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MISCELLANEOUS FIELD STUDIES
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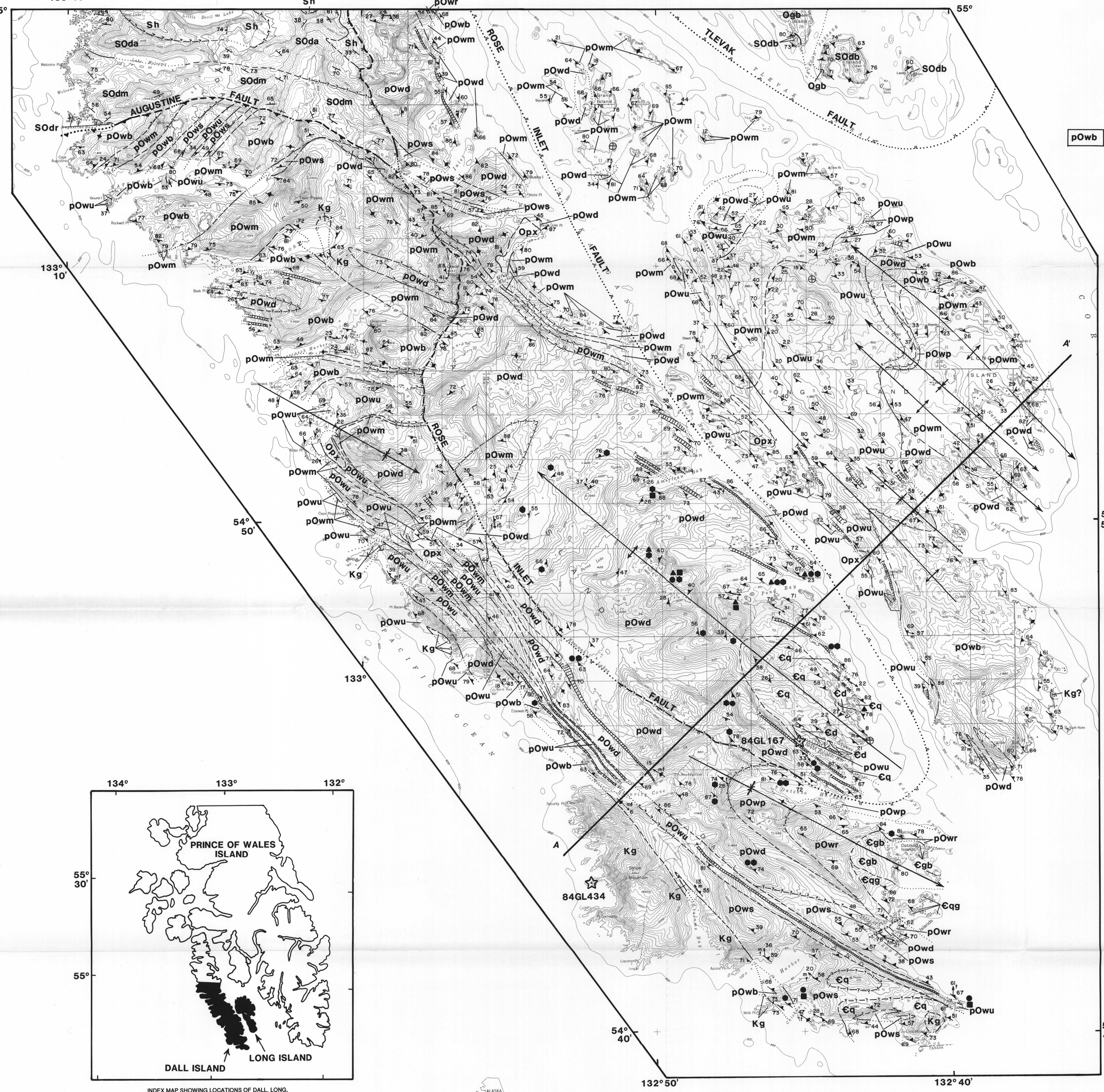
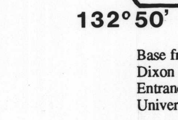


INDEX MAP SHOWING LOCATIONS OF DALL, LONG, AND PRINCE OF WALES ISLANDS, ALASKA

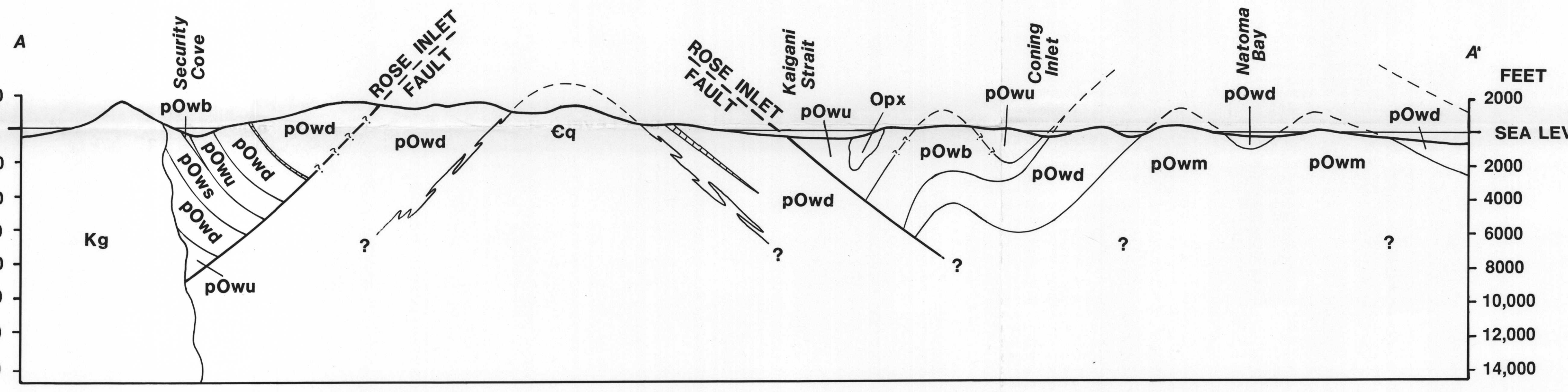


Base from U.S. Geological Survey, Dixon Entrance C-3, 1948; Dixon Entrance D-2, D-3, and D-4, 1951
Universal Transverse Mercator projection

Geology by G.E. Gehrels, 1984-87, assisted by T. Barr, 1984

SCALE 1:63 360

CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



GEOLOGIC MAP OF LONG ISLAND AND SOUTHERN AND CENTRAL DALL ISLAND, SOUTHEASTERN ALASKA

By

George E. Gehrels

1991

CORRELATION OF MAP UNITS
(*Metamorphic age)

- Kg — CRETACEOUS
- Sh — SILURIAN
- SOda, SOdm, SOdr, SOdb — SILURIAN AND ORDOVICIAN
- Opx, Ogb — ORDOVICIAN
- pOwb, pOwd, pOwr, pOwm, pOws, pOwp, pOwu — PRE-MIDDLE ORDOVICIAN*
- Ꞓq, Ꞓd, Ꞓgb, Ꞓqg — CAMBRIAN

INTRODUCTION

Long Island and southern and central Dall Island are underlain by a variety of stratified, intrusive, and metamorphic rocks that range in age from pre-Middle Ordovician through Early Cretaceous. These rocks belong to the Alexander terrane, which underlies much of southeast Alaska and parts of British Columbia, Yukon, and eastern Alaska (Gehrels and Saleeby, 1987a).

Most of the study area is underlain by pre-Middle Ordovician metavolcanic and metasedimentary rocks of the Wales Group. Because these rocks are highly deformed and regionally metamorphosed, the protolith stratigraphy of the Wales Group has not been determined. Hence, rocks of the Wales Group are herein divided into lithic units (rather than formal stratigraphic units) that may or may not be correlative throughout the area. Early Cambrian metaplutonic bodies, Ordovician gabbro and pyroxenite plutons, and several Cretaceous granodiorite bodies intrude rocks of the Wales Group. Stratified units include fine-grained clastic strata of the Descon Formation (Ordovician and Silurian) and the Silurian Heceta Limestone. Dominant structures include the Augustine thrust fault and the Rose Inlet and Tlevak normal(?) faults. These rocks and structures are described below and in Gehrels (1990).

The geology of Long and Dall Islands was mapped initially by Buddington and Chapin (1929). During the present study, Long Island and southern and central Dall Island were mapped in reconnaissance fashion by foot and skiff traverses along the shoreline and by foot traverses and selected helicopter landings in the interior of the islands. The geologic framework utilized during this mapping derives from previous mapping by Buddington and Chapin (1929), work by Eberlein and others (1983) in regions to the north of the area, and studies of similar rocks on southern Prince of Wales Island (Herreid and others, 1978; Gehrels and Saleeby, 1986, 1987a, b).

DESCRIPTION OF MAP UNITS
(*Metamorphic age)

Kg **Granodiorite (Cretaceous)**—Homogeneous, massive to moderately foliated, medium- to coarse-grained granodiorite. Most rocks consist of quartz, strongly zoned plagioclase (An_{30-40}), interstitial K-spar, hornblende, biotite, and large grains of sphene and opaques. Color index ranges from 5 to 20; mafic minerals include equal proportions of biotite and hornblende. Swarms of mafic inclusions consisting of hornblende, plagioclase, and biotite are common, particularly near margins of bodies. Rocks near margins of bodies are commonly foliated, with orientations parallel to those in adjacent country rocks. A U-Pb (zircon) age of 114 ± 2 Ma was determined on large granodiorite body on southwestern Dall Island (Gehrels, 1990). This body is referred to as the Stripe Mountain Granodiorite by Gehrels (1990)

Sh **Heceta Limestone (Silurian)**—Homogeneous, moderately recrystallized marble derived from massive to thick-bedded limestone. Most rocks are tan to light gray on fresh surfaces and medium gray on weathered surfaces. Local compositional layering on a 10-cm to 1-m scale is present locally and reflects primary bedding transposed into the regional foliation. These rocks are interpreted to be Silurian in age because they overlie Lower Silurian argillite in Coco Harbor (5 km north of study area along east shore of Dall Island) and are very similar to limestones of known Silurian age in View Cove (9 km north of study area along east shore of Dall Island). They are assigned to the Silurian Heceta Limestone by Gehrels (1990) on basis of similarities in protoliths and age

Descon Formation (Silurian and Ordovician)—Divided into:

SOda **Argillite**—Dark-gray argillite and black shale (locally siliceous) and subordinate mudstone, siltstone, and rhyolitic tuff and tuff breccia. Rocks have a slaty cleavage in most areas and a phyllitic foliation locally. These strata are contiguous with argillite in Coco Harbor (east side of Dall Island, 5 km north of study area) that yields Early Silurian graptolites (Eberlein and others, 1983). Gehrels (1990) assigns these strata and associated Ordovician and Silurian units to the Descon Formation on basis of similarities in lithic components and age

SOdm **Mudstone**—Interbedded gray to tan mudstone, siltstone, and subordinate argillite, shale, graywacke, and rhyolitic tuff and tuff breccia. These strata are in gradational contact with strata of argillite unit (SOda). Contact between two units is drawn where siltstone dominates over argillite

SOdr **Rhyolitic volcanic rocks**—Thin layers of silicic tuff and tuff breccia that are interbedded with strata of mudstone unit of the Descon Formation (SOdm)

SOdb **Basaltic volcanic rocks**—Moderately foliated basaltic pillow flows and fragmental basaltic volcanic rocks on southern Sukkwan Island and nearby smaller islands. Several limestone layers are interbedded with volcanic rocks on Jackson Island. These rocks are interpreted to belong to the Descon Formation because they strongly resemble Descon volcanic rocks to north on Sukkwan Island (Eberlein and others, 1983) and to east on Prince of Wales Island (Gehrels and Saleeby, 1986, 1987b)

Opx **Pyroxenite (Ordovician)**—Pyroxenite and pyroxene gabbro. Parts of some bodies are homogeneous, but most comprise heterogeneous dikes and small intrusive bodies that vary in mineralogy, grain size, and texture. Bodies rarely display a foliation and intrude across foliation in adjacent country rocks in Vesta Bay and near Koianglas. Most rocks consist of pyroxene, biotite, hornblende, and plagioclase that are variably altered to chlorite, albite, and epidote. Pyroxene grains in some bodies reach 20 cm in length, but more commonly are less than 5 cm in length. Some pegmatitic dikes display a well-preserved comb texture along their margins. K-Ar (hornblende) ages determined by M.A. Lanphere (written commun., 1989) indicate that these bodies were emplaced during Late Ordovician time

Ogb **Hornblende gabbro and hornblendite (Ordovician)**—Homogeneous to locally heterogeneous hornblende gabbro and hornblendite that underlie southern tip of Sukkwan Island. Pegmatitic hornblende gabbro dikes, locally with comb textures, present in some areas. Mafic minerals in most rocks are partially altered to chlorite and epidote. K-Ar (hornblende) ages of 440 and 449 Ma (Eberlein and others, 1983) record emplacement during Ordovician time

Wales Group (pre-Middle Ordovician*)—Divided into:

pOwb **Basaltic metavolcanic rocks**—Pillow flows, pillow breccia, tuff breccia, and tuff of basaltic to andesitic composition that are moderately metamorphosed and deformed. In most areas primary volcanic features are flattened and (or) elongated, but still readily recognizable. Primary stratigraphic layering is preserved in many areas and is almost everywhere parallel to regional foliation. Most rocks are metamorphosed to greenschist-facies chlorite-albite-epidote phyllite, except on southern Dall Island where rocks are hornblende schist. These rocks are in sharp depositional contact with massive marble layer on western Dall Island. Their contacts with dacitic metavolcanic rocks vary from sharp to gradational

pOwd **Dacitic metavolcanic rocks**—A thick sequence of predominantly fragmental volcanic rocks of probable dacitic composition. Subordinate components include marble layers of variable thickness, basaltic metavolcanic (generally fragmental) rocks, volcaniclastic strata, and dark-gray to black phyllite. On Long Island and north of Grace Harbor on Dall Island, primary volcanic textures are well preserved in these rocks. Most common unit is a dacitic breccia with 1- to 20-cm-scale angular fragments in a slightly darker tuffaceous matrix. In some layers tuffaceous matrix material is calcareous. Deformation recorded by these volcanic fragments increases in intensity southward on Dall Island, until, in vicinity of Pond Bay and American Bay, fragmental textures are rarely preserved. Their metamorphic grade also increases southward from chlorite-bearing rocks north of Grace Harbor to amphibole-garnet-muscovite-biotite-bearing schists in the Pond Bay-American Bay area. These rocks are intruded by dated body in Kaigani Harbor—part of the quartz diorite and granodiorite unit (Ꞓqg)

pOwr **Rhyolitic metavolcanic rocks**—Very leucocratic and silicic metavolcanic rocks and subordinate metapelite and marble. Volcanic fragments, generally 5 to 20 cm in length, are seen in most outcrops. Lack of matrix material around fragments in some units suggests that extrusive domelike structures are locally preserved. Sulfides are common in this unit, both disseminated through rocks and in thin layers

pOwm **Marble**—Massive to thick-bedded, gray to tan marble. Most exposures display 10-cm- to 2-m-scale compositional layering that reflects primary bedding in limestone. Thinner marble layers are commonly interbedded with metavolcanic rocks and minor metaclastic rocks. The thicker layers are quite homogeneous—it is common to see pure marble sections thicker than 100 m. A subordinate part of unit is marble breccia comprising 10- to 40-cm-scale angular carbonate clasts in a matrix of similar composition

pOws **Clastic metasedimentary rocks**—Variably deformed and metamorphosed clastic sedimentary rocks. Primary sedimentary structures such as graded bedding and crossbedding are preserved in some layers in northern part of study area on Dall Island. Most of these layers are sandstone or siltstone and comprise primarily volcanic detritus. Rocks assigned to this unit on southern Dall Island are amphibolite-facies hornblende-bearing schist and gneiss in which protolith features are difficult to determine. Higher grade rocks are interpreted to be metagraywackes on basis of widespread 10- to 50-cm-scale compositional layering. High-grade rocks in some areas have fragmental volcanic textures. Such metavolcanic(?) components could probably be subdivided from metasedimentary parts of unit with more detailed mapping

pOwp **Phyllite**—Dark-gray to black biotite phyllite derived from shale and argillite. On southern Dall Island unit contains subordinate rhyolitic metavolcanic rocks

pOwu **Dacitic metavolcanic rocks, marble, and phyllite, undivided**—A heterogeneous unit comprising undivided fragmental metadacite, calcareous metavolcanic rocks, marble, and subordinate phyllite. Rocks assigned to this unit along most shorelines consist of intimately interlayered dacitic metavolcanic rocks and marble. Common associations in such areas include (1) relatively pure marble and metadacite that are interlayered on a centimeter- to several-meter scale; (2) marble that contains abundant thin tuffaceous(?) metadacite layers; and (3) metadacite breccia comprising angular fragments enclosed in a calcareous metadacite matrix. In some areas these two rock types are also interlayered with dark-gray to black phyllite. This is predominant association in unit on southwestern and southern Dall Island. In this area metadacite and metapelite components contain abundant disseminated sulfides and thin sulfide-rich layers. In interior of Long Island unit represents areas in which metadacite, marble, and metapelite are present but have not been mapped separately. In some parts of this area individual rock types apparently underlie kilometer-size areas, boundaries of which were not determined, whereas in others various rock types are interbedded on an outcrop scale. More detailed mapping in this area would probably reveal a complex pattern of interlayering of various rock types

Ꞓq **Quartz diorite and granodiorite (Cambrian)**—Foliated, lineated, and gneissic biotite-hornblende quartz diorite and granodiorite with minor diorite. Most rocks have a foliation and a subordinate lineation, but still display a recognizable plutonic texture. This fabric ranges in intensity from massive quartz diorite and granodiorite with no deformational fabric, to a strongly foliated quartzofeldspathic schist. More deformed rocks also display a 5- to 20-cm-scale gneissic layering of leucocratic (color index=10) and more mafic (color index=40) components. These compositional layers are clearly different intrusive phases in most outcrops; in some, however, compositional layering may result from metamorphic segregation. In general, intrusive body near Kaigani Harbor is more intensely deformed than the intrusive bodies to the south. Where intrusive relations are preserved, more mafic components generally intrude leucocratic components, although opposite relation also occurs. In less deformed components, original rock is medium-grained and comprises hornblende>biotite (color index=20-40), quartz, nonzoned plagioclase, and K-spar. Most bodies also contain chlorite and epidote as alteration products. Contacts of bodies are generally parallel to foliation in adjacent metamorphic country rocks. A U-Pb (zircon) age of 554 ± 4 Ma on a granodiorite orthogneiss (sample loc. 84GL167) in Kaigani Harbor indicates that bodies are Early Cambrian in age (Gehrels, 1990). Dated body is referred to as Kaigani orthogneiss by Gehrels (1990)

Ꞓd **Diorite (Cambrian)**—Foliated and compositionally layered hornblende>biotite diorite and subordinate quartz diorite. Layering is on a 5- to 50-cm scale and results from variations in grain size and in ratio of plagioclase to mafic minerals. Most rocks consist primarily of hornblende and plagioclase with subordinate biotite. Chlorite and epidote are widespread alteration phases. Locally preserved intrusive relations indicate that various compositional layers within this unit are in some cases different intrusive components; in others, however, compositional layering may result from metamorphic segregation. Dikes and sills of this diorite form some mafic layers in quartz diorite and granodiorite unit (Ꞓq)

Ꞓgb **Gabbro (Cambrian)**—Hornblende gabbro and microgabbro metamorphosed to chlorite and locally biotite schist. Plutonic textures are preserved in some areas, but in most foliation and lineation are pervasive. Unit grades laterally into quartz diorite and gabbro unit (Ꞓqg) with an increasing proportion of quartz diorite

Ꞓqg **Quartz diorite and gabbro (Cambrian)**—Heterogenous unit comprising intrusive bodies ranging from gabbro to granodiorite in composition. These components are similar to rocks included in quartz diorite and granodiorite (Ꞓq) and gabbro (Ꞓgb) units. Most intrusive bodies in unit are meter-scale dikes and sills, generally of gabbroic rocks intruding quartz dioritic rocks. In addition to intrusive components, metavolcanic screens and pendants present throughout unit. In some areas, these country rocks form nearly 50 percent of outcrops

Contact—Dashed where approximately located; queried where inferred; dotted where concealed. Orientation shown where known

Thrust fault—Dashed where approximately located; dotted where concealed. Sawteeth on upper plate

Normal fault—Dashed where approximately located; queried where inferred; dotted where concealed. Hachures on upper plate

Antiform

Synform

Strike and dip of beds

Inclined—Bar and ball indicates tops of beds where known from sedimentary features

Vertical

Strike and dip of foliation

Inclined

Vertical

Horizontal

Mineral lineation

Fold axis

U-Pb age sample site—See text for ages

Occurrence of metamorphic biotite

Occurrence of metamorphic muscovite

Occurrence of metamorphic amphibole

Occurrence of metamorphic garnet

Marble layer in the Wales Group—Dotted where concealed; queried where extent uncertain

STRUCTURAL GEOLOGY

Dominant structures on Long Island and southern and central Dall Island include (1) the widespread fabrics and outcrop-scale folds that are common throughout the Wales Group, (2) several regional fold sets, (3) the Augustine thrust fault, and (4) the Rose Inlet and Tlevak normal(?) faults.

OUTCROP-SCALE STRUCTURES

Rocks of the Wales Group are foliated and lineated throughout the study area, and most units display outcrop-scale folds. Deformation is everywhere expressed as a phyllitic to schistose metamorphic foliation and as a flattening of protolith features. Dominant lineations include preferred orientations of minerals in the highly recrystallized (generally amphibolite-facies) rocks, elongation of pillows and fragments in volcanic rocks and clasts in carbonate breccias, widespread crenulation lineations, and fold axes. Bedding and primary compositional layering have generally been transposed into the regional foliation and lineation at an outcrop scale. At map scale, however, lithic units and contacts commonly diverge from the regional foliation.

Centimeter- to meter-scale folds are present in most outcrops on Long Island and the southern part of Dall Island. In most cases these folds plunge at shallow to moderate angles, deform the metamorphic foliation, and are parallel to accompanying mineral and elongation lineations. An earlier set of centimeter-scale, intrafolial folds is present in some outcrops.

Outcrop-scale folds and fabrics in the Wales Group formed after emplacement of the Cambrian metaplutonic bodies and prior to emplacement of the Ordovician plutons.

REGIONAL FOLDS

Regional folds are defined both by changes in dip of the regional foliation and by patterns in the distribution of major lithic units. The three major sets of folds include (1) gently northwest- and southeast-plunging antiforms and synforms on Long Island, (2) moderately southeast-plunging synforms on western and southeastern Dall Island, and (3) a moderately northwest-plunging antiform in the Wales Group below the Rose Inlet fault. These structures formed after Early Cambrian time and probably prior to deposition of the Descon Formation.

FAULTS

The Augustine fault juxtaposes greenschist-facies metamorphic rocks of the Wales Group over strata of the Descon Formation. In the absence of kinematic data, this fault is most likely a thrust because it puts older, higher-grade rocks over younger, lower-grade strata. There is little evidence of deformation adjacent to the south-dipping fault; foliation in the upper plate generally dips northwesterly, whereas lower-plate strata dip to the north or northeast. This fault probably moved during Silurian to Early Devonian time (Gehrels, 1990) on the basis of similarities with structures on southern Prince of Wales Island (Gehrels and Saleeby, 1987a,b).

In contrast to the Augustine fault, the Rose Inlet and Tlevak faults juxtapose lower grade rocks over higher grade rocks. Accordingly, they are tentatively interpreted as normal faults. The location of the Rose Inlet fault is well constrained only between Port Bazan and Coco Harbor. In this area, a northwest-striking, west-dipping fault is required to (1) truncate the eastern continuation of the Augustine fault, (2) separate northwest-striking Descon strata from metamorphic rocks of the Wales Group to the southeast, (3) juxtapose Silurian Limestone over the Wales Group, (4) juxtapose moderately deformed marble and metabasalt of the Wales Group over higher grade and more strongly deformed dacitic metavolcanic rocks, and (5) truncate the southeastern continuation of the undivided dacitic metavolcanic rocks, marble, and phyllite unit north of Port Bazan. The eastern continuation of the fault is located in Kaigani Strait to separate high-grade schist near American Bay and Pond Bay from lower-grade rocks on western Long Island.

The Rose Inlet fault was apparently deformed into a large antiform that plunges gently to both the northwest and southeast. Regional relations, as discussed by Gehrels (1990), suggest that the sense of displacement on this fault may have been top-to-the-east, but kinematic indicators were not observed along the fault in the study area.

The Tlevak fault is a speculative structure inferred to separate Descon strata on Sukkwan Island from rocks of the Wales Group on Long and Dall Islands. The existence of such a structure is indicated by relations to the east on southern Prince of Wales Island. In that area, rocks of the Wales Group crop out in a structural window beneath Ordovician and younger strata—the two assemblages are juxtaposed along the Keete Inlet normal(?) fault (Gehrels and Saleeby, 1987a,b). Regional map patterns of this fault system and the distribution of the Wales Group and Descon Formation suggest that a strand of the Keete Inlet normal(?) fault (herein referred to as the Tlevak fault) traces along Tlevak Strait.

The age of the Rose Inlet and Tlevak faults is constrained by relations in the study area only as being post-Early Cambrian. Similar normal(?) faults on Prince of Wales Island are known to truncate Devonian strata and be intruded by Early Cretaceous plutons. Regional relations suggest that the faults moved during Late Permian(?) to Triassic time (Gehrels and Saleeby, 1987a, b).

METAMORPHISM

Rocks of the Wales Group have been regionally metamorphosed to greenschist and locally amphibolite facies in the study area. Their metamorphic grade is generally higher below the Rose Inlet fault than in adjacent rocks above the fault, and the grade in rocks both above and below the fault increases southward. This pattern is shown in a general fashion by the distribution of higher grade metamorphic minerals on Dall Island. More detailed petrologic studies are necessary to define the distribution of metamorphic isograds in these areas.

ACKNOWLEDGMENTS

Acknowledgment is made to the donors of the Petroleum Research Fund, administered by the American Chemical Society, for partial support of this research. Terrence Barr provided excellent assistance in the field and conducted some of the mapping on Long Island.

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