31. PROGRESS IN LOWER PALEOZOIC STRATIGRAPHY, NORTHERN ELLESMERE ISLAND, DISTRICT OF FRANKLIN

Project 730051

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Abstract

Three major depositional phases have previously been distinguished in the Hazen Plateau and southern Grantland Mountains region of northern Ellesmere Island: a phase of nonmarine to shallow marine clastic deposition (Grant Land Formation) and the starved basin and flysch phases of the deep but ensialic Hazen Trough. New fossil identifications indicate that the Grant Land-Hazen contact is middle to late Early Cambrian at Ella Bay, Archer Fiord, but no older than Late Cambrian east of the head of Tanquary Fiord. Most of the Grant Land Formation now appears to be Early Cambrian in age and correlative with the clastic Ellesmere Group of central Ellesmere Island. The Grant Land Formation probably was derived from the ancient Pearya Mountains to the north, and the Ellesmere Group both from the Pearya Mountains and the Canadian Shield. The Hazen-Imina contact is close to the Ordovician-Silurian boundary at some localities and of different Llandoverian ages at others. A thick volcanic unit at Yelverton Inlet, separated from the underlying Grant Land Formation by a tongue of the lower Hazen Formation, extends in age upward to the early or middle Llandoverian. It is overlain by three shallow marine, predominantly sedimentary units the middle of which contains conodonts and corals of middle to late Llandoverian age. The sediments are overlain by the Imina Formation, here divided into three members with a combined age range from late Llandoverian(?) to early Ludlovian. A comparable volcanic-sedimentary succession had earlier been reported from the M'Clintock Inlet region, but the top of the volcanic unit there is early Ashgillian in age and that of the shallow marine sedimentary unit middle or late Ashgillian. The stratigraphic framework of that area has been extended downward into the early(?) Ordovician, but fossils of pre-late middle Ordovician age are lacking. New fossil finds indicate that on Judge Daly Promontory the Imina Formation overlies not the Cornwallis Group but a limestone of Ashgillian age correlative with the lower Allen Bay Formation.

Introduction

This paper reports significant modifications in the lower Paleozoic stratigraphic framework of northern Ellesmere Island. It is based on: (1) field observations in 1977; (2) identifications of fossils collected in 1977 and 1975 (both by Trettin); and (3) re-identifications of fossils collected in earlier years by J.Wm. Kerr, W.W. Nassichuk, and H.P. Trettin. The field work in 1975 and 1977 formed part of GSC Project 730057, designed to complete the reconnaissance geology of northern Ellesmere Island.

The fossil identifications are the most important part of this report. They were made by C.R. Barnes, W.H. Fritz, B.S. Norford, A.E.H. Pedder, J. Riva, R. Thorsteinsson, R.S. Tipnis, and T.T.Uyeno, and their contributions are apparent from the Appendix. J.Wm. Kerr provided an unpublished manuscript on a section south of Greely Fiord, measured in 1962 (Fig. 31.1, area VI). Trettin is responsible for the compilation of the data.

The Director and officers of the Continental Polar Shelf Project are thanked for help during the 1975 and 1977 field seasons. The manuscript has benefitted from critical reading by U. Mayr and A.D. Miall.

Depositional Framework

The oldest known deposits in northern Ellesmere Island, assigned to the Grant Land Formation, are nonmarine and shallow marine in origin. Subsequently three major depositional belts developed, the central Hazen Trough, and unstable shelves bordering it on the southeast and northwest. The Hazen Trough had two main phases of sedimentation, a starved basin phase, represented by the Hazen Formation, and a flysch phase represented by the Imina Formation. The southeastern shelf received mainly carbonate sediments with lesser amounts of craton-derived clastic sediments and some evaporites; its stratigraphic units are extensive laterally. The northwestern belt received volcanic rocks, generally siliceous to intermediate in composition and pyroclastic in origin, carbonate shelf sediments, and shallow marine to nonmarine clastic sediments, all characterized by marked facies changes over short distances. Recent information from the northeasternmost part of this belt (east of M'Clintock Inlet) is not included here because studies there, by U. Mayr and H.P. Trettin, have not yet been completed.

The stratigraphy of the southeastern shelf has been described by Norford (1966) and Kerr (1967, 1968) and that of Hazen Trough and northwestern belt by Trettin (1969a,b, 1971, 1976, 1978, and in press). Interpretative aspects are discussed by Trettin and Balkwill (1979).

Rock Units

Grant Land Formation

Distribution, Thickness, and Lithology This formation was established for clastic sediments in northern Ellesmere Island that underlie the Hazen Formation; its base is not exposed. The type section at Hare Fiord contains about 1100 m of strata, but the actual thickness is probably much greater. Thick successions are exposed in the Grantland Mountains* and northern Axel Heiberg Island, and relatively thin uppermost parts at St. Patrick Bay and Ella Bay, and on northwestern Judge Daly Promontory.

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* Previous spelling Grant Land Mountains; present spelling Grantland Mountains. The Grant Land Formation was named when the earlier spelling still was valid.

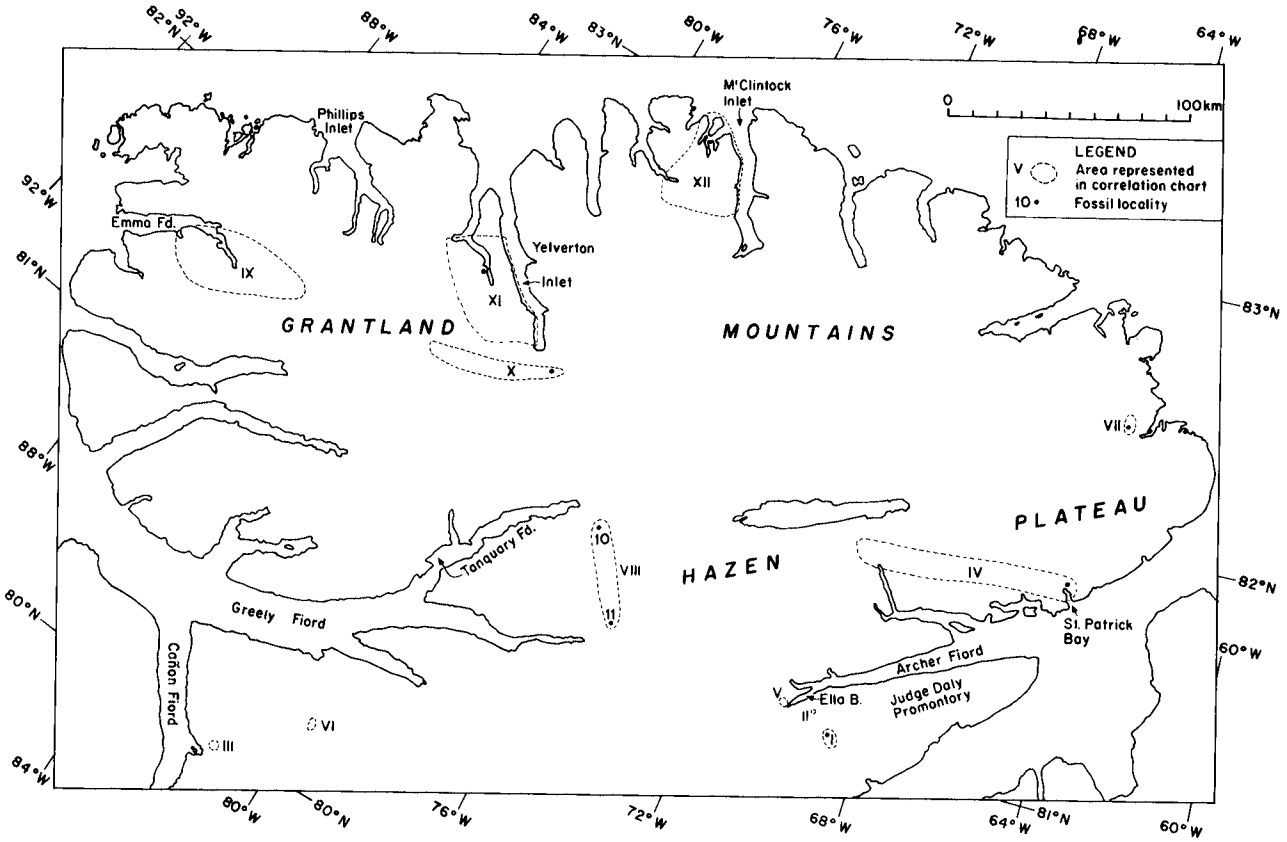


Figure 31.1. *Index.*

The succession in the Grantland Mountains consists mainly of alternating units of quartzose, variably feldspathic sandstone, and green, red and grey phyllite or slate with minor amounts of pebble conglomerate. The sandstones are medium to coarse grained in the lower part of the succession; they decrease both in grain size and abundance stratigraphically upward. The lower and middle parts of the succession probably were deposited by braided rivers; the uppermost part, which underlies deeper water sediments of the Hazen Formation, must be marine.

The strata at St. Patrick Bay, consisting of green and red slate and phyllite, are similar, both macroscopically by and microscopically, to the uppermost part of the formation in the Grantland Mountains.

A key section northwest of the head of Ella Bay was studied in detail in 1977 (Fig. 31.1-31.3). It is about 207 m thick and consists mainly of clayey to sandy, slaty siltstone with small amounts of very fine grained silty sandstone. The rocks are medium light grey to greenish grey and show flat lamination and small-scale cross-lamination, including flaser bedding. Petrographically, they are comparable to the strata at St. Patrick Bay but differ from them macroscopically by the absence of red beds.

Age and Correlation Macrofossils had previously not been found in the Grant Land Formation, and analyses for chitinozoans also were unsuccessful. The formation was tentatively considered as Middle to Late Cambrian in age because graptolites from the lower part of the Hazen Formation suggested that the Grant Land-Hazen contact probably is no older than latest Cambrian. The present collections indicate that this contact is markedly diachronous. At Ella Bay, it clearly is middle to late Early Cambrian (Appendix, identifications 4, 5) and tentatively correlated with a level in the upper part of the Kane Basin Formation (see below, Hazen Formation). East of the head of Tanquary Fiord, on the other hand, it can be no older than Late Cambrian (identification 10). The age of the base of the formation, and the correlation of its lower and middle parts still are a matter of conjecture. At present it is presumed that all of the Grant Land Formation in the south (St. Patrick Bay, Ella Bay, northwestern Judge Daly Promontory), and lower and middle parts of the formation in the Grantland Mountains are correlative with the bulk of the Ellesmere Group (except for the upper part of the Kane Basin Formation).

Provenance of Grant Land Formation and Parts of Ellesmere Group It was previously thought that the Grant Land Formation was derived from northerly sources (the ancient Pearya Mountains) because its clastic sediments are markedly coarser than those of the presumably correlative Parrish Glacier and Copes Bay formations. In spite of the revised correlation, this view still seems to be valid, for three reasons. (1) The lower and middle parts of the Grant Land Formation in the Grantland Mountains are coarser grained than any of the Cambrian clastic units in central Ellesmere Island (including the Ellesmere Group). (2) Paleocurrent determinations are difficult to make in the Grant Land Formation, but a few measurements from north of the head of Tanquary Fiord indicate transport in southerly directions. (3) Plagioclase is more abundant than K-feldspar in most specimens from the Grant Land Formation (Fig. 31.2). Numerous X-ray analyses on various lower Paleozoic and Devonian samples from northern and central Ellesmere Island have shown that this usually is the case with sediments derived from the Pearya orogenic welt; sediments derived from the Pearya orogenic welt; sediments derived from the Canadian Shield, on the other hand, are much richer

in K-feldspar. Probable reasons for this rule of thumb, and limitations to it, are discussed by Trettin (1978, p. 73-74). Briefly, Pearya seems to have included a large proportion of relatively young low grade metamorphic terrains that contained much albite, a feldspar relatively stable under surface conditions and hence preserved in derived sediments. The Arctic part of the Churchill Province, on the other hand, is older (probably Archean) and probably included a higher proportion of terrains of amphibolite or granulite grade. (Present outcrops in southeastern Ellesmere Island are of granulite grade (Frisch et al., 1978).) Such regions usually have a higher K-feldspar content than the low grade terrains and, furthermore, the plagioclase in them is relatively unstable and selectively destroyed during weathering. However, the proportion of plagioclase to K-feldspar in sediments can be changed by postdepositional processes such as metamorphism, metasomatism or selective replacement by clay minerals.

Feldspar composition and facies relationships suggest that the Rawlings Bay Formation of the Ellesmere Group was derived from the Shield whereas the Ritter Bay Formation was derived from the Pearya Mountains. Specimens from the Ritter Bay Formation in area I resemble specimens from the upper part of the Grant Land Formation in areas IV, V, and VIII, not only by the predominance of plagioclase over K-feldspar, but also in various petrographic aspects; for example, a relatively high content of chlorite that is pseudomorphous after mica and occurs in flakes considerably larger than associated other mineral clasts.

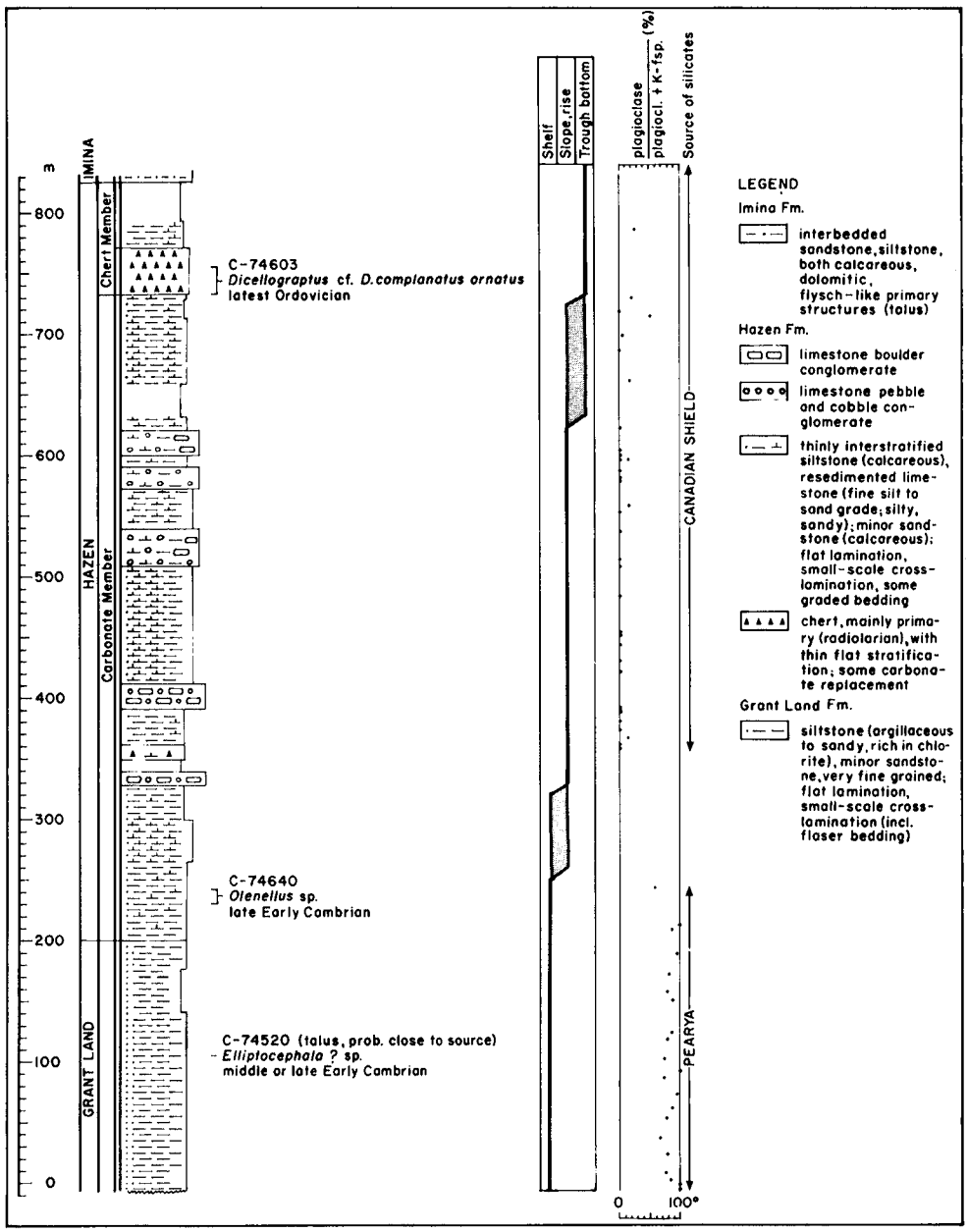


Figure 31.2. *Columnar presentation of section north of head of Ella Bay (Fig. 31.1, area V). Plagioclase/K-feldspar ratios based on peak heights in X-ray diffractograms.*

Hazen Formation

The Hazen Formation comprises a condensed succession of resedimented carbonate deposits, fine grained clastic sediments, and primary and replacement chert in the Hazen Plateau region, that lies stratigraphically between Grant Land and Imina formations. In most areas the formation is divisible into a lower member rich in carbonate rocks and an upper member rich in chert. The carbonate sediments include submarine slides, boulder to pebble conglomerate, and lime packstone, wackestone and mudstone. They were derived from both adjacent shelves, as were the associated clastic sediments. Those parts of the Hazen Formation close to the southeastern shelf are characterized by submarine slides and coarse conglomerates (Fig. 31.8) and by the predominance of K-feldspar over plagioclase in the clastic sediments (Fig. 31.2). Both sediments and fauna indicate deposition in progressively deeper waters (Fig. 31.2).

In 1977, the known outcrop area of the Hazen Formation was extended significantly, especially at Ella Bay and on northwestern Judge Daly Promontory. The original member C of the Zebra Cliffs Formation at M'Clintock Inlet and the former map unit 7 at Yelverton Inlet (Trettin, 1976, Fig. 11) now both are assigned to the Hazen Formation (area X).

Previous fossil identifications suggested that the formation is restricted to the early and middle Ordovician, but the present identifications demonstrate a much wider range – late Early Cambrian to Llandoverian.

At Ella Bay (Fig. 31.1, area V), the base of the Hazen Formation is placed at the base of the lowest (resedimented) limestone. The lower part of the Hazen Formation also differs from the Grant Land Formation by its darker tone (Fig. 31.4). **Olenellus** sp. (Fig. 31.6) was found in slate 32 to

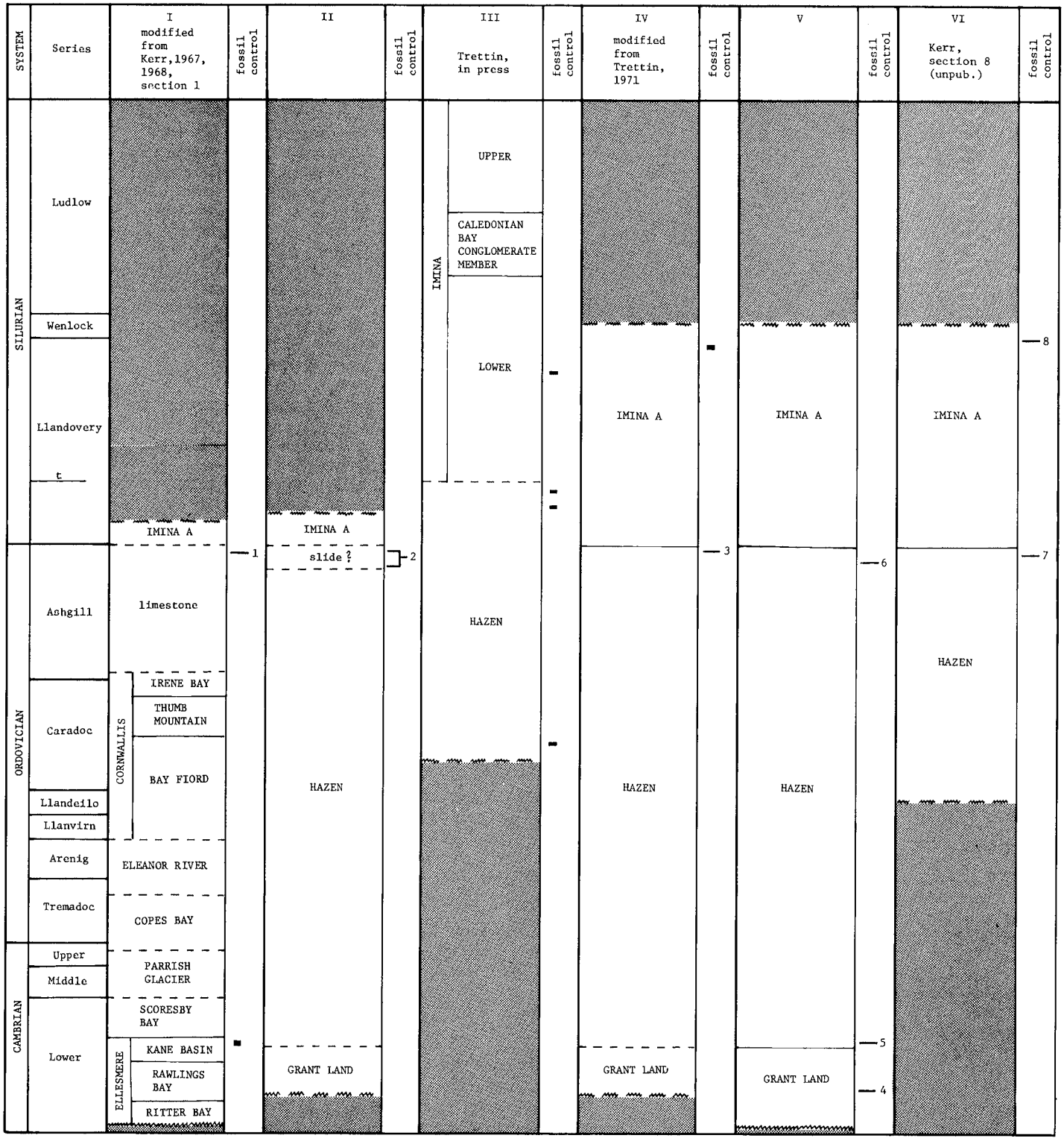


Figure 31.3. *Correlation chart. Age assignments for area I are partly based on studies by Barnes (1974) and Nowlan (1976) in other parts of the Arctic Islands.*

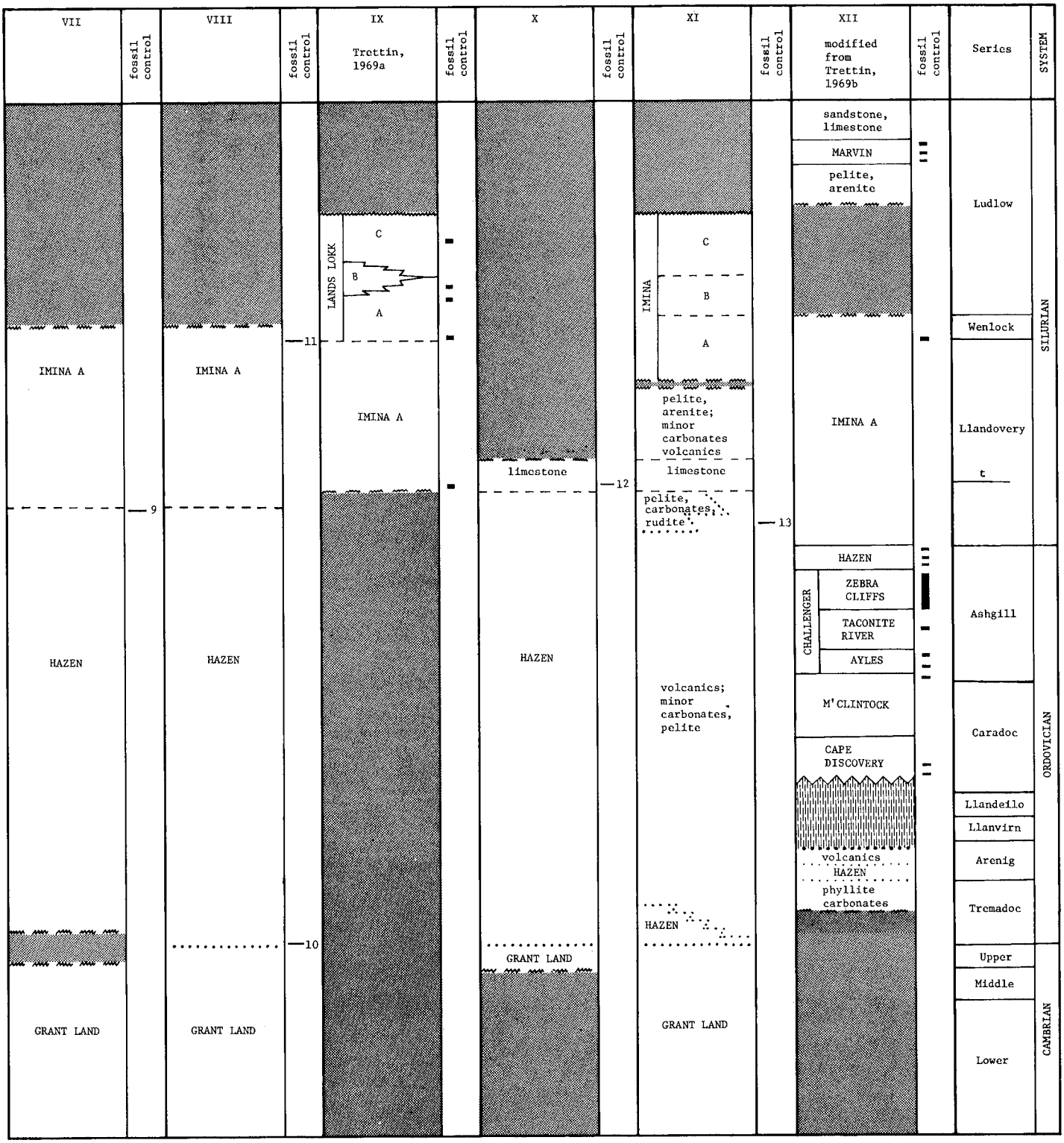


Figure 31.3 (cont'd.)

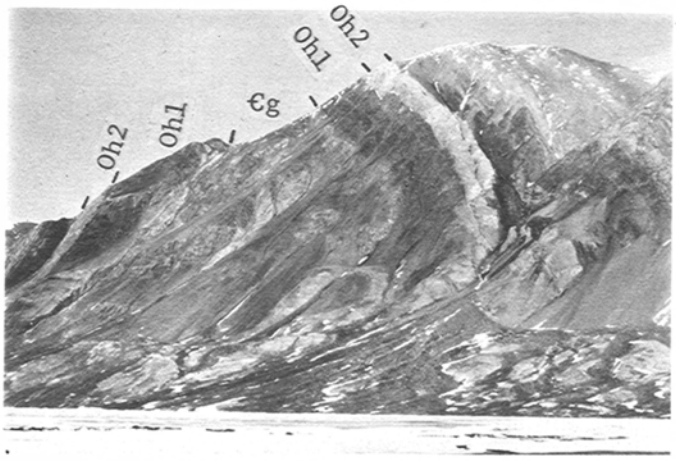
40 m above the base of the formation, and associated trace fossils (Fig. 31.7) show that trilobites lived in this environment so that these fossils are not resedimented. **Olenellus** also occurs in the upper part of the Kane Basin Formation (Kerr, 1967), and the base of the Hazen Formation therefore is tentatively correlated with the base of the **Olenullus**-bearing limestone in the former. The conodonts from the base of the Hazen Formation east of Tanquary Fiord (area VIII, identification 10), on the other hand, indicate an age no older than Late Cambrian and possibly as young as Early Ordovician.

Graptolites of the late Ashgillian **Dicellograptus complanatus ornatus** Zone have been collected from near the top of the formation in four areas (IV, V, VI, XII), suggesting that it is close to the Ordovician-Silurian boundary there. Llandoverian ages for that boundary are inferred at localities III and VII from graptolites (of different ages) and at locality X from conodonts and corals.

Imina Formation

The Imina Formation is a thick succession of sandstone and siltstone with less abundant conglomerate that shows flysch-like primary structures. A suitable type section is not exposed in the type area in northwesternmost Ellesmere Island, but excellent reference sections east of Cañon Fiord have been studied in some detail (Trettin, in press). Detailed studies of very short sections, made on the Hazen Plateau in 1977, confirm that the sediments were transported by concentrated and dilute sediment gravity flows, and probably also by bottom currents.

In northern Ellesmere Island, three informal members, A, B, and C, are presently distinguished. The widely distributed member A consists largely of calcareous and dolomitic sandstone and siltstone. At Emma Fiord, where it is overlain by pelite of the Lands Lokk Formation, it probably is limited to the Llandoverian; elsewhere it probably is late Llandoverian and Wenlockian in age. The most common graptolite in this unit is **Monograptus** aff. **M. priodon** (Bronn) (e.g. identification 11 and references cited).



εg = Grant Land Formation
Ohl = lower recessive unit of Hazen Formation
Oh2 = lowermost limestone conglomerate

Figure 31.4 *Core of Archer Fiord Anticlinorium on southeast side of Ella Bay (Fig. 31.1, area V), looking northeast. GSC 199480*

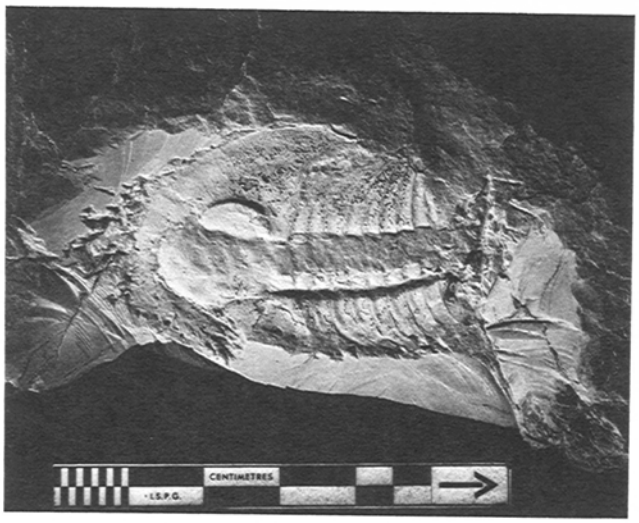


Figure 31.5. ***Elliptocephala****? sp. from Grant Land Formation at Ella Bay section. GSC 58513*

Member B, characterized by a large proportion of pelitic sediments and a low carbonate content of the clastic rocks, is extensively exposed on the north coast of Ellesmere Island where it has been traced from south of Phillips Inlet to south of M'Clintock Inlet. Member C, characterized by the presence of pebble conglomerate and also a low carbonate content, is recognized only southeast of Phillips Inlet. Lithological correlation with parts of the Lands Lokk Formation at Emma Fiord suggests that both units are early Ludlovian in age.

Previous paleocurrent and provenance studies have shown that member A was derived mainly from low grade metamorphic terrains of the Pearya orogenic welt to the north whereas member C, as well as the Caledonian Bay Conglomerate Member of the Imina Formation (area III), and member C of the Lands Lokk Formation, came mainly from lower Paleozoic sources to the west that included the Rens Fiord Uplift of northern Axel Heiberg Island. The westerly provenance probably explains the limited eastward extent of the conglomerates of member C of the Imina Formation.

Ordovician-Lower Silurian Units of Yelverton Inlet Area

A thick succession of variably metamorphosed beds, lying stratigraphically between Hazen and Imina formations, was investigated in the Yelverton Inlet region (XI) mainly in 1975, with some follow-up work in 1977. It is divisible into a lower unit, composed mainly of volcanic rocks, with local shelf carbonates and fine grained clastic sediments, and an upper unit, composed mainly of shelf carbonate and clastic sediments with small amounts of volcanic rocks. The volcanic rocks are separated from the underlying Grant Land Formation by a tongue, about 100 to 200 m thick, of the lower Hazen Formation. Conodonts from limestone, presumably in the uppermost part of the volcanic unit, are of Llandoverian, probably early or middle Llandoverian, age (identification 13). The volcanic rocks are separated from correlative, almost completely chertified strata of the Hazen Formation to the southeast (in area X of Fig. 31.1) by a belt, about 20 km wide, covered with younger and older rocks.

The overlying predominantly sedimentary unit is divisible into three subunits. The lower subunit consists of: phyllitic pelite and sandstone, in part conglomeratic; dolostone; minor amounts of limestone; and local conglomerate of cobble to boulder grade. The last occurs immediately adjacent to a serpentinized diatreme and probably was

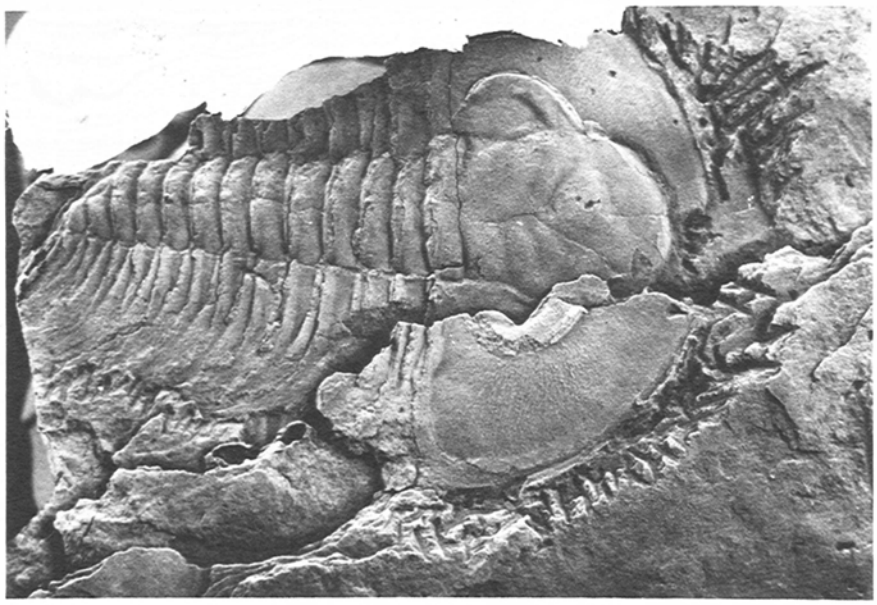


Figure 31.6.

Olenellus *sp. from Hazen Formation, Ella Bay section; XI.65. (GSC 56649; photo 202029-F by W.H. Fritz).*

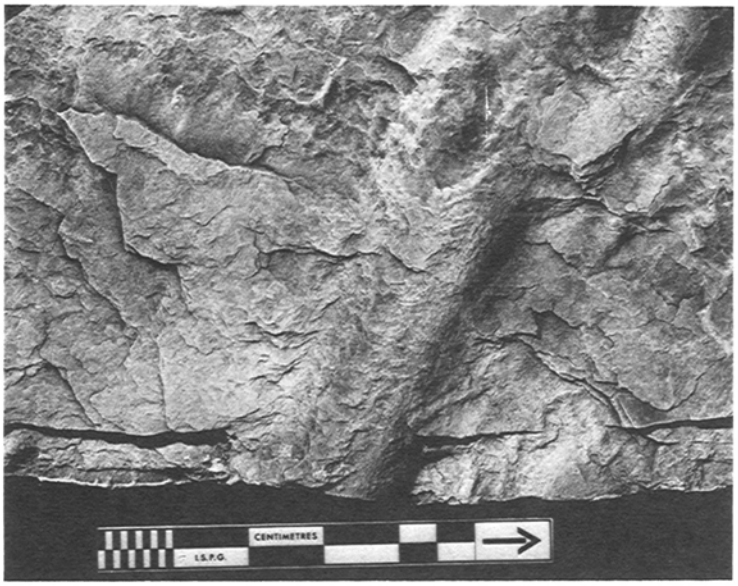


Figure 31.7.

Crawling track of trilobite from ***Olenellus****-bearing beds of Hazen Formation at Ella Bay section.*

formed by an explosion. The conglomeratic pelite and sandstone beds contain phenoclasts of dolostone, siltstone, etc. that are ellipsoidal in cross-section. They differ from typical shallow marine intraformational conglomerate by the poor sorting and random distribution of the phenoclasts. They have been seen in several other areas on the north coast of Ellesmere Island and probably constitute a time marker caused by unusual events – possibly volcanic explosions or earthquakes that set off tsunamis with extensive debris flows in their wake. In some parts of area XI, the lower subunit seems to be absent.

The second subunit consists of marble, tentatively correlated with a shelf limestone that overlies the Hazen Formation south of Yelverton Inlet in area X. Conodonts and corals from the latter area (identification 12) have a middle or late Llandoverian age.

The third subunit is composed of metamorphosed arenaceous and pelitic sediments with lesser amounts of carbonate and volcanic rocks. It probably is overlain by the Imina Formation, but the contact is not exposed.

Lower(?) and Middle(?) Ordovician Units of M'Clintock Inlet Area

The oldest lower Paleozoic beds observed west of M'Clintock Inlet are thinly stratified, greenish, greyish, and purplish pelitic carbonate rocks and related calcareous and dolomitic phyllites with some volcanic rocks that are overlain by dark grey slate and chert beds. The dark grey strata are interpreted as a tongue of the lower Hazen Formation, and the multicoloured beds as shelf equivalents of that unit. These predominantly sedimentary rocks are succeeded by a volcanic unit, in turn unconformably overlain by the upper

***Figure 31.8**. Elongate limestone boulders in Hazen Formation, Ella Bay section, 321-327 m; hammer handle is 30 cm long. GSC 199481*

middle Ordovician Cape Discovery Formation. The upper middle Ordovician to upper Silurian succession in the M'Clintock Inlet area is described by Trettin (1969b).

Ordovician Units of Judge Daly Promontory

On Judge Daly Promontory, the Imina Formation overlies an upper Ordovician shelf limestone unit correlative with the lower Allen Bay formation and not the Cornwallis Group as previously presumed (area I, identification 1). Elsewhere in central Ellesmere Island, the flysch deposits are separated from underlying shelf carbonates by intervening starved-basin, slope, or back-reef basin sediments assigned to Hazen or Cape Phillips Formation; the absence of these deposits in area I remains to be explained. One possible explanation would be that the southeastern slope of the Hazen Trough was so steep in this area that sediments of slope facies could not accumulate on it, but that trough bottom sediments of flysch facies abutted against it laterally. When the shelf margin subsided deeply (as demonstrated, for example, at Cañon Fiord), the trough bottom facies overstepped the shelf facies. Another stratigraphic anomaly on Judge Daly Promontory is the occurrence of shelf carbonates with early middle Ordovician conodonts between Hazen and Imina formations in area II (identification 2). These strata were tentatively interpreted as part of a submarine slide (Trettin in Tipnis, 1978), but more field work is required to verify this.

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Appendix: Summary of Fossil Identifications

The collections were made by Trettin in 1975 or 1977, except where otherwise indicated. Comments accompanying the various paleontological reports have in some cases been abbreviated or left out, but will be reproduced fully in the final reports. For stratigraphic position of the collections, see Figures 31.2 and 31.3.

1 Uppermost part of limestone unit underlying Imina Formation (equivalent to the lower Allen Bay Formation).

GSC locality C-75273: **Bighornia** sp., **Catenipora** sp.; late Ordovician, Ashgillian. (Identified by B.S. Norford)

2 Limestone unit, intercalated between Hazen and Imina formations, upper 20 m of 36 m thick section; possibly submarine slide (cf. Trettin in Tipnis, 1978).

GSC locality C-74617: **Panderodus gracilis** (Branson and Mehl), **Belodina leithi** Ethington and Furnish sensu fructo, **Belodina compressa** (Branson and Mehl), **Belodina monitorensis** Ethington and Schumacher, **Protopanderodus insculptus** (Branson and Mehl).

GSC locality C-74618: **Panderodus gracilis** (Branson and Mehl), aff. **Drepanoistodus forceps** (Lindström), **Oistodus venustus** Stauffer, **"Oistodus"** sp. aff. **"O." nevadensis** Ethington and Schumacher, **Pygodus** sp., **"Roundya" pyramidalis** Sweet and Bergström, **Tetraprioniodus** cf. **T. lindstroemi** Sweet and Bergström, **Periodon aculeatus** Hadding, **Phragmodus** sp.; probably post-middle Llanvirnian, pre-Caradocian because of the presence of **Pygodus.** (Identified by R.S. Tipnis)

3 Hazen Formation, chert member, about 7 m below top of formation.

GSC locality C-64: **Climacograptus hastatus** T.S. Hall, **Climacograptus longispinus hvalross** Ross and Berry, **Orthograptus** cf. **O. amplexicaulis abbreviatus** Elles and Wood, **Glyptograptus** cf. **G. occidentalis** Ruedemann; late Ordovician, late Ashgillian, Zone of **Dicellograptus complanatus ornatus.** (Collected by H.P. Trettin, 1967; reidentified by J. Riva)

4. Grant Land Formation, 94.5 m below top of incomplete section; talus, probably close to source.

GSC locality C-74520: **Elliptocephala**? sp. **Elliptocephala** is known from the Taconic sequence in New York and from boulders in the Levis Formation of the St. Lawrence Lowland, Quebec. At both localities strata containing the genus belong to the **Bonnia-Olenellus** Zone. The assignment of the present specimen is questioned because of the exceptionally wide border furrow on the cephalon, and therefore the age must also be questioned, but it can be stated as probably belonging to either the **Bonnia-Olenellus** or the **Nevadella** Zone; middle or late Early Cambrian (GSC type number 58513; see Fig. 31.5). (Identified by W.H. Fritz)

5 Hazen Formation, carbonate member, 32-40 m above base of formation.

GSC locality C-74640: **Olenellus** sp. (GSC type number 56649; see Fig. 31.6); late Early Cambrian, **Bonnia-Olenellus** Zone. (Identified by W.H. Fritz)

6 Hazen Formation, chert member, 553.5-555.5 m above base of formation.

GSC locality C-74603: **?Climacograptus** sp., **Dicellograptus** cf. **D. complanatus ornatus** Elles and Wood, **Orthograptus** sp.; late Ordovician, probably late Ashgillian, probably Zone of **Dicellograptus complanatus ornatus.** (Identified by B.S. Norford)

7 Hazen Formation, chert member 0-30 m below top of formation.

GSC locality 51962: **Climacograptus hastatus** T.S. Hall, **Climacograptus** of the **longispinus** type, **Climacograptus pacificus** (Ruedemann), **Orthograptus** sp. or some other biserial form; late Ordovician, late Ashgillian, Zone of **Dicellograptus complanatus ornatus.** (Collected by J.Wm. Kerr, 1962; identified by J. Riva)

8 Imina Formation, member A, about 600 m above base.

GSC locality 51963: **Stomatograptus** sp., **Monograptus** cf. **M. priodon** (Bronn); Silurian, latest Llandoverian or earliest Wenlockian. (Collected by J.Wm. Kerr, 1962; identified by R. Thorsteinsson)

9 Hazen Formation, chert member, upper few metres.

GSC locality C-74700: **Monograptus** spp., diplograptid; early Silurian, Llandoverian, older than latest Llandoverian. (Identified by B.S. Norford)

10 Hazen Formation, carbonate member, basal 10 m or so.

GSC locality C-54784: acodiform, oistodiform, drepanodiform specimens; Late Cambrian to Late Ordovician, possibly Early Ordovician. (Identified by C.R. Barnes)

11 Imina Formation, member A; position unknown.

GSC locality C-54052: **Monograptus** aff. **M. priodon** (Bronn); Silurian, late Llandoverian or Wenlockian. (Identified by B.S. Norford)

12 Unnamed limestone overlying Hazen Formation (map unit 8 of Trettin, 1976, but not Marvin Formation, as previously assumed).

GSC locality C-54790: **Aulacognathus** sp., **Belodella**? sp., **Belodina**? sp., **"Carniodus"**? sp., **Panderodus simplex** (Branson and Mehl), **P.** sp.; early Silurian, late Llandoverian (Telychian) or slightly older, **celloni** Zone or slightly older. **Aulacognathus** sp. differs in some important features from **Aulacognathus bullatus** Nicoll and Rexroad and may be slightly older. **Aulacognathus bullatus** has been reported from the **Icriodella inconstans** Zone of Aldridge (1972), of C_5 subdivision of the upper Llandovery Series (Telychian Stage). The **inconstans** Zone is identical with the **celloni** Zone. The specimens identified as **Belodina**? sp. and **Belodella**? sp. are new and morphologically transitional between "typical" **Belodina** (restricted to the Ordovician) and **Belodella. "Carniodus"**? sp. is fragmentary, so a definite assignment cannot be made. **"Carniodus"** has been reported from the **celloni** Zone and the underlying Bereich I of Walliser (1964, 1971). (Identified by T.T. Uyeno)

GSC locality C-54807 (same locality as C-54790): **Ecclimadictyon pandum** Nestor, **Favosites gothlandicus** Lamarck, **Angopora hisingeri** (Edwards and Haime) (sensu lato of Stel, 1978, p. 5b), **Paleofavosites multiporus** (Sokolov), **Halysites** sp. cf. **H. suessmilchi** Etheridge; early Silurian, Llandoverian, probably equivalent to Raikküla "Stage" of Estonia (see below).

GSC locality 74814 (approximately same location and stratigraphic level as C-54790): **Favosites gothlandicus** Lamarck, **Favosites subfavosus** Klaamann, **Halysites** sp. cf. **H. suessmilchi** Etheridge, **Propora** (sensu lato) sp. nov., **Pseudophaulactis** sp. indet., **Pseudopilophyllum** sp. nov., **Craterophyllum vatium** McLean; early Silurian, Llandoverian, upper Raikküla or Adavere "Stage" of Estonia (=middle or upper Llandovery). This fauna is related to that of the Offley Island Formation of western north Greenland (Poulsen, 1941; McLean, 1977). The specimens of **Favosites gothlandicus** are small and have extremely fine septral apparatus. Such forms, as well as **Paleofavosites multiporus** and **Favosites subfavosus**, are known from the Raikküla "Stage" in Istonia (Klaamann, 1964). Cocks et al. (1971, Fig. 9) correlate the Raikküla "Stage" with an interval in the middle Llandovery, encompassing the **cyphus** to **convolutus** graptolite zones of Britain, and Viyra (1977) has established a correlation between the "bottom part" of the overlying Adavere "Stage" and the European **celloni** conodont Zone, which is approximately equivalent to the British upper Llandoverian **inconstans** Zone (Aldridge, 1975). [Collected by W.W. Nassichuk, 1966 (see Nassichuk and Christie, 1969) and re-identified by A.E.H. Pedder; full report in Pedder, in prep.].

13 Limestone in fault slice of unnamed volcanic unit in Yelverton Inlet region; probably from upper part of unit.

GSC localities C-54800, C-54801: **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 Llandoverian. 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 (op. cit.) 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 Llandoverian-early Wenlockian age. The tentative age assignment for this limited material is based on the **Astropentagnathus** n. sp. (Identified by C.R. Barnes)