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BEDROCK GEOLOGY, YELVERTON INLET MAP AREA, NORTHERN ELLESMERE ISLAND, INTERIM REPORT AND MAP

(340F, 560D)

H.P. Trettin and T. Frisch

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INTRODUCTION

INITIAL EXPLORATION AND GEOLOGICAL INVESTIGATIONS

The first extensive geographic exploration of the north coast of Ellesmere Island was made by Pelham Aldrich and four companions who travelled with a man-hauled sledge from Alert in northeasternmost Ellesmere Island as far west as Cape Alert, the northwestern extremity of Wootton Peninsula. Aldrich and his men participated in the British naval expedition under Sir George Nares that investigated parts of northern Ellesmere Island and Greenland in 1875 - 1876. The remaining parts of the coastal area were first charted by Robert Peary who, accompanied by Greenland Inuit, travelled with dogs and sledges from Alert to northernmost Axel Heiberg Island in 1906.

The geology of northern parts of the Yelverton Inlet map-area was first explored by R.L. Christie in 1954 (1957). He accompanied an expedition, led by G. Hattersley-Smith, that travelled with dogs and sledges from Ward Hunt Island to Lands Lokk on southern Kleybolte Peninsula. Subsequent investigations were done on foot from fly camps established by aircraft or during brief landings. A small airplane, the Piper Super Cub, was used in 1962, small helicopters with piston engines were employed in 1966 and 1975, and larger helicopters with turbine engines in subsequent years. Frisch carried out field work in part of the area in 1966 (1974) and 1975 (1976; Trettin and Frisch, 1980), and Trettin in 1962, 1966 (1971b), 1975 (1976), 1977, 1980, and 1984. All this work was done in the course of broader regional reconnaissance projects and involved only fractions of the field seasons mentioned. In addition, D.G. Wilson briefly investigated the Eureka Sound Group on northern Wootton Peninsula in 1975 (1976).

SCOPE OF PRESENT REPORT

This report is a provisional account of the bedrock geology of the Yelverton Inlet map-area, as known in 1987. Because of the numerous and important remaining problems, it is likely that the picture presented here will be changed substantially by further studies, planned for 1988. Emphasis is on local features; tectonic interpretations that require a broader overview are only briefly discussed in the following section. The Quaternary geology of parts of the area is presently being studied by J.A. Evans of the Department of Geography, University of Alberta.

LABORATORY STUDIES, CLASSIFICATION OF VOLCANIC ROCKS, AND CARBONATE TERMINOLOGY

Most samples have been studied in thin-section and by whole-rock X-ray diffraction (Appendix 3). In addition, some volcanic and plutonic-metamorphic rocks have been analyzed by standard chemical techniques (Appendix 2), and some minerals by electron microprobe (Appendix 4).

Most volcanic rocks in the Yelverton Inlet map-area are too altered for classification on the basis of major elements. In contrast to the relatively mobile major elements and many trace elements, the elements Y, Nb, Zr, and Ti have proven to be to be both relatively stable (e.g. Smith and Smith, 1976; Davies et al., 1978), and useful for classification (Winchester and Floyd, 1977) and tectonic interpretation (e.g. Pearce and Norry, 1979; Meschede, 1986) although even these elements can be mobile if CO_2 is present in the fluid phase during metamorphism (Murphy and Hynes, 1986). However, Mortensen (1981) found that the Winchester-Floyd classification provided consistent and meaningful results for a metamorphosed and highly altered suite of volcanic rocks in the Pelly Mountains, Yukon Territory and our own results from various units in northern Ellesmere and Axel Heiberg islands confirm this conclusion. We are therefore reporting here all whole-rock chemical analyses that include analyses for these four elements, regardless of the alteration state of the rocks, and we are relying on the Winchester-Floyd classification for the names of the rocks.

For general names of unmetamorphosed carbonate rocks we are using the terminology of Dunham (1962) and for the size grades of carbonate crystals (Appendix 1), a terminology based on Leighton and Pendexter (1962) and Drummond (1963).

ACKNOWLEDGEMENTS

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STRATIGRAPHIC-STRUCTURAL FRAMEWORK

REGIONAL FRAMEWORK

Interpretation of the pre-Carboniferous geology of northern Ellesmere Island has been difficult because of exceedingly complex structures and absence of fossils older than late Middle Ordovician. The K-Ar determinations obtained in the sixties' and early seventies' were of little value for the resolution of these problems because of the effects of younger thermal events. Only after the receipt of Rb-Sr and U-Pb age determinations (Sinha and Frisch, 1975, 1976; Trettin et al., 1982, 1987; Trettin and Parrish, 1987) has it been possible to establish a framework compatible with current tectonic concepts (Trettin, 1987b and in preparation), although many problems remain, especially in the present map-area.

The first-order tectonic elements of the Arctic Islands are the Franklinian mobile belt, which existed from Late Proterozoic (Neohadrynian) to earliest Carboniferous (Tournaisian) time, and the Pearya Terrane. The Cambrian to Upper Silurian/ Lower Devonian strata of the mobile belt were deposited on a cratonic shelf and in an adjacent deep-water basin with an unstable boundary that advanced cratonward in several major steps. The deep-water basin is divisible into a southeastern exclusively sedimentary subprovince (which in northern Ellesmere Island coincides largely with the Hazen Fold Belt; Fig. 1) and a northwestern subprovince that contains volcanic rocks in addition to the predominant sedimentary rocks (Clements Markham and Northern Heiberg fold belts). The strata of the sedimentary subprovince are linked with those of the shelf province by interlocking facies changes. The Clements Markham Fold Belt is separated from the Hazen Fold Belt by a major fault, younger strata, and glaciers.

Pearya (Fig. 2) is a composite terrane divisible into four major successions:

(I) Sedimentary and possibly volcanic rocks of unknown age, deformed, metamorphosed to amphibolite grade, and intruded by granitic plutons in late Neohelikian time (about 1.0-1.1 Ga). The succession occurs in three separate areas, named the Cape Columbia, Mitchell Point, and Deuchars Glacier belts.

(II) Sedimentary and minor volcanic rocks of presumed Hadrynian to Early Ordovician age that probably overlie Succession I with angular unconformity although the contact is not exposed. The sedimentary rocks, mainly shelf carbonates, mudrock, and quartzite with some glaciogenic (?) diamictite, are miogeoclinal in aspect; the volcanic rocks appear to be rift-related. These complexly deformed strata strata have been metamorphosed in the greenschist facies and locally also in the amphibolite facies. Their stratigraphy is poorly known. Succession II occurs in six separate areas, named the Mount Disraeli, Disraeli Glacier, Empire, Kulutingwak, Cape Alfred Ernest, and Audhild Bay belts.

(III) Volcanic and sedimentary rocks of assumed late Early - early Middle Ordovician age (Bromley Island Belt). The volcanics are characteristic of arc settings, the sediments of shallow marine to deep-water environments. This intensely deformed succession, which is unsuitable for stratigraphic studies, has been metamorphosed under subgreenschist to amphibolite facies conditions. Fault slices of a granitic to predominantly ultramafic suite are associated with this succession; one yielded a late Arenigian U-Pb age.

(IV) The faulted contact between successions II and III is unconformably overlain by perhaps 8 - 9 km of Middle Ordovician to Upper Silurian sedimentary and volcanic rocks, deposited in nonmarine to deep-water environments. The nearly unmetamorphosed, fossiliferous succession has been divided into eleven units of formational rank (Trettin, 1987c).

The angular unconformity at the base of Succession IV represents the mid-Ordovician M'Clintock Orogeny, which was accompanied by regional metamorphism up to amphibolite grade and by granitic plutonism.

The Pearya Terrane is related to the Caledonides by the Grenville age of its crystalline basement, the radiometric age of the ultramafic suite associated with Succession III, and the presence of a mid-Ordovician orogen, comparable in age and character to the Taconic. By contrast, the Franklinian mobile belt has a crystalline basement of Archean-Aphebian age and was not deformed in the Ordovician.

Regional considerations suggest that the Pearya Terrane was transported by sinistral strike slip and accreted, as several slices, in Late Silurian - Early Devonian time. The Clements Markham Fold Belt appears to have been involved in the sinistral motion to some extent.

These events were followed by major compression in Middle or Late Devonian to Early Carboniferous time (Ellesmerian Orogeny), which affected the entire mobile belt.

The Ellesmerian Orogen is overlain with angular unconformity by a Carboniferous to Upper Cretaceous, predominantly sedimentary succession, deposited in the Sverdrup Basin. Volcanism and intrusion were most extensive during a rift-event in the Cretaceous (Albian to Santonian) that may be related to the development of the Alpha Cordillera in the adjacent Arctic Ocean (Ricketts et al., 1984; Trettin and Parrish, 1987; Embry and Osadetz, in prep.). The Sverdrup Basin was deformed by the Paleogene Eurekan Orogeny, which produced syntectonic clastic sediments assigned to the Eureka Sound Group. The Neogene to Recent record is characterized by the interplay of isostatic uplift and erosion.

YELVERTON INLET MAP-AREA

The Yelverton Inlet map-area is underlain mainly by successions I and II of the Pearya Terrane and by the Clements Markham Fold Belt. Succession I of the Pearya Terrane is represented by the Mitchell Point and Deuchars Glacier belts, and Succession II by the Kulutingwak Belt and parts of the Empire and Cape Alfred Ernest belts.

Structurally, the Pearya Terrane is divisible into four blocks that are separated by major faults and differ in structural trends (see Trettin, 1987b, Fig. 23).

(1) A block in the eastern part of the map-area, consisting of the Empire and Deuchars Glacier belts, continues northeastward into the M'Clintock Inlet and Clements Markham Inlet map-areas where it includes other elements. In the Yelverton Inlet map-area, it is characterized by arcuate trends, subparallel with the Yelverton Thrust, which bounds this block on the southwest.

(2) The southwest-trending Mitchell Point Belt, bounded by the Petersen Bay Fault on the southeast and the Mitchell Point Fault on the northwest. Structural trends are subparallel with the overall orientation of the belt.

(3) The Cape Alfred Ernest Belt on the northwest side of the Mitchell Point Belt, characterized by northerly trending internal

structures.

(4) The Kulutingwak Belt, essentially a west-trending, south-verging, faulted anticline formed in a stack of thrust sheets.

It is impossible to interpret the genesis of this complex arrangement in the context of the present map-area alone. An overview of the structural development of northern Ellesmere Island (Trettin, 1987b) suggests that the present configuration and orientation of these blocks, and the arcuate trends in block 1, originated essentially during the Late Silurian - Early Devonian strike slip and accretion event. However, certain internal structures must have been inherited from the Grenvillian and/or M'Clintock orogenies, and modifications must have occurred during the Ellesmerian and Eurekan orogenies.

The Clements Markham Fold Belt in this area consists mainly of Silurian flysch assigned to the Imina and Lands Lokk formations, but also includes volcanic and associated carbonate rocks of Early Silurian age assigned to the Kulutingwak Fiord assemblage and metavolcanic and metasedimentary rocks of uncertain age assigned to the Petersen Bay assemblage.

Of special importance for the interpretation of the regional tectonic history are sediments composed of serpentinite fragments, and associated brecciated serpentinite, exposed in a thrust slice at the base of the Kulutingwak Belt (core of Kulutingwak Anticline). These rocks probably represent vestiges of oceanic rocks that either underlay the Clements Markham Fold Belt or separated it from the Pearya Terrane.

Intrusive suites of post-Helikian pre-Carboniferous age include:

(1) A layered gabbro-peridotite intrusion at Cape Fanshawe Martin

that has yielded an Early Devonian K-Ar age but probably is older (Ordovician ?).

(2) A relatively large pluton of quartz monzonite and granodiorite at Cape Woods. U-Pb analyses on zircon and sphene indicate that the magma was derived from Helikian sources and emplaced probably in late Early Devonian time. It is interpreted as a syntectonic or post-tectonic intrusion, related to the accretion of Pearya.

(3) Dykes and sills of different composition, age, and metamorphic state that have not been studied in detail or dated.

The Sverdrup Basin succession is represented only by the Upper Carboniferous Borup Fiord Formation, which underlies a small area in the southeastern part of the map-area.

The early Late Cretaceous igneous event produced the Hansen Point volcanics and the Wootton Intrusion. Both are bimodal in composition and associated with the Mitchell Point Fault. A younger generation of unmetamorphosed mafic dykes is probably also related to this event but isotopic age determinations have not yet been made.

Strata of the Eureka Sound Group are preserved in a fault-bounded structural depression on northern Wootton Peninsula.

PEARYA TERRANE, SUCCESSION I

Succession I of Pearya consists of granitoid gneiss with lesser proportions of amphibolite and schist, and with rare occurrences of marble that may be tectonic intercalations. It occurs in three major belts named for Cape Columbia, Mitchell Point, and Deuchars Glacier, respectively. Most of the Mitchell Point Belt and a large part of the Deuchars Glacier Belt are exposed in the present map-area.

MITCHELL POINT BELT (map-unit nHn)

The Mitchell Point Belt proper extends from the southeastern coast of lower Ayles Fiord to northeast of Phillips Inlet. Overall it is 110 km long, up to 30 km wide, and bounded by the Mitchell Point Fault and Wootton Intrusion on the northwest and by the Petersen Bay Fault on the southeast. It consists mainly of granitoid gneiss with lesser proportions of amphibolite and clastic metasediments. Foliation and internal lithological contacts are parallel with the overall southwesterly trend of the belt; dip directions are variable.

A relatively large fault block of gneiss also occurs on a peninsula in Phillips Inlet, and small fault blocks of gneiss are present northeast of Ayles Fiord in the northeasternmost part of the Yelverton Inlet map-area and in adjacent parts of the M'Clintock Inlet map-area. Both occurrences are aligned with the Mitchell Point Belt proper but are separated from it by fiords and younger strata. This relationship suggests that the Mitchell Point Belt proper is continuous with these outliers in the subsurface.

Map-unit nHn consists largely of quartzofeldspathic gneiss but also includes smaller proportions of amphibolite and metasedimentary schist.

The quartzofeldspathic gneisses are of granitoid composition and consist chiefly of plagioclase, microcline, quartz, biotite, and epidote (App. 3, Table 1A). Augen of feldspar (generally microcline) are typical, and cross-cutting veins of finer-grained felsic biotite gneiss are common. Dark green hornblende is locally an additional mafic mineral but garnet is uncommon. A variety of gneiss occurring on the east shore of Milne Fiord contains clinopyroxene, partly replaced by Fe-rich green to bluish green hornblende and partly altered to biotite. This rock is almost certainly meta-igneous, and the other gneisses are probably also of igneous origin.

Adjacent to the Petersen Bay Fault, the rocks are sheared, even mylonitized, and exhibit retrograde metamorphism in a 1-2 km wide zone (see below, Major Faults).

The amphibolites of the Mitchell Point Belt occur as generally concordant layers that range in thickness from about 10 cm to several metres. Some show features indicative of an intrusive origin such as: locally discordant contacts, recrystallized plagioclase phenocrysts concentrated in the central parts of the bodies, and margins finer grained than interiors. In zones of strong deformation, notably at Mitchell Point, the amphibolites are attenuated. They are composed essentially of brownish or olive green hornblende, plagioclase, and minor brown biotite.

Closer to the Petersen Bay Fault, the gneisses and amphibolites are cataclastic and locally mylonitic, with cross-cutting pseudotachylite veins. Concomitant with increasing deformation, feldspar becomes more heavily altered to epidote or muscovite, and biotite is replaced by chlorite.

Metasediments are uncommon among the gneisses. They are rusty-weathering garnetiferous mica schists, forming concordant intercalations, up to several hundred metres thick. Characteristic mineral assemblages are:

kyanite-garnet-muscovite-biotite-plagioclase-quartz,

staurolite-garnet-biotite-chlorite-muscovite-quartz,

garnet-biotite-muscovite-chlorite-plagioclase-quartz.

Kyanite is well developed in crystals up to 1 cm in length and is later than garnet, which exhibits S-shaped inclusion trails out of alignment with the rock schistosity.

The two marble layers enclosed by gneiss on the east shore of Milne Fiord are probably fault slices of a different tectonic unit (Succession II or Clements Markham Fold Belt ?), as nowhere else has marble been found in the Mitchell Point Belt. Clots of serpentine (presumably altered olivine) are evident in some of the marble, and fine-grained phlogopite and a humite mineral (probably clinohumite) have been recognized in one thin section. Although thoroughly metamorphosed, the marble is consistently fine grained, and generally has the appearance of a low-grade metamorphic rock.

DEUCHARS GLACIER BELT (map-unit nHn)

The Deuchars Glacier Belt straddles the boundary between the Yelverton Inlet and M'Clintock Inlet map-areas but is described here <u>in toto</u>. It is crescent-shaped, about 30 km long in a northwesterly direction, and up to 12 km wide (see Trettin et al., 1987, Fig. 7). The contact with surrounding strata of the Hadrynian - Lower Ordovician Empire Belt is mostly covered by glaciers or difficult of access but appeared to be faulted wherever seen. It is a high-angle reverse fault, named Deuchars Thrust, on the southwestern side of the belt. The internal structure of the belt is poorly known but schistosity and foliation have an arcuate, westerly to northwesterly trend.

Rock samples collected at 13 localities during brief helicopter landings suggest that the belt is composed mainly of granitic rocks with smaller proportions of schist and very small amounts of amphibolite.

The granitic rocks include about equal proportions of granodiorite and granite, including leucocratic varieties of both rock types (App. 3, Table 1B). A specimen of tonalite may represent altered granodiorite because of the presence of chessboard twinning (suggesting original K-feldspar) in some of its albite. The grain size ranges from fine to coarse and is mainly medium or coarse. Some rocks are massive and others cataclastic and somewhat gneissic, the mica defining discontinuous, undulating, rather irregular S-planes. Augen of relatively large, tectonically abraded feldspar are present in some of the gneissic rocks. The mica is generally much finer in grain size than the feldspar.

The schists consist mainly of quartz, plagioclase and biotite with or without small proportions of muscovite and K-feldspar and rare chloritoid (App. 3, Table 1C). The plagioclase compositions range from albite to andesine (in different specimens). The rocks show a thin, flat or undulating layering, layers rich in biotite alternating with layers rich in quartz and feldspar. Quartz and feldspar generally are fine grained, but augen of fine and medium grained feldspar occur in some rocks.

A specimen of amphibolite is fine grained and composed mainly of hornblende and plagioclase with small amounts of biotite and quartz and shows a vague layering, not paralleled by the orientation of the hornblende crystals.

The granitic rocks appear to be metamorphosed intrusions, the origin of the schists and amphibolites is uncertain.

AGE OF METAMORPHISM AND PLUTONISM

The Precambrian age of Succession I was first established by Sinha and Frisch (1975) by means of a Rb-Sr analysis on widely separated samples from the Mitchell Point Belt, which indicated an age no younger than 726 $\pm$ 12 Ma or 802 $\pm$ 19 Ma (recalculated). Application of the same method to samples from the Cape Columbia Belt (Sinha and Frisch, 1976) produced a nine-point isochron age of 1060 $\pm$ 18 Ma. Massive granite of plutonic aspect from two localities in the Deuchars Glacier Belt was analyzed by the U-Pb zircon method (Trettin and Parrish, 1987). Three collinear analyses defined an upper intercept age of 1037 +25/-20 Ma, but older, xenocrystic zircon was detected in one sample, and there was some evidence for recent Pb loss. Combined, the analyses from the Cape Columbia and Deuchars Glacier belts suggest that that Succession I was subjected to granitic plutonism and amphibolite-grade metamorphism during a Grenville-age orogeny, about 1.0-1.1 Ga ago.

PEARYA TERRANE, SUCCESSION II

INTRODUCTION

Succession II occurs in six different belts, three of which -- the Empire, Kulutingwak, and Cape Alfred Ernest belts -- are exposed in the Yelverton Inlet map-area. The stratigraphy of Succession II is difficult to resolve because of the absence of fossils and extremely complex structure. The facts that Succession II has a lower grade metamorphic grade than I and that it and lacks extensive granitic plutons suggest that it is younger than the Grenvillian Orogeny, and hence separated from Sucession I by an angular unconformity. However, the contacts between the two successions seem to be faulted everywhere and the base of Succession II has not been identified.

The only part of Succession II that is amenable to conventional stratigraphic treatment is the Milne Fiord assemblage, exposed in the Milne Fiord - Ayles Fiord region of the Yelverton Inlet and M'Clintock Inlet map-areas. This assemblage can be regarded as the precursor of a group and consists of three divisions that are precursors of formations; introduction of formal names is deferred until the stratigraphy of the entire succession is better known. The Milne Fiord assemblage has been assigned to the Late Cambrian - Early Ordovician on the basis of a U-Pb age determination, and contains the youngest known strata of Succession II.

The older parts of Succession II, presumably of Hadrynian-Cambrian age, have been mapped by lithology and have not yet been placed into stratigraphic units. The following designations are used:

c= carbonate rocks (limestone, dolostone, marble)

p= slate, phyllite, minor schist (p for pelite)

q= quartzite

qf= feldspathic quartzite

s= schist (greenschist or amphibolite facies)

t= chert

v= volcanic rocks

w= sandy mudrock, argillaceous sandstone (w for wacke)

x= diamictite (= phyllite, sandy and conglomeratic)

The lithological map-units represent: (1) single stratigraphic units or parts of such units (e.g. map-units qp, v and x); (2) combinations of two or more stratigraphic units that have yet to be differentiated (e.g. pwxc, pwxqc, psqc); or (3) recurrent rock types that constitute more than one stratigraphic unit (e.g. map-unit c). Of special importance are the glaciogenic (?) diamictites (x) and associated sandy mudrocks and argillaceous sandstones (w), which have unique, diagnostic features that permit approximate correlation of parts of the Cape Alfred Ernest, Kulutingwak, Empire, Disraeli Glacier and Mount Disraeli belts with each other and probably also with late Hadrynian (early Vendian or Varangian) diamictites in other regions, especially Svalbard (Table 1).

The stratigraphic order within the pre-Milne Fiord succession is poorly known but tentative stratigraphic sequences have been established northeast of Yelverton Inlet (westernmost Empire Belt) and on northeastern Wootton Peninsula (Cape Alfred Ernest Belt).

CARTOGRAPHIC CONVENTIONS

It is difficult to portray the present state of knowledge on the map in a conventional manner. Our approach to the problem has been guided by the following objectives: (1) to provide the basic lithological information; (2) to use a simple colour scheme that is applicable to other map-areas in northern Ellesmere Island; and (3) to indicate the tentatively inferred ages, but to separate interpretation from factual information.

Lithological letter symbols (listed above) provide the basic information, but only the relatively abundant rock types are listed. Rare but significant rock types, not included in the generalized symbol, may be shown in brackets at the localities where they were encountered.

Different **colour schemes** can be applied by the users of this uncoloured map at their own convenience. It is here suggested to indicate the predominant or most significant rock type of a recurrent lithological assemblage, regardless of age or stratigraphic assignment (see legend).

Tentative age designations are indicated by capital letters and numerals in brackets and given with question marks where specific interpretations are attempted. They are not part of the map-unit designation, and detached from it on the map. The conventions used are listed in Table 1.

Provisional stratigraphic designations are reserved for the Milne Fiord assemblage and shown in the conventional manner, e.g. O_{M3} (division 3 of Milne Fiord assemblage).

Ma	Okulitch, in press			This map		adapted from Harland et al., 1982	
570 + 40/-20	HADRYNIAN	NEO-HADRYNIAN	EDIACARAN	HI 3	HI	EDIACARAN	VENDIAN
590 ± 10				HI 2[3]		VARANGIAN[2]	
700 ± 50		PALEO-HADRYNIAN		HI 1			RIPHEAN
1000 ± 50	HELIKIAN	NEO-HELIKIAN	LATE	nH[1]			
1100 ± 10			MIDDLE				
1200 ± 30			EARLY				
1400 + 30/-100							

(1) Age of metamorphism and plutonism
(2) Two glacial episodes
(3) Diamictite assemblage (may include younger and/or older strata)

Table 1
Late Proterozoic time-stratigraphic terminology

EMPIRE BELT

The Empire Belt, named for the British Empire Range, extends from east of Yelverton Inlet to southeast of M'Clintock Inlet. In the Yelverton Inlet map-area, it is in faulted contact with the Mitchell Point Belt on the northwest (Mitchell Point Fault) and with the Clements Markham Fold Belt on the west and south (Yelverton Thrust). The fault-bounded Deuchars Glacier Belt pierces the southwestern part of the Empire Belt. Structural trends are arcuate, swinging from northwesterly directions in the south through northerly to northeasterly directions in the northeast.

Peninsula northeast of Yelverton Inlet

Three units or groups of units (described and numbered below in ascending order) can be placed into a stratigraphic succession but the position of two others remains uncertain.

Map-unit pwxqc and associated thinner carbonate units (c)

Map-unit pwxqc, which underlies southeastern and central parts of the peninsula northeast of Yelverton Inlet, consists of variably metamorphosed mudrock, sandy mudrock and argillaceous sandstone (wacke), conglomeratic mudrock (diamictite), quartzite, and carbonate rocks, with very small proportions of chert and volcanics. Associated carbonate units that are mappable from air photographs are designated map-unit c; some may represent fault slices or infolds of the ridge-forming map-unit c discussed below.

The **mudrocks** are metamorphosed mainly to phyllite, but locally to schist or hornfels. The phyllite is mostly medium grey and pyritiferous and commonly weathers rusty brown owing to limonite stain derived from the pyrite. It consists mainly of quartz (mean of uncorrected XRD determinations = 62 %) and smaller amounts of chlorite (18 %), mica (10 %, mainly muscovite, minor biotite), feldspar (10 %, mainly albite) and trace amounts of calcite and dolomite (App. 3, Table 2Aa). Pelitic schist was encountered at one locality only [marked (ss)], where it consists of quartz (uncorrected XRD determination = 55 %), reddish brown biotite (22 %), andesine (20 %), and staurolite (5 %).

The **wackes and diamictites** are greenish grey, or medium to medium dark grey and generally massive although one specimen of wacke is laminated. Microscopically, they are characterized by unsorted sand or sand and pebbles, respectively, that are embedded in an abundant argillaceous matrix. The pebbles are rounded and consist of pure or impure, microcrystalline dolostone or limestone and to a lesser extent of mudrock and tuff. The sand fraction is characterized by rounded quartz, but also includes small amounts of chert, siltstone fragments, etc. (App. 3, Table 2Ac).

The **quartzite** is very fine and fine grained, variably pelitic, commonly interlaminated with pelitic phyllite, and in some instances calcareous.

The **carbonate rocks** consist of pure and impure limestone and dolostone that have been metamorphosed to microcrystalline to coarsely crystalline marble.

Rocks interpreted as metamorphosed **chert** were encountered at two localities northeast of Yelverton Inlet [marked (t)]. They are medium dark grey, schistose and recrystallized to silt-grade quartzite. They are characterized by a high silica content and unusually flat grain shapes. One specimen has a relatively high plagioclase content (uncorrected XRD determination = 15 %), suggesting that it is of volcanic origin. A schist interpreted as a **siliceous tuff** was encountered at one locality [marked (v)]. It is composed of albite and quartz with about 16 % of chlorite (uncorrected XRD determination).

Mode of origin, age, and correlation. The carbonates, mudrocks and associated quartzites represent a variety of marine shelf environments, and the same is inferred for the diamictites and wackes because of their association with these rocks. The diamictites resemble subaqueous debris flows with respect to matrix abundance and poor sorting of sand fraction and phenoclasts. Such flows are common on submarine fans but the present assemblage differs from typical fan deposits by the absence of Bouma sequences. On the other hand, the diamictites are also comparable to widespread glaciogenic deposits of early Vendian or Varangian age, especially in Svalbard (Hambrey et al., 1981). The base of these deposits appears to be slightly younger than the base of the Neohadrynian, equated by Okulitch (in press) with the base of the Windermere Supergroup. Most are probably marine tillites, but submarine debris flows, which are common in the glaciomarine environment, may also be present. Diagnostic features, such as striated pavement, striated phenoclasts, and dropstones have not yet been recorded but a specimen of laminated phyllite contains out-sized quartz grains that may be analogous to dropstones. A common characteristic of the diamictites in northern Ellesmere Island and Svalbard is the abundance of carbonate clasts; quartzite clasts are also fairly abundant in both areas (Hambrey et al., 1981; Kowallis and Craddock, 1984).

In many areas affected by the Varangian glaciation, two sets of glacial deposits have been distinguished that are separated by nonglacial sediments (Hambrey, 1983). In northern Ellesmere Island, it remains to be determined whether the mudrocks, quartzites and carbonate rocks that are associated with the diamictites represent interglacial sediments or whether they belong to underlying or overlying units.

Ridge-forming carbonates (map-unit c)

A ridge-forming carbonate unit overlies map-unit pwxqc both northeast and south of the Deuchars Glacier Belt in synclines and on the flanks of anticlines. The thickness of the unit has not yet been measured but is estimated to be in the order of 400 to 600 m. A few samples represent: finely microcrystalline (5 - 25 micrometres) limestone (recrystallized lime mudstone) with impurities of dolomite, quartz, and muscovite; finely microcrystalline dolostone; and interlaminated quartz siltstone.

Predominantly argillaceous strata (map-unit pvc)

The ridge-forming map-unit c is overlain, and flanked on the northeast, by phyllite, locally with interbedded volcanic and carbonate rocks (map-unit pvc). The phyllite is medium light grey to medium dark grey and partly laminated. Dark grey phyllite locally contains pyrite cubes up 7 mm in edge length. The rocks are composed of quartz (mean of four uncorrected XRD analyses = 66 %), chlorite (16 %), feldspar (8 %, mainly albite, minor K-feldspar), mica (7 %, mainly muscovite), and dolomite (3 %) (App. 3, Table 2Ad). A specimen of tuffaceous greenschist is composed mainly of chlorite (uncorrected XRD analysis = 38%), albite (37 %), and K-feldspar (12 %) with small amounts of actinolite, epidote, and quartz (App.3, Table 2Ae).

Quartzite units of uncertain stratigraphic position (qf and q)

Map-unit qf forms a narrow outcrop belt, about 6 km long, in the centre of the peninsula that is recognizable on air photographs by its light grey tone. It seems to overlie southwest-dipping strata of map-unit pwxqc to the northeast, but the contact is concealed and may be faulted and stratigraphic tops have not been determined. The southwestern limit of the unit is concealed by a glacier. A typical specimen represents a highly altered feldspathic quartzite. Quartz and feldspar of medium sand to granule grade are embedded in an abundant pseudomatrix of microcrystalline to finely crystalline quartz and intergrown muscovite. The rock contains about 15 % feldspar (7.5 % of albite and K-feldspar each; combined point count and XRD analysis) and 3 % muscovite in addition to the predominant quartz (82 %), but this is clearly not its original composition. Textural evidence suggests that part of the feldspar has been replaced by aggregates of quartz and muscovite, and that part of the albite may be altered K-feldspar (chessboard twinning). Another specimen of similar grain size and composition contains somewhat rounded crystals of calcite that either represent resedimented carbonate or replaced grains of feldspar and perhaps quartz.

The strata differ from the quartzites associated with the diamictites (map-unit pwxqc) by their much larger grain size and higher feldspar content and probably represent a younger or older unit. The second interpretation is favoured because coarse grained, arkosic sediments commonly occur above unconformities floored by granitoid basement. Moreover, the strata are comparable to map-unit qp on Wootton

Peninsula, tentatively placed below the diamictites on structural grounds (see below, Cape Alfred Ernest Belt). The contact with map-unit pwxqc therefore is shown as an assumed thrust fault.

Map-unit q occurs east of the head of Petersen Bay where it is in faulted contact with ridge-forming carbonates (map-unit c). The unit, which is represented mostly by talus, consists mainly of quartzite, probably with smaller amounts of metamorphosed mudrock. A typical sample of quartzite is composed largely of fine grained, well sorted quartz (uncorrected XRD determination = 93 %) and very small amounts of plagioclase (1 %) that are surrounded by a sparse pseudomatrix of microcrystalline muscovite (2 %) and chlorite (2 %).

Peninsula northeast of Milne Fiord-Milne Glacier

This area is underlain by the Milne Fiord assemblage and by three map-units of uncertain age and affinity.

Milne Fiord assemblage

The Milne Fiord assemblage is an informal unit of group rank that consists of three divisions of formational rank. The type area of the unit is on the peninsula northeast of Milne Fiord and Milne Glacier where it forms well-defined anticlines and synclines with an arcuate, northwesterly to northeasterly trend.

Division 1 (map-unit $ЄO_{M1}$) is about 150 - 200 m thick at a stratigraphic section northeast of Ayles Fiord (M'Clintock Inlet map-area; Trettin, 1987c). The unit may be thicker in the northeastern part of the Yelverton Inlet map-area but has not been measured there. It consists of microcrystalline marble that is purely calcareous at some localities and calcareous and dolomitic at others and locally contains interlaminated phyllite. The strata weather mainly medium light grey but also reddish.

Division 2 (map-unit $€O_{M2}$) overlies division 1 with abrupt but apparently conformable contact. At section SEMF (southeast of Milne Fiord) it is roughly 900 m thick according to a photogrammetric determination. On air photographs the division is readily recognizable by a relatively recessive weathering profile and dark tone. It consists mainly of phyllite (App. 3, Table 2Af), in part calcareous and dolomitic, with a smaller proportion of intercalated volcanic rocks, mainly tuff, and rare carbonate rocks.

The average composition of six specimens of calcareous and dolomitic phyllite, according to uncorrected XRD determinations, is: quartz 60 %, carbonates 20 % (dolomite 13 %, calcite 7 %), feldspar (mainly albite, minor K-feldspar) 8 %, chlorite 7 %, and mica (mainly muscovite) 6 %. Both total carbonate content and calcite/dolomite ratio are rather variable (App. 3, Table 2Ag).

Carbonates were encountered in a 68 m thick unit that is 127 - 195 m below the top of the division at a section southwest of Ayles Fiord (SWAF; Appendix 5). The unit consists mainly of argillaceous and sandy, microcrystalline dolostone and of lesser amounts of dolomitic lime mudstone (App. 3, Table 2B). Pelitic phyllite and a bed of tuff are interbedded with the carbonates.

A porphyritic welded tuff, occurring a few metres below the top of the division at section SEMF, is important because it has yielded a zircon age (see below). Phenocrysts of quartz, K-feldspar, and albite are set in a sheared microfelsitic groundmass with a discontinuous, undulating lamination. The rock is classified as a rhyolite on the basis of both major element and trace element composition (App. 2, Table 3; Irvine and Baragar, 1971; Winchester and Floyd, 1977). In addition to siliceous volcanics, the division also contains chlorite-rich (34 - 43 % in uncorrected XRD determinations) phyllites that probably represent tuffs or tuffaceous sediments of intermediate or mafic composition (App. 3, Table 2B).

Division 3 (map-unit CO_{M3}) overlies 2 with generally gradational (but locally abrupt) contact. At section EMG the lower few metres consist of quartzite beds that are 5 - 10 cm thick and separated by thin layers of phyllite. This transitional unit is overlain by quartzite that is 540 m thick according to photogrammetric determination but has not been studied.

Quartzite samples from various other localities are composed almost entirely of quartz with very small amounts (up to 2 % in uncorrected XRD determinations) of feldspar in some cases. The grain size is fine to medium and the sorting moderate to good. The grains appear to have been rounded originally but have been affected by pressure solution and replacement by a secondary matrix of finely microcrystalline (10 - 20 micrometres) drop-like quartz and small amounts of muscovite. Undulatory extinction is very common.

Age. The rhyolite near the top of division 2 has yielded a U-Pb zircon age of 503.2 +7.8/-1.7 Ma (Trettin et al., 1987) -- early Tremadocian with confidence limits in the latest Cambrian and Tremadocian according to the time scales of Harland et al. (1982) and Palmer (1983); Tremadocian with confidence limits in the Tremadocian according to McKerrow et al. (1985); or Cambrian according to Odin

(1985). Divisions 1 and 2 are here considered as Late Cambrian and/or Early Ordovician in age; division 3 is regarded as Early Ordovician.

Map-units of uncertain age and affinity

The area between the Milne Fiord and Petersen Bay assemblages is underlain by carbonates (**map-unit c**); interstratified phyllite and carbonates (**map-unit pc**); and metavolcanic schist and weakly recrystallized marble with mafic intrusions (**map-unit cv**). Most schists of the latter unit consist of feldspar and either fine-grained chlorite + biotite or actinolite and are interlayered with laminated marble and calcareous schists. Fresh olivine-clinopyroxene gabbro and brown biotite - green hornblende metagabbro (with its original igneous texture still discernible) occur as sheets up to 10 m thick in schist and marble. The margins of both the fresh and the metamorphosed gabbro bodies are sheared and slickensided.

The age and stratigraphic affinity of these lithological units are uncertain. The main carbonate body (map-unit c) appears to be thicker than the carbonates of the Petersen Bay assemblage at Kulutingwak Fiord and Yelverton Inlet and is more reminiscent of Succession II. Map-units cv and pc may be low-grade metamorphic equivalents of the Petersen Bay asssemblage but are also comparable to parts of the Empire Belt, for example to map-unit pvc, southwest of Milne Glacier, or to parts of map-unit psvqc in the M'Clintock Inlet map-area (Trettin, 1987c).

Peninsula northeast of Ayles Fiord (map-unit scq)

This area is underlain by a unit of schist, marble and quartzite that extends into the M'Clintock Inlet map-area. The unit is bordered on the north by the Cape Fanshawe Martin Intrusion and contains small fault blocks of gneiss only one of which is shown on the present map. Schist and impure quartzite evidently have been metamorphosed in the greenschist facies as they contain biotite, muscovite and chlorite in addition to quartz and feldspar. The close association of these metasediments with the gneiss suggests that they belong to a relatively old part of Succession II.

CAPE ALFRED ERNEST BELT

The Cape Alfred Ernest Belt proper, extending from Wootton Peninsula to east of Henson Bay in the Cape Stallworthy map-area, is about 100 km long, and up to 25 km wide. On Wootton Peninsula the Cape Alfred Ernest Belt is separated from the Mitchell Point Belt by the Mitchell Point Fault, and by the Wootton Intrusion, which has been emplaced into that fault. In the northeastern part of the peninsula a tentative stratigraphic order has been inferred from structural relationships; in the remaining parts of the belt structural and stratigraphic relationships are unknown and lithological units are described in an east to west geographic order. An outcrop area of metasedimentary rocks northeast of the head of Yelverton Inlet, also described here, either represents a relatively highly metamorphosed northeasterly extension of the Cape Alfred Ernest Belt or an atypical component of the Mitchell Point Belt.

Northeastern Wootton Peninsula

Three lithological units are distinguished here that are in thrust-faulted contact with each other. They can be placed into a tentative stratigraphic order if it is assumed that older rocks have been thrust upon younger ones, but this assumption may not be valid because of the complex structural history of Succession II.

Map-unit qp

This unit consists mainly of quartzite with lesser proportions of interstratified slate or phyllite. The quartzite occurs mostly as felsenmeer that does not reveal primary structures, but outcrop with medium-scale planar cross-bedding has been observed locally. Average grain size ranges from very fine to coarse sand grade, and maximum grain size from very fine sand to granule grade. Sorting commonly is moderate or poor. The quartz sand grains appear to have been rounded originally but have been affected markedly by pressure solution and replacement. Uncorrected XRD analyses indicate that the rocks consist mostly of quartz (mean about 95%) with small amounts of feldspar, mainly plagioclase (2%), muscovite (2%) and chlorite (1%)(App. 3, Table 3Aa). Small amounts of secondary dolomite and/or calcite are present in some specimens. In thin section the quartz sand grains are seen to be embedded in a pseudomatrix of muscovite, chlorite and quartz.

The slates and phyllites are medium dark grey and dusky green and represent slightly metamorphosed mudrock and sandy mudrock. A typical specimen consists mainly of quartz (uncorrected XRD analysis = 68%) with lesser proportions of albite (14%), muscovite (8%), chlorite (8%), and K-feldspar.

The scanty available information suggests that the unit is of fluvial, transitional (delta front) or shallow marine origin. If it indeed occurs stratigraphically below map-unit pxc it probably is Paleohadrynian or earliest Neohadrynian in age.

Map-units pwxc and c

Map-unit pwxc, which is similar to pwxqc northeast of Yelverton Inlet, consists of phyllite, sandy phyllite and argillaceous sandstone (wacke), diamictite, and carbonate rocks. Thin carbonate units are included in pwxc but a thicker unit that overlies pwxc in a synclinal structure is shown separately as map-unit c.

The **phyllite** is light grey to medium dark grey, commonly shows a thin flat lamination, and consists of quartz (mean of 9 uncorrected XRD analyses = 56 %), calcite (14 %), dolomite (12 %), feldspar (7%), mica (7 %), and chlorite (4 %)(App. 3, Table 3Ab). The feldspar is mainly albite with small amounts of K-feldspar, the mica mainly muscovite with trace amounts of biotite in some specimens. Mica and chlorite define a continuous schistosity that forms low to high angles with a lamination caused by vertical variations in grain size, mineral composition, or concentration of submicroscopic carbonaceous impurities.

The **diamictites and wackes** are light grey to predominantly greenish grey and occur as massive units, several metres or more in thickness. Texturally, they are characterized by an abundant argillaceous matrix (comparable in composition to the phyllite described above), in which are embedded unsorted clasts ranging in size grade from very fine sand to pebbles. The sand fraction is dominated by rounded quartz but also includes fragments of carbonate and siliciclastic sediments, feldspar, and recrystallized chert (App. 3, Table 3Ac). The pebbles are rounded, and ovoid or discoid in shape. Two pebbles analyzed by XRD (App. 3, Table 3B) represent calcareous and dolomitic quartz sandstone (#16) and highly dolomitic mudrock (#17). The rocks are correlated with the diamictites in map-unit pwxqc on Wootton Peninsula and tentatively considered to be late Hadrynian (early Vendian or Varangian) in age.

The **carbonate rocks** comprise microcrystalline limestone, dolomitic limestone, and dolostone. Most are relatively pure but one contains significant amounts of quartz silt. One dolostone that is extensively replaced by chert has a relict oolitic texture (App. 3, Table 3B).

Map-units v and c

These two units comprise associated volcanic and carbonate rocks. The **volcanics** are mainly siliceous in composition -- only one out of 17 specimens analyzed in thin section represents an intermediate or mafic rock (andesite or basalt; App. 2, Table 4). Stable trace element ratios place four typical specimens into the fields of comendite-pantellerite, rhyolite, and rhyodacite (Fig. 3). Flows are more commonly represented than tuffs in the specimens collected. Most flow rocks are porphyritic, containing phenocrysts mainly of feldspar (K- feldspar and/or plagioclase) and less commonly quartz. The groundmass is microfelsitic and often spherulitic. Optical and XRD analyses indicate that the plagioclase (groundmass and phenocrysts) is albite. Fe-Ti oxides, chlorite, and muscovite are present in variable, generally minor proportions. The rocks tentatively identified as tuffs are sheared microfelsites that may represent recrystallized vitric material. The intrusions (dykes and/or sills) have a hypidiomorphic granular groundmass, in which graphic intergrowths are common. The volcanic and intrusive rocks commonly are altered by calcite, occuring both as replacement and veinfill.

Carbonate units that have been mapped separately are shown as **map-unit c.** A specimen from the southwestern outcrop belt of map-unit c consists of a slightly recrystallized (cryptocrystalline to finely microcrystalline) lime mudstone that contains microcrystalline to very finely crystalline dolomite and abundant veinlets of calcite. A specimen from the northeastern outcrop belt consists of microcrystalline to very coarsely crystalline marble.

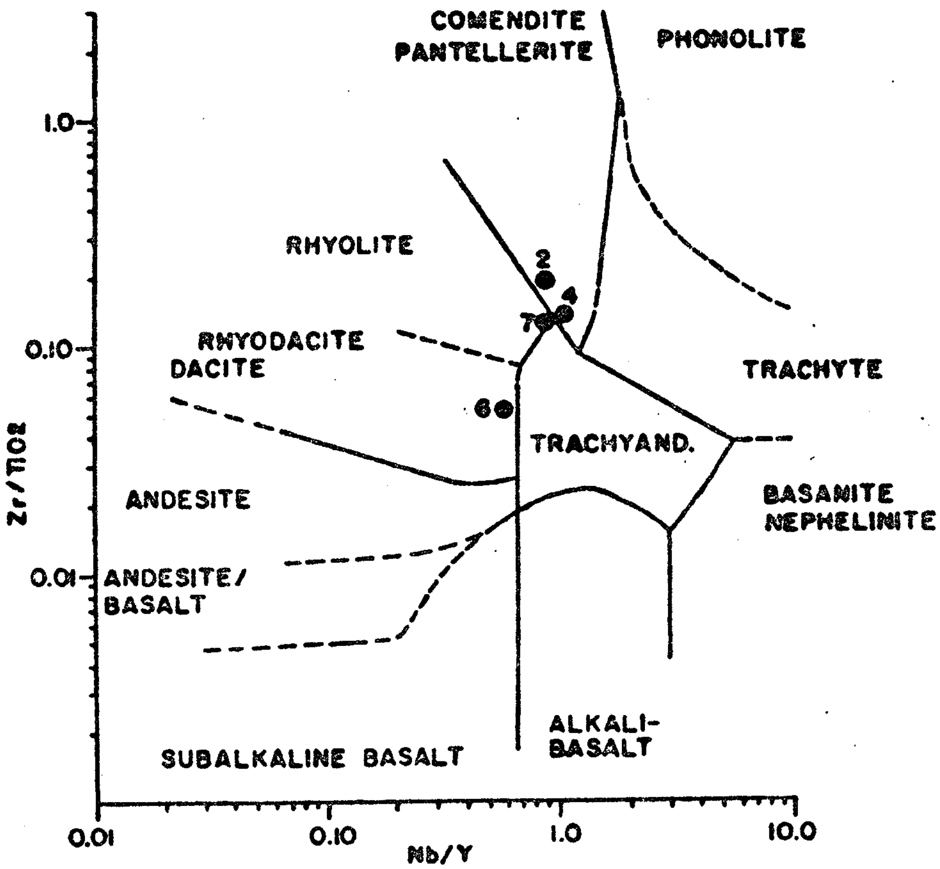

Figure 3. Volcanics on northeastern Wootton Peninsula (map-unit v); stable trace element ratios of analyzed samples; classification based on Winchester and Floyd, 1977, Fig. 6.

Age. If map-unit v indeed occurs stratigraphically above pwxc it probably is no older than late Vendian (Ediacaran). A large sample of limestone from the southwestern outcrop belt (locality F1) yielded a single conodont fragment identified by C.R. Barnes as an "acantodiform element, short, wide; black but not corroded" that probably is no older than Early Ordovician. However, this conodont may be a contaminant as three additional large samples, taken from the same locality in a subsequent year, did not contain any conodonts.

Mode of origin. Apart from the metamorphism, the volcanics are remarkably similar to the Cretaceous Hansen Point volcanics, and, like the latter, may have originated by melting of sialic crust during a rift event.

Central and western Wotton Peninsula

Map-unit c

This map-unit, which underlies an extensive area on north-central Wootton Peninsula, is in faulted contact with map-unit pwxc and the Eureka Sound Group; its contact with map-unit sc has not been examined. Samples from three localities are of dolostone, lime mudstone and marble. The dolostone is very light grey to medium grey, microcrystalline to very finely crystalline, and contains small amounts of lime mud and siliclastic impurities, mainly quartz of silt to fine sand grade with trace amounts of muscovite.

The lime mudstone is medium light grey to medium dark grey and also purple red. It is variably dolomitic, silty or sandy and slightly recrystallized, the calcite crystals in a typical sample being in the 8-10 micrometre range. A vague lamination is present in some specimens.

Solution zones are common and slaty cleavage is rare.

A specimen of coarsely microcrystalline and phanerocrystalline marble probably represents very fine and fine grained calcarenite and coarse calcilutite in which agreggate grains have been transformed into single crystals. The strata also contain significant amounts of siliciclastic sand and mud composed of quartz, feldspar and muscovite.

No conodonts or other fossils were recovered from three large samples analyzed.

Map-units sc and c

Southwestern Wootton Peninsula is underlain mainly by schist with less abundant marble and minor amounts of quartzite. Most of these rocks are included in map-unit sc but two occurrences of marble are shown as map-unit c. The strata are intruded by the Cape Woods pluton; small granitic bodies with gneissic texture [shown as (gd) at two points on the map]; and mafic dykes and sills.

Most **schists** are rich in calcite and dolomite (combined 25 - 40 % of the uncorrected XRD analyses), but one sample lacks carbonates (App. 3, Table 3B). Other significant constitutents are quartz (24 - 69 %), feldspar (2 - 12 %), and mica and chlorite (combined 3 - 26 %). Some rocks contain muscovite alone, others muscovite and biotite, or biotite alone. One sample had a few percent of garnet and fairly abundant tremolite (22 %). Sillimanite, kyanite, and staurolite are developed near the Cape Woods pluton (Frisch, 1974, p. 77).

A specimen of **marble** consists mainly of dolomite with smaller amounts of calcite, tremolite, quartz and K-feldspar (App. 3, Table 3B #15).

A specimen of **quartzite** is very fine to fine grained, slightly calcareous, and schistose, owing to the presence of small amounts of chlorite and muscovite (App. 3, Table 3B # 14).

Western peninsula in Phillips Inlet (map-unit c)

On the western peninsula in Phillips Inlet, Succession II is in faulted contact with an outlier of the Mitchell Point Belt on the southeast and with the Imina Formation on the northwest. It consists of two belts of carbonate rocks (map-unit c) that are separated by volcanic rocks, tentatively assigned to the Kulutingwak Fiord assemblage (map-unit S_K?).

Map-unit c consists of marble representing variably recrystallized limestone, dolomitic limestone and dolostone. The rocks are medium to medium dark grey, somewhat schistose, and criss-crossed by abundant veinlets of calcite and dolomite. In thin section, remnants of cryptocrystalline lime mud are seen to be preserved in small patches, especially in those areas where carbonaceous matter has been concentrated by metamorphic processes, but generally the lime mud now is microcrystalline. The calcite in the veinlets ranges in grade up to coarsely crystalline. The dolomite ranges in crystal size from microcrystalline to coarsely crystalline. The carbonate rocks are nearly pure or contain small amounts of quartz and muscovite.

No conodonts or other fossil fragments were recovered from five large samples analyzed.

Northeast of mouth of Yelverton Inlet (map-unit s)

A unit of amphibolite-grade schist occurs northeast of the entrance of Yelverton Inlet (Frisch, 1974, p. 39). It consists of knotted garnet-chlorite-mica schist, largely of pelitic composition but with thin psammitic layers, quartzite, and minor marble beds, a few tens of centimetres thick. Minor folds are common in quartzite and marble, and crenulation and foliation in schist. The schists and impure quartzites show signs of retrogressive metamorphism, such as chlorite replacement of garnet and biotite, development of late muscovite, and sericitization of plagioclase. As mentioned, it is uncertain whether this unit belongs to Succession II (Cape Alfred Ernest Belt) or to Succession I (Mitchell Point Belt).

KULUTINGWAK BELT

This narrow, slightly arcuate outcrop belt of Succession II extends for about 53 km from the west side of Yelverton Inlet across Kulutingwak Inlet to east of Phillips Inlet; its maximum width is 3.6 km.

The structure in the central part of the belt is outlined by resistant carbonate rocks (map-unit c) that define the south-verging Kulutingwak Anticline, which is split by a south-directed backlimb thrust. Detrital serpentine rocks rocks (map-unit ub) are exposed in the core of the anticline for 4.8 km. For most of its length, the Kulutingwak Belt is in faulted contact with the Imina Formation both on the north and the south; but in the northwest it is bordered by the Petersen Bay assemblage. The fact that the Imina Formation overlies Succession II (map-unit c) with faulted contact in the west-central part of the belt suggests that the Imina Formation wrapped over the Kulutingwak Anticline prior to erosion. Three main phases of deformation are inferred from this configuration (see Trettin, 1987b, Fig. 25):

(1) Low-angle thrust faulting resulting in the following sequence (listed in descending structural order):

Imina Formation

- thrust fault -

Pearya Terrane, Succession II (internally thrust-faulted; stratigraphic order of units uncertain)

map-units scvq, p

map-unit c

map-unit x

- thrust fault -

Serpentinite (map-unit ub)

(2) Folding (formation of the Kulutingwak Anticline).

(3) Southward overturning of the Kulutingwak Anticline and backlimb thrust-faulting.

Map-unit x

Map-unit x occurs as a fault slice, about 5 m thick, between the serpentinite and map-unit c. It is an unsorted, matrix-supported, massive conglomerate with phenoclasts up to 30 cm in diameter. The phenoclasts consist mainly of microcrystalline dolostone with lesser amounts of quartzite (fine to coarse grained), recrystallized chert, and siliceous volcanic rocks (microfelsite). The sandy matrix is composed of quartz and dolostone grains with smaller proportions of feldspar, muscovite, chert, and siliceous volcanic rock fragments (App. 3, Table 4B #17). The sandy conglomerate is related to other diamictites of Succession II by phenoclast composition and texture although both matrix and phenoclasts are coarser than elsewhere.

Map-unit c

Map-unit c, probably a few tens of metres thick, consists of marble and minor dolomitic schist. Four analyzed samples are composed mainly of calcite and variable amounts of quartz, with or without dolomite and small amounts of muscovite and feldspar (App.3, Table 4Ab). The calcite ranges in size grade from microcrystalline to coarsely crystalline and is mainly phanerocrystalline. Some rocks show a lamination caused by variations in the concentration of silt to sand-grade impurities and in the crystal size of the calcite. This, and the rounded appearance of the crystals, suggest that the laminated rocks were calcarenites. Schist associated with the marble in the area south of the west arm of Kulutingwak Fiord represents metamorphosed sandy mudrock and fine grained (?) calcareous sandstone with interlaminated mudrock. Two analyzed samples contain 16 - 26 % of dolomite (App. 3, Table 4B # 18, 19). The age relationships of map-unit c with the diamictite are uncertain.

Map-units spcqv and p

Map-unit spcqv is composed of argillaceous sediments metamorphosed to schist and phyllite and of lesser amounts of marble, volcanic rocks and quartzite.

Schist is represented by samples from the central part of the belt. The rocks are composed of quartz (range of 6 uncorrected XRD determinations = 39 - 83 %), feldspar (3 - 11 %; predominantly albite with small amouts of K-feldspar), mica (2 - 17 %; mainly muscovite with rare biotite), chlorite (2 - 15 %), with or without calcite (0 - 8 %) and dolomite (0 - 7 %; App. 3, Table 4B # 3 - 8). A sedimentary lamination commonly is discernible from variations in mineral composition. The schistosity is parallel or subparallel with the lamination.

Samples from the western part of the belt are classified as **phyllite.** Two analyzed specimens have relatively high percentages of chlorite (34 - 38%) and muscovite (19 - 25 %), and correspondingly less quartz (18 - 28%), calcite (3 - 16%), albite (2 - 13 %), dolomite (0 - 3%) and K-feldspar (0 - 1 %; App. 3, Table 4B #12). The high chlorite content suggests a tuffaceous origin.

Marble units vary in thickness from millimetres to a few tens of metres and are massive or laminated. The thickest units may be structural repetitions of map-unit c, but this is not certain. The colour of the rocks varies from very light grey to medium grey. Some rocks are composed almost entirely of calcite with only a few percent of quartz, others have considerable proportions of quartz (up to 42 % in uncorrected XRD analyses), dolomite (up to 16 %) and muscovite (up to 7 %; App. 3, Table 4B # 9 - 13). The quartz ranges in size grade from silt to medium sand, and the calcite from finely microcrystalline to very coarsely crystalline with some of the crystal size variation perhaps inherited from preexisting calcarenites.

Quartzite is relatively rare and occurs in units ranging in thickness from millimetres to a few metres. Some samples are of coarse silt and very fine sand grade, one is bimodal with grains up to granule grade. The rocks are relatively pure, containing on the average about 93 % of quartz (uncorrected XRD determinations), with or without small amounts of muscovite, chlorite, plagioclase, and dolomite (App. 3, Table 4Aa).

One thin **volcanic flow** of siliceous composition was encountered south of the west arm of Kulutingwak Fiord. Altered fragmental volcanic rocks, interpreted as lithic and crystal tuff of siliceous to intermediate composition occur east of the fiord (App. 3, Table 4B #14 - 16).

Map-unit p consists of dark grey, pyritic slate that probably belongs to map-unit spcqv but is separated from that unit by overburden.

SUMMARY OF TENTATIVE STRATIGRAPHY

The tentative stratigraphic order of some of the units assigned to Succession II in the Yelverton Inlet map-area may be summarized as follows (table gives sedimentary protoliths of metamorphic rocks):

(4) Milne Fiord assemblage (Upper Cambrian - Lower Ordovician)

--- Division 3 (Lower Ordovician):
quartzite, minor mudrock (540 m +)

--- Division 2 (Upper Cambrian? - Tremadocian):
mudrock, minor carbonates, volcanics (ca. 900 m)

--- Division 1 (Upper Cambrian ?)
limestone, dolostone (150 - 200 +m)

--- gap ---

(3) Units between diamictite assemblage and Milne Fiord assemblage (Ediacaran - Cambrian)

--- map-units v and c of Empire Belt:
siliceous, partly alkaline volcanics; carbonates
(overthrust by diamictite assemblage)

--- gap ---

--- map-units p and pvc SW of Milne Fiord - Milne Glacier:
mudrock, minor volcanics, carbonates
(overlies ridge-forming carbonates)

--- map-unit c SW of Milne Fiord - Milne Glacier:
ridge-forming limestone, dolostone (400 - 600 m ?)
(overlies diamictite assemblage)

map-unit c on NE Wootton Peninsula:
carbonates
(overlies diamictite-bearing assemblage)

--- gap ---

(2) Diamictite assemblage (Varangian / lower Neohadrynian?)

--- map-unit x, parts of map-units pwxqc, pwxc:
diamictite and associated mudrock
(associated quartzite, limestone, etc. may represent interglacial sediments or strata that underlie or overlie the glacial sediments)

--- gap ---

(1) Units underlying diamictites (Riphean / Paleohadrynian - lowermost Neohadrynian ?)

--- map-unit qp of Wotton Peninsula:

quartzite, mudrock
(thrust over diamictite assemblage)

--- map-unit qf northeast of Yelverton Inlet ?:
feldspathic quartzite
(structural relationships with diamictite unknown)

The stratigraphic position of the following units is unknown but thought to be below (4), either within (3) or (1):

--- map-unit sc of Wootton Peninsula
mudrock, carbonates, minor quartzite

--- map-units c of northwestern Wootton Peninsula, Phillips Inlet, Kulutingwak Belt:
limestone, dolostone

--- map-unit spcqv of Kulutingwak Belt:
mudrock, carbonates, quartzite, volcanics

--- map-unit q east of head of Petersen Bay:
quartzite, minor phyllite

CLEMENTS MARKHAM FOLD BELT

PETERSEN BAY ASSEMBLAGE (map-units lPz_P, lPz_{PBc})

The informal name, Petersen Bay assemblage, is here introduced for an intensely deformed unit of heterogeneous metamorphic rocks that flanks the Mitchell Point Belt on the southeast, being separated from it by the Petersen Bay Fault. It forms two elongate, narrow outcrop belts, extending from southwestern Wootton Peninsula to east of Yelverton Inlet, and from southwest of Petersen Bay to Ayles Fiord, respectively. The unit consists mainly of schist, both of volcanic and pelitic origin, with lesser proportions of amphibolite and marble. The metamorphic rank of these rocks ranges from greenschist to amphibolite facies and generally increases towards the Petersen Bay Fault, i.e. to the northwest or north. In addition, the unit includes some problematic plagioclase-free amphibole rocks, very briefly discussed below, that require further field and laboratory study. The Petersen Bay assemblage is tentatively assigned to the Ordovician or lowermost Silurian on the basis of structural setting and poorly preserved echinoderm columnals.

Lithology

Schist and amphibolite generally weather brown and commonly contain large, deformed lenses of white quartz.

Amphibolite and amphibole-rich schists are characterized by high proportions of amphibole and plagioclase with or without biotite, chlorite, quartz, carbonate, epidote, etc. (App. 3, Table 5 #1 - 4). Much of the amphibole occurs as randomly oriented blades, highly sieved with inclusions. Optical and X-ray diffraction analyses show that both triclinic and orthorhombic types (anthophyllite-gedrite, grey-green in ordinary light) are present. The triclinic amphibole in a typical specimen from east of Kulutingwak Fiord is classified as ferri-tschermakite and ferri-tschermakitic hornblende on the basis of microprobe analyses (App. 4). The plagioclase in the same specimen has the composition An_{33}. In samples of schist from Milne Fiord, the triclinic amphibole is a pale green variety, probably actinolite.

Also occuring at this locality and on Petersen Bay (Frisch, 1974, p. 36) are amphibolites with "eyes" of plagioclase granules, which were interpreted as recrystallized amygdules or phenocrysts. The amphibole in this rock is granoblastic dark green hornblende.

These rocks probably represent mafic volcanics (basalt and/or basaltic andesite), originally metamporphosed in the amphibolite facies, locally with some retrograde metamorphism.

One type of **plagioclase-free amphibole rock,** encountered on the eastern shore of Milne Fiord, is characterized by euhedral pink garnet (5 mm across) in a monomineralic matrix of fine-grained grass- to bluish green (sodic ?) amphibole. Chemical analyses are planned to test the possibility that this rock is a metamorphosed eclogite. Another type, observed in the Petersen Bay area, consists entirely of granoblastic amphibole (Frisch, 1974, p. 36), and it will have to be determined whether it is a metamorphosed peridotite.

Higher-grade **pelitic schists** contain kyanite and staurolite (not found together) in addition to garnet. Garnet and staurolite invariably occur as spongy porphyroblasts, garnet being the earlier of the two and showing signs of instability. Porphyroblastic brown biotite formed late and grew across the foliation.

Mica schists are composed of varying proportions of quartz, plagioclase, mica (biotite and/or muscovite), with or without amphibole, chlorite, carbonates (calcite and minor dolomite) and very small amounts of garnet or staurolite (App. 3, Table 5 #5 - 18). The rocks do not show any features suggesting that they are volcanic flows but may include tuffaceous material or volcanic-derived sediments. If so, these volcanic components are probably of intermediate composition (i.e. neither basaltic nor rhyolitic).

Distinct **carbonate units** that were mappable from air photographs are designated as map-unit lPz_{PBc} but other occurrences are present. The rocks examined consist mainly of calcite with varying proportions of dolomite, quartz, tremolite, or muscovite, the latter two minerals indicative of the lower greenschist facies. However, garnet and a humite mineral, tentatively identified in an outcrop on the eastern shore of Milne Fiord, suggest that higher metamorphic grades prevailed locally.

Of special importance is marble northeast of Kulutingwak Fiord (locality F/), which contains large calcite crystals that are strongly reminiscent of fractured echinoderm columnals. This skeletal (?) material is embedded in microcrystalline to very finely crystalline (about 15 - 80 micrometres) twinned calcite with very small amounts of dolomite and quartz. The rock is interpreted as a metamorphosed lime wackestone.

Age and tectonic affinity

The structural setting of the Petersen Bay assemblage suggests that it is older than the Imina Formation, i.e. no younger than middle Llandovery. A lower age limit may be defined by the crystals interpreted as echinoderm columnals. Such columnals date back to the Early Cambrian but are uncommon before the Early Ordovician. No conodonts were recovered from several large samples of the same rock.

Tectonic interpretation of the Petersen Bay assemblage is difficult because of its metamorphic state. It is comparable, however, to all known sedimentary-volcanic units of the Clements Markham Fold Belt, namely the Yelverton, Mount Rawlinson and Kulutingwak Fiord assemblages, and member B of the Lands Lokk Formation (see below). All four units are now interpreted as arc assemblages because of the chemical composition of their volcanic rocks. Correlation with the Kulutingwak or Mount Rawlinson assemblages is feasible if one accepts an Ordovician and/or Early Silurian age for the Petersen Bay assemblage.

KULUTINGWAK FIORD ASSEMBLAGE (map-unit S_K)

Type area

The informal name, Kulutingwak Fiord assemblage (Trettin et al., 1987) is used for Lower Silurian and (?) older volcanic and minor carbonate strata south of Kulutingwak Fiord that are in faulted contact with the Imina Formation on the northwest and with the Lands Lokk Formation on the southeast. The narrow outcrop belt of this unit, 18.5 km long overall and 0.3 km wide, is located mainly in the southwestern part of the Yelverton map-area but extends into the adjacent Otto Fiord map-area.

An analyzed (App. 2, Table 5) sample of a porphyritic flow consists of phenocrysts and microphenocrysts of albite and actinolite in a groundmass of albite, K-feldspar, actinolite, chlorite, epidote, quartz, and minor calcite and apatite (Fig. 4). The rock is classified

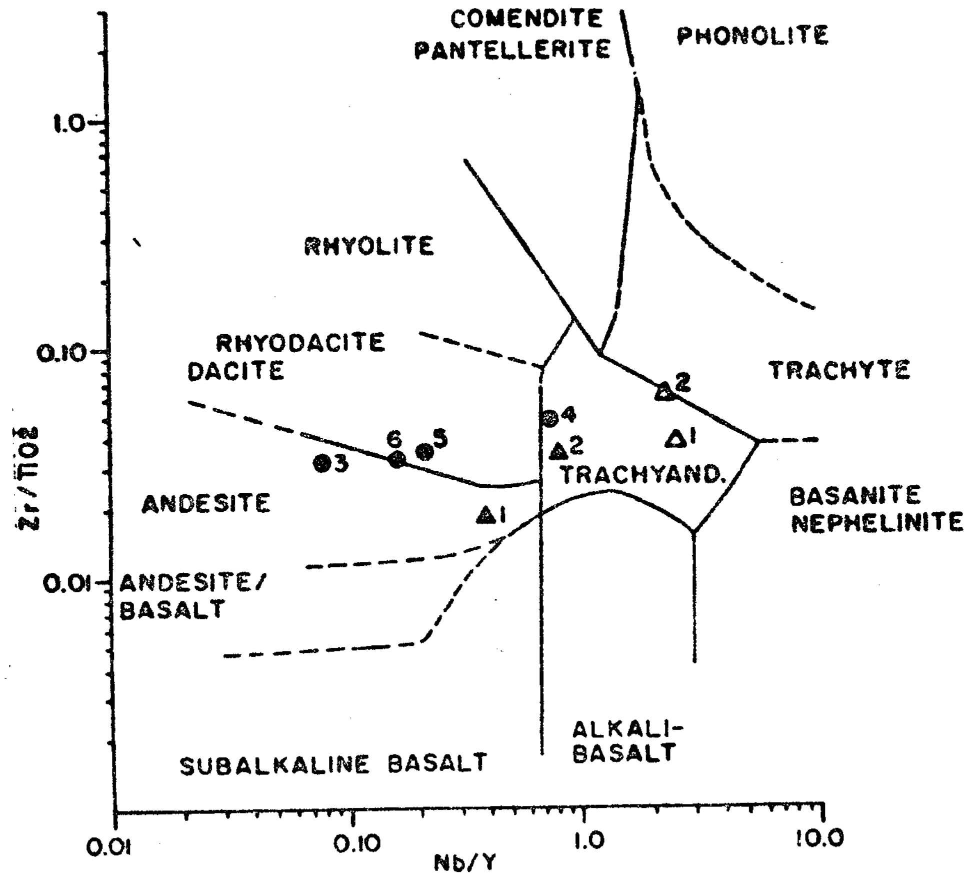

Figure 4. Stable trace element ratios of samples from Mount Rawlinson assemblage (solid circles), and Kulutingwak Fiord assemblage (type area: solid triangles; Phillips Inlet: open triangles); classification based on Winchester and Floyd (1977, Fig. 6). Age and correlation of volcanics at Phillips Inlet are uncertain.

as trachyandesite on the basis of stable trace elements (Winchester and Floyd, 1977) or as tristanite, potassic alkali basalt series on the basis of major elements (Irvine and Baragar, 1971). The first interpretation is preferred because of the petrographic evidence for spilitization.

A fragmental volcanic rock with a similar mineral composition is classified as andesite or calcalcalkaline (high Al) andesite (average series) on the basis of stable trace elements (Fig. 4) and major elements respectively.

A specimen of conodont-bearing limestone examined in thin section consists mainly of pelmatozoan columnals, commonly in solution contact with each other, and some interstitial lime mud. The rock could be interpreted either as an original lime packstone or as a skeletal lime wackestone that has lost its matrix due to pressure solution.

The conodonts from the limestone at locality F were identified as follows by C.R. Barnes (**in** Trettin et al., 1979, #13):

Astropentagnathus n. sp.

cf. **Falcodus**? n. sp. sensu fructo (of Schönlaub, 1971)

Ozarkodina cf. **O. gaertneri** sensu fructo Walliser (a form element of **Pterospathodus** cf. **P. amorphognathoides**)

Panderodus sp.

Belodina? sp.

"Early Silurian, early to middle Llandovery. The **Belodina** sp. specimens are grey and poorly preserved; this genus is not known to occur in strata younger than Ordovician. The platform elements of **Astropentagnathus** n. sp. suggest that it is ancestral to **A. irregularis**

Mostler reported by Schönlaub (1971) from the lower part of the **celloni** Zone in the Carnic Alps and from the lower part of the Cape Storm Formation (transitional facies) by Mirza (1976). **Falcodus** n. sp. also was reported by Schönlaub from the **celloni** Zone. The specimen identified as **Ozarkodina** cf. **O. gaertneri** sensu fructo Walliser consists of a single fragmentary element only; it belongs within **Pterospathodus amorphognathoides.** The P. **amorphognathoides** Zone is of late Llandovery - early Wenlock age. The tentative age assignment for this limited material is based on the **Astropenthagnathus** n. sp.."

The Kulutingwak Fiord assemblage lies on strike with the Mount Rawlinson assemblage of northeastern Ellesmere Island (M'Clintock and Clements Markham Inlet map-areas), which also occurs as fault slices that are bordered by the Imina and Lands Lokk formations on the northwest and southeast respectively. The Mount Rawlinson assemblage consists of flows and tuffs with comparable composition (andesite, dacite, trachyandesite, cf. Fig. 4) and lesser amounts of carbonate rocks and radiolarian chert. Combined, the volcanic and sedimentary strata of the Mount Rawlinson and Kulutingwak Fiord assemblages are characteristic of a volcanic arc environment. However, direct correlation is not possible because the lower part of the Mount Rawlinson assemblage has a Middle Ordovician (Llandeilo or Caradoc) U-Pb zircon age of 454.7 +9.7/-4.5 Ma (Trettin et al., 1987). If the two units indeed represent the same arc, then its age ranges from Middle Ordovician or earlier to Early Silurian.

Possible equivalent at Phillips Inlet (map-unit S_K?)

On the western peninsula in Phillips Inlet, a narrow belt of volcanic rocks is flanked with faulted contact by marble of the Cape Alfred Ernest Belt (map-unit c) both on the southeast and northwest. The unit consists of abundant fragmental rocks, probably lithic tuffs, and some flows. The rocks do not show any schistosity but the plagioclase has generally been altered to albite and most mafic minerals have been altered to chlorite although some clinopyroxene is preserved; in addition there is some some carbonate and quartz alteration. The presence of calcic plagioclase and common biotite in one sample is attributed to thermal metamorphism by a diabase dyke. One analyzed specimen is classified as trachyandesite and another as trachyandesite transitional to trachyte on the basis of stable trace elements (App. 2, Table 5; Fig. 4).

Although bordered by marble of presumed Hadrynian or Cambrian age, the unit is not included in Succession II because of the absence of a schistosity. Tentative correlation with the Kulutingwak Fiord assemblage is based on composition and general alteration state (assuming that the biotite and labradorite are secondary). However, the possibility that the unit is correlative with Hansen Point volcanics cannot be ruled out.

IMINA FORMATION

In the Clements Markham Fold Belt, the name, Imina Formation (Christie, 1957; Trettin, 1969), designates a uniform succession of interstratified calcareous and dolomitic sandstone and mudrock that underlies the Lands Lokk Formation. The contact between the two formations is exposed in the Otto Fiord map-area, east of Emma Fiord, where it is conformable. Graptolites from the uppermost part of the formation at that locality have been assigned to the late

Llandovery (J.W. Kerr and R. Thorsteinsson in Trettin, 1969, p. 37). The base of the formation is concealed but the fossil collections mentioned imply that it occurs not far above the top of the Kulutingwak Fiord assemblage or coincides with it. The type area is on the northwestern coast of Ellesmere Island between Phillips Inlet and Cape Bourne (Christie, 1957), in the general vicinity of Imina Inlet. Exposures in the Clements Markham Fold Belt are unsuitable for stratigraphic section work because of tight folding, complex faulting and poor preservation -- the unit occurs mainly as felsenmeer.

The name Imina Formation has also been applied to lithologically similar strata on the Hazen Plateau and in central Ellesmere Island (Trettin, 1971, 1978, 1979). However, these beds are underlain and overlain by different units, have a much wider age range, and probably are separated from the Clements Markham Fold Belt by a sinistral strike slip fault with large displacement. For these reasons a new name (Danish River Formation) will be introduced for them (Trettin, in prep.).

The sandstones are mainly very fine or fine grained but range in grade up to very coarse grained. Sorting varies from moderate to good. Combined point count and (corrected) XRD analyses from other parts of the Clements Markham Fold Belt indicate that the sandstones, where unmetamorphosed or weakly metamorphosed, consist mainly of quartz (mean content about 51 %) with lesser amounts of calcareous and dolomitic carbonate grains (20 %), feldspar (albite 13 %, K-feldspar 3%), phyllosilicates and related schist and phyllite fragments (10 %), and chert (3 %). The mudrocks are similar in mineral composition but lack rock fragments and chert. The sandstones are associated with the mudrocks in Bouma sequences or occur as massive beds.

The formation was deposited in a deep-water setting (submarine fan or basin floor environment) by sediment gravity flows derived from a source area composed of low-grade metamorphic sililiclastic and carbonate sediments.

In much of the Clements Markham Fold Belt the metamorphic grade of the Imina Formation is below greenschist facies but in the Yelverton Inlet map-area and the adjacent part of the Otto Fiord map-area it increases to upper greenschist and lower amphibolite facies near the faulted contact with the Mitchell Point Belt. Normally the sandstones contain trace amounts of detrital biotite, and (in contrast to the mudrocks) do not have a slaty cleavage. With incipient regional metamorphism the detrital biotite disappears and slaty cleavage develops. The next stages are characterized by (1) disappearance of detrital biotite, recrystallization of muscovite and chlorite and concomitant development of a schistosity, and (2) development of metamorphic biotite which may or may not be accompanied by muscovite and chlorite. On the unnamed peninsula between Yelverton Inlet and Kulutingwak Fiord, stage (1) is apparent at a locality 12 km southeast of the fault and stage 2 at localities 1.2 - 1.5 km southeast of the fault, i.e. close to the contact with the Petersen Bay assemblage. Garnet occurs close to the contact with the Neohelikian gneiss on the unnamed peninsula in Phillips Inlet.

LANDS LOKK FORMATION (map-units S_L, S_{L1}, S_{L2})

The name, Lands Lokk Formation, was given to a succession of clastic sediments and minor volcanic and carbonate rocks in northwestern Ellesmere Island that overlies the Imina Formation with conformable contact (Trettin, 1969). Three members were distinguished in the type area around upper Emma Fiord. Member A consists mainly of dark grey mudrock with minor proportions of tuff and tuffaceous sediments, is probably more than 1 km thick, and ranges in age from late Llandovery to Ludlow. Member B, composed of mudrock, volcanics and minor amounts of carbonate rocks, is a local facies restricted to the vicinity of Emma Fiord. Member C has a minimum thickness of 1 km in the area west of Emma Fiord (Trettin, 1987a) where it ranges in age from late Llandovery or Wenlock to Ludlow. It is composed of interstratified sandstone and mudrock with minor amounts of pebble conglomerate and has primary structures indicative of deposition by sediment gravity flows. Although member C overlies A locally, the fossil collections indicate that the two units are largely correlative facies, member A representing basin floor environments and member C submarine fan environments.

The sandstones and mudrocks of the Lands Lokk Formation differ from those of the Imina Formation by a scarcity or absence of carbonate material. The composition of 7 specimens of sandstone from the Emma Fiord area, analyzed by point count, is listed in Trettin, 1969, Table XIII. The rocks are composed of chert (18 - 70 %, mean 41 %), quartz (27 - 47 %, mean 38 %), carbonate (0 - 24 %, mean 9 %), feldspar (trace to 11 %, mean 4 %), chlorite (trace to 4 %, mean 2 %), argillaceous rock fragments (trace to 6 %, mean 2%), muscovite (1 - 4 %, mean 2 %), opaque material (trace to 3 %, mean 1 %), and metamorphic rock fragments (trace to 4 %, mean 1%, exclusive of quatzite and marble). The mean values of six uncorrected XRD analyses are: quartz (= quartz + chert) 83 %, chlorite 6 %, plagioclase (albite) 4 %, mica 4 %, calcite 3 %, dolomite 1 %. The uncorrected value for feldspar / feldspar + quartz is 5 %, the true value probably no less than 10 %.

Member A (map-unit S_{L1}) is exposed in a small area at the southern border of the Yelverton Inlet map-area where it consists mainly of dark grey, slaty mudrock. Member C (map-unit S_{L3}) occurs to the north of member A and consists of interstratified sandstone and mudrock with flysch-like primary structures. The two units have not been distinguished in the region east of Yelverton Inlet (map-unit S_L).

A total of 49 paleocurrent determinations from member C, based on flute marks and associated grooves and ridges show northerly to southeasterly directions with a vector mean of 84^o (reference meridian = 82^o W).

LOWER PALEOZOIC OR OLDER OCEANIC ROCKS

PLUTONIC AND DERIVED SEDIMENTARY SERPENTINITE

WEST OF UPPER KULUTINGWAK FIORD (map-unit um)

Map-unit um is exposed in the core of the Kulutingwak Anticline for a distance of about 4.8 km. In the centre of the belt the rocks are overlain by conglomeratic diamictite (map-unit x) with faulted contact; elsewhere the contact with Succession II is covered.

The unit consists entirely of serpentinite, composed largely of serpentine group minerals (mainly antigorite), with varying amounts of carbonate replacement and small amounts of opaque minerals. The rocks are brecciated or fragmental but have no schistosity and show no evidence of mylonitization. Three textural types can be summarized as follows.

Type 1: massive in hand specimen; under the microscope tightly packed, closely fitting fragments are outlined by opaque minerals.

Type 2: (most common) poorly sorted or unsorted fragments, ranging in size from less than 1 mm to 30 cm (or more) are embedded in a matrix of flakey serpentine; some fragments, especially those more than a few millimetres in diameter, are rounded, others are angular to subangular.

Type 3: size-sorted, very thin bedded or laminated, some layers graded; fragments commonly angular and fairly closely packed.

Type 1 is interpreted as fractured plutonic source rock, type 2 as detritus close to source (mainly talus), and type 3 as detritus that has been size-sorted and transported by currents. Comparable Recent deposits occur in oceanic fracture zones where mantle is exposed on submarine ridges (LaGabrielle and Auzende, 1982; Rona et al., 1987). The unit probably represents vestiges of oceanic mantle and initial sediments that either underlay the Clements Markham Fold Belt or separated it from the Pearya Terrane.

POST-HELIKIAN, PRE-CARBONIFEROUS PLUTONIC ROCKS

CAPE FANSHAWE MARTIN INTRUSION (map-unit O?b)

The Cape Fanshawe Martin Intrusion, described in more detail by Frisch (1974), extends from the Yelverton Inlet map-area into the M'Clintock Inlet map-area and is about 11 km long and 6 km wide. In the Yelverton Inlet map-area it intrudes schist, marble and quartzite of the Empire Belt. It is layered and can be divided into an olivine-rich central zone of peridote and gabbro, and a larger outer zone composed of gabbro. Cryptic zoning is shown by olivine and plagioclase, which are more magnesian and more calcic, respectively, in the inner zone than in the outer. Igneous layering, steeply inclined to vertical, and fluxion cumulate texture are especially common in the inner zone.

Age. A K-Ar determination on biotite from a norite of the outer zone yielded an age of 383 $\pm$ 16 Ma (recalculated from Frisch, 1974), Eifelian-Givetian according to the time scale of McKerrow et al. (1985) or Eifelian according to the time scale of Odin (1985). However, the nearby Cape Richards syenite - quartz monzonite complex (of the M'Clintock Inlet map-area), which had yielded an Early Devonian hornblende age of 398 $\pm$ 18 Ma (recalculated from Frisch, 1974), has a Middle Ordovician sphene age of 463 $\pm$ 5 Ma (Trettin et al., 1987); and the ultramafic to granitic M'Clintock West body, which had yielded an Early Devonian hornblende age of 398 $\pm$ 20 Ma, has a late Arenigian zircon age of 481 +7/-6 Ma (Trettin et al., 1982). It is possible that the Cape Fanshawe Martin Intrusion also is Ordovician in age, its K-Ar age having been reset by an Early Devonian thermal event.

CAPE WOODS PLUTON (map-unit Dqm)

The Cape Woods pluton (Frisch, 1974), which covers about 166 km^2, intrudes schist of presumed Cambrian and/or Hadrynian age (see above, Succession II, map-unit sc of Wootton Peninsula). The typical rock is a medium-grained biotite-quartz monzonite or granodiorite with abundant K-feldspar phenocrysts. Aplite and pegmatite veins and segregations are common. Whereas the bulk of the intrusion is undeformed, crush texture and foliation occur at its margin. This and the presence of sillimanite, kyanite and staurolite in the contact aureole indicate considerable heat and stress during emplacement. Small foliate intrusions of granodiorite and related rocks within map-unit sc [marked (gd)] on the map, may be related to the pluton.

A K-Ar determination on biotite gave an apparent age of 352 ± 15 Ma (recalculated from Wanless et al., 1974), interpreted as a cooling age. The best estimate for the crystallization of the pluton is given by a U-Pb sphene age of 390 ± 10 Ma (Trettin et al., 1987). Regression analysis of four zircon fractions, which include a significant proportion of xenocrystic material, yielded intercept ages of 369 +4/-5 Ma and ca. 1360 ± 200 Ma respectively. The upper intercept age suggests that the magma was derived from Helikian sources, probably Succession I of the Pearya Terrane.

METAMORPHOSED DYKES AND SILLS

Dykes and sills of different composition, metamorphic state, and age are common but only the most prominent and extensive bodies apparent on air photographs are shown on the map. The rocks discussed here probably all are pre-Carboniferous in age because of their metamorphic state but have not yet been dated.

Metamorphosed dykes and or sills of granitic to intermediate composition occur in the Empire Belt both southwest and northeast of Milne Glacier or Milne Fiord. A metamorphosed, somewhat mylonitized dyke or sill occurs southwest of Milne Glacier in map-unit pwxqc in the southwestern part of the M'Clintock Inlet map-area (loc. 77TM332c) and similar bodies may be present within the southeastern part of the Yelverton Inlet map-area. It is composed of sodic albite (52 % in uncorrected XRD determination), chlorite (24 %), quartz (13 %) and minor stilpnomelane. East of lower Milne Glacier, a metamorphosed felsic sill intrudes the uppermost part of division 2 of the Milne Fiord assemblage, about 10 cm below the contact with division 3. A sample of this rock consists mostly of sodic albite (77 % in point count) with smaller amounts of quartz (9 %), chlorite (8%), opaque minerals (5 %), and carbonate (1 %).

Metamorphosed dykes and sills of mafic composition are common in successions I and II of the Pearya Terrane and in the Petersen Bay assemblage. The metamorphic grade in these rocks varies from amphibolite to greenschist facies (see above, Succession II, Empire Belt, map-unit cv).

UPPER CRETACEOUS VOLCANIC AND PLUTONIC ROCKS,

HANSEN POINT VOLCANICS (map-unit K_{HP})

The informal name, Hansen Point volcanics, is applied to strata exposed in the vicinity of Hansen Point and on eastern Wootton Peninsula. On the southeast side the unit is overthrust by the Mitchell Point Belt along the Mitchell Point Fault; its base and top are not exposed and its thickness is unknown.

A volcanic conglomerate was noted by Christie (1957; geological map). Samples from two localities northeast of Yelverton Bay (75FS500 and 82TM212) represent flows of siliceous and mafic composition (App. 2, Table 6). At these localities siliceous rocks are far more abundant than mafic rocks but the suite collected may not be representative of the unit as a whole.

Ratios of Zr/TiO_2 versus Nb/Y (Winchester and Floyd, 1977) place four of the five samples in the fields of rhyodacite/dacite and rhyolite and the fifth in the field of comendite-pantellerite, a slightly alkaline rock (Fig. 5). Four of the five siliceous rocks analyzed are calc-alkaline and tholeiitic rhyolites according to their major-element composition (classification of Irvine and Baragar, 1971); the fifth (# 3) has not been classified because of its relatively high CO_2 content.

The two basalt specimens are subalkaline basalts according to their immobile trace elements. Their Ti, Zr and Y ratios conform with those of continental within-plate basalts (Fig. 6). Specimen # 2 is a "tholeiitic basalt, average series" according to the major-element classification of Irvine and Baragar (1971); specimen #1 is too altered (see CO_2 and H_2O contents) for application of this classification.

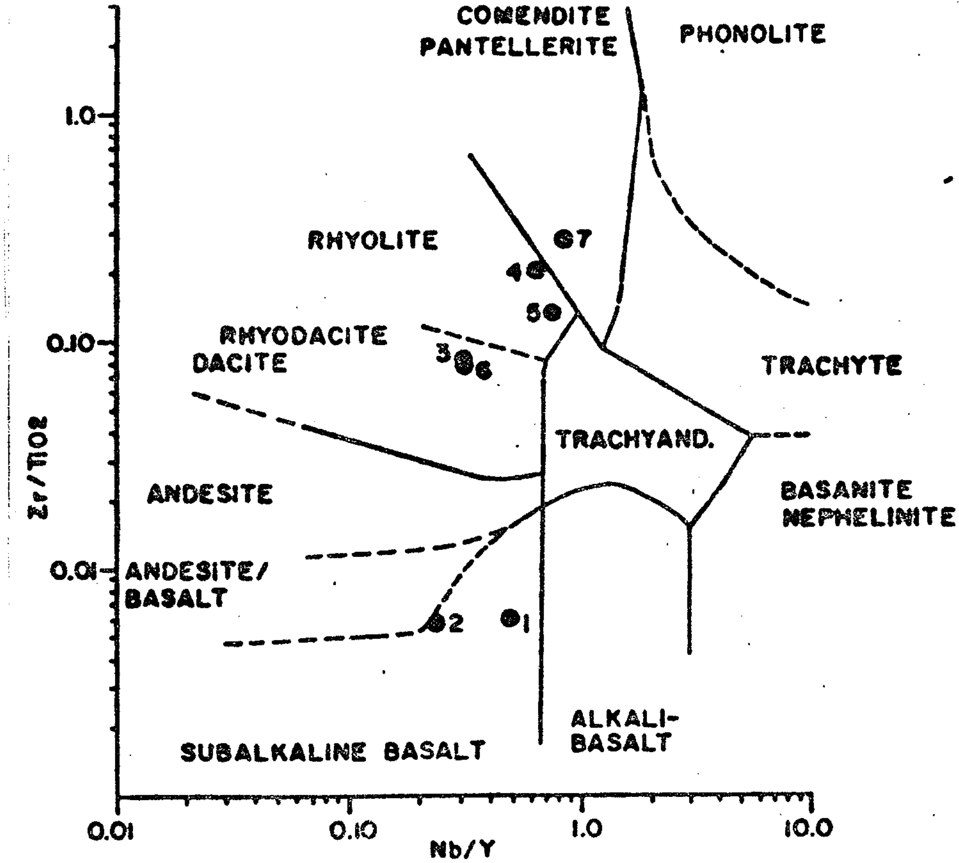

Figure 5. Hansen Point volcanics, stable trace element ratios; classification based on Winchester and Floyd, 1977, Fig. 6.

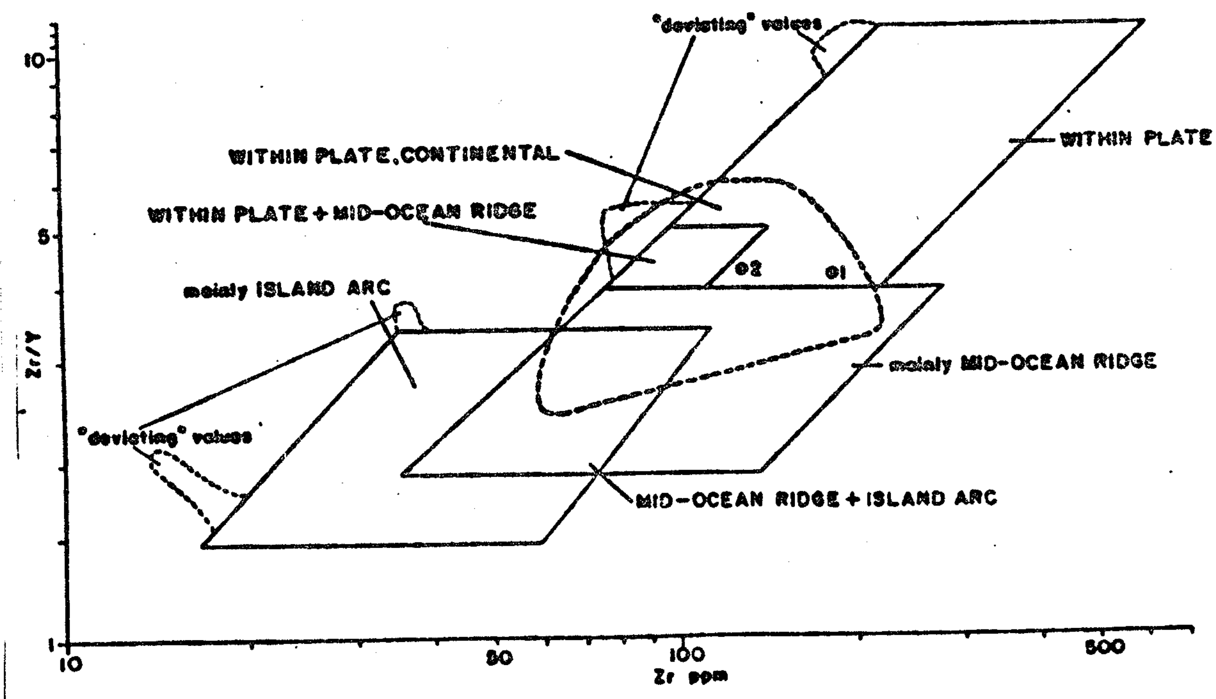

Figure 6. Hansen Point volcanics, stable trace element ratios in basalts; tectonic environment after Pearce and Norry, 1979, Figure 3 and data listed by Holm (1982; field for "within plate, continental").

Petrographically the present unit differs from all pre-Devonian volcanics in the region in the fact that plagioclase of intermediate and calcic composition is preserved in some specimens. The K-feldspar, however, is microcline, not sanidine; pyroxene is not preserved; and one specimen of basalt (#2) has been altered to a "spilite", composed of albite, tremolite, actinolite, chlorite, epidote, etc.

Regression of four zircon fractions (Trettin and Parrish, 1987) yielded a highly discordant regression with intercept ages of 1150 +41/-39 Ma and 88 +20/-21 Ma. The upper intercept probably indicates the source of the magma (Succession I of Pearya), and the lower intercept the age of crystallization, Turonian - Coniacian according to the time scale of Harland et al. (1982). The Hansen Point volcanics probably are correlative with unnamed lower Cretaceous volcanics south of Phillips Inlet and north of Emma Fiord assigned to the early Late Cretaceous on the basis of microfossils (Osadetz et al., in prep.).

WOOTTON INTRUSION (map-units Kb, Kg)

The name, Wootton intrusion, is applied to scattered outcrops of intrusive rocks -- mainly gabbro with lesser amounts of felsic and hybrid rocks -- that extend from the coast of Phillips Inlet north-eastwards into the ice fields of Wootton Peninsula. The outcrop belt is about 28 km long and up to 4.4 km wide. The outcrops in the icefields are so close to each other and so similar in lithology that they almost certainly represent a single body. It is uncertain, however, whether a gabbroic dyke exposed on the coast of Phillips Inlet, is contiguous with this body or merely aligned with it. The intrusion separates the Mitchell Point Belt from the Cape Alfred Ernest Belt and evidently has been injected into the Mitchell Point Fault.

The lithology of this body is known only from brief helicopter landings at five localities; the icefields of Wootton Peninsula are difficult to explore because they are often covered by fog.

Fifteen rock samples, studied in thin section in conjunction with whole-rock X-ray diffraction and some chemical analyses, represent ten different rock types that can be assigned to three major lithological associations, gabbroic, felsic and intermediate (hybrid) in gross composition. Mafic rocks are far more abundant than felsic ones, but the latter predominate in the north-central part of the outcrop area (loc. 82TM212c) where they form a cliff about 2 km wide at the base and up to 600 m high. Mafic rocks prevail at two other sample sites (82TM212b, 212e) but are cut by felsic dykelets that commonly contain dark-coloured xenoliths. Associated rocks of intermediate composition appear to have resulted from assimilation of basic rocks by the felsic magmas. A list of the rock types encountered follows; more detailed studies are in progress.

Felsic association

Granite, leucocratic, fine grained

Granodiorite, medium grained

Quartz monzonite, fine and medium grained (clinopyroxene present in two specimens)

Intermediate association

Quartz monzodiorite transitional to granodiorite, fine grained, laminated (contains clinopyroxene)

Monzodiorite, melanocratic, fine grained, porphyritic (phenocrysts of plagioclase)

Clinopyroxene-hornblende-quartz gabbro, leucocratic, fine and medium grained

Gabbroic association

Clinopyroxene-hornblende gabbro, normal and melanocratic, fine and medium grained

Hornblende-clinopyroxene gabbro, medium grained

Clinopyroxene gabbro, fine grained

Olivine gabbro, melanocratic, medium to coarse grained (forsterite and small amounts of orthopyroxene and phlogopitic biotite are present but clinopyroxene predominates)

Zircons from the Wootton Intrusion yielded a slightly discordant U-Pb age of 92.0 $\pm$ 1.0 Ma, late Cenomanian according to the time scale of Harland et al. (1982). Volume relationships suggest that the felsic material in this body has also been derived, to some extent, from crustal rocks.

UNMETAMORPHOSED DYKES

Unmetamorphosed mafic dykes occur in many units but have been examined in a few areas only. Two types are presently distinguished. The first, which is ubiquitous, consists of clinopyroxene and plagioclase, locally accompanied by olivine. Regional relationships suggest that most and perhaps all of these rocks are Cretaceous in age.

The second type, particularly common on the eastern shore of Milne Fiord, is a brown-weathering lamprophyre, specifically olivine-clinopyroxene camptonite. These dykes are 10 cm to 2 m thick, markedly porphyritic, in places ocellar, and generally fresh. Phenocrysts (1 - 2 mm) of olivine, commonly altered, and pinkish clinopyroxene, rimmed by brown hornblende, are set in a fine-grained matrix of brown amphibole, pinkish clinopyroxene, plagioclase, and subordinate olivine. The amphibole, probably kaersutite, typically has green rims and replaces much of the groundmass clinopyroxene. Some dykes contain ocelli, up to 2 mm across, consisting of feldspar needles and brown biotite flakes. The freshness and alkaline composition of the lamprophyres suggests that they also are Cretaceous (or possibly early Tertiary) in age.

EUREKA SOUND GROUP (map-unit T_E)

Tertiary clastic sediments are divisible into two units (Wilson, 1976). The **lower unit** has a minimum thickness of 500 m; its base is not exposed. In the lower part of the unit, thin siltstone beds (8 - 12 cm) predominate over very thin sandstone beds (2 - 4 cm); in the upper part the sandstone beds are thicker (10 - 22 cm) and more abundant than the very thin siltstone beds (2 - 4 cm). The siltstone is dark grey, micaceous, and somewhat clayey and contains macerated plant fragments. Siltstone units commonly contain laminae of sandstone that form flaser structures. The sandstones are light grey, friable, and composed of moderately sorted, well rounded grains that range in grade up to medium grained in the upper part of the section. Rare climbing ripple marks of low amplitude were the only sedimentary structures observed in the sandstones. Fragments of silicified wood, up to 10 cm long, occur in the upper part of the unit.

The unit was interpreted to have been deposited in a nearshore marine envirnment during a regression. Several florules identified by W.S. Hopkins, Jr. were of unspecified Maastrichtian to Eocene age, but one was of early Tertiary age.

The **upper unit** is about 200 m thick and consists of rhythmic deposits composed of a basal conglomerate, up to 1.5 m thick (locally absent), and an overlying sandstone unit, 3 - 4 m thick, that becomes finer grained upward. In the southern part of the outcrop area (loc. 75W1), the basal conglomerates are channel deposits with erosional bases and estimated widths of 40 - 60 m. Their phenoclasts range in diameter from 10 to 80 cm with a mode of about 20 cm and are composed of schist, gneiss, chert, and quartzite and minor amounts of marble, gabbro, and sandstone. In the northern part (loc. 75W2) the phenoclasts range from 0.2 to 7 cm, the mode being 2 cm. The grain size of the matrix ranges from medium to very coarse grained and the mode is coarse grained; that of the sandstone beds above the conglomerates from very coarse to medium grained. Both sandy matrix and sandstone beds are composed of quartz and a variety of rock fragments.

The upper unit was interpreted as a braided river deposit and limited data, such as channel orientation at loc. 75W1 and decrease in grain size from loc. 75W1 to loc. 75W2, suggested northeastward current flow.

The entire succession was assigned to the Eureka Sound Group by Christie (1957), the term group being used in the older sense of an undivided reconnaissance unit. Wilson (1976), on the basis of lithological correlation with eastern Axel Heiberg Island (Balkwill and Bustin, 1975; Balkwill et al., 1975), assigned the lower unit to the redefined Eureka Sound Formation and the upper unit to the Beaufort Formation. Recent studies by Miall (1986) and Ricketts (1986) in other areas suggest that both units are part of the Eureka Sound, which has been raised to group level by both authors but divided into different sets of formations. The upper unit is lithologically comparable to the Boulder Hills Formation northeast of Lake Hazen of uncertain Eocene - early Oligocene age (Miall, 1986) and to the Mokka Fiord Formation of eastern Axel Heiberg Island (Ricketts, 1986; Ricketts and McIntyre, 1986) of established middle Eocene and possible late Eocene age.

MAJOR FAULTS

The most important faults in the Yelverton Inlet map-area are the extensive Petersen Bay and Mitchell Point faults, which had a long and complex history; the Yelverton Thrust; and the faults bounding the Deuchars Glacier Belt.

The Petersen Bay Fault bounds the Mitchell Point Belt proper on the southeast side. About 135 km long, it extends from southwest of Ayles Fiord to Phillips Inlet and has a sinuous southwesterly trend. The attitude of the fault is difficult to determine because of insufficient exposure but adjacent marble and schist of the Petersen Bay assemblage dip steeply northwest on the east side of Yelverton Inlet. At Yelverton Inlet and Kulutingwak Fiord, the gneiss adjacent to the fault is brecciated and shows retrograde metamorphism over a width of 1 - 2 km. The strata southeast of the fault (Petersen Bay assemblage and Imina Formation) have been subjected to amphibolite-grade metamorphism, which decreases to lower greenschist grade southeastward. This metamorphism is almost certainly pre-Late Carboniferous in age as the strata of the Sverdrup Basin do not show regional metamorphism of greenschist or higher grade; the association of the metamorphism with the fault implies that the latter also dates back to Devonian or earlier time. The youngest formation affected by the metamorphism is the Lower Silurian Imina Formation, but the deformation that caused it probably is no older than Ludlow because the Imina Formation is part of a conformable succession that extends into the Ludlow.

The Late Silurian to Early Carboniferous history of the fault apparently was complex and at least three different phases are inferred during this interval:

(1) Regional considerations suggest that the fault may have originated in the Late Silurian as a major sinistral strike slip (or transpressive) fault, along which the Mitchell Point Belt was transported to the southwest (Trettin, 1987b).

(2) Slightly later (?) southwestward motion of southeastern Pearya on the Yelverton Thrust (see below) would have resulted in (relative) dextral motion along the northeastern portion of the fault.

(3) Late Devonian - Early Carboniferous (Ellesmerian) NW-SE compression may have resulted in high-angle reverse faulting. Carboniferous or younger strata are not preserved in the vicinity of the fault and the later motions therefore are unknown. It is possible, for example, that strike slip occurred during the initiation of the Sverdrup Basin in the Carboniferous (U. Mayr, pers. com., 1986). Analogy with the Mitchell Point Fault (see below) suggests early Late Cretaceous normal faulting, and early Tertiary thrust faulting -- in all five or six different phases of motion. The somewhat irregular, sinuous trend suggests episodes of crossfaulting, the effects of which have been smoothed by subsequent compressional events.

The Mitchell Point Fault bounds the Mitchell Point Belt on the northwest side. It is exposed only in two small areas, south of Hansen Point and west of Kulutingwak Fiord respectively, where the Mitchell Point Belt is bordered by the Hansen Point volcanics, but probably extends from Petersen Bay (or farther northeast) to the north coast of Phillips Inlet. However, the southwestern part of the fault has been invaded by the Wootton Intrusion.

The earlier history of the Mitchell Point Fault is poorly known.

Analogy with the Petersen Bay Fault suggests that Late Silurian sinistral strike slip was followed by Late Devonian - Early Carboniferous Ellesmerian thrust faulting. Well documented are early Late Cretaceous extension that permitted the ascent of the Wootton Intrusion; and Late Cretaceous or Paleogene (Eurekan) northwestward-directed thrust faulting that placed the Mitchell Point Belt upon the Hansen Point volcanics.

The Yelverton Thrust, known only from brief reconnaissance work, places Hadrynian-Cambrian strata of the Empire Belt on the Lower Silurian Imina Formation of the Empire Belt. The fault indicates southwestward motion of the southeastern part of Pearya and has been attributed to the Late Silurian - Early Devonian phase of strike slip that resulted in the accretion of Pearya (Trettin, 1987).

The faults bounding the Deuchars Glacier Belt are mostly subparallel with the Yelverton Thrust and probably also date back to Late Silurian - Early Devonian transpression. The southwestern boundary fault, where exposed, is a very steeply dipping reverse fault that has been named the Deuchars Thrust. The northern boundary fault, which is entirely concealed, and the very steep eastern boundary fault either are high-angle reverse faults or normal faults.

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APPENDIX 1

TERMS USED TO DESCRIBE THE SIZE RANGES OF CARBONATE CRYSTALS

The grades distinguished correspond to the Wentworth scale, and the names used have been adapted from Leighton and Pendexter (1962) and Drummond (1963). In this nomenclature, carbonate grains of sand size are described in terms of sand grades (i.e. very fine, fine, etc.), those of silt size are termed microcrystalline, and those of clay size, cryptocrystalline. Although the cryptocrystalline grains are visible in thin section under the highest power objective, the term seems justified as optical tests cannot be made on these crystals.

2-1 mm......................very coarsely crystalline

1-0.5 mm....................coarsely crystalline

0.5-0.25 mm.................medium crystalline

0.25-0.12 mm................finely crystalline

0.12-0.06 mm................very finely crystalline

0.06-0.004 mm...............microcrystalline

0.06-0.03 mm................coarsely microcrystalline

0.03-0.004 mm...............finely microcrystalline

0.004 mm or less............cryptocrystalline

APPENDIX 2

CHEMICAL ANALYSES

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Generally, major elements have been analyzed by wave-length dispersive X-ray fluorescence on fused discs (method 1), in combination with rapid techniques (method 4) for FeO, H_2O and CO_2, and with optical emission spectography (method 3) for low values of MnO, MgO, and CaO.

Of special importance for the classification and interpretation of volcanic rocks are the stable trace elements Nb, Y, and Zr, which have been determined by energy-dispersive X-ray fluorescence (method 2), and Ti, which has been analyzed by a variety of methods (1, 3, and 5= colorimetric spectography). In those cases where duplicate analyses have been made by method 2 for Nb, Y, and Zr, the arithmetic mean is recorded, regardless of confidence limits. Where two or more methods have been used to determine TiO_2 a value has been selected (by G.R. Lachance) that appeared most approriate in view of the observed scatter and the reliability of given methods for certain concentrations.

Other trace elements have been determined by methods 1, 2, or 3. The lower detection limit is shown by the symbol , which does not necessarily imply that the trace elements actually are present.

Table 1. Analytical methods and estimated maximum error.

Method 1: wave-length dispersive X-ray fluorescence.

Method 2: energy dispersive X-ray fluorescence using Compton scatter.

Method 3: spectometric analysis, using direct reading of emission spectra.

Method 4: rapid chemical techniques.

Method 5: colorimetric spectroscopy.

	Methods 1, 4		Method 3	
	Relative % *	Absolute % (=detection limit)	Relative %	Detection limit %
SiO_2	1	0.40		
Al_2O_3	1	0.40		
TiO_2	1	0.02		0.015
Fe_2O_3	1	0.10		
FeO	2	0.20		
MnO	2	0.01		0.0065
MgO	1	0.01		0.080
CaO	1	0.10		0.0030
Na_2O	1	0.50		
K_2O	1	0.05		
P_2O_5	1	0.02		
CO_2	3	0.05		
H_2O	5	0.10		

* of concentration

	Method 1		Method 3		Method 2	
	Relative % *	Absolute ppm (=detection limit)	Relative % *	Detection limit ppm	Relative % *	Absolute ppm (= detection limit)
As			15	2000	10	30
B			15	50		
Ba	2	20	15	5		
Br					10	10
Co			15	10		
Cr			15	5		
Cu			15	7		
La			15	100	10	10
Mo			15	50		
Nb					10	10
Ni	10	20	15	10		
Pb			15	700	10	30
Rb	2	20			10	10
Sr	10	20	15	10	10	10
Th					10	10
U					10	30
V			15	20		
Y			15	40	10	10
Yb			15	4		
Zn	10	20	15	200		
Zr	10	20	15	20	10	10

Appendix 2

Table 2: Devchars Glacier Belt, granitic rocks   GDℓ = granodiorite, leucocratic; GD = granodiorite; GR = granite; TN = tonalite

Field #	80TH 213 E1		77TH 331 F1		77TH 331 G1		77TH 322 E4		77TH 331 E2		77TH 322 E1		77TH 322 G1	
An. #	10-84-2		10-84-7		10-84-8		10-84-4		10-84-6		10-84-3		10-84-5	
#	1	Meth.	2	Meth.	3	Meth.	4	Meth.	5	Meth.	6	Meth.	7	Meth.
SiO_2 %	70.8	1	72.3	1	72.3	1	72.8	1	76.1	1	76.2	1	76.9	1
Al_2O_3	16.5	1	14.0	1	14.0	1	15.2	1	13.9	1	12.7	1	12.8	1
TiO_2	0.17	1	0.33	1	0.49	1	0.38	1	0.13	1	0.38	1	0.13	1
Fe_2O_3	0.3	1	0.6	1	0.9	1	0.3	1	0.3	1	0.2	1	0.4	1
FeO	0.7	4	1.9	4	2.3	4	1.7	4	0.8	4	1.7	4	0.6	4
MnO	0.00	1	0.05	1	0.05	1	0.01	1	0.04	1	0.02	1	0.01	1
MgO	0.36	1	1.10	1	0.87	1	0.87	1	0.24	1	0.46	1	0.20	1
CaO	0.44	1	0.81	1	0.66	1	0.76	1	0.61	1	0.60	1	0.23	1
Na_2O	3.2	1	2.5	1	4.4	1	6.2	1	2.7	1	2.5	1	2.1	1
K_2O	6.75	1	4.70	1	2.17	1	0.85	1	4.99	1	4.31	1	4.57	1
P_2O_5	0.22	1	0.10	1	0.15	1	0.20	1	0.08	1	0.18	1	0.12	1
CO_2	0.0	4	0.0	4	0.0	4	0.0	4	0.0	4	0.1	4	0.01	4
H_2O	0.7	4	1.1	4	1.3	4	0.7	4	0.7	4	0.9	4	1.1	4
Total	99.4		99.5		99.6		100.0		100.6		100.3		99.2	
As ppm	5	2	6	2	4	2	3	2	13		3	2	6	2
B														
Ba	690	1	450	1	590	1	90	1	170	1	440	1	2310	
Br	4	2	4	2	4	2	5	2	3		2	2	3	2
Co														
Cr														
Cu														
La														
Mo	0	2	0	2	0	2	0	2	0		0	2	0	2
Nb	6	2	8	2	12	2	10	2	4		8	2	18	2
Ni														
Pb	6	2	2	2	3	2	0	2	31		1	2	10	2
Rb	290	2	150	2	78	2	43	2	200		150	2	220	2
Sr	130	2	73	2	91	2	150	2	53		110	2	26	2
Th	11	2	16	2	19	2	17	2	11		15	2	12	2
U	8	2	10	2	7	2	7	2	9		3	2	4	2
V														
Y	25	2	37	2	37	2	46	2	30		40	2	35	2
Yb														
Zn														
Zr	70	2	120	2	240	2	170	2	72		160	2	72	2
Rock type	GD		GR		GD		TN		GR		GR		GDℓ	
K_2O/Na_2O	1.39		1.24		0.32		0.09		1.22		1.13		1.43	
$Al_2O_3/(K_2O+Na_2O+CaO)$	1.23		1.31		1.30		1.22		1.27		1.29		1.45	

Appendix 2
Table 3
Unit: Milne Fiord assemblage,
division 2

Field #	82TM211C	
An. #	110-83-82, 86-83-52	
#		Meth.
SiO_2 %	74.6	1
Al_2O_3	12.3	1
TiO_2	0.18	5, 1
Fe_2O_3	1.1	1
FeO	<0.03	4
MnO	0.03	1
MgO	0.31	1
CaO	1.54	1
Na_2O	3.2	1
K_2O	4.48	1
P_2O_5	0.04	1
CO_2	2.0	4
H_2O	0.8	4
Total	100.6	

As ppm	5	2
B	21	3
Ba	290	3
Br	1.5	2
Co	<7	3
Cr	290	3
Cu	8	3
La	53	3
Mo	1	2
Nb	25	2
Ni	<10	3
Pb	8.5	2
Rb	119	2
Sr	82	2
Th	42.5	2
U	7.5	2
V	<10	3
Y	39	2
Yb	3.8	3
Zn	<20	1
Zr	155.5	2

Field #	Anal. #	#	TiO_2 % Meth. 1	Meth. 3	Meth. 5	chosen value	Nb ppm a	b	$\bar{x}$	Y ppm a	b	$\bar{x}$	Zr ppm a	b	$\bar{x}$
82TM211C	86-83-52	1	0.15		0.20	0.18	26	24	25	41	37	39	160	151	155.5

Appendix 2

Table 4

Unit: volcanics on northeastern Wootton Peninsula (map-unit v)

Field #	75 TM 226-1		75 TM 213-2		75TM 214-2		75TM 212-2		75 TM 226-3		75 TM 212-4		75TM 214-1	
An. #	57-79-11		86-83-34		10-79-16		57-79-8, 86-83-32		10-79-7, 86-83-36		57-79-9, 86-83-33		10-79-15, 86-83-35	
#	1	Meth.	2	Meth.	3	Meth.	4	Meth.	5	Meth.	6	Meth.	7	Meth.
SiO_2 %	65.8	1	70.0±	1	71.4	1	72.0	1	73.5	1	74.2	1	74.4	1
Al_2O_3	14.7	1		ND	13.9	1	13.9	1	12.0	1	11.6	1	12.6	1
TiO_2	0.82	3	0.32	5,3,1	0.34	3	0.35	5,1	0.33	5,3,1	0.71	5,1	0.37	5,3,1
Fe_2O_3	4.4	1		ND	2.8	1	3.1	1	2.4	1	5.2	1	3.1	1
FeO	1.9	4		"	0.3	4	0.2	4	0.2	4	0.9	4	0.1	4
MnO	0.07	3		"	0.07	3	0.07	3	0.06	3	0.14	3	0.04	3
MgO	0.78	1		"	0.30	3	0.15	3	0.21	3	0.27	1	0.27	3
CaO	2.02	1		"	0.52	3	0.31	3	1.03	3	0.28	3	0.33	1
Na_2O	5.1	1		"	3.7	1	3.0	1	4.5	1	0.51	3	1.9	1
K_2O	3.89	1		"	4.43	1	5.97	1	3.65	1	2.89	1	4.91	1
P_2O_5	0.15	1		"	0.04	1	0.03	1	0.03	1	0.17	1	0.02	1
CO_2	0.2	4		"	0.2	4	0.1	4	0.8	4	0.2	4	0.1	4
H_2O	0.6	4		"	1.0	4	1.1	4	0.6	4	3.6	4	1.4	4
Total	100.4				99.0		100.3		99.3		100.7		99.5	
As ppm	<2000	3	33.5	2	<2000	3	4.5	2	10	2	14	2	24	2
B	<50	3		ND	<50	3	< 0	3	<50	3		ND	<50	3
Ba	1000	3		ND	1120	3	480	3	660	3	380	3	680	3
Br		ND	0.5	2		ND	7.5	2	2.5	2	1.5	2	2	2
Co	<10	3		ND	15	3	<10	3	19	3	<10	3	<10	3
Cr	7	3		ND	11	3	5	3	10	3	<20	3	<5	3
Cu	21	3		ND	18	3	15	3	17	3	9	3	11	3
La	89	3		ND	<100	3	76	3	120	3	55	3	<100	3
Mo	<50	3	0	2	<50	3	0	2	0	2	0.5	2	0	2
Nb		ND	81.5	2		ND	78.5	2	77.5	2	31	2	54	2
Ni	<10	3		ND	<10	3	10	3	<10	3	<10	3	<10	3
Pb	<700	3	32.5	2	<700	3	24.5	2	18	2	7.5	2	14	2
Rb	<20	1	213	2	110	1	246	2	135.5	2	135.5	2	197.5	2
Sr	96	3	86.5	2	63	3	32.5	2	42.5	2	20.5	2	61	2
Th		ND	31	2		ND	38.5	2	28.5	2	15.5	2	24	2
U		ND	6.5	2		ND	9	2	11	2	6.5	2	7	2
V	19	3		ND	30	3	100	3	28	3	220	3	<20	3
Y	77	3	91.5	2	<40	3	73.5	2	99.5	2	63	2	60.5	2
Yb	6.4	3		ND	8.7	3	4.6	3	13	3	3.8	3	5.3	3
Zn	<200	3		ND	40	1	<200	3	50	1	<200	3	30	1
Zr	510	3	614.5	2	410	3	490	2	593	2	373.5	2	470	2

Appendix 2
Table 4
Unit: volcanics on northeastern Wootton Peninsula

			TiO_2 %				Nb ppm			Y ppm			Zr ppm		
Field #	Anal. #	#	Meth. 1	Meth. 3	Meth. 5	chosen value	a	b	$\bar{x}$	a	b	$\bar{x}$	a	b	$\bar{x}$
75TM213-2	86-83-34	2	0.30	0.30	0.34	0.32	80	83	81.5	90	93	91.5	615	614	614.5
75TM212-2	86-83-32	4	0.33	0.28	0.38	0.35	81	76	78.5	73	74	73.5	499	480	489.5
75TM226-3	86-83-36*	5	0.3	0.3	0.36	0.33	78	77	77.5	101	98	99.5	587	599	593
75TM212-4	86-83-33	6	0.68	0.57	0.74	0.71	32	30	31	63	63	63	373	374	373.5
75TM214-1	86-83-35	7	0.37	0.36	0.38	0.37	54	54	54	58	63	60.5	466	474	470

Appendix 2
Table 5

Unit: Kulutingwak Fiord assemblage, type area

Field #	75TM181-2		75TM181-1	
An. #	57-79-7, 86-83-31		57-79-6, 86-83-30	
#	1	Meth.	2	Meth.
SiO_2 %	52.4	1	57.4	1
Al_2O_3	14.7	1	16.5	1
TiO_2	0.74	5, 1	0.55	5, 1
Fe_2O_3	2.5	1	3.4	1
FeO	4.5	4	2.0	4
MnO	0.17	3, 1	0.10	3
MgO	3.76	1	1.87	1
CaO	8.60	1	4.68	1
Na_2O	4.4	1	5.5	1
K_2O	2.81	1	4.47	1
P_2O_5	0.28	1	0.25	1
CO_2	3.5	4	1.3	4
H_2O	1.9	4	1.5	4
Total	100.3		99.5	

As ppm	9	2	8.5	2
B		ND	30*	3
Ba	1500	3	2600	3
Br	1.5	2	2	2
Co	18	3	11	3
Cr	26	3	49	3
Cu	30	3	31	3
La	66	3	55	3
Mo	0	2	0	2
Nb	9	2	13.5	2
Ni	12	3	25	3
Pb	20.5	2	19	2
Rb	67	2	102.5	2
Sr	358	2	445	2
Th	19	2	39	2
U	1.5	2	8	2
V	140	3	100	3
Y	23	2	16.5	2
Yb	2.4	3	1.5	3
Zn	100	1	<200	3
Zr	137	2	184.5	2

Unit: Kulutingwak Fiord assemblage (?), Phillips Inlet

Field #	66TM315E1		66TM315E6	
An. #	96-83-1		96-83-2	
#	1	Meth.	2	Meth.
SiO_2 %	53.4	1	53.4	1
Al_2O_3	12.9	1	16.1	1
TiO_2	1.09	1	0.99	
Fe_2O_3	3.7	1	4.7	1
FeO	3.1	4	2.6	4
MnO	0.27	1	0.15	
MgO	2.07	1	2.21	
CaO	8.15	1	4.62	
Na_2O	4.5	1	5.1	1
K_2O	1.43	1	3.87	1
P_2O_5	0.23	1	0.23	1
CO_2	6.3	4	3.5	4
H_2O T	1.8	4	1.5	4
Total				

As ppm	12	2	6	2
B				
Ba				
Br	5	2	5	2
Co				
Cr				
Cu				
La				
Mo	0	2	0	2
Nb	110	2	150	2
Ni				
Pb	0	2	12	2
Rb	42	2	86	2
Sr	270	2	280	2
Th	24	2	31	2
U	9	2	16	2
V				
Y	44	2	66	2
Yb				
Zn				
Zr	400	2	630	2

Appendix 2
Table 5

Unit: Kulutingwak Fiord assemblage, type area

Field #	Anal. #	#	TiO_2 %				Nb ppm			Y ppm			Zr ppm		
			Meth. 1	Meth. 3	Meth. 5	chosen value	a	b	$\bar{x}$	a	b	$\bar{x}$	a	b	$\bar{x}$
75 TM 181-2	86-83-31	1	0.70	0.58	0.78	0.74	8	10	9	21	25	23	134	140	137
75 TM 181-1	86-83-30	2	0.52	0.38	0.59	0.55	12	15	13.5	17	16	16.5	187	182	184.5

Appendix 2
Table 6
Unit: Hansen Point volcanics

Field #	75 FS 500-6		75 FS 500-9		82 TM 212 A1		75 FS 500-2		75 FS 500-1		82 TM 212 A2		75 FS 500-3	
An. #	86-83-56		10-79-6, 86-83-40		110-82-3, 86-83-41		10-79-7, 86-83-38		10-79-4, 86-83-37		110-82-4, 86-83-42		10-79-5, 86-83-39	
#	1	Meth.	2	Meth.	3	Meth.	4	Meth.	5	Meth.	6	Meth.	7	Meth.
SiO_2 %	40.3	1	48.4	1	64.1	1	69.4	1	72.3	1	72.8	1	79.2	1
Al_2O_3	15.0	1	14.9	1	11.3	1	13.9	1	13.7	1	12.3	1	10.4	1
TiO_2	3.1	5, 1	2.24	5, 1	0.42	5, 1	0.39	5, 3, 1	0.44	5, 3, 1	0.57	5, 1	0.14	6, 3, 1
Fe_2O_3	5.7	1	2.9	1	0.0	1	3.9	1	3.2	1	2.7	1	0.0	1
FeO	7.7	4	8.6	4	2.9	4	1.1	4	0.2	4	1.2	4	2.0	4
MnO	0.22	1	0.20	3	0.26	1	0.06	3	0.02	3	0.04	1	0.03	3
MgO	1.7	1	6.52	1	0.55	1	0.14	3	0.11	3	0.19	1	0.12	3
CaO	12.8	1	10.90	1	7.49	1	0.42	3	0.77	3	1.16	1	0.43	3
Na_2O	1.9	1	2.4	1	1.1	1	3.8	1	3.4	1	2.2	1	2.0	1
K_2O	0.34	1	0.41	1	4.47	1	4.83	1	4.96	1	4.77	1	3.61	1
P_2O_5	0.40	1	0.27	1	0.12	1	0.02	1	0.04	1	0.14	1	0.0	1
CO_2	7.4	4	0.3	4	5.4	4	0.4	4	0.0	4	0.5	4	0.1	4
H_2O	3.7	4	3.1	4	1.9	4	1.2	4	0.9	4	1.3	4	1.0	4
Total	100.3				100.0		99.6		100.0		99.9		99.0	
As ppm	11	2	16.5	2	5.5	2	21	2	9	2	11.5	2	6.5	2
B		ND	<50	3	29	3	<50	3	<50	3	15	3	<50	3
Ba	200	1	92	3	690	3	1100	3	920	3	750	3	51	3
Br	0	2	3.5	2	2.5	2	4	2	2	2	0	2	6	2
Co		ND	56	3	<7	3	14	3	19	3	<7	3	11	3
Cr		ND	166	3	67	3	9	3	12	3	85	3	<5	3
Cu		ND	69	3	9	3	19	3	17	3	10	3	12	3
La		ND	<100	3	80	3	<100	3	<100	3	45	3	<100	3
Mo	0	2	0	2	0.5	2	0	2	0	2	0	2	0	2
Nb	22	2	7.5	2	24	2	86	2	56.5	2	29	2	122	2
Ni		ND	70	3	<10	3	<10	3	<10	3	<30	3	<10	3
Pb	21.5	2	22.5	2	22	2	24	2	23.5	2	25	2	41.5	2
Rb	6	2	14	2	148.5	2	185	2	175.5	2	180	2	231	2
Sr	231	2	275	2	72.5	2	89	2	78	2	78.5	2	10	2
Th	4.5	2	8	2	22	2	25.5	2	24	2	19	2	39	2
U	0	2	0	2	11	2	12	2	7	2	5.5	2	11.5	2
V		ND	300	3	21	3	23	3	40	3	21	3	<20	3
Y	45.5	2	31.5	2	76	2	102.5	2	76	2	90	2	147	2
Yb		ND	<4	3	5.6	3	12	3	10	3	<2	3	13	3
Zn		ND	60	1	70	1	130	1	50	1	<20	1	90	1
Zr	185.5	2	129.5	2	355.5	2	785.5	2	579	2	447.5	2	396.5	2

Appendix 2

Table 6

Unit: Hansen Point volcanics

Field #	Anal. #	#	TiO_2 % Meth. 1	Meth. 3	Meth. 5	chosen value	Nb ppm a	b	$\bar{x}$	Y ppm a	b	$\bar{x}$	Zr ppm a	b	$\bar{x}$
75 FS 500-6	86-83-56	1	3.09		3.30	3.1	19	25	22	42	49	45.5	176	195	185.5
75 FS 500-9	86-83-40	2	2.23	1.93	2.25	2.24	6	9	7.5	30	33	31.5	125	134	129.5
82 TM 212 A1	86-83-41	3	0.40		0.44	0.42	26	22	24	79	73	76	366	345	355.5
75 FS 500-2	86-83-38	4	0.37	0.36	0.42	0.39	85	87	86	97	108	102.5	793	778	785.5
75 FS 500-1	86-83-37	5	0.42	0.42	0.46	0.44	58	55	56.5	72	80	76	582	576	579
82 TM 212 A2	86-83-42	6	0.58		0.57	0.57	27	31	29	91	89	90	446	449	447.5
75 FS 500-3	86-83-39	7	0.11	0.13	0.17	0.14	122	122	122	145	149	147	394	399	396.5

APPENDIX 3

X-RAY DIFFRACTION AND THIN-SECTION ANALYSES

H.P. Trettin

The values listed for individual minerals represent the relative height of the principal peak as percentage of the sum of all minerals identified. This value is roughly proportional to the abundance of the mineral but is also affected by other factors. All mineral identifications in the diffractograms have been checked, and in some instances modified, by thin section study. For example, in standard X-ray diffractograms, illite cannot be distinguished from mica, and chlorite cannot be distinguished from kaolinite, but the thin sections show that the peaks must have been caused by mica and chlorite.

Peak height ratios of selected mineral pairs are useful because they permit comparisons between rock units or rock types. The following ratios therefore are listed in all those cases where the minerals concerned are present in sufficient quantity (e.g. P/ P+K only where F/ F+ Q 5 %):

F/ F+Q = (total feldspar/ quartz + total feldspar) x 100

P/ P+K = (plagioclase/ plagioclase + K-feldspar) x 100

D/ D+C = (dolomite/ dolomite + calcite) x 100

(The ratios have been calculted from the peak heights and not from the rounded off percentages.)

The following correction factors were obtained for medium to coarse grained, slightly metamorphosed (lower greenschist facies or less) sandstones of the Lower Cambrian Grant Land Formation by comparison with point count analyses of stained thin sections:

Ratio	Conversion factor (to be applied to XRD data)	Range in analyzed samples
F/ F+Q	x 1.9	2 - 31 %
P/ P+Q	x 0.95	55 - 100 %

These conversion factors may be applicable to suites with similar grain size, concentration, and alteration states, but are not valid universally. Royse et al. (1971) demonstrated that the weight percentage of dolomite can be obtained by adding 2.3 % to D/ D+C, but Lumsden (1979) inferred a more complex relationship.

Table 1A. Mitchell Point Belt, uncorrected XRD analyses of granitoid gneiss.

	N	Range	$\bar{X}$
Quartz	6	57-69	62.2
K-feldspar	"	3-19	9.3
Plagioclase	"	13-28	20.3
Mica	"	0-8	2.8
Chlorite	"	1-12	5.7
F/F+Q	"	26-35	32.3
P/P+K	"	43-89	69.2

Table 1B. Deuchars Glacier Belt, point count analyses of granitoid gneiss (433-1029 points per section). Plagioclase/ K-feldspar ratio from corrected XRD determinations.

	Granite			Granodiorite		
	N	Range	$\bar{X}$	N	Range	$\bar{X}$
Quartz	5	37-50	44	3	17-40	29
Microcline	"	11-28	21	"	12-14	13
Albite	"	11-30	24	"	38-60	46
Biotite	"	1-11	4	"	5-18	10
Muscovite	"	1-20	7	"	0-2	1
Chlorite	"	0-1	1	"	0-2	1

Table 1C. Deuchars Glacier Belt, uncorrected XRD analyses of schist.

	N	Range	$\bar{X}$
Quartz	4	59-69	64.3
K-feldspar	"	0-13	4.0
Plagioclase	"	8-17	13.3
Mica	"	4-32	18.8
F/F+Q	"	12-29	20.5
P/P+K	"	54-100	85.3

TABLE 2 A

	a) XRD analyses (in %)				b) XRD analyses (in %)				c) XRD analyses (in %)			
	map-unit PW×9				map-unit PW×9				map-unit PW×9			
	Empire Belt NE of Yelverton Inlet				Empire Belt, NE of Yelverton Inlet				Empire Belt NE of Yelverton Inlet			
	Phyllite				phyllite, sandy (wacke)				diamictite			
	N	Range	x̄	σ	N	Range	x̄	σ	N	Range	x̄	σ
Quartz	4	57-62	61.5		4	51-80	70.3		3	49-80	69.3	
K-Feldspar	"	0-1	0.3		"	0-5	1.8		"	1-5	2.3	
Plagioclase	"	4-15	9.5		"	0-8	2.3		"	1-8	3.0	
Mica	"	8-12	10.0		"	2-13	6.8		"	2-13	7.7	
Chlorite	"	7-24	18.0		"	1-10	4.0		"	1-10	4.7	
Calcite	"	0-1	0.3		"	4-28	15.3		"	4-28	13.0	
Dolomite	"	0-1	0.3									
F/F+Q	"	6-21	13.5		"	0-15	15.0		"	3-15	6.0	
P/P+K	3	89-100	96.3		2	2-92	46.0		2	0-92	30.7	
D/D+C					4	0-0	0		"	0-0	0	

* includes 1 spec. from. M'Clintock Inl. map-area

	d) XRD analyses (in %)				e) XRD analyses (in %)				F) XRD analyses (in %)			
	map-unit PVC				map-unit PVC				Milne Fiord ass., div. 2			
	Empire Belt SW. of Milne Fiord				Empire Belt SW of Milne Glac.				Empire Belt Section SW of Ayles Fd.			
	Phyllite *				Phyllitic tuff				Phyllite			
	N	Range	x̄	σ	N	Range	x̄		N	Range	x̄	σ
Quartz	4	54-77	66.0		1	4			8	65-79	71.0	
K-feldspar	"	1-4	2.8		"	12			"	0-1	0.4	
plagioclase	"	2-7	4.8		"	37			"	4-16	9.5	
Mica	"	3-12	7.0						"	2-20	9.4	
Chlorite	"	13-20	16.0		"	38			"	5-16	9.1	
Calcite									"	0-1	0.4	
Dolomite	"	0-13	3.3						"	0-3	0.9	
Actinolite					"	6						
Epidote					"	4						
F/F+Q	4	4-17	11.0		"	93			"	7-17	11.9	
P/P+K	3	61-66	63.0		"	76			"	76-100	93.0	
D/D+C	.											

	g) XRD analyses (in %)				) XRD analyses (in %)				) XRD analyses (in %)			
	Milne Fiord ass., div. 2											
	Empire Belt Section SW of Ayles Fd.											
	Phyllite, calc.-dol.											
	N	Range	x̄	σ	N	Range	x̄	σ	N	Range	x̄	σ
Quartz	6	62-77	60.0									
K-Feldspar	"	0-2	1.0									
Plagioclase	"	3-10	6.5									
Mica	"	2-10	6.2									
Chlorite	"	2-16	7.0									
Calcite	"	0-19	6.5									
Dolomite	"	0-25	12.7									
F/F+Q	"	7-18	11.0									
P/P+K	"	9-100	72.7									
D/D+C	"	0-100	63.5									

TABLE 2B XRD analyses (in %) with thin section data

Belt	Empire	"	"	"	"	"	"	"
Location	Section SW of lower Ayles Fiord	"	"	"	"	"	"	"
Rock type	limestone	dolostone	"	tuff, phyllitic	"	" ?	"	volc. flow or sill, schist.
Unit	Milne Fiord ass., div. 2	"	"	"	"	"	"	"
Field #	77TM 4-396m	77TM 4-391.5m	77TM 4-412.9m	77TM 4-100	77TM 4-126m	77TM 4-290m	77TM 4-393m	77TM 4-462m
#	1	2	3	4	5	6	7	8
Quartz	11	25	28	29	25	22	45	29
K-feldspar	3	3	1	3	3	5	5	3
Plagioclase	tr	1	1	13	13	14	1	38
Mica	1	1	1		13	5	2	14
- Muscovite	x	x	x			x	x	x
- Biotite					x			
Chlorite	1			43	27	20	34	1
Chloritoid								
Amphibole						6		
- Tremolite								
- Actinolite						x		
- Hornblende								
Epidote						2		
Staurolite								
Garnet								
Diopside								
Graphite								
Calcite	56	1	-	12	19	26	12	
Dolomite	28	68	69				1	14
F/F+Q	24	15	5	36	38	45	11	59
P/P+K				83	82	74	11	93
D/D+C	34	99	100					

TABLE 3A

	a) XRD analyses (in %)				b) XRD analyses (in %)				c) XRD analyses (in %)			
	map-unit 9P				map-unit PWXC				map-unit PWXC			
	Cape Alfred Ernest Belt NE Wootton Pen.				Cape Alfred Ernest Belt NE Wootton Pen.				Cape Alfred Ernest Belt NE Wootton Pen.			
	quartzite				phyllite				diamictite			
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ
Quartz	12	86-99	94.8	3.7	9	41-69	56.2	8.1	5	60-77	70.0	
K-Feldspar	"	0-2	0.1	0.3	"	0-2	0.8	0.6	"	0-1	0.6	
Plagioclase	"	0-4	1.4	1.6	"	2-12	6.1	3.1	"	1-9	5.2	
Mica	"	0-7	2.4	1.9	"	2-14	6.9	4.0	"	0-7	4.4	
Chlorite	"	0-2	0.6	0.9	"	0-12	4.0	3.7	"	0-8	4.4	
Calcite	"	0-1	0.1	0.3	"	3-31	14.0	10.8	"	0-13	3.6	
Dolomite	"	0-3	0.7	1.2	"	0-28	12.3	8.5	"	0-29	12.0	
F/F+Q	"	0-5	1.5	1.8	"	6-16	10.8	3.8	"	4-10	7.2	
P/P+K	1	88			7	74-100	90.6	9.3	3	91-100	97.0	
D/D+C					9	0-92	46.6	29.7	4	25-100	80.5	

	) XRD analyses (in %)				) XRD analyses (in %)				) XRD analyses (in %)			
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$		N	Range	$\bar{x}$	σ
Quartz												
K-feldspar												
plagioclase												
Mica												
Chlorite												
Calcite												
Dolomite												
F/F+Q												
P/P+K												
D/D+C												

	) XRD analyses (in %)				) XRD analyses (in %)				) XRD analyses (in %)			
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ
Quartz												
K-feldspar												
Plagioclase												
Mica												
Chlorite												
Calcite												
Dolomite												
F/F+Q												
P/P+K												
D/D+C												

TABLE 3B

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Belt	Cape Alfred Ernst	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
Location	NE Wootton Pen.	〃	〃	〃	〃	〃	SW Wootton Pen.	〃	〃	〃	〃	〃	〃	〃	〃	NE Wootton Pen.	〃
Rock type	calc. marble	〃	calc.-dol. marble	dolostone	dolostone, w qtz. veins	dolostone, v. cherty	schist	〃	〃	〃	〃	〃	〃	quartzite	dol. marble	pebble in diamictite (sandst.)	pebble in diamictite (mudrock)
Unit	PwxC	〃	〃	〃	〃	〃	SC	〃	〃	〃	〃	〃	〃	〃	〃	PwxC	〃
Field #	75TH 228-1	75TH 215-2	75TH 215-1	75TH 209-3	75TH 234	75TH 232	77TH 328D1	80TH 217e1	77TH 327d2	77TH 328e2	77TH 217d1	77TH 328c1	80TH 217a2	77TH 328e1	80TH 217a1	75TH 205-1	75TH 230-1
#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Quartz	2	1	2	2	27	63	24	32	54	54	57	60	69	88	3	63	55
K-feldspar			1				1	12		1		tr	1		3	1	
Plagioclase			1	1		1	8		2	2	2	2	4	5		8	2
Mica	3			2			13		10	13	7	6	23	2		3	3
– Muscovite	x			X			x			X		X	X	X		x	x
– Biotite							X				X		X				
Chlorite							19	3				4	3	5		5	
Chloritoid																	
Amphibole																	
– Tremolite								22							7		
– Actinolite																	
– Hornblende																	
Epidote																	
Staurolite																	
Garnet								3									
Diopside																	
Graphite																	
Calcite	69	61	48			2	24	16	21	4	21	18			7	14	2
Dolomite	27	38	48	96	73	34	16	11	13	26	12	9			81	7	37
F/F+Q							26	28	3	5	3	5	7	5	47	12	4
P/P+K							91	0								91	
D/D+C	28	39	50	100	100	95	41	40	39	88	36	34	90	100	92	35	94

TABLE 4A

	a) XRD analyses (in %)				b) XRD analyses (in %)				) XRD analyses (in %)			
	scqv				c							
	Kulutingwak Belt				Kulutingwak Belt							
	quartzite				marble							
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ
Quartz	3	89-99	93.4		4	2-22	10.8					
K-Feldspar					"	0-1	0.3					
Plagioclase	"	0-2	1.3		"	0-2	1.0					
Mica	"	0-3	1.7		"	0-5	2.0					
Chlorite	"	0-2	1.0									
Calcite	"	0-1	0.3		"	51-93	76.5					
Dolomite	"	0-5	2.3		"	0-31	9.8					
F/F+Q	"	0-2	1.3		"	0-14	6.8					
P/P+K												
D/D+C					"	0-38	11.8					

	) XRD analyses (in %)				) XRD analyses (in %)				) XRD analyses (in %)			
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$		N	Range	$\bar{x}$	σ
Quartz												
K-feldspar												
plagioclase												
Mica												
Chlorite												
Calcite												
Dolomite												
F/F+Q												
P/P+K												
D/D+C												

	) XRD analyses (in %)				) XRD analyses (in %)				) XRD analyses (in %)			
	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ	N	Range	$\bar{x}$	σ
Quartz												
K-feldspar												
Plagioclase												
Mica												
Chlorite												
Calcite												
Dolomite												
F/F+Q												
P/P+K												
D/D+C												

TABLE 4B

Belt	Kuluting= wak	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Location	E. of Phillips Inlet	"	S. and W. of Kulutingwak Fiord	"	E. of Kulutingwak Fiord	S. and W. of Kulutingwak Fiord	"	"	"	E. of Kulutingwak Fiord	"	S. and W. of Kulutingwak Fiord	"	"	E. of Kulutingwak Fiord	"	S. and W. of Kulutingwak Fiord	"	"
Rock type	phyllite	"	schist	"	"	"	"	"	marble	"	"	"	"	volcanic flow	altered tuff	"	diamictite	sandstone, argill.	sandstone
Unit	SPCqv	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	X	C	C
Field #	62TM 57e	62TM 57a1	75TM 159-3	75TM 160-1	75TM 100-4	75TM 159-2	75TM 154-1	75TM 154-2	75TM 155-2	75TM 100-1	75TM 108-2	75TM 155-1	75TM 159-1	75TM 155-4	75TM 100-3	75TM 106	75TM 162-2	75-53A-3	75-53A-6
#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Quartz	18	28	39	63	64	76	77	83	2	3	5	42	39	31	41	41	60	69	78
K-feldspar		1	1	1	1	1						tr	tr				tr	tr	
Plagioclase	13	2	7	.2	6	5	11	6				tr	1	47	19	22	1	1	1
Mica	19	25	14	17	8	9	2	3					7		9	8	1	4	6
- Muscovite	X	X	X	X	X	X	X	X					X		X	X	X	X	X
- Biotite																			
Chlorite	34	38	2	4	15	9	2	7						10	22	15			
Chloritoid																			
Amphibole																			
- Tremolite																			
- Actinolite																			
- Hornblende																			
Epidote																			
Staurolite																			
Garnet																			
Diopside																			
Graphite																			
Calcite	16	3	32	3	7		8	1	98	97	95	58	37	12	9	13			
Dolomite		3	7			1							16				38	26	16
F/F+Q	43	10	16	4	9	7	13	7				tr	5	60	32	35	2	2	2
P/P+K	100		91	83	88	82	100	100						100	100	100			
D/D+C	0	46	17	75	0		0		0	0	0	0	30	0	0	0	100	100	100

TABLE 5.

Belt																			
Location	NE of Phillips Inlet	"	E. of Phillips Inlet	W. of Kulutingwak Fiord	NE of Phillips Inlet	E. of Yelverton Inlet	W. of Kulutingwak Fiord	E. of Kulutingwak Fiord	"	NE of Phillips Inlet	E. of Kulutingwak Fiord	E of Yelverton Inlet	E. of Kulutingwak Fiord	NE of Phillips Inlet	E. of Yelverton Inlet	W. of Kulutingwak Fiord	"		NE of Phillips Inlet
Rock type	amphibolite	"	"	"	Schist	"	"	"	"	"	"	"	"	"	"	"	"		"
Unit	Petersen Bay ass.	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"		"
Field #	62 TM 55g3	62 TM 5541	84 TM 234a1	75 TM 186-4	62 TM 5543	77 TM 321i6	75 TM 186-2	75 TM 167-2	75 TM 172	62 TM 5542	75 TM 167-3	77 TM 321i2	75 TM 167-1	62 TM 5544	77 TM 321i1	75 TM 186-1	75 TM 186-3		62 TM 55i2
#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18
Quartz			7	34	40	44	54	55	58	59	60	64	65	68	72	84	88		52
K-feldspar			6		14	3		6	2		3	2	1						8
Plagioclase	27	14	31	25		17	12	8	2	19	5	11	4	8	6	6	1		28
Mica	2	5				21	22	1	16		9	13	7	14		9	5		
- Muscovite	x	x								x			x						1
- Biotite	x					X	x	x	x		x	x	x			x			10
Chlorite		11	3	6	38	5	2	2	1	9	1	4	1	10					1
Chloritoid																			
Amphibole	71	64	53	34		10	9	20	4	4	7	6	6		22		6		
- Tremolite																			
- Actinolite																			
- Hornblende / Tschermakite	x	x	x	x ⊕		x		x	x	x	x	x	x		x		x		
- Anthophyllite						x	x												
Epidote		3	tr							2									
Staurolite																			
Garnet														tr					
Diopside																			
Graphite																			
Calcite		3			8			6	17	8	10		14						
Dolomite								2			4		2						
Plag. comp.				An35 ⊕															An28
F/F+Q	100	100	83	42	26	31	20	20	7	25	12	17	7	11	8	7	6		75
P/P+K	100	100	84	100	100	95	100	57		100	61	87	82	100	100	100	76		73*
D/D+C		0			0			28	0	0	27		14						
	XRD (+ thin section)																	Point count ↑	

⊕ Probe determination

* from XRD, corrected (×0.95)

APPENDIX 4

MICROPROBE ANALYSES OF AMPHIBOLES

G.M. LeCheminant

The analyzed amphibole is from map-unit sm, east of Kulutingwak Fiord (85TM186-4).

Analytical results:

WT%	1	2	3	4	5	6	AV
SIO2	44.64	44.28	44.83	43.99	44.10	44.25	44.35
TIO2	.48	.38	.34	.42	.42	.41	.41
AL2O3	15.08	15.45	14.66	15.72	15.57	15.77	15.38
CR2O3	.38	.45	0.00	.61	.58	.48	.42
FEO	9.99	10.22	9.87	10.35	10.29	10.39	10.18
MNO	.08	.20	.13	.16	.21	.12	.15
MGO	14.23	13.41	13.70	13.08	13.67	13.21	13.55
CAO	10.34	10.15	10.44	10.13	10.19	10.17	10.24
NA2O	1.84	1.95	1.27	2.12	1.70	2.02	1.82
K2O	.23	.22	.16	.25	.21	.18	.21
TOTALS	97.29	96.71	95.40	96.83	96.94	97.00	96.70

Classification:

1: ferri-tschermakitic hornblende

2: "

3: "

4: ferri-tschermakite

5: "

6: ferri-tschermakitic hornblende

APPENDIX 5

STRATIGRAPHIC SECTIONS

H.P. Trettin

Section southeast of head of Milne Fiord (Milne Fiord assemblage, divisions 2 and 3 and upper part of division 1).

Section southwest of of Ayles Fiord (Milne Fiord assemblage, parts of divisions 2 and 3).

SOUTHEAST OF MILNE FIORD (SEMF)

Location: Yelverton Inlet map-area (340F), southeast of head of Milne Inlet;
UTM Zone 17X, 51275 E, 9156800 N.

Field notes by H.P. Trettin, 1980; photogrammetric thickness determinations by Geophoto Ltd., 1980.

Base of section: core of anticline, level within Milne Fiord assemblage, division 1.

MILNE FIORD ASSEMBLAGE

Division 1

150 ± m
Marble, calcareous and dolomitic

Division 2

900 ± m
Phyllite, dark grey with two or more beds of tuffaceous schist in lower and middle part and rhyolite (probably welded tuff in uppermost part); the latter has U-Pb zircon age of 503.2 +7.8/-1.7 Ma.

Division 3

550 ± m

Mainly quartzite, massive with thinly interstratified phyllite, pelitic, in lower few metres.

Top of section: limit of exposures.

SECTION SOUTHWEST OF AYLES FIORD (SWAF)

Location: Yelverton Inlet map-area (340F), peninsula between Milne and Ayles fiords;
UTM Zone 17X, 9179500N, 510600E.

Measured by H.P. Trettin, 1977.

Base of section: talus slope covered with phyllite etc.; level within division 2 of Milne Fiord assemblage.

MILNE FIORD ASSEMBLAGE
Division 2

unit 1, 0 - 345 m (345 m)
Phyllite, medium grey, medium dark grey and greenish grey; partly argillaceous; partly argillaceous and calcareous/dolomitic; partly tuffaceous (=chloritic and feldspathic) and calcareous.

unit 2, 345 - 413 m (68 m)
Mainly dolostone and lime mudstone, minor phyllite; flat lamination and small-scale cross-lamination.
Dolostone: microcrystalline, variably argillaceous and sandy.
Lime mudstone: dolomitic argillaceous.
Phyllite: argillaceous phyllite interlaminated with dolostone and lime mudstone; lenses of tuffaceous tuffaceous phyllite at 392.5 - 393.5 m.

unit 3, 413 - 518 m (105 m)
Phyllite as in unit 1; felsic tuff, phyllitic, at 462 - 462.5 m.

unit 4, 518 - 540 m (22 m)
Phyllite, medium dark grey, argillaceous, quartzose.

Division 3

unit 5, 540 - 660 m (120 m)
Quartzite, very fine to medium grained, almost pure; massive; parting thickness 5 - 30 cm, commonly about 20 cm; jointing normal to bedding.

Top of section: present erosion surface (dip slope).

GEOLOGY, YELVERTON INLET (340F, 560E)

Geology by T. Frisch 1966, 1975; H.P. Trettin 1966, 1975, 1977, 1980, 1984; and D.G. Wilson 1975.

Compiled by H.P. Trettin and T. Frisch, 1987.

LEGEND

POST-ELLESMERIAN COVER

QUATERNARY

Q	unconsolidated sediments

CRETACEOUS and (?) TERTIARY
Maastrichtian (?) and Paleogene

TE	**Eureka Sound Group** sandstone, conglomerate, mudrock

CRETACEOUS
Upper Cretaceous

KHP	**Hansen Point volcanics** rhyolite, basalt, alkaline volcanics

CARBONIFEROUS
Upper Carboniferous

CB	**Borup Fiord Formation** clastic and (?) carbonate sediments

CLEMENTS MARKHAM FOLD BELT

SILURIAN
Llandovery or Wenlock to lower Ludlow

SL2	**Lands Lokk Formation** **member C** sandstone, mudrock, minor conglomerate
SL1	**member A** mudrock

SL	**Lands Lokk Fm.** mudrock, sandstone

Llandovery

SI	**Imina Formation** sandstone, mudrock : resistant marker within formation
SK	**Kulutingwak Fiord assemblage** volcanics (incl. andesite, trachyandesite) minor limestone

Lower Paleozoic (?), probably pre-upper Llandovery

IPzPB	**Petersen Bay assemblage** schist, amphibolite (including plagioclase-free amphibole rocks), marble
PzPBc	marble (mappable from air photographs); stratigraphic position within Petersen Bay assemblage unknown

PEARYA TERRANE

CAMBRIAN and ORDOVICIAN
Lower Ordovician

OM3	**Milne Fiord assemblage** **division 3** quartzite, minor phyllite

Upper Cambrian and/or Lower Ordovician

€OM2	**division 2** phyllite, minor marble (dolostone, limestone), volcanics (incl. rhyolite)
€OM1	**division 1** marble (limestone, minor dolostone)

HADRYNIAN AND CAMBRIAN

Age and stratigraphic order mostly unknown.

Lithological designations

c= carbonate rocks (limestone, dolostone,marble)

p= (pelite) slate, phyllite, minor schist

q= quartzite

qf= feldspathic quartzite

s= schist (greenschist or amphibolite facies)

ss= staurolite-bearing schist

t= chert

v= identifiable metavolcanic rocks (greenschist facies)

w= (wacke) sandy mudrock, argillaceous sandstone

x= diamictite

Suggested scheme for combination of Hadrynian-Cambrian map-units (recurrent lithological units, unrelated to tentative age assignments)

- [ ] predominantly carbonate rocks (map-unit c)

- [ ] pelitic and mixed assemblages, low-grade metamorphic (map-units p, pvc, pc, spcqv)

- [ ] pelitic and mixed assemblages, greenschist and/or amphibolite facies (s, sc, scq)

- [ ] metavolcanic rocks with or without metasediments (map-units v, cv)

- [ ] diamictite and/or wacke-bearing assemblages (map-units x, pxc, pxqc)

- [ ] predominantly quartzite (map-units q, qp, qf)

Tentative age assignments (not part of map-unit designations; shown in brackets, detached from lithological letter symbols):

Ꞓ= Cambrian

H 3: Ediacaran

H 2: Varangian

H 1: post-Helikian, pre-Varangian

H Ꞓ: Hadrynian and/or Cambrian

NEOHELIKIAN (age of metamorphism and plutonism)
Upper Neohelikian

- [ ] gneiss, minor amphibolite, schist

LOWER PALEOZOIC OR OLDER OCEANIC ROCKS

Lower Paleozoic or older

vb	sandstone, conglomerate, breccia, mudrock composed of serpentinite fragments; minor brecciated serpentinite

INTRUSIONS

CRETACEOUS
Upper Cretaceous

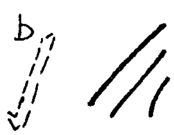
uKb	**Wootton Intrusion** mainly gabbro, minor granitic and hybrid rocks

DEVONIAN
Lower (?) Devonian

Dqm	**Cape Woods Pluton** quartz monzonite, granodiorite
× (gd)	small outcrops of gneissic granodiorite and related rocks, perhaps related to Cape Woods Pluton

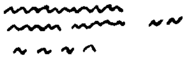
LOWER DEVONIAN OR OLDER (ORDOVICIAN ?)

O?b	**Cape Fanshawe Martin Intrusion** gabbro, peridotite



mafic dykes and sills of different ages

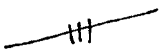
geological boundary (defined, approximate, assumed; projected through ice, overburden or water)



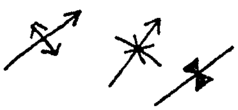
fault (defined, approximate, assumed; projected through ice, overburden or water)

thrust fault (defined, approximate, assumed)

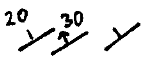
normal fault (defined, approximate, assumed)



lineament (from air photographs)



anticline, syncline (arrow indicates plunge), synform



strike and dip of bedding, tops known (field determination; photogrammetric determination; dip unknown)

strike and dip of bedding, tops unknown; dip estimates from air photographs

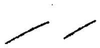
g: gentle (about 3^{o} - 10^{o})

m: medium (about 10^{o} - 25^{o})

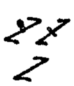
s: steep (about 25^{o} - 45^{o})

vs: very steep (about 45^{o} - 89^{o})

vertical



trend of bedding



schistosity, gneissosity (inclined, vertical, dip unknown; dip estimates as for bedding)

primary flow structures in igneous rocks (vertical)

F x fossil locality

U-Pb x age determination

stratigraphic section (ground, photogrammetric)

Note 1. It appears that the Hadrynian-Cambrian succession of the Kulutingwak Belt was thrust underneath the Silurian Imina Formation during an early phase of deformation, but this is not indicated on the map. At a later stage, the stack of thrust sheets was folded into the Kulutingwak Anticline, and another generation of thrust faults developed, some of which place the Hadrynian-Cambrian strata upon the Silurian strata. The (triangular) thrust symbols shown at the contact between the Hadynian-Cambrian rocks and the Imina Formation refer to this event.