (1982) interpreted body to be a ring-dike complex and subdivided it into twelve phases of aegirine- and riebekite-bearing granite, aplite, porphyry, and pegmatite. As reported in Saint-André and others (1983), Bernard Collot divided granite into three main phases: (1) albitic aegirine granite around margin, (2) fine-grained albitic arfvedsonite-aegirine granite in center, and (3) albitic arfvedsonite granite between them.

The Bokan Mountain Granite was dated by a variety of isotopic methods, all of which yield Jurassic ages. Lanphere and others (1964) reported K-Ar ages of 185±8Ma and 190±8Ma (Middle to Early Jurassic) on riebekite (arfvedsonite?) (loc. 16, table 2), and Saint-André and others (1983) reported a U-Pb apparent age of 171±5Ma (Middle Jurassic) on basis of analyses of 10 zircon fractions (loc. 17, table 2). This U-Pb age is considered suspect, however, because: (1) their radiogenic lead/common lead is so low that even a small error in assigned composition of common lead results in a large uncertainty in apparent age and (2) several fractions plot above concordia on a $^{206}Pb^*/^{238}U$ versus $^{207}Pb^*/^{235}U$ concordia diagram, which indicates that their concentrations of uranium and lead may be incorrect due to incomplete dissolution of zircon and (or) incomplete equilibration of sample and spike. This interpretation is supported by their lower intercept with concordia of 0±15 Ma. Rb/Sr analyses of ten whole-rock samples from various phases of granite yield an $^{87}Sr/^{86}Sr$ versus $^{87}Rb/^{86}Sr$ isochron apparent age of less than 156 Ma (Armstrong, 1985). A selection of seven samples yielded an isochron age of 151±5 Ma (Late Jurassic) which Armstrong (1985) interpreted to be a minimum age for granite.

Four major phases recognized by Thompson and others (1982, their fig. 2) are shown separately on map sheet and rest are combined into an undivided granite unit. Divided into:

Jbr **Riebekite granite porphyry**—Granite porphyry consisting of quartz phenocrysts (as much as 5 mm in diameter), subhedral riebekite phenocrysts (as long as 4 mm), albite, and potassium feldspar. Rock grades outward through a transition zone of aegirine- and riebekite-bearing granite into aegirine granite porphyry (Jba)

Jba **Aegirine granite porphyry**—Granite porphyry consisting of quartz and microperthite phenocrysts (as much as 8 mm in diameter) in a groundmass of quartz, microcline, albite, aegirine, sphene, zircon, monazite, muscovite, and fluorite

Jbfr **Fine-grained riebekite granite porphyry**—Granite porphyry consisting of microcline, quartz, and riebekite phenocrysts in a groundmass of albite, microcline, quartz, and riebekite

Jbfa **Felty-aegirine granite**—Granite exposed in central part of Bokan Mountain body consisting of fine aegirine needles in an aplitic groundmass of quartz, potassium feldspar, albite, and accessory sphene and fluorite

Jbu **Granite, undivided**—Undivided riebekite- and (or) aegerine-bearing granite, aplite, pegmatite, syenite, and porphyry

Dph **Plagioclase-porphyritic hypabyssal rocks (Early Devonian or younger)**—Small intrusive bodies of plagioclase porphyry found in association with the Karheen

Formation in Klakas Inlet region. Similar bodies were mapped by Herreid and others (1978) in Devonian strata 2 to 8 km north of study area (near Keete Inlet). Large (.4 to 1.5 cm long), euhedral, moderately altered, interlocking grains of labradorite and andesine constitute most of rock. Light-green to light-pinkish-brown diopsidic(?) augite constitutes from 15 to 30 percent of most samples and is present as several-millimeter-scale, subhedral grains intergrown with plagioclase. In some samples, clinopyroxene grains have rims of green or reddish-brown hornblende and opaque minerals. Microcline and microperthite are generally present as sub-millimeter-scale grains in interstices of plagioclase grains. Abundance of potassium feldspar is quite variable. Opaque minerals are present as skeletal grains as much as 3 mm across. Millimeter-scale angular clots of chlorite and subordinate opaque minerals, calcite, and white mica fill miarolitic cavities in rock. These cavities and lack of hornfelsic aureoles around intrusive bodies indicate that they were emplaced at shallow levels.

Crosscutting relations with the Karheen Formation indicate that these rocks are Devonian or younger in age, and mineralogical and textural similarities suggest that they are related to the plagioclase-porphyritic volcanic rocks unit (Dkpv) of the Lower Devonian Karheen Formation in southwestern part of study area

Sd **Leucodiorite (Late Silurian)**—Massive, medium- to coarse-grained, leucocratic diorite and subordinate monzodiorite and monzonite in Kassa Inlet and inland to southeast. On Kassa Island body intrudes across metamorphic fabrics in the Wales Group (pOw) and has a hornblende-hornfels contact aureole that extends for several meters. Dikes also cut deformational fabrics in Ordovician metaplutonic rocks belonging to the Ruth Bay assemblage (Or) south of Kassa Inlet. Map patterns indicate that body cuts across northern continuations of Bird Rocks and Shipwreck Point thrust faults.

These rocks lack quartz, have a color index of less than 25, and include 1- to 6-mm-long anhedral grains of arfvedsonite that in some samples contain cores of aegirine-augite. Melanite(?) garnet constitutes as much as 10 percent of rock and is generally medium to dark brown, moderately zoned, subhedral to euhedral, and as much as 4 mm in diameter. Euhedral to subhedral grains of sphene (as long as to 5 mm) are commonly intergrown with garnet and arfvedsonite. Opaque minerals are rare. Grains listed above tend to form in glomerocrysts as much as 1 cm in diameter. Moderately zoned, tabular plagioclase grains (as long as 7 mm) constitute most of rock. Cores of these grains are highly altered and of unknown composition whereas outer parts are fresh and oligoclase in composition. Microperthite is generally less abundant than plagioclase and forms in interstices between plagioclase grains and glomerocrysts of other minerals.

A U-Pb apparent age of 418±5Ma (Late Silurian) was determined on a sample of leucodiorite from Kassa Island (loc. 11, table 2)

SOsy **Quartz syenite and granite (Early Silurian and (or) Late Ordovician)**—A heterogeneous suite of massive, fine- to medium-grained, gray-, reddish-gray-, and maroon-weathering quartz syenite and granite in McLean Arm-Nichols Bay region. In Stone Rock Bay, these rocks intrude, and locally grade into, rocks belonging to the pyroxenite and hornblendite unit (SOpx). Along shoreline between Cape Chacon and Nichols Bay and inland between McLean Arm and Nichols Bay, these rocks are difficult to distinguish from rocks belonging to quartz monzonite and granite unit (SOqm). More detailed mapping in this area would probably result in designation of a map unit representing rocks intermediate in composition and texture between quartz syenitic and quartz monzonitic rocks. As mapped here, these intermediate rocks are included with rocks in the quartz monzonite and granite unit (SOqm). Dikes of maroon to red feldspar-porphyritic syenite cut rocks belonging to all units in McLean Arm-Nichols Bay area and represent latest phase of syenitic intrusive activity.

Quartz syenitic and granitic rocks have a low color index (generally less than 20) and consist primarily of interlocking, fine- to medium-grained microperthite, quartz, and plagioclase. Plagioclase forms tabular grains as long as 3 mm that are generally largest grains in rock. They are highly altered to white mica, calcite, and epidote and have albitized rims. Compositionally they range from low-calcium andesine to oligoclase and are not zoned. Potassium feldspar is present as sub-millimeter-scale anhedral grains of microperthite intergrown with quartz around plagioclase grains. Potassium feldspar grains are not as highly altered as plagioclase but have a slight overprint of fine-grained white mica, calcite, and epidote. Ratio of microperthite to plagioclase is generally about 2:1. Submillimeter-scale quartz grains constitute from 5 to 30 percent of most rock samples. Ferromagnesian minerals include glomerocrysts of green hornblende and subordinate brown biotite, opaque minerals, and sphene. In most samples, hornblende and biotite are moderately altered to chlorite and opaque minerals. Zircon is an abundant accessory mineral and medium-brown garnet is locally present. Syenitic rocks described by MacKevett (1963) are quite similar, except for a greater abundance of quartz, to rocks described above.

A U-Pb apparent age of 438±5Ma (latest Ordovician and (or) earliest Silurian) was determined on a sample of quartz syenite from sample locality 10 (table 2)

SOpx **Pyroxenite and hornblendite (Early Silurian and (or) Late Ordovician)**—Coarse-grained to pegmatitic pyroxenite, hornblende pyroxenite, and hornblendite found along eastern shore of southernmost Prince of Wales Island. In McLean Arm, Stone Rock Bay, and at west end of elongate body north of Cape Chacon, unit consists of medium- to coarse-grained pyroxenite and hornblende pyroxenite. Hornblende generally rims augite and is associated with abundant opaque minerals. Plagioclase locally fills interstices of large grains. MacKevett (1963) reported that biotite is present in some samples. Ultramafic body along shoreline north of Cape Chacon is a coarse-grained hornblendite to hornblende pegmatite containing hornblende crystals as long as 10 cm. Large grains of anhedral opaque minerals are common. The pyroxenite and hornblendite are intruded by quartz monzonite (SOqm) along shoreline north of Cape Chacon and by quartz syenite (SOsy) at several localities in Stone Rock Bay. Also in Stone Rock Bay, however, quartz syenite (SOsy) grades into fine-grained pyroxenite over a distance of several meters. MacKevett (1963, p. 17) reported that contacts between pyroxenite and quartz monzonite are "gradational through a zone of hybrid rock or intrusive breccia." These relations and close spatial association of ultramafic rocks with quartz syenite (SOsy) and quartz monzonite (SOqm) suggest that rocks of these three units may be, in part, coeval and genetically related. A Late Ordovician and (or) Early Silurian age is accordingly assigned to these ultramafic rocks

SOgr **Granite (Early Silurian and (or) Late Ordovician)**—Weakly foliated, light-pink to light-gray, coarse-grained granite found along east shore of Prince of Wales Island between Kendrick Islands and McLean Arm. Foliation is generally parallel to strong foliation and layering in the Kendrick Bay assemblage (SOk) and weak foliation in adjacent bodies of quartz monzonite and granite (SOqm). Foliated sills of granite are generally parallel to foliation in these rocks, suggesting that granite was emplaced during waning stages of deformation and metamorphism.

Granite has a color index of less than 10 and consists primarily of interlocking plagioclase, quartz, and large potassium feldspar grains. Plagioclase is generally oligoclase, with moderate zoning from calcic interiors to sodic rims. Some grains show oscillatory zoning as well. Their interiors are moderately altered to white mica, calcite, and epidote. Rims are slightly albitized. Plagioclase is present both as small grains enclosed in potassium feldspar and as subhedral grains (as long as 5 mm) intergrown with potassium feldspar and quartz. Large anhedral quartz grains are intergrown with feldspar and constitute as much as 40 percent of some samples. Potassium feldspar is present both as poikilitic microperthite grains as much as 1.5 cm across and as microcline grains less than several millimeters in diameter. Ferromagnesian minerals are altered to chlorite and opaque minerals in most samples, although large books of brown biotite are preserved in some rocks. Shape of chlorite masses suggests that biotite was originally dominant over hornblende. Large subhedral sphene and small euhedral zircon grains are common accessory phases.

A U-Pb apparent age of 438±5Ma (loc. 9, table 2) indicates that rocks in this map unit were emplaced during latest Ordovician and (or) earliest Silurian time (Gehrels and Saleeby, 1987)

SOqm **Quartz monzonite and granite (Early Silurian and (or) Late Ordovician)**—Medium-grained quartz monzonite and granite underlie much of eastern and central parts of southern Prince of Wales Island. In most areas rocks are massive, although along east shore of Prince of Wales Island they are locally foliated. Between Kendrick and Ingraham Bays, foliated rocks are mapped as a separate unit of foliated quartz monzonite (SOfqm). Mafic dikes are widespread in quartz monzonitic rocks and locally show evidence of emplacement prior to complete crystallization of their country rocks. Agmatite consisting of microdiorite blocks in a quartz monzonite host is also common. Quartz monzonitic rocks intrude slightly older quartz diorite (Oqd) and are in turn intruded by granite (SOgr) and quartz syenite (SOsy).

Rocks in this unit are quite variable in color index, relative proportions of plagioclase versus potassium feldspar, and abundance of quartz but generally are quartz monzonite, granite, granodiorite, or quartz monzodiorite in composition. Color index ranges from 5 to as much as 50, with an average of approximately 25. More mafic and more leucocratic phases are in most cases gradational with quartz monzonite and are interpreted to be cogenetic.

Most rocks consist primarily of interlocking plagioclase, potassium feldspar, and quartz. Tabular and subhedral grains of plagioclase have moderate compositional zoning. Their cores generally are highly altered to white mica, calcite, and epidote, and outer parts are sodic andesine to calcic oligoclase in composition. In highly altered rocks plagioclase has albitized rims, but widespread albitization reported by MacKevett (1963) was not observed in samples from outside western Kendrick Bay region. Plagioclase grains are locally as long as 7 mm and were probably among the early minerals to crystallize. Potassium feldspar is present both as subhedral grains as long as several millimeters and as smaller microperthite grains in interstices of ferromagnesian minerals and larger feldspars. Potassium feldspar is slightly subordinate to plagioclase in abundance in most rocks. Quartz constitutes between 5 and 40 percent of rocks and is present as anhedral grains in interstices of feldspar and ferromagnesian minerals. Green hornblende (commonly containing cores of light-green augite) is slightly more abundant than brown biotite. Common glomerocrysts of hornblende and biotite are as much as 1 cm in diameter. Opaque minerals and sphene are common in glomerocrysts as well. Apatite and zircon are common accessory minerals.

Biotite quartz monzonite from locality 8 (table 2) yields a U-Pb apparent age of 438±4 Ma (latest Ordovician and (or) earliest Silurian). Lanphere and others (1964) reported K-Ar apparent ages of 454±22 Ma on hornblende (loc. 13, table 2) and 379±18 Ma on biotite (loc. 14, table 2) from quartz monzonite in South Arm of Kendrick Bay. Armstrong (1985) reported an $^{87}Rb/^{86}Sr$ versus $^{87}Sr/^{86}Sr$ isochron age of 432±19 Ma on basis of analyses of rock samples collected from this map unit, a more foliated quartz monzonite that may or may not belong to this unit, and gabbro that may belong to rocks in diorite unit (Od). His samples of quartz monzonite alone do not have a sufficient range in $^{87}Rb/^{86}Sr$ to define a meaningful isochron and are, therefore, not reliably dated by this method. Assuming that biotite age of Lanphere (1964) is not a crystallization age, various geochronological data and field relations are consistent with emplacement of these rocks during Late Ordovician and (or) Early Silurian time

SOfqm **Foliated quartz monzonite (Early Silurian and (or) Late Ordovician)**—Foliated and locally layered quartz monzonite found near large quartz monzonite and granite bodies (SOqm) in Kendrick Bay region. Contacts between foliated quartz monzonite (SOfqm) and nonfoliated quartz monzonite (SOqm) are gradational where exposed, suggesting that rocks in these two units are coeval and genetically related. Between Ingraham and Kendrick Bays, these foliated rocks intrude and produce hornblende-hornfels aureoles in adjacent volcanic rocks of the Descon Formation. Foliation is defined by elongation of quartzo-feldspathic minerals and alignment of hornblende and biotite. On Kendrick Islands and locally to north, these rocks have a faint centimeter-scale layering defined by variations in relative proportion of quartzo-feldspathic versus ferromagnesian minerals.

Mineralogy of these rocks is similar to that in associated quartz monzonite and granite (SOqm); dominant minerals include millimeter-scale subhedral plagioclase, quartz, potassium feldspar, and hornblende and biotite. Primary differences are that quartz is finer grained and elongate and hornblende and biotite are generally aligned and found in elongate masses

Oqd **Quartz diorite and diorite (Late Ordovician)**—Fine- to medium-grained quartz diorite and subordinate diorite and quartz monzonite found primarily in Kendrick Bay region (MacKevett, 1963). Quartz diorite is commonly massive although mafic dikes and agmatitic zones are widespread. Dioritic rocks are more heterogenous and commonly contain zones of diorite-basite migmatite and agmatite and comb-textured dikes of hornblende pegmatite. Rocks in this unit intrude the Descon Formation and are intruded by Late Ordovician and (or) Early Silurian quartz monzonite and granite (SOqm).

Quartz diorite consists primarily of interlocking plagioclase, hornblende, and quartz. Tabular grains of plagioclase (andesine) range in length from less than 1 mm to 6 mm. Grains are slightly zoned and interiors commonly are more highly altered to white mica, calcite, and epidote than margins. Potassium feldspar is generally absent although a few samples contain interstitial microperthite. Quartz generally constitutes less that 15 percent of rock and is present as small interstitial grains. Green hornblende forms several-millimeter-long grains intergrown with subordinate brown biotite (generally chloritized) and opaque minerals. Hornblende grains are commonly poikilitic with many small inclusions of quartz, plagioclase, and accessory minerals. Opaque minerals are locally more than 1 mm in diameter and constitute as much as several percent of some samples. Sphene is present as large subhedral grains. Apatite and zircon are minor accessory phases.

Age of quartz diorite is constrained by a U-Pb apparent age of 445±5Ma (Late Ordovician) on a sample from Kendrick Bay (loc. 6, table 2). Lanphere and others (1964) reported a K-Ar apparent age of 439±21 Ma (Late Ordovician) on hornblende from quartz diorite in western Kendrick Bay (loc. 15, table 2)

Ofgd **Foliated granodiorite (Late Ordovician)**—Foliated and locally layered leucocratic granodiorite found near Tah Island. These rocks intrude and are interlayered with foliated and layered Late Ordovician dioritic rocks (Ofd). Contacts between granodiorite and diorite are nearly everywhere parallel to foliation and layering in diorite and foliation in granodiorite. Some rocks have only a slight foliation, yielding well-preserved plutonic textures. Highly foliated rocks are generally confined to narrow domains that may have been ductile shear zones. Contact relations with dioritic rocks combined with style and variability of foliation in granodiorite indicate that granodiorite was emplaced and deformed prior to complete crystallization of diorite.

Highly foliated components of this unit comprise fine-grained, interlocking quartz, plagioclase, and subordinate potassium feldspar and subhedral green hornblende. Their foliation is defined by alignment of elongate hornblende and quartz grains, thin layers of chlorite and epidote aligned parallel to foliation, and slight centimeter-scale variations in grain size and relative abundance of minerals. Opaque minerals are more common in coarser grained quartzofeldspathic layers. Less foliated rocks retain their primary texture and consist of medium-grained plagioclase (oligoclase), quartz, and microperthite. As much as 15 percent of rock consists of hornblende grains moderately recrystallized to chlorite and opaque minerals.

Age of rocks in this unit has not been determined directly as a geochronologic sample of foliated leucogranodiorite from larger island west of Tah Island did not yield zircons. Intrusive and structural relations suggest, however, that these rocks are generally coeval with foliated and layered diorite and quartz diorite (Ofd) of known Late Ordovician age

Ofd **Foliated and layered diorite and quartz diorite (Late Ordovician)**—Moderately to highly foliated and layered diorite and quartz diorite found near Tah Bay and at Max Cove. Rocks that are moderately foliated and display intrusive relations continuously grade into highly layered and foliated rocks that only locally display protolith relations. In highly deformed domains, dioritic and quartz dioritic rocks form strongly foliated, several-centimeter-thick layers in which compositional layering is nearly everywhere parallel to penetrative foliation. Locally, however, quartz dioritic layers intrude at an acute angle across foliation in dioritic rocks, yet contain a foliation parallel to that in their country rocks. Crosscutting relations are common in moderately deformed rocks. In most cases, the less strongly foliated silicic rocks intrude more strongly foliated mafic country rocks.

A continuous gradation from highly to moderately deformed rocks is seen along east shore of narrow inlet east of Tah Bay. In northern part of inlet (and inland to east), rocks have a strong and laterally continuous foliation and layering. To south, rocks become less foliated, intrusive contacts between various layers are well preserved, and layering and foliation are variable in orientation. In southern part of this narrow inlet, various layers are clearly intrusive dikes and sills with well-preserved igneous fabrics, most rocks are not as highly foliated, and average thickness of compositional units increases to several tens of centimeters. Quartz diorite also replaces diorite as dominant rock type. .

Dioritic to quartz dioritic rocks belonging to this unit contain varying proportions of green hornblende, plagioclase, and quartz. In dioritic rocks, elongate green hornblende grains (as long as 5 mm) constitute 25 to 50 percent of rock. Anhedral plagioclase grains of andesine composition are generally smaller than hornblende. Quartz and potassium feldspar are minor components of dioritic rocks and are present as small grains intergrown with plagioclase. Most rocks are fairly unaltered although in some samples hornblende is replaced by chlorite, epidote, and opaque grains. In general, plagioclase is altered to white mica, epidote, and calcite. Hornblendite is a minor component and consists of interlocking, subhedral, green hornblende grains locally more than 1 cm in length. Plagioclase fills interstices of hornblende grains. Quartz dioritic rocks are similar to diorite except for greater proportions of quartz and potassium feldspar and presence of large anhedral sphene grains.

A moderately foliated quartz diorite at Tah Bay (loc. 7, table 2) yields a U-Pb apparent age of 446±5 Ma (Late Ordovician). This is interpreted as approximate age of formation of this unit on basis of intrusive and structural relations described above. Similarities in mineralogy, composition, and apparent age indicate that these rocks may be related to rocks in the quartz diorite and diorite unit (Oqd).

Intrusive relations indicate that these rocks were deformed prior to complete crystallization. This deformation was probably in response to mostly magmatic processes because there is no evidence in area of regional deformation during Late Ordovician time

Od **Diorite (Ordovician)**—A heterogeneous suite of diorite and subordinate hypabyssal diorite and gabbro primarily in western and southern parts of study area. On Klakas Island, at Ruth Bay, and along western shore of Max Cove, rocks are medium grained and homogeneous but have a penetrative cataclastic fabric in many locales. Along east shore of Max Cove, they are massive and agmatitic with diorite clasts in a quartz diorite or leucogranodiorite matrix or moderately layered and foliated. On Middle Island (Barrier Islands), dioritic rocks are present as dikes and small intrusive bodies of diorite, quartz diorite, and subordinate gabbro that are interpreted to be subvolcanic to nearby basaltic to andesitic rocks (SOdbv) of the Descon Formation. On southernmost Prince of Wales Island, rocks are massive and homogeneous and both intrude and are intruded by quartz-porphyritic granodiorite (Oqgd).

Dioritic rocks belonging to this unit have a color index of approximately 40, with a range from 65 for more gabbroic rocks to as low as 25. Most rocks are medium grained and consist primarily of green hornblende, moderately altered plagioclase, and subordinate quartz and potassium feldspar. Hornblende is several millimeters or less in length, subhedral, and only slightly altered in most rocks. In a few samples, particularly near Max Cove, a small amount of biotite is intergrown with hornblende and some hornblende grains contain small cores of augite. Small grains of opaque minerals, apatite, and sphene are associated with ferromagnesian minerals. Slightly zoned, moderately to highly altered, subhedral grains of plagioclase are as long as 5 mm. Outer parts of most grains are andesine in composition; interiors are too highly altered for compositional analysis. Quartz is present as small interstitial grains in most samples and rarely constitutes more than 10 percent of rock. Potassium feldspar is rare except near Max Cove where samples contain as much as 10 percent interstitial microperthite.

Dioritic rock samples yield a U-Pb apparent age of approximately 480-460 Ma from Max Cove (loc. 4, table 2). This approximate age combined with close association between dioritic rocks and quartz-porphyritic granodiorite (Oqgd) and quartz diorite (Oqd) indicate that diorite is of Middle and (or) Early and possibly locally Late Ordovician age

Ogd **Leucogranodiorite (Middle Ordovician)**—Leucogranodiorite in Klakas Inlet region intrudes Ordovician diorite (Od) and rocks of the Descon Formation (SOdbv, SOda) and is locally overlain by clastic strata of the Karheen Formation (Dkcg, Dkbx). Contacts between leucogranodiorite and older rocks are commonly agmatitic, with 10-cm-scale clasts of country rock enveloped in leucogranodiorite. In most areas of Klakas Inlet and Max Cove, rocks in this unit are penetratively brecciated and consist of centimeter-scale angular clasts in a matrix of fine-grained rock fragments, quartz, and plagioclase. Adjacent to brecciated domains are regions in which rocks are highly fractured—only rarely are they not deformed.

Rocks in this unit consist of interlocking and commonly myrmekitic plagioclase, quartz, and subordinate interstitial microperthite. Subhedral, nonzoned plagioclase grains range from a few millimeters to more than 1 cm in length. Compositionally, plagioclase is oligoclase to calcic albite. In most rocks plagioclase is overprinted by fine-grained, secondary white mica, calcite, and epidote. Quartz is present as large grains with myrmekitic or sutured boundaries against plagioclase and as small interstitial grains. Leucogranodiorite contains as much as 20 percent microperthite mostly as small grains in interstices of plagioclase and quartz. Original ferromagnesian minerals are totally altered to blocky masses of chlorite and tiny opaque grains; shape suggests that hornblende was probably original ferromagnesian mineral. These chlorite masses constitute less than 5 percent of most rocks.

Age of this rock type was determined by U-Pb apparent ages of 462±15 Ma (Middle Ordovician) from a sample on Klakas Island (loc. 2, table 2) and 468± approximately 15 Ma (Middle Ordovician) from a sample in Max Cove (loc. 3, table 2). Turner and others (1977) reported a K-Ar (hornblende) apparent age of 428±13 Ma on granodiorite at locality 12 (table 2), which they interpret to be a minimum age. This granodiorite is intruded by leucogranodiorite dated at locality 3 (table 2), which suggests that the K-Ar age of 428±13 Ma is considerably younger than emplacement age of rock. Their age is interpreted to record timing of deformation and alteration of pre-middle Lower Devonian rocks in southern Klakas Inlet region (Gehrels and Saleeby, 1987)

Oqgd **Quartz-porphyritic granodiorite (Middle Ordovician)**—Large bodies of medium-grained, quartz-porphyritic granodiorite exposed on southwesternmost Prince of Wales Island. On Barrier Islands and along southeastern shore of Hessa Inlet, quartz-porphyritic granodiorite includes many small bodies of diorite, larger ones of which are shown on map sheet. Near dioritic bodies, granodiorite is agmatitic and contains angular and lens-shaped blocks of diorite, microdiorite, or microgabbro. These rocks are also intruded by unmapped dikes and small bodies of fine-grained quartz diorite, diorite, gabbro, and basalt in many locales. Intrusive relations suggest that dikes were emplaced prior to solidification of granodiorite. In many locales, quartz-porphyritic granodiorite is also intruded by diorite (Od). Contradictory intrusive relations with diorite and evidence for syn-igneous emplacement of dioritic dikes indicate that this unit and diorite (Od) are, at least in part, coeval.

Granodiorite consists primarily of large plagioclase and quartz grains, small, highly altered ferromagnesian minerals, and interstitial microperthite. Plagioclase is generally subhedral, tabular, 2 to 6 mm in length, and oligoclase in composition. Interiors of grains commonly contain secondary white mica, calcite, and epidote, and margins are commonly albitized. Myrmekitic intergrowths with quartz are common along margins of grains. In some samples, all plagioclase grains are myrmekitic. In most samples plagioclase is present in irregular clusters separated by large (as much as 1 cm in diameter) bluish quartz grains. Microperthite and subordinate microcline fill interstices of plagioclase and quartz. These grains constitute 10 to 20 percent of most samples, rendering a plagioclase to potassium feldspar proportion of about 3:1. In a few samples, microperthite grains are quite large and envelop plagioclase. Original ferromagnesian minerals are entirely altered to millimeter-scale blocky masses of chlorite and opaque minerals. Shape of these masses suggests that secondary minerals replaced hornblende rather than biotite. Color index of most rocks ranges from 5 to 20. Sphene and zircon are tiny accessory phases in most samples.

A U-Pb apparent age of 472±5 Ma (Middle Ordovician) obtained from a sample from Hessa Inlet (loc. 1, table 2) indicates that these rocks were emplaced during Middle Ordovician time

pOgb **Metagabbro (pre-Middle Ordovician)**—A heterogeneous body of metamorphosed and deformed gabbro intrudes the Wales Group near Ship Island Passage. These rocks generally consist of several-millimeter- to centimeter-scale grains of clinopyroxene, hornblende, chlorite, and opaque minerals, millimeter-scale grains of zoned and highly altered plagioclase, and abundant small grains of chlorite, epidote, calcite, and white mica. These rocks intrude the Wales Group (pOw) and were regionally metamorphosed to greenschist facies. Minimum age is constrained by interpretation that regional metamorphism occurred during Middle Cambrian to Early Ordovician time (Gehrels and Saleeby, 1987)

SURFICIAL DEPOSITS AND DIKES

Quaternary surficial deposits consist of beach deposits along the shores of many bays, colluvium and soil in the interior of the island, and alluvium along some creeks. Bedrock is moderately to well exposed along most beaches; beach deposits are extensive only in the interior parts of some bays that have very gentle topography. These beach deposits are shown with a stippled pattern on the accompanying map sheet where bedrock is obscured. Surficial deposits are widespread in the interior of the island but are generally less than a few meters thick. These deposits are not shown on the map sheet because of their limited thickness and discontinuous distribution.

Dikes of basaltic to dacitic(?) composition are widespread in the study area. They are not mapped separately on the map sheet because of their narrow width and poorly constrained length and also because of their abundance; in many locales there are several tens of dikes per kilometer of shoreline. There are at least two sets of dikes in the study area—an early set coeval with Ordovician and (or) Silurian intrusive rocks and a younger set that intrudes the Devonian strata. The older dikes commonly have schistose borders and are tabular to irregular in shape, as thick as 1 m, and laterally discontinuous. They consist predominantly of fine-grained, moderately chloritized hornblende, highly altered plagioclase, and abundant secondary epidote, chlorite, white mica, calcite, and other minerals. The younger dikes are tabular, laterally continuous, as thick as 1 m, steeply dipping, and more resistant to erosion than their enclosing country rocks. They commonly have sharp planar contacts and consist of hornblende phenocrysts set in a matrix of green hornblende, plagioclase (andesine), minor opaque minerals, and secondary epidote, chlorite, and calcite.

Crosscutting relations indicate that the dikes belonging to the second set were emplaced after middle Early Devonian time. These dikes apparently do not intrude mid-Cretaceous intrusive rocks (Herreid and others, 1978), and their relations with the Jurassic Bokan Mountain Granite are ambiguous. MacKevett (1963) reported that the dikes of this set are less common within the granite than within adjacent Paleozoic country rocks, which indicates that they may be, in large part, of pre-Jurassic age. Some dikes are apparently post-Jurassic in age, however, as albitization associated with the Jurassic granite affected some dike rocks. These relations suggest that most dikes of the younger set were emplaced between middle Early Devonian and Jurassic time. Regional relations suggest that they were possibly emplaced during a latest Paleozoic(?) to Triassic rifting event that affected rocks throughout the Prince of Wales Island region (Gehrels and Saleeby, 1987).

STRUCTURAL GEOLOGY

The dominant regional structures in the study area consist of thrust faults, the Keete Inlet fault, and several sets of strike-slip faults. The nature of the faults and their sense and age of displacement are described below. Structures restricted to a particular map unit (for example, folds and deformational fabrics in the Wales Group) are described for each unit in the Description of Map Units.

THRUST FAULTS

Shipwreck Point, Bird Rocks, and Ruth Island faults

Thrust faults west of, and structurally beneath, the Keete Inlet fault dip easterly at moderate angles and imbricate a variety of Ordovician and older rocks. These faults were studied primarily along the south shore of the peninsula south of Kassa Inlet—their trace to the north is inferred from topography and from strong lineaments on aerial photographs. The southern shore of Kassa Inlet was not revisited to check for the trace of these faults.

The Bird Rocks thrust fault forms a major tectonic boundary in that it juxtaposes Ordovician metaplutonic and subordinate metavolcanic and metasedimentary rocks (Ruth Bay assemblage, unit Or) against amphibolite-facies rocks of the Wales Group (pOw). The fault is recognized along the shoreline west of Ruth Bay as a wide zone of brecciation that separates amphibolite-facies rocks of the Wales Group (pOw) from rocks belonging to the Ruth Bay assemblage. The Ruth Island fault is recognized as a several-meter-wide zone in which rocks belonging to the Ruth Bay assemblage are brecciated into 10-cm-scale angular blocks. Zones of brecciation associated with both the Ruth Island and Bird Rocks thrust faults are intruded by Cretaceous granodiorite (Kgd) along the shoreline west of Ruth Bay.

The Shipwreck Point thrust fault cuts rocks of the Wales Group (pOw) and juxtaposes amphibolite-facies rocks to the east against greenschist-facies rocks to the west. Structural trends on either side of the fault are also quite different: to the west the foliation and axes of asymmetric folds strike and trend northeasterly, whereas to the east the structural grain is northwesterly. The fault is exposed in the bay east of Shipwreck Point as a several-meter-wide zone of breccia intruded by swarms of gabbro dikes (Kgb).

These faults are interpreted to dip easterly because slickenside surfaces within fault zones and in rocks on either side generally dip at moderate angles easterly and because their traces inland indicate gently east-dipping fault planes. Their slip-line is recorded by a predominance of east-northeast-trending slickenside striae on minor fault surfaces (Gehrels and Saleeby, 1987). A southwestward direction of movement is indicated by (1) juxtaposition of higher grade rocks over lower grade rocks along the Shipwreck Point thrust fault (assuming that higher grade rocks were at greater depth than lower grade rocks prior to movement on the fault) and (2) southwestward overturning of a regional antiform within the Ruth Bay assemblage (Or) above the Ruth Island thrust fault. A detailed study of minor folds along the shoreline west of the Bird Rocks thrust fault demonstrates that asymmetric folds in the Wales Group formed prior to movement on the thrust faults.

To the north, the Shipwreck Point, Bird Rocks, and Ruth Island thrust faults are intruded by a large body of Silurian leucodiorite (Sd) in Kassa Inlet and are apparently cut by the Keete Inlet fault. Rocks of the Wales Group north and west of Kassa Inlet and on the large island north of Kassa Island are greenschist facies and are interpreted to lie structurally beneath the Shipwreck Point thrust fault. In contrast, rocks on the northeastern corner of Kassa Island were apparently of regional amphibolite facies prior to contact metamorphism related to intrusion of the Silurian leucodiorite (Sd) body. The Shipwreck Point thrust fault is, therefore, shown to separate these amphibolite-facies rocks from greenschist-facies rocks to the north and west. Because metaplutonic rocks belonging to the Ruth Bay assemblage (Or) are not found on Kassa Island, the northward continuation of the Bird Rocks thrust fault is drawn south and east of Kassa Island.

The minimum age of movement on these faults is constrained by the crosscutting body of Silurian leucodiorite on and adjacent to Kassa Island. Their maximum age is indicated by exposures of brecciated Middle Ordovician metagranodiorite along the Ruth Island and Bird Rocks thrust faults west of Ruth Bay. Regional relations suggest that thrust faults in this system moved primarily during Silurian and earliest Devonian time (Gehrels and Saleeby, 1987).

Frederick Cove fault

The Frederick Cove thrust fault juxtaposes two different stratigraphic sections of the Descon Formation along the northern edge of the study area. North of the fault, argillite, shale, mudstone, and siltstone generally dip and face to the southwest. Rocks south of the fault consist of volcanic rocks and subordinate marine clastic strata that, on the basis of reconnaissance mapping along the north shore of Moira Sound, probably underlie the clastic strata exposed north of the fault.

The fault is not exposed at the head of Frederick Cove, but strong topographic and vegetational lineaments can be traced inland on aerial photographs from the northern and southern shorelines at the head of the bay. Volcanic rocks along the shore of Frederick Cove near the southern lineament have a strong foliation that dips moderately to the south-southwest. This fabric possibly formed during movement on the Frederick Cove thrust fault. The two lineaments can be traced westward across the island to the east shore of Klakas Inlet, where a steeply dipping, highly altered shear zone is exposed. Slickenside striae observed within this shear zone generally plunge steeply to the south or southwest. The westward continuation of the fault was mapped by Herreid and others (1978) along the west shore of Klakas Inlet, just north of the map area. Herreid and others (1978) interpreted this fault as a southwest-dipping thrust separating volcanic rocks of the Descon Formation to the south from marine clastic strata to the north. On the ridge west of Klakas Inlet, the fault is overlain by Lower Devonian clastic strata (Herreid and others, 1978). This fault is significant because it demonstrates that northern Klakas Inlet is not controlled by a major strike-slip fault (as suggested by Herreid and others, 1978) and that the strata along Klakas Inlet do not belong to a continuous, south-dipping section (as suggested by Eberlein and others, 1983).

Anchor Island fault

The Anchor Island thrust fault is recognized as a wide zone of penetrative brecciation in Ordovician rocks south of Tah Island, in the southern Klakas Inlet region, and along the east shore of Kassa Inlet. Along the shoreline south of Tah Island, Ordovician volcanic rocks are strongly brecciated, moderately foliated, and dip at moderate angles to the northeast. In southern Klakas Inlet, Ordovician volcanic, sedimentary, and intrusive rocks are strongly brecciated, locally semischistose, and pervasively altered in a zone several kilometers wide. These rocks are mapped as the Klakas Inlet assemblage (DSk) where deformation and alteration have obliterated their primary intrusive and stratigraphic relations. The zone of brecciation extends northwestward to the east shore of Kassa Inlet where it is truncated by the Keete Inlet fault. The distribution of brecciation along the Anchor Island thrust fault zone is shown with small "x"'s, and the distribution and structural grain of the semischistose fabric is shown with a shear symbol on the map sheet.

The age of movement on this fault zone is constrained by the Middle and Late(?) Ordovician age of rocks that it deforms and by stratigraphic relations with the sedimentary breccia unit (Dkbx) of the Karheen Formation in southern Klakas Inlet. This breccia unconformably overlies rocks belonging to the Klakas Inlet assemblage (DSk), is moderately deformed, and is overlain by nondeformed middle Lower Devonian sandstone and mudstone (Dkms) of the Karheen Formation. These relations suggest that the fault moved prior to, during, and perhaps after deposition of the sedimentary breccia, which is of Early Devonian age. Regional relations suggest that movement along the fault zone began after middle Early Silurian time (Gehrels and Saleeby, 1987).

KEETE INLET FAULT

The Keete Inlet fault is a major structural and stratigraphic boundary in the study area and to the north on south-central Prince of Wales Island (Redman, 1981). In the map area, the fault dips moderately to the northeast and juxtaposes Ordovician, Early Silurian(?), and Silurian rocks against rocks in both the Wales Group (pOw) and the Ruth Bay assemblage (Or). The fault continues north of the study area through Keete Inlet (Herreid and others, 1978) and then swings eastward toward the North Arm of Moira Sound (Redman, 1981). South of Klakas Island, the fault bends westward into Cordova Bay and then probably turns south toward Dixon Entrance.

The age of movement on the Keete Inlet fault is constrained as post-middle Early Devonian and pre-mid-Cretaceous because the fault cuts Devonian strata and is intruded by Cretaceous granodiorite. The sinuosity of the fault in, and north of, the study area combined with its regional juxtaposition of younger rocks over older rocks suggests that it is a normal fault (Gehrels and Saleeby, 1987) rather than a thrust fault (as suggested by Herreid and others (1978), Redman (1981), and Gehrels and others (1983b)). Eastward movement on this fault is suggested by the interpretation that rocks in the Ruth Bay assemblage (Or) are deeper level equivalents of Ordovician and Lower Silurian(?) rocks in the upper plate to the east. Regional evidence for a latest Paleozoic(?) and Triassic rifting event in the area (Gehrels and Saleeeby, 1987) indicates that the fault may have moved during latest Paleozoic(?) and Triassic time.

STRIKE-SLIP FAULTS

Northwest- to north-northwest-striking faults

The dominant set of strike-slip faults in the study area consists of anastomosing, curviplanar, and structurally interconnected northwest- to north-northwest-striking faults that have a left-lateral sense of displacement. These faults control the major northwest-trending inlets and valleys on the western and southern parts of the island. Where exposed, the fault zones generally consist of several parallel strands separated by moderately deformed and brecciated rocks. In stratified rocks, the zone of deformation along each strand is generally several meters wide and is manifest as a steeply dipping phyllonitic foliation within which protolith features are disrupted and (or) highly deformed. Intrusive rocks generally show intense cataclastic brecciation in a zone as wide as several tens of meters and across a wider zone in which the rocks are fractured and cut by many narrow shear zones. The Max Cove and Tah Bay-Klinkwan Cove-Nichols Bay fault zones consist of several subparallel strands and are structurally connected by the Biscuit Lagoon, Hunter Creek, Feikert Claims, and Billy Claims faults.

These faults are known to have predominantly strike-slip displacement because slickenside striae exposed within the fault zones plunge consistently within 20° of horizontal. Offsets of outcrop-scale stratigraphic markers within these zones are common but indicate both right-lateral and left-lateral senses of offset. Regional offsets of contacts and map units in many locales indicate that the faults are characterized by predominantly left-lateral displacement. Along the Max Cove fault (in Max Cove), the leucogranodiorite-diorite contact near the end of the peninsula, as well as the base of the Karheen Formation in several locales are offset approximately 1 km in a left-lateral sense. The Klinkwan Cove fault offsets the Devonian sandstone (Dks)-conglomeratic rocks (Dkcg) contact by as much as 1 km in a left-lateral sense south of Klinkwan Cove. In Hunter Bay and for 8 km to the south, the Klinkwan Cove fault juxtaposes strata of the Karheen Formation against pre-Devonian rocks; this apparent offset, combined with shallow-plunging slickenside striae along the fault, indicates at least a component of left-lateral displacement.

The Nichols Bay fault appears to have a larger amount of strike-slip displacement, as indicated by the juxtaposition of different Ordovician and Lower Silurian rocks in Nichols Bay. Assuming that the volcanic and sedimentary rocks between Nichols Lake and northern Nichols Bay are the offset equivalents of volcanic and sedimentary rocks in southern Nichols Bay, the horizontal separation is approximately 7 to 10 km in a left-lateral sense. This sense and amount of offset are also indicated by separation of the large mass of quartz-porphyritic granodiorite (Oqgd) across the Nichols Bay fault. The lack of syenitic rocks on the southwest side of the fault in Nichols Bay constrains the amount of displacement to greater than 4 km. Patterns of dioritic rocks in Hessa Inlet are most consistent with approximately 4 km of left-slip on the Nichols Bay fault zone. The stratigraphic relations along the Klinkwan Cove fault are such that most of the displacement on the Nichols Bay zone must continue northward along the Tah Bay fault, the amount of displacement along which is not independently constrained.

Dioritic intrusive rocks in Hessa Inlet appear to be offset by 1 km or more in a left-lateral sense along the Biscuit Lagoon fault. The distribution of the Descon Formation along the Feikert Claims and Billy Claims faults is consistent with several kilometers of cumulative left-lateral displacement.

The age of displacement on these faults is constrained by offsets of strata of the Karheen Formation and by the observation that tabular basaltic dikes of probable pre-mid-Cretaceous age locally intrude the fault zones. This is consistent with the observation that the Max Cove, Klinkwan Cove, and Tah Bay faults do not offset the Keete Inlet fault, which is known to exhibit pre-mid-Cretaceous displacement. Faults in this set cut the north- to north-northeast-striking faults in the study area and are apparently cut by the Cape Chacon fault.

North- to north-northeast-striking faults

These faults control the major north- to north-northeast-trending inlets and valleys along the southern shore of Prince of Wales Island. The Buschmann Pass and Hessa Narrows faults have a structural style similar to the northwest- to north-northwest-striking faults described above, but the other faults in this set were not studied in detail. Abundant shallow-plunging slickenside striae associated with the Buschmann Pass and Hessa Narrows faults indicate that they have predominantly strike-slip displacement. A right-lateral sense of displacement on these and most other faults in the set is indicated by the horizontal separation of the individual subunits of Karheen Formation and the basal contact of the Karheen Formation. The amounts of right-lateral separation across the major faults are as follows: Buschmann Pass fault north of Buschmann Pass, 4 to 7 km; Hessa Narrows fault, 1 km; Brownson Bay fault, approximately 500 m; Surf Point fault, a few hundred meters(?); and Bert Millar Cutoff fault, over 1 km. In contrast, the Nichols Lake fault exhibits a separation of between 0.5 and 1.5 km in a left-lateral sense. The only fault belonging to this set that is recognized on the northeast side of the Nichols Bay fault is the Alice Claims fault, which exhibits 1 km or less of right-lateral displacement. Other faults belonging to this set probably exist northeast of the Nichols Bay fault but are not yet recognized due to lack of geologic control.

Faults belonging to this set cut the Karheen Formation and are cut by the northwest- to north-northwest-striking faults described above, which are interpreted to display post-middle Early Devonian to pre-mid-Cretaceous displacement.

Cape Chacon fault

This fault is a major north-striking structure that extends from west of Cape Chacon to Kendrick Bay. In McLean Arm, it apparently offsets both syenitic rocks and the Max Cove fault by several hundred meters in a right-lateral sense. This indicates that it is younger than the two main sets of strike-slip faults in the area, which moved between middle Early Devonian and mid-Cretaceous time.

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Table 1. *Paleontologic sample localities*

Sample locality (map No.)	General location	Fossil	Map unit	Remarks	Identified by	Field or sample No.	Reference
1	Klakas Inlet	Early Devonian (Pragian?)	Dksh	Graptolites in black shale	H. Jaeger	64ACn1171	Churkin and others (1970).
	do	do	do	do	do	64A1172	do.
	do	do	do	do	do	64A1182	do.
	do	do	do	do	do	64A1183	do.
	Clam Cove	do	do	do	do	64A1191	do.
2	Max Cove	Early Devonian	Dkl	Conodonts in limestone	N.M. Savage		Savage, written commun. (1985).
3	Klakas Inlet, east shore	Latest Early Ordovician; Early Middle Ordovican	SOdms	Graptolites in shale (sample G-1 of Eberlein and others, 1983); conodonts in limestone layer.	C. Carter; A. Harris	72AE221	Eberlein and others (1983); Harris, written commun. (1980).
4	Kassa Inlet	Middle Early Devonian	Dkms	Conodonts in limestone layer	N.M. Savage	4	Savage and Gehrels (1984).
5	Max Cove	do	Dkl	do	do	5	do.
6	Klinkwan Cove	do	Dks	do	do	6	do.
7	Tah Bay	do	Dkl	do	do	7	do.
8	Hunter Bay	do	Dks	do	do	8	do.
9	Buschman Pass	Middle Early Devonian	Dkl	do	do	9	do.
10	Brownson Bay	do	do	do	do	10	do.
11	Ingraham Bay	do	do	do	do	11	do.
12	Moira Sound	Middle Ordovican	SOda	Graptolites (sample G-14 of Eberlein and others, 1983)	C. Carter	74AE167	Eberlein and others (1983).
13	do		SOdms	Graptolites	do	74AE168	do.
5(?)	Max Cove	Middle Devonian	Dkl	*Favosites hemisphericus* and *Alveolites* sp. (may be same as sample loc. 5).	E. Kirk	15 Ach 203	Buddington and Chapin (1929).
8(?)	Hunter Bay	Dks	do	*Atrypa reticularis, Favorsites hemisphericus, Alveolites*sp., *Cyathophyllem* sp., and *Syringopora* sp. (may be same as sample loc. 8).	do	15 Ach 188	do.
9(?)	Hessa Inlet	Dkl	do	*Cladopora* sp. and crinoid columnals(may be same as sample loc. 9).	do	15 Ach 180	do.

Table 2. *Description of geochronologic localites*
[*, sample location on map sheet is approximate. See Gehrels and Saleeby (1987) for more information]

Sample locality (map No.)	Radiometric age (Ma)	Age	Map unit	Map sample No.	Reference
1	472±5 (U-Pb zircon)	Middle Ordovician	Quartz-porphyritic granodiorite (Oqgd)	82GP702	Gehrels and Saleeby (1987).
2	462±15 (U-Pb zircon)	Middle Ordovician	Leucogranodiorite (Ogd)	72AE215	Gehrels and Saleeby (1987).
3	468±15 (U-Pb zircon)	Middle Ordovician	Leucogranodiorite (Ogd)	82GP48	Gehrels and Saleeby (1987).
4	480-460 (U-Pb zircon)	Ordovician	Diorite (Od)	82GP40	Gehrels and Saleeby (1987).
5	465±7 (U-Pb zircon)	Middle Ordovician	Foliated granodiorite (Or)	79AE114	Gehrels and Saleeby (1987).
6	445±5 (U-Pb zircon)	Late Ordovician	Quartz diorite (Oqd)	82GP28	Gehrels and Saleeby (1987).
7	446±5 (U-Pb zircon)	Late Ordovician	Foliated and layered quartz diorite (Ofd)	82GP346	Gehrels and Saleeby (1987).
8	438±4 (U-Pb zircon)	Early Silurian and (or) Late Ordovician.	Quartz monzonite (SOqm)	83GP255	Gehrels and Saleeby (1987).
9	438±5 (U-Pb zircon)	Early Silurian and (or) Late Ordovician.	Granite (SOgr)	83GP335	Gehrels and Saleeby (1987).
10	438±5 (U-Pb zircon)	Early Silurian and (or) Late Ordovician	Quartz syenite (SOsy)	83GP364	Gehrels and Saleeby (1987).
11	418±5 (U-Pb zircon)	Late Silurian	Leucodiorite (Sd)	82GP626	Gehrels and Saleeby (1987).
12	428±13 (K-Ar hornblende minimum age)	———	Diorite (Od)	Sample 5	of Turner and others (1977) (station number DT72-58c).
13*	454±22 (K-Ar hornblende)	———	Quartz monzonite (SOqm)	Sample 7	of Lanphere and others (1964).
14*	379±18 (K-Ar biotite)	———	Quartz monzonite (SOqm)	Sample 6	of Lanphere and others (1964).
15*	439±21 (K-Ar hornblende)	———	Quartz diorite (Oqd)	Sample 5	of Lanphere and others (1964).
16*	185±8 (K-Ar riebekite)	———	Bokan Mountain Granite	Sample 1	of Lanphere and others (1964).
	190±8 (K-Ar riebekite)	———	Bokan Mountain Granite	Sample 4	of Lanphere and others (1964).
17*	171±5 (U-Pb zircon)	———	Bokan Mountain Granite	———	Saint-André and others (1983)