SUMMARY OF PRE-CARBONIFEROUS GEOLOGY, NORTHERN HEIBERG FOLD BELT, CLEMENTS MARKHAM FOLD BELT, AND PEARYA

(To accompany geological maps of northern Ellesmere and Axel Heiberg islands)

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INTRODUCTION

This series of maps is based on geological investigations between 1975 and 1992 and on published earlier work. Accounts of the Upper Devonian to Tertiary stratigraphy of the area are contained in reports by Mayr (1992), Embry (1991), Miall (1979), and Ricketts (1994). The pre-Carboniferous geology is discussed in Trettin (1994) and in an as yet unpublished GSC bulletin (cited as Trettin, in press), that supersede earlier summaries. The purpose of these notes is to summarize information from the unpublished bulletin, which is essential for the understanding of the maps.

For brevity, formational nomenclature and type sections are not discussed and citations are kept to a minimum, but selected references are given at the end of this summary. Relevant fossil identifications, published or new, are listed in appendices of the unpublished bulletin. They were made by the following scientists — macrofossils: B.S. Norford, A.E.H. Pedder, J.W. Kerr, and R. Thorsteinsson; conodonts: T.T. Uyeno, G.S. Nowlan, R.V. Tipnis, and C.R. Barnes; ostracodes: M.J. Copeland; calcimicrobes, algae, and sponges: T.A. de Freitas; palynomorphs: D.H. McGregor. Most isotopic age determinations have been published (see selected references), but an unpublished determination by J.E. Gabites is presented in an appendix of the unpublished bulletin. Radiometric ages are interpreted according to the time scale of Okulitch (1995).

The volcanic rocks are metamorphosed or altered, and their classification is based on trace element ratios (after Winchester and Floyd, 1977, fig. 6). Assignment to the calc-alkaline or tholeiitic clans, where applicable, is based on the major-element classification of Irvine and Baragar (1971). The term mudrock is used for all clastic sediments finer grained than sandstone, i.e., siltstone, claystone, mudstone, or shale.

The project area is divisible into five geological subprovinces that are shown as coloured insets on the geological maps. Two of these, the Hazen and Central Ellesmere Fold belts, are discussed in Trettin (1994).

The **Northern Heiberg Fold Belt** forms the northwesternmost part of the southeast-plunging Princess Margaret Arch of Axel Heiberg Island, and structural trends are northwest. It contains an estimated 8 km of sedimentary and volcanic rocks, ranging in age from late Neoproterozoic or Early Cambrian to Early Devonian, which are assigned to six major units, the Jaeger Lake, Aurland Fiord, Grant Land, Hazen, Svartevaeg, and Stallworthy formations. A high-angle unconformity separates the Lower Devonian and (?)older Stallworthy Formation from the Early Cambrian, or older, to Silurian formations. Mechanically incompetent pre-Devonian units are tightly folded, whereas competent carbonate and volcanic units form major thrust sheets that verge southwest or northeast. The Stallworthy Formation occurs as a northeast-dipping panel.

The **Clements Markham Fold Belt** is a heterogeneous tectonic province that lies between the Hazen Fold Belt and Pearya. Structural trends are slightly arcuate in southwesterly to westerly directions, parallel with the overall orientation of the belt. Anomalous westerly to northwesterly trends occur in northwestern parts that may be underlain at depth by Pearyan basement. It contains an estimated 4 to 5 km of strata ranging in age from Early Cambrian, or older, to Late Silurian, and up to 1360 m of Middle-Upper Devonian strata (Mayr, 1992). The pre-Devonian rocks are composed of similar deep-water sediments as the Hazen Fold Belt, but also include volcanics and shallow-water marine sediments. They are assigned to two major successions, A and B, that predate and postdate, respectively, sedimentary overlap in the latest Llandovery. Succession A occurs in five separate belts that differ in stratigraphy and in the age range of the exposures. In contrast, the basal unit of Succession B is uniform over large areas, including the Hazen Fold Belt and parts of the North Greenland Fold Belt.

The southeastern belt of Succession A is comparable in stratigraphy to the lower four formations of the Hazen Fold Belt, and this comparison has been used for a tentative palinspastic reconstruction of regional facies belts. It places the southeastern belt of the Clements Markham Fold Belt on the present continental shelf off Ellesmere Island, but the Hazen Fold Belt on a re-entrant of the Arctic continental margin that has a more southerly trend than the adjacent segments.

The sedimentary rocks form complex chevron folds. Extensive, southwest-trending, linear faults form the southeastern and northwestern boundaries of the fold belt and also occur within it. They include the Porter Bay Fault (on the *Clements Markham Inlet-Robeson Channel* map-sheet[1]), the Mount Rawlinson and M'Clintock Glacier faults (*M'Clintock Inlet*), part of the Petersen Bay Fault (*Yelverton Inlet*), and the Emma Fiord Fault Zone and Inlet Head Fault (*Otto Fiord*). They probably date back to the early Paleozoic, but have been re-activated at later times under different stress conditions.

Pearya is characterized by a distinct stratigraphy and tectonic history, and by highly diverse structural trends. It is interpreted as a suspect terrane that probably was accreted prior to latest Llandovery time, but retained a distinct stratigraphic identity in its northern part until the Late Silurian. The main outcrop area on the north coast of Ellesmere Island is divisible into three domains, Northeast, Central, and Southwest Pearya, based on differences in structural trend and in the age range of the exposures. In *Yelverton Inlet*, they are separated by the northeastern part of the Petersen Bay Fault and by the Mitchell Point Fault Zone. Three minor, fault-bounded uplifts, located southwest of the main outcrop area, are surrounded by Succession B of the Clements Markham Fold Belt (Aurland Fiord and Kulutingwak inliers).

The rocks of Pearya are assigned to a crystalline basement of late Mesoproterozoic age (Succession 1) and four sedimentary-volcanic successions (2 to 5) with an estimated thickness greater than 8 km. Succession 5 is further divisible into a lower and an upper part (5A and 5B). These major units are separated by unconformities or, in case the case of Successions 2 and 3, by faults that probably represent a suture.

STRATIGRAPHY

Northern Heiberg Fold Belt

Outcrops are confined to the western part of *Cape Stallworthy-Bukken Fiord*. The Jaeger Lake Formation, (new term; map unit ꞒJ), consists of more than 425 m of mafic metavolcanics and interbedded carbonates, mainly dolostone. Apart from stromatolites, the unit is unfossiliferous, and its lower and upper contacts are faulted. The fact that it has been thrust over the Grant Land Formation suggests an Early Cambrian or older age. It probably is correlative with the Yelverton Formation of the Clements Markham Fold Belt, which is similar in gross lithology and trace element composition.

The Aurland Fiord Formation (new term; map unit ꞒA) comprises unfossiliferous dolostone and calcareous marble with minor phyllite and chert. It appears to be more than 600 m thick in the area southeast of Aurland Fiord but may be repeated by unrecognized faults or folds. The lower and upper contacts are faulted or concealed. This formation also is thrust over the Grant Land Formation and probably is Early Cambrian or older in age.

The upper Lower Cambrian Grant Land Formation (map unit ꞒG), established in the Hazen Fold Belt, is represented by quartzite and grey, green, and purple phyllite or slate. Studies in the Tanquary Fiord-Hare Fiord region of Ellesmere Island indicate a late Early Cambrian age and correlation with the Ellesmere Group. There, the formation is more than 1.4 km thick. The sediments were derived from the continental interior and deposited on submarine fans.

The Hazen Formation (map unit Ꞓ-SH) also was established in the Hazen Fold Belt. It is a condensed, deep-water succession of late Early Cambrian to Early Silurian (early late Llandovery) age; composed of resedimented carbonates, mudrock, and minor sandstone and chert in the lower part (carbonate member), and of radiolarian chert and mudrock in the upper part (chert member). In the Northern Heiberg Fold Belt the carbonate member is represented by a minimum of 59 m of laminated, dolomitic, lime mudstone and calcareous dolostone, with minor carbonate conglomerate and calcarenite, exposed in a syncline southeast of Aurland Fiord. Dark grey chert, exposed in several areas north and south of Rens Fiord, probably represents mainly the chert member, but has been mapped as undifferentiated Hazen Formation. Ghosts of radiolarians are present both in chert and carbonate rocks, but no diagnostic fossils have been found.

The Svartevaeg Formation (modified; map units SSV1 and SSV2) is composed of more than 1.6 km of volcanic and sedimentary strata assigned to two members. Member A is exposed only in the Svartevaeg Cliffs, where it is thrust over the Stallworthy Formation. It includes about 1 km of volcanic flows and minor tuff, with small amounts of volcanic-derived sandstone and siltstone and a few carbonate olistoliths. The volcanics are mainly calc-alkaline andesites or basaltic andesites of volcanic arc origin. Member A has not been dated directly, but is probably Llandovery in age. Member B consists mainly of volcanic-derived sandstone, siltstone, and minor conglomerate of andesitic composition, with small amounts of carbonate conglomerate and variable proportions of predominantly tuffaceous volcanics. The clastic sediments were deposited by sediment gravity-flows, probably in a forearc setting. This member occurs in three outcrop belts, located (1) in the Svartevaeg Cliffs, (2) northeast of Eetookashoo Bay and Rens Fiord, and (3) southwest of Aurland Fiord. It is unconformably overlain by the Emma Fiord Formation in the first area, and by the Stallworthy Formation in the second. The unit is more than 600 m thick in the Svartevaeg Cliffs, where it is relatively rich in conglomerate. There, it has yielded a graptolite of probable latest Llandovery age. Graptolites of late Wenlock age have been collected from strata about 15 m below the unconformable upper contact, in an area northeast of Rens Fiord.

The Stallworthy Formation (map units DS1, DS2, and DS3) is an upward fining succession of sandstone, mudrock, and minor conglomerate or breccia. It is about 4 km thick and divisible into three members. Conglomerate and breccia are of pebble to cobble grade and consist largely of chert, whereas the sandstones consist mainly of quartz, with variable chert and minor feldspar. The unfossiliferous lower part (members A and B) probably was deposited in alluvial fan and fluvial environments. The upper part (member C) contains a sparse fauna of pelecypods and brachiopods, and probably represents brackish water and shallow marine, deltaic settings. Fossil fish, occurring about 1.3 to 1.5 km above the base of the formation, are of late Llandovery or early Pragian age.

Clements Markham Fold Belt

Succession A

Southeastern belt

The southeastern belt, which extends from southeast of Phillips Inlet to northwest of Yelverton Pass (*Otto Fiord, Tanquary Fiord,* and *M'Clintock Inlet*), includes the Yelverton, Grant Land, and Hazen formations, and the Yelverton Pass beds.

The Yelverton Formation (new term; map unit ꞒY) comprises more than 1 km of partly metamorphosed volcanic flows and tuffs, largely mafic tholeiites, with lesser amounts of sediment. It has been thrust over the Grant Land Formation and its base is not exposed. The metasediments include recrystallized limestone, phyllite, and minor chert and dolostone. The unit is similar in lithology to the Jaeger Lake Formation and probably Early Cambrian, or older, in age.

The Lower Cambrian Grant Land Formation (map unit ꞒG) is represented by quartzite and variegated phyllite, and the Lower Cambrian to Lower Silurian Hazen Formation (map unit Ꞓ-SH) by chert that is both of radiolarian and replacement origin. Resedimented carbonates, ranging from lime mudstone to flat-pebble conglomerate, are preserved locally.

The Yelverton Pass beds (map unit SYP) comprise about 100 to 200 m of skeletal pebble conglomerate and recrystallized limestone on the northwestern side of Yelverton Pass. The strata are unconformably overlain by the Carboniferous Borup Fiord Formation and their base is not exposed. The limestone has yielded conodonts of late Llandovery age (*celloni* Zone, or slightly older). A unit of replacement chert on the southeastern side of the pass is tentatively correlated with these strata. The latter overlies the Hazen Formation with an abrupt contact, that probably represents a low-angle normal fault or an unconformity.

Southwestern belt

The key exposures of the southwestern belt are at Fire Bay, on the southeast side of Emma Fiord (*Cape Stallworthy-Bukken Fiord,* Inset B), but minor exposures extend for about 43 km to the northeast (*Otto Fiord*). The strata are assigned to the Hazen and Fire Bay formations. The Hazen Formation consists of radiolarian chert and has yielded graptolites of Llanvirn-Llandeilo and Caradoc ages. Its base is not exposed.

The Fire Bay Formation (new term; map units SF, SF1, SF2, and SF3) lies stratigraphically between the Hazen and Danish River formations, but the contacts are concealed. It consists of sedimentary and volcanic rocks assigned to three members. The thickness of the formation is difficult to establish because of its complex structure. Member A consists of 200 to 300 m of sandstone, mudrock, and conglomerate, with minor amounts of tuff. The clastic sediments are composed mainly of volcanic rock fragments and minerals, with variable proportions of quartz, chert, and carbonate. Primary structures indicate deposition by sediment gravity-flows. The member is divisible into a northwestern and a southeastern facies, the former coarser grained and richer in volcanic content than the latter. Vertically it is divisible into four major units (A1 to A4) that are recognized in both facies belt. Unit A2 is a quartz-rich conglomerate that is underlain and overlain by relatively fine-grained sediments (A1 and A3). Member B consists of an estimated 200 to 300 m of volcanic flows and tuffs and is divisible into a lower, recessive unit (B1) and an upper, resistant unit (B2). The rocks represent a bimodal, felsic and basaltic suite with a significant proportion of alkali basalt and probably originated in a weakly extensional tectonic setting. Member C is composed of probably less than 100 m of laminated mudrock that is dark grey, dolomitic and, in part, contains quartz-sand. A graptolite from the lower part of the formation (unit A3) is probably of early late Llandovery age, and a graptolite from member C, of unspecified middle or late Llandovery age. These collections, together with the stratigraphic position of the formation, indicate a late Llandovery age.

Nine or more carbonate olistoliths (map unit OO) of similar lithology and age occur in the Hazen Formation, at the Hazen-Fire Bay contact, and in the lower Fire Bay Formation. Conodonts and macrofossils from these strata are of Whiterockian (late Arenig-early Llanvirn) age. Derived from northwesterly shallow marine sources, they were emplaced during a major event of submarine sliding that probably occurred during the late Llandovery.

Northwestern belt

Outcrops of the northwestern belt are restricted to the vicinity of the upper reaches of Kulutingwak Inlet (*Yelverton Inlet,* Inset). Two formations are distinguished in the Kulutingwak Anticlinorium. The Kulutingwak Formation (new term; map units OK, OK1, OK2) is a sedimentary-volcanic assemblage, divisible into two members, that underlies the Danish River Formation with an abrupt contact. Its base is not exposed. Member A consists of more than 100 m of tuffaceous phyllite, volcanogenic sandstone, volcanic flows, and thin units of marble. Trace element analyses of the highly altered volcanics suggest rhyodacite-dacite, andesite, subalkaline basalt, and alkali basalt. A zircon analysis yielded a weighted mean of 449.7 +3.5/-9 Ma (Caradoc-Ashgill). Member B includes 200 to 300 m of calcareous and dolomitic marble, with ghosts of crinoid ossicles, and minor amounts of intercalated volcanic material. The most diagnostic conodonts obtained from these strata are of Caradoc-Ashgill aspect. Metamorphic rocks in the footwall of the Petersen Bay Fault are interpreted as probable or possible equivalents of the Kulutingwak Formation (map units OKs, OKc, OKs? and OKc?).

The Phillips Inlet Formation (new term; map units SPI, SPI1, and SPI2) ocurrs as lenticular thrust sheets within the lower part of the Kulutingwak Formation and is divisible into two members. Member A comprises no less than 300 m of predominantly coarse clastic sediments, ranging in grade up to boulder conglomerate, that are composed of detrital serpentinite with small amounts of carbonate and chromite. Most strata are massive, but laminae, graded bedding, and scoop-shaped cross-strata also are present. Member B consists of less than 10 m of massive, polymict conglomerate, without serpentinite. Both members probably were deposited by sediment gravity-flows. The age of the formation is uncertain. It is tentatively correlated with member A of the Fire Bay Formation, which contains trace amounts of detrital chromite and serpentinite. Alternatively, it may be correlative with Ordovician units of Pearya that also contain ultramafic material: member A of the Cape Discovery Formation (early Caradoc) or the Taconite River Formation (Ashgill).

West-central belt

The west-central belt is underlain by map unit OSV, which occurs as a fault block within the Emma Fiord Fault Zone southeast of Kulutingwak Fiord (*Yelverton Inlet* and *Otto Fiord*). The volcanics are flows and tuffs of andesite and trachyandesite. An associated limestone yielded conodonts of probable early to middle Llandovery age.

Northeastern belt

The northeastern belt consists of two areas of nunataks, located northwest of Clements Markham Inlet (*Clements Markham Inlet-Robeson Channel*) and at Disraeli Glacier (*M'Clintock Inlet*), that are structurally aligned. Both areas are underlain by the Mount Rawlinson Complex (new term; map unit OR). In the first area an estimated 1 to 2 km of volcanics with intercalated calcareous and dolomitic marble and chert are thrust over a sheet of dolostone and phyllite, tentatively included in the complex as map unit ORc, that in turn is thrust over the Lands Lokk Formation. The contact with the structurally overlying Danish River Formation is discussed below. The trace element ratios of the volcanics are in the field of andesite and in the boundary area of rhyodacite-dacite and trachyandesite. A volcanic flow from the lower or middle part of the complex yielded a zircon age of 454 +9.7/-4.6 Ma, late Caradoc, with confidence limits in the Llandeilo and near the Caradoc-Ashgill boundary. Considering the thickness of the complex, strata of Ashgill and possibly Llandovery age may be present in its undated upper part. The rocks at Disraeli Glacier are in fault contact with the Danish River and Lands Lokk formations and consist of tuffaceous rocks and radiolarian chert.

Succession B

Succession B overlaps Succession A and parts of Pearya. The lower part, latest Llandovery to early Ludlow in age, consists of flyschoid sediments assigned to the Danish River and Lands Lokk formations. The strata now assigned to the Danish River Formation (map unit SDR) were previously mapped as Imina Formation. In the Clements Markham Fold Belt, the Danish River Formation overlies the Fire Bay and Kulutingwak formations and the Mount Rawlinson Complex. The concealed contact with the Fire Bay Formation may be conformable because there is no significant age gap. The contact with the Kulutingwak Formation appears to be a disconformity or low-angle unconformity, with a hiatus extending from latest Ordovocian to early late Llandovery. The contact with the Mount Rawlinson Complex has not been examined on the ground. Air photo interpretation and observations from a helicopter suggest a high-angle unconformity. The Danish River Formation consists mainly of sandstone and mudrock with minor granule to fine-pebble conglomerate, and rare carbonate olistoliths. Throughout northern and central Ellesmere Island, the rocks show a fairly uniform composition of silicates (mainly quartz, lesser feldspar, mica, chlorite, metamorphic and volcanic fragments, and chert) and detrital carbonate grains (23% on average for sandstones of the Clements Markham Fold Belt). The strata typically occur in Bouma sequences or as massive sandstone beds. Paleocurrent determinations in the vicinity of Emma Fiord demonstrate strike-parallel transport from northeast to southwest. Graptolite collections from the Fire Bay, Danish River, and Lands Lokk formations indicate that in the Clements Markham Fold Belt the Danish River Formation is late Llandovery in age and correlative with the lowermost part of the formation in the type section at Caledonian Bay. It also is correlative with the Merqujôq Formation of North Greenland (Higgins et al., 1991).

The Lands Lokk Formation (map unit SL; revised) probably overlies the Danish River Formation conformably throughout the Clements Markham Fold Belt, but the contacts are faulted or concealed everywhere. In *Clements Markham Inlet-Robeson Channel,* it is locally disconformably overlain by the Markham River Formation. The Lands Lokk Formation consists of sandstone, mudrock, and minor conglomerate, locally with tuff and rare carbonates. The clastic sediments typically form Bouma sequences or occur as massive sandstone beds. It differs from the Danish River Formation in detrital composition, a higher proportion of mudrock, and a darker hue. Two lithofacies are distinguished south and east of the head of Emma Fiord (*Otto Fiord*). The mudrock-volcanogenic facies (SLpv), probably more than 600 m thick, consists mainly of medium to dark grey laminated mudrock, with small amounts of quartzose sandstone and volcanogenic sandstone. The sandstone-mudrock facies (map unit SLq) has a minimum thickness of about 800 m in the Hvitland Peninsula 1 section where it was studied in detail. There it overlies, and evidently prograded over, the mudrock-volcanogenic facies, but graptolite identifications in the broader region show the same overall age range for both facies. Map unit SLq mainly consists of interbedded quartz-chert sandstone and mudrock, with minor amounts of pebble conglomerate and very small amounts of volcanogenic strata. A third lithofacies, which contains significant proportions of quartz-chert conglomerate (map unit SLqcg), has been mapped southwest of Yelverton Inlet. It probably occurs in the upper part of the formation. The bulk of the formation probably is of deep-water origin, but strata of shallow marine aspect occur locally in *Clements Markham Inlet-Robeson Channel*. Graptolites range in age from latest Llandovery to early Ludlow. The Lands Lokk Formation is partly correlative with member B of the Danish River Formation at Caledonian Bay and the Nordkronen Formation of North Greenland (Higgins et al., 1991a) and compositionally similar to both units. It probably was derived from orogenic sources adjacent to northeasternmost Greenland. Northwesterly paleocurrent directions on Hvitland Peninsula (*Otto Fiord*), and northeasterly directions in an area southeast of Kulutingwak Fiord probably represent fan progradation into a sub-basin of the generally southwest trending Franklinian Deep-water Basin.

In the northeastern part of the fold belt (*Clements Markham Inlet-Robeson Channel*) a variety of shallow marine carbonate and clastic sediments, assigned to two formations, make up the upper part of Succession B. The Markham River Formation (new term; map unit SMR) overlies the Lands Lokk Formation with a disconformable contact in a small area northeast of Markham River. The stratigraphic top is not preserved. It contains a minimum of 166 m of interstratified dolomitic carbonates, cherty and dolomitic spiculite, and clastic sediments. The carbonates comprise a basal nodular dolostone, dolostone, dolomitic oncolite, and calcareous and dolomitic skeletal grainstone. The clastic sediments consist of conglomerate, sandstone, and minor siltstone. Ostracodes from the Markham River Formation, combined with palynomorphs from the Lands Lokk, suggest a middle and/or late Ludlow age, correlative with the Piper Pass Formation.

The Piper Pass Formation (map unit SPP) occurs in an intensely deformed fault slice along the Porter Bay Fault. It consists mainly of lime mudstone with smaller proportions of wackestone or packstone and calcareous-dolomitic mudrock. Conodonts range in age from early late to latest Ludlow.

The Bourne Complex of Kleybolte Peninsula (map unit DB, *Cape Stallworthy-Bukken Fiord*) is a fault-bounded hybrid unit composed of volcanic rocks and metasediments with two generations of dykes. The volcanics are porphyritic andesites or basaltic andesites of arc origin. The metasediments include phyllite, slate, argillite, and minor sandstone, and are partly volcanogenic. Age determinations on hornblende phenocrysts by means of the ^{40}Ar-^{39}Ar method yielded a Givetian apparent age of 380 ± 10 Ma (Henry, 1991). However, the unit may be correlative with the nearby Svartevaeg Formation and its argon ratio may have been reset by the older generation of dykes, which are different in chemical composition and inferred tectonic environment.

Pearya

Succession 1

The crystalline basement of Pearya occurs in three main areas, the Cape Columbia, Deuchars Glacier and Mitchell Point belts, and several smaller areas, the Ayles Fiord and Yelverton Inlet outliers (see index maps). It consists mainly of granitoid gneiss, with lesser proportions of amphibolite and schist, and small amounts of marble and quartzite. Isotopic age determinations indicate granitoid intrusion and metamorphism between 1.0 and 1.1 Ga and another phase of plutonism at 965 ± 2 Ma (Phillips Inlet Pluton).

Succession 2

This complex and poorly known succession comprises unnamed metasediments and metavolcanics, ranging in age from Neoproterozoic to Early Ordovician. It probably overlies Succession 1 nonconformably, but the contacts are faulted, sheared, or concealed. Phyllite, marble, quartzite, and schist are abundant, whereas conglomeratic greywacke (diamictite), greywacke, felsic and tholeiitic mafic metavolcanics, and metachert are less common. The metamorphic grade ranges from lower greenschist to lower amphibolite facies. These strata are assigned either to recurrent lithologic units or to preliminary lithostratigraphic units of local extent.

The lithological units are designated as follows:

c: carbonate rocks	t: chert
p: phyllite	v: volcanics
q: quartzite	w: greywacke/sandy murock
s: schist	x: conglomeratic greywacke (diamictite) and interbedded mudrock

The local lithostratigraphic units are listed below in alphabetical order:

- A: Northeast of lower Ayles Fiord (*Yelverton Inlet* and *M'Clintock Inlet*), map unit A
- D: East and West of the Upper reaches of Disraeli Glacier (*M'Clintock Inlet* and *Clements Markham Inlet-Robeson Channel*), map units D1 to D3
- L: Arthur Laing Peninsula (*Clements Markham Inlet-Robeson Channel*), map units L1 to L6
- M: East of Milne Fiord and Milne Glacier (*Yelverton Inlet* and *M'Clintock Inlet*), map units M1 to M5
- W: Northeastern Wootton Peninsula (*Yelverton Inlet*), map units W1 to W3
- Y: Northeast of Yelverton Inlet (*Yelverton Inlet*), map units Y1 to Y4

The oldest known strata of Succession 2 are schist and quartzite assigned to map unit A, which overlie Succession 1 with a sheared contact in an anticline northeast of the lower reaches of Ayles Fiord. Higher in the section three widespread markers permit tentative age assignments and some correlations. The first is a characteristic, massive diamictite (map unit L2 and equivalents within map units Y2 and W2) that probably is glaciogenic in origin and late, but not latest Neoproterozoic in age, or Varanger in terms of Harland et al. (1993). The second marker is a resistant carbonate unit (map units L4, Y3, W3, and (?) D2), which is separated from the diamictite by a unit of recessive clastic sediments (map unit L3 and equivalents). The carbonates have yielded sponge spicules on Arthur Laing Peninsula and may be Early Cambrian in age. The third marker consists of a unit of phyllite, with minor volcanics and carbonates, that occurs near the top of Succession 2 (map unit M4). Volcanic zircon from the uppermost part yielded a Tremadoc age of 503.2 +7.8/-1.7 Ma. Units that are inferred to be correlative are shown with identical colours on the maps.

Succession 3

Succession 3 is identical with the Maskell Inlet Complex (map units OMI, OMIc), a variably metamorphosed, intensely deformed unit of *M'Clintock Inlet* is composed of arc-type andesite and basalt, with some carbonates, clastics, and chert. The faulted contact with Succession 2, which is unconformably overlain by lower Caradoc strata of Succession 4, is interpreted as a suture. The complex is tentatively correlated with the plutonic Thores Suite, which is Arenig in age.

Succession 4

Succession 4 is identical with the Egingwah Group of *M'Clintock Inlet* and *Clements Markham Inlet-Robeson Channel*, which comprises three conformable formations of Caradoc-Ashgill age. The Cape Discovery Formation (map unit OCD) overlies Successions 2 and 3 with a high-angle unconformity and consists of roughly 1 km of clastic and carbonate sediments with minor volcanics, assigned to four members. Member A, locally more than 300 m thick, consists of clastic sediments derived from Successions 2 and 3 that range from boulder conglomerate to mudrock, and includes minor amounts of alkaline volcanics. The basal conglomerate probably is nonmarine in origin and the remainder shallow marine. Member B consists of more than 110 m of limestone and dolostone. Member C is composed of about 300 m of reddish weathering, laminated, silty and sandy limestone, with minor amounts of calcareous siltstone, sandstone, and flat-pebble conglomerate. It is of peritidal aspect. Member D contains about 470 m of volcanic-derived red sandstone, siltstone, and minor conglomerate, with small amounts of dolostone and one andesite flow. Macrofossils and conodonts indicate an early Caradoc age for members A and B.

The M'Clintock Formation (map unit OMC) consists of probably more than 1 km of volcanic flows and tuffs and very small amounts of limestone and volcanic-derived sediments. The volcanics are altered and range in composition from felsic (rhyodacite-dacite) to predominantly mafic (andesite and basalt). Most appear to be calc-alkaline or tholeiitic, but alkaline rocks (trachyandesite and alkali basalt) are also present. The formation probably represents a volcanic arc. A coral of Ashgill age occurs about 70 m below the top of the formation.

The Ayles Formation (map unit OA) comprises approximately 1.1 to 1.3 km of dolostone locally assigned to a lower, resistant unit (OA1) and an upper, more recessive unit (OA2). It contains a diverse benthonic fauna of Ashgill age.

Succession 5A

Succession 5A is identical with the Harley Ridge Group (revised) of Ashgill age, which comprises two widespread formations. The Taconite River Formation (map unit OTR) overlies the Ayles or M'Clintock formations with a low-angle unconformity in most of its area of occurrence, but overlies Succession 2 with a high-angle unconformity west of the head of M'Clintock Inlet. It ranges in thickness from a few tens of metres to more than 600 m and consists mainly of clastic redbeds, predominantly sandstone and mudrock, minor boulder to pebble conglomerate with a smaller proportion of limestone that contains benthos of Late Ordovician age. The conglomerates are probably of nonmarine origin, but the bulk of the formation is of peritidal to shallow marine aspect.

The Zebra Cliffs Formation (revised) generally overlies the Taconite River with conformable contact, but oversteps it on Harley Ridge, east of the head of M'Clintock Inlet, where it lies on Succession 2 with a high-angle unconformity. It ranges in thickness from about 300 m to probably more than 1 km and is divisible into three members. Members A and C (revised) consist of carbonate rocks, chiefly wackestones or lime mudstones of subtidal shelf origin, and minor dolostone. The carbonates contain an abundant and varied benthonic fauna of Ashgill in age. Member B (revised) occurs in the lower part of the formation and is up to about 50 m thick. It consists of variegated mudrock, sandstone, limestone, and local pebble conglomerate. These facies indicate a brief regressive-transgressive event.

Succession 5B

This succession comprises clastic and carbonate sediments of Ashgill to Late Silurian age which show marked lithological variations in space and time. Three generalized facies belts are distinguished on the map legends and index maps of *M'Clintock Inlet* and *Clements Markham Inlet-Robeson Channel.*

Southeastern shallow-marine belts

Two belts of shallow-marine sediments, assigned to the Lorimer Ridge and Marvin formations, flank the central deep-marine belt discussed below. The Lorimer Ridge Formation (map unit OLR) overlies the Zebra Cliffs Formation with a low-angle unconformity on Harley Ridge, southeast of the head of M'Clintock Inlet. Elsewhere the contacts are concealed. It is about 813 m thick on Lorimer Ridge and consists of variegated siliciclastic sediments, mainly sandstone and mudrock with rare pebble conglomerate, and with lesser proportions of limestone. The siliciclastics are reddish, green, and grey in colour and represent shallow marine or peritidal environments. The limestones are of subtidal origin and contain benthonic faunas of Ashgill age. The proportion of siliciclastic sediments and redbeds increases in an easterly direction. The Marvin Formation (revised term; map unit OSM) overlies the Lorimer Ridge Formation with a conformable contact and comprises more than 580 m of limestone, minor dolostone, and calcified spiculite in a section southeast of Disraeli Fiord. It represents platform environments and probably also includes microbial reefs. Fossil collections indicate an age range from Ashgill to Late Silurian, possibly with a hiatus extending from latest Ashgill to middle Llandovery.

Central deep marine belt

This belt contains two outcrop areas of the Cranstone Formation (map unit SC). The Cranstone overlies the Lorimer Ridge Formation with concealed contact and its top is not preserved. East of the lower reaches of Disraeli Glacier it includes about 1 km of mudrock, conglomerate, and sandstone, all with flyschoid primary structures. The formation is divided in two members with several subdivisions. A cliff-forming conglomerate, about 400 m thick, forms the lower part of member B. The sediments were derived from a variety of igneous, metamorphic, and sedimentary sources to the northeast, but cobbles and boulders of fossiliferous carbonate rocks probably came from the adjacent Marvin Formation. The formation has yielded graptolites of middle Llandovery age.

Northwestern deep and shallow marine belt

This belt is exposed west and east of the central part of M'Clintock Inlet and bordered on the southeast by shallow marine strata of the Lorimer Ridge and Marvin formations. It comprises the Ooblooyah Creek, Danish River, Lands Lokk, and Marvin formations, and the Crash Point beds. These formations represent a half-cycle that probably is tectonically controlled: the lower two are of deep-water origin, the incomplete Lands Lokk Formation probably is transitional, and the upper two are of subtidal to peritidal platform origin. The Ooblooyah Creek Formation (new term; map unit OOC) overlies the Zebra Cliffs Formation with faulted or concealed contacts. It consists of a few hundred metres of calcareous mudrock and resedimented, impure carbonates that are predominantly dark grey and contain graptolites of Ashgill age. The fault-bounded Danish River Formation (map unit SDR) comprises calcareous-dolomitic sandstone, mudrock, and minor pebble conglomerate, all with flyschoid primary structures. Exposures in the Zebra Cliffs are about 230 m thick and have yielded graptolites of unspecified late Llandovery or Wenlock age, but the formation is probably restricted to the late Llandovery. An estimated 300 m of brownish grey, flat-laminated, sandy mudrock that underlie the Marvin Formation in a syncline near Crash Point probably represent the uppermost part of the Lands Lokk Formation (map unit SL). If so, these unfossiliferous rocks of subtidal aspect are early Ludlow in age. The Lands Lokk Formation is abruptly overlain by a tongue of the upper part of the Marvin Formation (map unit SM), which consists of 150 of limestone, sandy limestone, and minor calcareous sandstone. It contains conodonts and macrofossils of Late Silurian, probably Ludlow, age and is tentatively correlated with the Piper Pass Formation (middle and late Ludlow). The Marvin Formation is overlain with gradational contact by the Crash Point beds (map unit SCP), that consists of more than 100 m of shallow marine sandstone, limestone, and mudrock. Conodonts of undifferentiated Ludlow or Pridoli age are present. The top of the unit is not preserved.

PHANEROZOIC INTRUSIONS

Granitoid intrusions and related dykes and plugs

Early and Middle Ordovician

Granitoid intrusions of Ordovician age are restricted to Pearya. The Ayles Fiord Intrusion (map unit LOgd, *M'Clintock Inlet*) is a concordant sheet of peraluminous granodiorite that intrudes the crest of a small anticline formed in schist of Succession 2, north of the middle part of Ayles Fiord. The intrusion yielded an Arenig crystallization age of 475 ± 1 Ma (monazite) and a late Arenig cooling age of 470.6 ± 2.5 Ma (^{40}Ar-^{39}Ar plateau age on biotite). The crustal derivation of the intrusion is apparent from its chemical composition and from the presence of inherited zircon. The structural setting and the presence of bent feldspar crystals indicate a syntectonic origin.

The Cape Richards Intrusive Complex (map unit MOqm, *M'Clintock Inlet*), emplaced into Succession 2, has two outcrop areas of roughly circular or oval shape. Rocks of the outer zone consist chiefly of quartz monzonite, close to granodiorite, and those of the inner zone chiefly consist of hornblende syenite. These become progressively more felsic outward from the centre and contain riebeckite-bearing dykes. A sphene age of 463 ± 5 Ma suggests crystallization during Llanvirn time and a zircon upper intercept age, derivation from the crystalline basement of Pearya. The partly alkaline composition and the unaltered and unbrecciated state of the rocks suggest post-tectonic emplacement.

The elongate, fault-bounded Markham Fiord Pluton (map unit Ogd, *Clements Markham Inlet-Robeson Channel*) consists of metaluminous to peraluminous granodiorite, quartz monzodiorite, and tonalite, with minor amounts of fine-grained gabbro. Most rocks are shattered or altered. Unabraded zircon yielded a Llanvirn-Llandeilo upper intercept age of 462 ± 11 Ma.

The brecciated and highly altered Disraeli Glacier Pluton (map unit O?g, *M'Clintock Inlet*) intrudes strata of Succession 3. It has not been dated but is included in this group because of its setting and composition.

Middle Devonian

The large (166 km^2) Cape Woods Pluton (map unit Dqm, *Yelverton Inlet*), intrudes Succession 2 of Pearya. The country rocks are generally of greenschist grade, but sillimanite, kyanite, and staurolite are developed in the contact aureole. The intrusive rock is a metaluminous to slightly peraluminous, biotite-quartz monzonite or granodiorite with abundant K-feldspar phenocrysts. A sphene age of 390 ± 10 Ma suggests crystallization during the Eifelian, and a zircon upper intercept age of ca. 1360 ± 200 Ma derivation from Succession 1. Post-tectonic emplacement is apparent from the structural setting of the pluton.

Late Devonian

In the Northern Heiberg Fold Belt four aligned small intrusions of tonalite and granodiorite intrude the Grant Land Formation southwest of Cape Thomas Hubbard (map units Dqd, Dgd, and Dg, *Cape Stallworthy-Bukken Fiord*). Zircon analysis on a tonalite produced an upper intercept source age of about 2 Ga and a lower intercept crystallization age between 360 and 370 Ma.

South of eastern Rens Fiord, a southeast-trending belt of plugs and dykes of porphyritic felsite (map unit Dta, *Cape Stallworthy-Bukken Fiord*) intrudes the Grant Land Formation. These intrusions probably represent silicified trachyandesites (trace element classification), or original rhyolite and dacite (major element analysis). Zircon analysis indicates a crystallization age of 368 ± 3 Ma, close to the Frasnian-Famennian boundary, and a source age of 2436 Ma.

In the western part of the Clements Markham Fold Belt, a small plug of tonalite intrudes turbidites of the undifferentiated Danish River and Lands Lokk formations in an area about 19 km south-southeast of the head of Phillips Inlet (map unit Dtn, *Otto Fiord*). A ^{40}Ar-^{39}Ar determination on hornblende provided an early Famennian plateau age of 364.1 ± 2.0 Ma.

Less than 1 km south of the tonalite, a larger granitoid intrusion of more mafic composition is exposed. A typical sample is a clinopyroxene-bearing monzonite. Ultramafic rocks composed of olivine, clinopyroxene, and serpentine locally occur at its border. The intrusion is known only from brief reconnaissance in 1962 and requires more study.

Late Early Carboniferous

The Petersen Bay Pluton (map unit Cmd, *Yelverton Inlet*) intrudes Succession 2 and consists of metaluminous monzodiorite and peraluminous tonalite. Nearly concordant zircon analyses indicate a crystalization age of 334.5 ± 1.5 Ma, late Early Carboniferous (Viséan). The pluton is approximately coeval with the Emma Fiord Formation and probably the result of plume activity and/or rifting that initiated the Sverdrup Basin.

Late Cretaceous

The Marvin Pluton of Marvin Peninsula (map unit Kqm, *M'Clintock Inlet*) intrudes the Upper Ordovician Taconite River Formation. Compositionally it lies in the boundary field of metaluminous granodiorite, quartz monzodiorite, and quartz diorite. A ^{40}Ar-^{39}Ar determination on hornblende provided a plateau age of 94.2 ± 0.7 Ma, latest Cenomanian. The pluton is approximately coeval with the bimodal Wootton Intrusive Complex (see below).

Small granitoid plugs intrude thermally metamorphosed sediments of Succession 2 of Pearya, on southeastern Kleybolte Peninsula (map unit K?sy, *Cape Stallworthy-Bukken Fiord*). Two are shown on the map, but others are present. The northern pluton, a syenite, yielded hornblende K-Ar ages of 73.6 ± 3.5 Ma and 84.2 ± 3.9 Ma. These ages indicate either Late Cretaceous intrusion or argon loss during rifting. Other undated small granitoid intrusions are present in the western part of the Clements Markham Fold Belt.

Ultramafic, mafic, and bimodal intrusions

The Thores Suite of Pearya (map units Oum and Og, *M'Clintock Inlet*) is represented by five fault-bounded exposures, referred to as the M'Clintock West, M'Clintock East, Thores River, Bromley Island, and Ootah Bay bodies. It consists chiefly of an ultramafic-mafic assemblage of serpentinite, wehrlite, clinopyroxenite, and varieties of gabbro, with lesser proportions of granitoid differentiates ranging in composition from diorite to leucocratic granite. Zircon from a granitoid intrusion in the M'Clintock West body had an upper intercept age of 481 +7/-6 Ma. The suite is interpreted as a subarc plutonic complex that is genetically related to the volcanic rocks of the Maskell Inlet Complex (Succession 3).

The Cape Fanshawe Martin Intrusion (map unit O?b, *Yelverton Inlet* and *M'Clintock Inlet*), which intrudes Succession 2 of Pearya, is divisible into an inner zone of ultramafic and mafic rocks (peridotite, troctolite, olivine-gabbroic anorthosite, pyroxenite, etc.), and a larger outer zone of mafic rocks (gabbro with and without orthopyroxene, anorthositic gabbro, anorthosite, olivine gabbro). Cryptic zoning is shown by olivine and plagioclase, which are more magnesian and calcic, respectively, in the inner zone than in the outer. Igneous layering, steeply inclined to vertical in attiude, and fluxion cumulate texture are especially common in the inner zone. A K-Ar determination on biotite from the outer zone yielded a (recalculated) Devonian apparent age of 383 ± 16 Ma, comparable to K-Ar ages from the Ordovician M'Clintock West body and Cape Richards Intrusive Complex and probably provides only an upper age limit. The crystallization age may be as old as Ordovician.

The Wootton Intrusive Complex (map units Kb* and Kbg, *Yelverton Inlet*) lies within the Mitchell Point Fault Zone, which separates the Mitchell Point gneiss belt from metasediments of Succession 2 of Southwest Pearya. Zircon from a quartz monzonite, showing slight inheritance, provided a lower intercept age of 92.0 ± 1.0 Ma (Turonian). The complex is partly co-eval with the basaltic Strand Fiord Formation of Axel Heiberg Island and the product of a major rifting event.

An undated body of dunite and serpentinite occurs in the Kleybolte Fault Zone of Kleybolte Peninsula (map unit ds, *Cape Stallworthy-Bukken Fiord*). The undated gabbroic Aurland Fiord Pluton (map unit b) of the Northern Heiberg Fold Belt may intrude the Hazen Formation, but the contact is concealed.

Mafic dykes and sills are ubiquiteous. Many are probably Late Cretaceous in age, but older swarms are also present. Dykes with mafic-alkaline composition are common in the pre-Carboniferous inlier at Fire Bay, Emma Fiord (*Cape Stallworthy-Bukken Fiord*). A lamprophyre, possibly of Cretaceous age, occurs on northeastern Marvin Peninsula (map unit K?lamp, *M'Clintock Inlet*).

OROGENIC HISTORY

Evidence for Proterozoic and Early-Middle Ordovician orogenies is restricted to Pearya. Stratigraphic evidence suggests that accretion of Pearya occurred prior to mid-late Llandovery time, and this event probably is indicated by unconformities of Late Ordovician and Early Silurian ages in Pearya and in the Clements Markham Fold Belt. Movements of Late Silurian-Early Devonian and Late Devonian-Early Carboniferous age affected all three sub-provinces.

Grenville Orogeny of Pearya

A Grenville-age orogeny, accompanied by amphibolite-grade metamorphism and extensive granitoid plutonism is apparent from isotopic ages of 1.0 to 1.1 Ga and 965 ± 2 Ma.

Early-Middle Ordovician M'Clintock Orogeny of Pearya

An Early to early Middle Ordovician deformation, the M'Clintock Orogeny, is evident from a high-angle unconformity exposed in the northwestern part of *M'Clintock Inlet*. It is underlain, in different areas, by Successions 2 or 3 or the Thores Suite, and is overlain mainly by Succession 4, but locally by Succesion 5. The age of the deformation is bracketted by the Arenig radiometric age of the Thores Suite and by early Caradoc fossils from the Cape Discovery Formation. Isotopic ages from the syntectonic Ayles Fiord Intrusion and the post-tectonic Cape Richards Intrusive Complex restrict the orogenic interval to late Arenig and possibly early Llanvirn time. The event was accompanied by Barrovian metamorphism, which ranges up to lower amphibolite grade in present exposures.

The tight and complex folds in Successions 2 and 3, which contrast with the undeformed or monoclinal structure of unconformably overlying strata of he Cape Discovery Formation, probably formed at this time. The most important structural feature is a series of faults, including the Oakley River Fault, that place Succession 3 or the Thores Suite in the east and north against Succession 2 in the west and south. These faults, which were re-activated during later events, are interpreted as part of a suture along which a volcanic arc and subarc plutonic complex collided with a shelf succession and its granitoid crystalline basement.

The tightly folded strata of Succcesions 2 and 3 in the western part of *M'Clintock Inlet* and in the eastern part of *Yelverton Inlet* form a highly arcuate belt that is rounded on the outside and angular on the inside, near the upper reaches of Ayles Fiord. This configuration probably is the relict of a re-entrant on an older plate margin.

There are indications that the M'Clintock Orogen is two-sided, i.e., that Succession 3 and the Thores Suite are also in suture-fault contact with the rocks of Successions 1 and 2, exposed farther northeast in *Clements Markham Inlet-Robeson Channel,* but the contacts are covered. The fact that this area was affected by Early-Middle Ordovician orogenic activity is apparent from the presence of the Markham Fiord Pluton.

The M'Clintock Orogeny is comparable in age and character to Early-Middle Ordovician orogenies in the Caledonian and Appalachian mobile belts, but has no counterpart in the Franklinian mobile belt.

Late Ordovician-Early Silurian disturbances in Pearya and Clements Markham Fold Belt and the accretion of Pearya

In Pearya (*M'Clintock Inlet*) differential vertical movements are indicated by unconformities at the base of the Taconite River and Lorimer Ridge formations (Ashgill), and by the sediments of the Cranstone Formation (middle Llandovery). In the southwestern part of the Clements Markham Fold Belt the volcanics and olistostromes of the Fire Bay Formation probably indicate extension and submarine sliding. In the northwestern and northeastern parts of the fold belt an unconformity is tentatively inferred that separates the Danish River Formation from the Kulutingwak Formation and the Mount Rawlinson Complex.

The hypothesis that Pearya is an exotic terrane implies that prior to accretion it was separated by a plate boundary from the rest of the Arctic Islands. A convergent plate margin may be indicated by Caradoc-Ashgill volcanics, such as the Mount Rawlinson Complex and Kulutingwak Formation of the Clements Markham Fold Belt, or the M'Clintock Formation of Pearya. Moreover, basement ages and the M'Clintock Orogeny link Pearya with the Caledonides rather than the Franklinian mobile belt, and the structural trends of Pearya are markedly different from those of the Clements Markham Fold Belt, especially in *Clements Markham Inlet-Robeson Channel*.

The age of accretion probably is bracketted by the Caradoc-Ashgill volcanism and the late Llandovery flyschoid overlap and coincides with the Ashgill-Llandovery movements mentioned above. No extensive compression, i.e., widespread folding and thrust faulting, is apparent during this interval, but strike slip with a limited compressive component is permissible. If so, the movements probably occurred along extensive linear faults, such as the Mount Rawlinson and M'Clintock Glacier faults and the Emma Fiord Fault Zone. These faults, however, were subsequently overlapped by the Danish River Formation and re-activated under different stress regimes, and no evidence for earlier strike slip has been obtained so far.

Late Silurian-Early Devonian events

Northern Heiberg Fold Belt

East of Rens Fiord, member B of the Svartevaeg Formation is unconformably overlain by the Stallworthy Formation. The strike-parallel exposures east of Rens Fiord reveal only a low-angle discordance, but a high-angle discordance perpendicular to strike can be inferred from the marked difference in structural style below and above the unconformity. Member B of the Svartevaeg Formation is tightly and complexly folded, as are the Hazen and Grant Land formations, whereas the Stallworthy forms a monoclinal panel (*Cape Stallworthy-Bukken Fiord,* cross-section A-A'). This contrast is not adequately explained by differences in lithology, but suggests an intervening compressive deformation. The age of the event is bracketted by late Wenlock graptolites near the top of the Svartevaeg Formation and by late Lochkovian or early Pragian ostracoderms about 1.5 km above the base of the Stallworthy. The deformation is tentatively interpreted as a plate collision that terminated the subduction regime indicated by the chemical composition of the Svartevaeg volcanics. If so, the colliding plate probably was overthrust by the North American continental margin. This is apparent from the low grade of metamorphism of the Northern Heiberg Fold Belt and from the polarity of the arc-forearc-subduction zone system.

Clements Markham Fold Belt and Pearya

A major deformation of Clements Markham Fold Belt and Pearya is apparent from a high-angle unconformity at the base of the Sverdrup Basin. In the north coast region, the age of this deformation is bracketted by fossils of Late Silurian (late Ludlow or later) and late Early Carboniferous ages. Present information suggests that two major phases occurred, the first in Late Silurian-Early Devonian and the second in Late Devonian-Early Carboniferous times. Evidence for the first phase, which appears to have been more intensive, has come from three areas in northwestern Ellesmere Island.

The Cape Woods Pluton of Southwest Pearya (*Yelverton Inlet*) has the characteristics of a post-tectonic intrusion. It was derived from Succession 1 and emplaced in Givetian time. Allowing for an incubation period of 10 to 40 million years, the tectonism that caused crustal thickening and melting probably occurred in Late Silurian or Early Devonian time.

The following events are apparent in the Clements Markham Fold Belt in the vicinity of Kulutingwak Fiord and Yelverton Inlet (*Yelverton Inlet*): (1) folding of the Danish River Formation about west-northwest striking axes; (2) a clockwise rotation of these trends on the southeastern side of the Petersen Bay Fault, probably caused by dextral motion of the Mitchell Point gneiss belt along the fault; (3) southeastward thrusting of the heated Mitchell Point gneiss over the Clements Markham Fold Belt, which resulted in a southeastward diminishing Barrovian metamorphism of lower amphibolite to lower greenschist grade. Event 3 affected the Kulutingwak and Danish River formations and can be no older than latest Llandovery. A ^{40}Ar-^{39}Ar analysis on muscovite indicates that the metamorphism is no younger than 424 Ma, late Ludlow.

Farther southeast, in the Clements Markham Fold Belt, the Silurian and older formations show tight and complex chevron folds and underlie the Sverdrup Basin with a high-angle unconformity, whereas the Okse Bay Formation is only gently tilted. The base of the Okse Bay Formation is concealed and strata of latest Silurian to early Givetian age are not exposed in this region. The contrast in structural style indicates either a high-angle unconformity somewhere within the missing interval or a structural detachment.

Devonian-Early Carboniferous Ellesmerian Orogeny

Northern Heiberg Fold Belt

A high-angle unconformity that separates the Carboniferous Emma Fiord or Borup Fiord formations from the Stallworthy Formation and older units probably represents the Ellesmerian Orogeny. The Ellesmerian structures are difficult to distinguish from older structures, but two major thrust faults are attributed to this event. The southwest-verging Svartevaeg Thrust places the Svartevaeg Formation upon the Stallworthy and appears to be overlain by undisturbed strata of the Borup Fiord Formation. The Aurland Fiord Thrust, which places an extensive subhorizonatal sheet of the Aurland Fiord Formation upon the Grant Land and Hazen formations is probably rooted southwest of Aurland Fiord and had northeastward movement. The thrust sheet is cut by unaltered mafic dykes of probable Cretaceous age and seems to overlie Late Devonian intrusions within the Grant Land Formation, but the contacts are not exposed or preserved (*Cape Stallworthy-Bukken Fiord,* Inset E and cross-section B-B').

Pearya and Clements Markham Fold Belt

Ellesmerian deformation probably was extensive, but is demonstrable only in the vicinity of Yelverton Pass where Devonian strata are preserved. There, tilted strata of the Okse Bay Formation, that are of unspecified Givetian-Frasnian age are, overlain with a low-angle unconformity by Carboniferous and Triassic strata of the Sverdrup Basin.

ECONOMIC GEOLOGY

The project area has potential for a variety of mineral deposits, but has not been prospected systematically. Copper potential is indicated by the following showings, found in the course of this project: (1) malachite in volcanics of the Yelverton Formation southwest of Yelverton Inlet (*Otto Fiord,* vicinity of section SWYI); (2) a veinlet of chalcocite and minor bornite in volcanics of member A of the Kulutingwak Formation south of the Kulutingwak Anticlinorium (*Yelverton Inlet,* Inset, loc. Cu); (3) tennantite crystals in dolostone of the Zebra Cliffs Formation north of Thores River (*M'Clintock Inlet,* Inset D, loc. Cu); and (4) malachite in dolomitic rocks of the Markham River Formation northwest of Markham River (*Clements Markham Inlet-Robeson Channel,* vicinity of section MR). Showings (3) and (4) occur within a National Park Reserve that occupies the northeastern part of the project area.

[1] Abbreviated titles of the map-sheets are shown in italics

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