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UPPER PALEOZOIC AND MESOZOIC STRATIGRAPHY IN THE YELVERTON PASS REGION, ELLESMERE ISLAND DISTRICT OF FRANKLIN

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ABSTRACT

Upper Paleozoic and Mesozoic formations in the Tanquary Fiord - Yelverton Pass area of the Sverdrup Basin include rocks of both marginal and basinal facies with a maximum thickness of about 11,000 feet. Formational thicknesses are variable, particularly near the basin margin, and all formations are separated by disconformities. The entire upper Paleozoic - Mesozoic sequence is structurally conformable internally. A late Paleozoic - early Mesozoic structural high, the Tanquary structural high, lying between Yelverton Pass and the head of Tanquary Fiord, is named. Upper Triassic beds rest unconformably on lower Paleozoic basement rocks over most of this feature, whereas, adjacent to the high, the basement rocks are unconformably overlain by upper Paleozoic beds.

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INTRODUCTION

This report describes the geology of an area of some 500 square miles that includes part of Yelverton Pass[1] and the head of Tanquary Fiord in northern Ellesmere Island (see Figure 1). The centre of this area is about latitude 81° 40' N, and longitude 78° 00' W. The report deals mainly with the stratigraphy of upper Paleozoic and Mesozoic rocks; in addition, major structural features are discussed. It is based upon work carried out jointly by the authors in the summer of 1963 and by Nassichuk in 1966. At that time Nassichuk was a member of a field party on Operation Grant Land, an airborne mapping project directed by Christie.

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Yelverton Pass lies along a series of deeply glaciated and glacierized valleys that connect the head of Yelverton Bay on the north coast of Ellesmere Island with the head of Tanquary Fiord, a northeasterly extension of the Greely Fiord and Nansen Sound systems. The elevation in the pass is a little less than 2,000 feet above sea level. The valley system transects the northeasterly-trending United States Range, dividing its ice cap into two major parts and, thus, constitutes a major topographic feature in the landscape of northern Ellesmere Island.

There is no permanent settlement in the area. Since 1963, however, the Defence Research Board has maintained a scientific station at the head of Tanquary Fiord which is usually occupied during parts of the spring and summer seasons. This station is resupplied by icebreaker each year.

Geological mapping and stratigraphic studies on Ellesmere Island were extended to the head of Tanquary Fiord in 1962 by R. Thorsteinsson, E.T. Tozer, H.P. Trettin, and J.W. Kerr, all of the Geological Survey of Canada. During aerial reconnaissance in 1962, Thorsteinsson and Tozer observed a thick sequence of upper Paleozoic and Mesozoic strata near Yelverton Pass and suggested that this area be visited.

Accounts and summaries of upper Paleozoic and Mesozoic rocks of Ellesmere Island have been written recently by Thorsteinsson and Tozer (in press), Thorsteinsson and Tozer (1957, 1960), and Tozer (1960, 1961, 1963a, and 1963b). In these are references to earlier works by Schei, Kittl, Nathorst, Herr, Bentham, Troelsen and others. Recent studies of the lower Paleozoic eugeosynclinal rocks of northern Ellesmere and northern Axel Heiberg have been published by Trettin (1966, 1967).

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[1] Name approved by the Canadian Permanent Committee on Geographical Names. Yelverton Pass is defined as the immediate vicinity of the divide separating north- and south-flowing waters in the deep depression that joins the heads of Tanquary Fiord and Yelverton Bay.

ACKNOWLEDGMENTS

The writers are indebted to Dr. R. Thorsteinsson who suggested the field project, identified fusulinids, and made available unpublished data from adjacent areas. The Defence Research Board and particularly Dr. G. Hattersley-Smith generously provided logistic support and accommodation at the scientific station at the head of Tanquary Fiord. Drs. E.W. Bamber, W.C. Bell, H. Frebold, J.A. Jeletzky, D.C. MacGregor, B.S. Norford, E.T. Tozer, T.T. Uyeno and Mr. T. P. Chamney, all of the Geological Survey of Canada, and Dr. A. Logan of the University of New Brunswick, identified various fossils for this report. Skillful piloting of a DeHavilland Beaver aircraft by 'Terry' Hendrigan of Atlas Aviation, Resolute Bay enabled the authors to obtain data from widely separated areas in a short time. A helicopter ably piloted by W. Myers of Autair Helicopters Ltd., St. Jean, P.Q. provided support in 1966.

STRATIGRAPHY

The Upper Paleozoic and Mesozoic rocks of the Tanquary Fiord and Yelverton Pass regions were deposited in the Sverdrup Basin, which underlies much of the Queen Elizabeth Islands (see Fig. 1). Strata of the Sverdrup Basin lie with angular unconformity on lower and middle Paleozoic rocks of the Franklinian Geosyncline. Between late Mississippian[1] and early Tertiary time some 40,000 feet of sediments were deposited in central parts of the basin. In the area under discussion, about 11,000 feet of rocks belonging to the Pennsylvanian, Permian, Triassic, Jurassic and Cretaceous systems are known to occur. Although rocks within the Sverdrup Basin have not yet been completely mapped, field work in the last decade, mostly by Thorsteinsson and Tozer, has led to the establishment of a generalized stratigraphic framework and facies scheme. A comprehensive summary has been written by Thorsteinsson and Tozer (in press), and the present writers have found that the facies of upper Paleozoic and Mesozoic rocks in the vicinity of Tanquary Fiord and Yelverton Pass are consistent with the regional belts outlined by the earlier workers.

Upper Paleozoic strata at the head of Tanquary Fiord, near the eastern margin of the Sverdrup Basin, include three formations with a total thickness of about 1,500 feet. The Belcher Channel Formation is predominantly limestone, whereas the underlying Canyon Fiord Formation and the overlying Sabine Bay Formation consist mainly of sandstone. At Yelverton Pass, about 20 miles northwest of the head of Tanquary Fiord and near the axis of the basin, the upper Paleozoic section is about 5,000 feet thick and three formations are represented: Borup Fiord[2] Formation (sandstone, shale, conglomerate), Nansen[2] Formation (sandstone, limestone) and Trold Fiord[2] Formation (sandstone, limestone). Variations in thickness of upper

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[1] Exposures of non-marine rocks of this age, apparently thin and of limited areal extent, are known on northern Axel Heiberg Island and northern Ellesmere Island (see Kerr and Trettin, 1962).

[2] New formational names; discussed in later sections of the report.

Paleozoic rocks between the marginal and axial facies belts of the basin, such as that just described, are widespread in the Sverdrup Basin, as are disconformities that mark transgressions and regressions of late Paleozoic seas. Differences in thickness between the upper Paleozoic basin marginal sequence of rocks at Tanquary Fiord and the upper Paleozoic basinal sequence at Yelverton Pass are emphasized by the absence of rocks of this age, with the exception of a few outliers, over a prominent structurally high region between the two areas. Over most of the structural high, Upper Triassic rocks (Heiberg Formation) rest unconformably on lower Paleozoic basement rocks of the Franklinian Geosyncline (see fig. 3). This structural feature, which appeared in late Paleozoic and early Mesozoic time, has been described by Christie (1964b) and is here named the Tanquary structural high (see fig. 4). The effects on sedimentation of this high, which was apparently formed by local tectonic activity, are distinct from the effects caused by widespread marginal emergence and submergence. The structurally high region is similar in some respects to the Boothia uplift on the southern margin of the basin, where Paleozoic formations are thin or missing over much of the uplifted area and thicken considerably to the east and west.

The Triassic, Jurassic, and Cretaceous Systems are represented by clastic marine and non-marine rocks having a thickness of about 6,000 feet between Yelverton Pass and the head of Tanquary Fiord. The Triassic units, all of which are composed essentially of sandstone, include the Bjorne, Schei Point, and Heiberg Formations. The Bjorne and Schei Point Formations represent near-shore facies in the Lower and Middle Triassic respectively, whereas the Upper Triassic Heiberg Formation is mainly non-marine and occurs both in central and marginal regions of the Sverdrup Basin (Tozer, 1961). The Jurassic and Lower Cretaceous rocks, a monotonous sequence of black shales with some sandstone beds, are referred to herein as "Jurassic-Cretaceous Shales and Sandstone". The presence of ammonites, pelecypods, and foraminifera in the shales suggest that equivalents of the Savik, Awingak, and Deer Bay formations, known elsewhere in the basin, may be present. The youngest Mesozoic unit in the area, the Isachsen Formation, is composed of non-marine sandstone of Lower Cretaceous age.

Pre-Carboniferous Basement Rocks

The 'basement' in the context of this paper is the terrane upon which the basal beds of the Sverdrup Basin were deposited: in general terms, the folded and eroded rocks of the Franklinian Geosyncline.

The Pre-Carboniferous basement rocks in the Tanquary Fiord-Yelverton Pass region are mainly impure sandstones, lithic arenites, and shales of the Cape Rawson Group[1]. The Cape Rawson rocks are tightly folded and the folds are overturned to the south. The rocks are slightly metamorphosed. North of Yelverton Pass, the basement includes bedded black chert with intercalated black shale beds overlain unconformably by 200 feet of light grey, stromatoporoidal, biohermal Silurian limestone.

[1] "Cape Rawson Group" is well established in the literature as a reconnaissance term but the usage of "Group" does not conform to the accepted rules of stratigraphic nomenclature and is herein used provisionally.

Trettin (1967) noted that thinly bedded chert is relatively common in the Cape Rawson Group. A lower Ordovician or older age for the basement rocks at the head of Tanquary Fiord was suggested (op. cit. p. 213) because of their stratigraphic relationship with Ordovician graptolite-bearing beds of the group at Archer Fiord (see Fig. 1).

At M'Clintock Inlet, some 50 miles north of Yelverton Pass, chert beds have been observed in the pre-Middle Ordovician basement complex (Trettin, 1966).

Silurian limestones such as occur in the basement complex of Yelverton Pass are known at a few other localities on northern Ellesmere Island. Christie (1964a) reported Upper Silurian limestones from the north side of Clements Markham Glacier[1] which appear to be on trend with limestones at Yelverton Pass. Trettin (1967) recorded stromatoporoidal patch reefs that contain the Silurian brachiopod Conchidium in the M'Clintock Inlet area. Early and Middle Silurian graptolites occur in carbonate rocks of the undivided Allen Bay-Read Bay Formations on the east side of Canyon Fiord, some one hundred miles to the south of the Yelverton Pass area (J.W. Kerr, pers. comm.).

Fossils were collected from the stromatoporoidal limestone unit north of Yelverton Pass, mentioned earlier; the fossil locality (GSC locs. 74813, 74814) is on the north side of the valley joining Yelverton Pass and Yelverton Bay, 13 miles northwest of Yelverton Lake. The fossils were identified by B.S. Norford, Geological Survey of Canada, who reported a Silurian age:

Favosites sp.
Halysites sp.
Propora sp.
?Coenites sp.
rhynchonellid brachiopod
cerioid and phaceloid rugose corals
echinoderm fragments
gastropods
stromatoporoid

In addition, T.T. Uyeno, Geological Survey of Canada, identified the conodont Panderodus from the same limestone (GSC loc. 78414). This genus is known to range from Middle Ordovician to Middle Devonian.

Upper Paleozoic rocks north of the Yelverton Pass region

Although a considerable amount of information on upper Paleozoic stratigraphy and biostratigraphy of the Sverdrup Basin has been obtained within the last decade (see Douglas et al., 1963), relatively little has been obtained pertaining to the

[1] Fossiliferous Silurian limestone at the entrance of Colan Bay, near Alert (Christie, 1964, p. 28; Blackadar, 1954, p. 10) is now known to be drift.

region north of the area studied in this report other than that obtained from reconnaissance surveys and a few widely scattered fossil localities (see Blackadar, 1954; Christie, 1957, 1964a). Formation relationships in the northern region, particularly on the north coast of Ellesmere Island, remain uncertain, but in general terms the nomenclatural and facies scheme devised for upper Paleozoic rocks of the Sverdrup Basin (Thorsteinsson and Tozer, in press) are applicable. Detailed stratigraphic studies at several places in northern Ellesmere Island allow some general remarks on the stratigraphy of the northeastern part of the Sverdrup Basin.

Stratigraphic relationships along the presumed northeast margin of the Sverdrup Basin, in the area extending from Tanquary Fiord northeastward to Lake Hazen and Feilden Peninsula, generally resemble those in the southern and southwestern marginal facies belt. At the head of Tanquary Fiord and near Henrietta Nesmith Glacier, north of Lake Hazen, the predominantly clastic Canyon Fiord Formation rests unconformably on folded Cape Rawson rocks and is overlain by limestones and argillaceous limestones of the Belcher Channel Formation. The Guide Hill Group[1], comprising predominantly red-weathering sandstone and conglomerate, and the Feilden Group comprising carbonate rocks, both mapped by Blackadar (1954) in the Feilden Peninsula region, are probably equivalent to the Canyon Fiord and Belcher Channel Formations respectively, although the relationships proposed are necessarily tentative at this stage of reconnaissance mapping. Beds considered by Feilden and de Rance (1878, p. 559) to underlie the Guide Hill and Feilden Groups were named the Dana Bay beds; this unit has since been mapped by Blackadar and is discussed by him and others (Blackadar, 1954, p. 13; Kerr and Trettin, 1962, p. 249; Christie, 1964a, p. 35), but its stratigraphic position and significance is still uncertain.

Isolated occurrences of a heterogenous, mainly red-weathering clastic sequence of rocks, the Borup Fiord Formation, are known to extend from Lands Lokk on the northwestern extremity of Ellesmere Island northeastward at least to Markham Bay. This formation is characteristic of the axial regions of the Sverdrup Basin, and appears to be slightly older than the basin-marginal, Canyon Fiord Formation. At Lands Lokk and at Yelverton Pass the Borup Fiord Formation is overlain by sandstone and limestone of the Nansen Formation. Similar relationships are found at Cape Nares and three miles south of Ward Hunt Island where Borup Fiord conglomerate and sandstone is overlain by limestone of the Nansen Formation. About 2,000 feet of limestone on Ward Hunt Island contain, in the lower 300 feet, Middle Pennsylvanian (Moscovian) fusulinids that were described by Thompson (1961); the entire sequence is presemably equivalent to the Nansen Formation.

A unit of gypsiferous rocks several hundred feet thick is exposed discontinuously between Ayles Fiord and Clements Markham Inlet, and in the United States Range south of M'Clintock Inlet (H.P. Trettin and G. Hattersley-Smith, pers. comm.). The evaporite unit overlies a thick sequence of shaly limestone, calcareous shale, compositionally immature sandstone, evaporites, solution breccia and minor conglomerate (the Borup Fiord Formation) at M'Clintock Inlet and, thus, may be equivalent to part of the Nansen Formation. The stratigraphic relationships elsewhere in the region, however, are unknown.

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[1] 'Group' is used as a reconnaissance term at this locality, and does not conform to the accepted rules of stratigraphic nomenclature.

Sandstones equivalent to the Sabine Bay Formation or perhaps to the younger Assistance Formation overlie carbonate beds of the Belcher Channel Formation at Henrietta Nesmith Glacier. Comparable sandstone units have not been found in north coastal Ellesmere Island, which was presumably nearer the axis of the Sverdrup Basin. A section of thinly-bedded black chert and grey, unfossiliferous silty limestone, several hundred feet thick occurs at M'Clintock Inlet; however these beds, studied only locally, cannot be assigned to any established formation and their stratigraphic relationships are unknown.

Upper Paleozoic rocks at the head of Tanquary Fiord

Upper Paleozoic rocks are thin or absent over the Tanquary structural high, the eastern extremity of which is marked by a northeast-trending valley tributary to the head of Tanquary Fiord (see fig. 4); over the structural high, Triassic sandstone beds rest directly on folded Cape Rawson rocks.

Moderately to steeply dipping upper Paleozoic beds assigned to the Canyon Fiord, Belcher Channel and Sabine Bay Formations are exposed east of the valley noted above, and trend parallel to it; they form a limb of a south-plunging, faulted anticline. The valley itself marks a major fault zone that appears to be a branch of the Lake Hazen fault zone (Christie, 1964a, p. 65), a major mountain-front fault that can be traced southwestward from Lake Hazen and that crosses Tanquary Fiord about 6 miles from its head.

Canyon Fiord Formation

The Cayon Fiord Formation[1] was named by Troelsen (1950) for conglomerate, sandstone and impure limestone that unconformably overlies lower Paleozoic rocks of the Franklinian Geosyncline. The type section is in Canyon Fiord, central Ellesmere Island where the formation is about 3,000 feet thick. Canyon Fiord strata are discontinuous along the southern and eastern margins of the Sverdrup Basin; occurrences are on Melville, Devon and Ellesmere Islands (Tozer and Thorsteinsson, 1964; Nassichuk, 1965). According to Thorsteinsson (oral comm.) the formation is best developed in central regions of Canyon Fiord where it is at least 3,000 feet thick and ranges in age from Namurian to Sakmarian.

The Canyon Fiord Formation is locally discontinuous and lithologically variable in the area of study. It is well exposed on a ridge about two miles east of the head of Tanquary Fiord, where the unit is about 500 feet thick and rests with pronounced angular unconformity on green-weathering phyllitic shales and sandstones of the Cape Rawson Group. The lower two-thirds of the formation, conspicuously red-weathering, consists essentially of thick-bedded,coarse, feldspathic sandstone, and chert-limestone-pebble conglomerate with a sandy matrix. The upper one-third of the

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[1]A comprehensive statement on the distribution and relationships of the Canyon Fiord Formation was provided by Tozer and Thorsteinsson (1964, p. 93).

formation includes sandstone similar to that in the lower part and, in addition, fossiliferous, impure carbonate rocks. The latter rocks are thick-bedded limestone breccias containing brachiopods and corals, and thin-bedded, finely crystalline limestone, in part crinoidal.

The basal, clastic beds are absent and fossiliferous limestone rests directly on truncated basement rocks for about two miles along strike of the bedding and south of the ridge described above. Such marked variation in thickness is evidently characteristic of the Canyon Fiord Formation in the region of the head of Tanquary Fiord.

Conglomerate with chert and limestone pebbles, like that at Canyon Fiord, occurs on the Tanquary structural high about 28 miles northwest of the head of Tanquary Fiord. Less than 50 feet of conglomerate are exposed at the locality examined, and this is overlain by about 200 feet of light grey weathering Nansen limestone containing Triticites; however, due to faulting, these are minimum measured thicknesses.

Belcher Channel Formation

The Belcher Channel Formation was named by Harker and Thorsteinsson (1960) for limestone and quartzose sandstone with Lower Permian fossils. The type section of the formation is on Grinnell Peninsula, Devon Island, where it is about 600 feet[1] thick. The formation is discontinuous along the southern and eastern margins of the Sverdrup Basin and occurs on Melville, Helena, Devon and Ellesmere Islands (Harker and Thorsteinsson, 1960; Tozer and Thorsteinsson, 1964; Nassichuk 1965, 1967). The Belcher Channel Formation is best developed in central Ellesmere Island where it is nearly 2,000 feet thick and ranges in age from late Carboniferous (Orenburgian) to Lower Permian (Artinskian) (Thorsteinsson, pers. comm.).

The Belcher Channel Formation in the vicinity of the head of Tanquary Fiord is less than 500 feet thick and consists of fossiliferous limestone with some very calcareous sandstone. Limestones are variable in composition and lithology: in some sections relatively pure, medium- to thick-bedded limestones predominate, while in others, they are thin-bedded and sandy. Locally, fissile, argillaceous limestone beds are present. Both the clastic and the crystalline rocks of the Belcher Channel Formation are fine-grained. Colours of the limestones vary from neutral grey to light yellowish grey and mottled grey, and of the argillaceous limestones, dark grey or black. Sandy varieties are green-grey.

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[1] Harker and Thorsteinsson (1960) subdivided the type section of the formation into three lithologic units, the lowest of which was a limestone and chert pebble-conglomerate. Thorsteinsson (pers. comm., 1964) after studying Permian rocks on Ellesmere Island suggested to one of the authors (Nassichuk) that the lower conglomerate unit might logically be assigned to the Canyon Fiord Formation. Nassichuk re-studied the type Belcher Channel Formation in 1964 and indicated (Nassichuk, 1965) assignment of the conglomerate to the Canyon Fiord Formation.

The entire formation is very fossiliferous, and numerous fossil collections were obtained; only preliminary examinations of these have been made. Corals collected from near the base of the formation two miles east of the head of Tanquary Fiord (GSC Loc. 58890) closely resemble species known to occur in the type Belcher Channel (Bamber, pers. comm.). Fossils collected by Ekblaw in 1917 near the head of Tanquary Fiord (Ekblaw, 1918; fusulinids in the collection identified later by Troelsen: 1950, p. 69) undoubtedly are from the Belcher Channel Formation.

Sabine Bay Formation

The Sabine Bay Formation was named by Tozer and Thorsteinsson (1964) and includes beds of chert pebble-conglomerate and quartzose sandstone with minor coal seams that disconformably overlie the Belcher Channel Formation. The type section, on the eastern side of Sabine Peninsula, Melville Island, is 400 feet thick. A few minor limestone beds near the base of the type section have yielded ammonoids that indicate an Artinskian[1] age (Nassichuk, 1965).

The Sabine Bay Formation probably is equivalent to the lower part of the Assistance Formation and is exposed only as isolated occurrences on Melville and Ellesmere islands, near the southern and eastern margins of the Sverdrup Basin. On Ellesmere Island it extends in a narrow belt from south of Canyon Fiord, northward past Tanquary Fiord, and at least to Henrietta Nesmith Glacier in the Lake Hazen region.

In the vicinity of the head of Tanquary Fiord the Sabine Bay Formation, comprising unfossiliferous sandstones of various colours, rests on the Belcher Channel Formation and ranges in thickness from a feather edge to about 600 feet. It is disconformably overlain by sandstone beds of the Triassic Bjorne Formation. Best exposures are about 2 miles east of the head of Tanquary Fiord where the formation comprises white, partly dolomitic, resistant quartzose sandstones that are well-bedded and fine to medium grained. At this locality the formation weathers white to pale grey. Seven miles along strike to the northeast the formation consists predominantly of grey to dark grey quartzose sandstone with a few beds of white sandstone. At the latter locality, in addition, pale green argillaceous sandstone and maroon and black shale are interbedded throughout.

Upper Paleozoic rocks at Yelverton Pass

In the area of study, the western extremity of the Tanquary structural high is at Yelverton Pass (<u>see</u> fig. 4). Upper Paleozoic formations are thin or absent in the immediate vicinity of the pass; however, only a few miles to the north (3 miles north

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[1]See also other data on the age of the type Sabine Bay Formation (Tozer and Thorsteinsson, 1964, p. 104).

of Yelverton Lake[1]) nearly 2,000 feet of clastic rocks are assigned to the Borup Fiord and Nansen formations. The upper Paleozoic section thickens northwestward from the pass and at the northernmost section studied, some 13 miles northwest of Yelverton Lake, about 5,000 feet of beds are exposed and are divisible into three formations. The lowest unit rests unconformably on Silurian limestone and comprises red-weathering conglomerate, sandstone, and siltstone (Borup Fiord Formation); the middle one comprises grey sandstone and limestone (Nansen Formation); and the upper one is a thin unit of skeletal limestone and glauconitic sandstone (Trold Fiord Formation). Thus, traversing north from Yelverton Pass, one leaves a region that was emergent in late Paleozoic time - the Tanquary high - and enters one that was subsident or relatively stable.

The striking and abrupt variations in thickness of upper Paleozoic formations can be attributed to removal by erosion rather than to thinning due to onlapping. That is, on the Tanquary high, already-deposited beds were elevated by vertical movement on faults and the formations were entirely or partially stripped by subaerial processes. Major faults along which such movement might have occurred are evident at Yelverton Pass and northeast of Tanquary Fiord. Considerable stratigraphic displacement is evident on some of these faults where late Paleozoic and basement rocks are thrust against Jura-Cretaceous shales and sandstones. Although this displacement evidently occurred in Cretaceous or later time, earlier movement relating to the Tanquary high might have occurred on the same or subsidiary faults.

Borup Fiord Formation

The Borup Fiord Formation was named by Thorsteinsson and Tozer (in press) for a heterogenous, red-weathering assemblage of conglomerate, sandstone and siltstone. The formation is widely exposed in northern regions of Axel Heiberg and Ellesmere Islands, near the axis of the Sverdrup Basin, and rests either on upper Mississippian rocks or on older rocks of the Franklinian Geosyncline. The type section, which is 540 feet thick, is on the north side of Hare Fiord on northwestern Ellesmere Island. According to Thorsteinsson (oral comm.) the Borup Fiord Formation is of Namurian age and predates the basin marginal Canyon Fiord Formation.

Three miles north of Yelverton Lake the Borup Fiord Formation consists of recessive, thin-bedded, red- and green-weathering sandstone, siltstone, and shale with minor conglomerate. There the unit is faulted against younger beds so that the base is not exposed; about 1,000 feet of the formation is evident. Conformably overlying and contrasting with the Borup Fiord Formation at that locality are thickly bedded white sandstones of the lower part of the Nansen Formation.

[1]Name approved by the Canadian Permanent Committee on Geographical Names

Thirteen miles north of Yelverton Lake the Borup Fiord Formation is 1,500 feet thick and rests unconformably on Silurian limestones. The formation there consists of red-weathering sandstone and siltstone with interbedded conglomerate. Conglomerate beds near the base of the unit are relatively thick and conspicuous. The conformably overlying sandstone and limestone of the Nansen Sound Formation are cliff-forming and contrast markedly with the recessive red-beds.

The Borup Fiord conglomerates contain well-rounded pebbles, generally less than 2 cm diameter, mainly of chert and quartz. Sandstones are medium to coarse grained and pale green or light grey on the fresh surface. They are extremely quartzose but many beds are characterized by a salt-and-pepper speckled appearance owing to the presence of dark accessory grains. Some sandstones have a distinctive, earthy, white mottled appearance owing to abundant opaque white chert grains. Green chamosite[1] is abundant in thin-section. Interbedded siltstone units are commonly recessive, 2 to 10 feet thick, and consist of individual beds one to 2 inches thick. The rocks are red-brown on both weathered and fresh surfaces and vary from argillaceous iron-stained siltstone to gritty shale. Micaceous partings are present in the sandy varieties.

No fossils have been found in the Borup Fiord Formation at Yelverton Pass although the unit has been sampled and examined for microfaunas and microfloras. However, fusulinids of probable late Pennsylvanian age have been found in the overlying Nansen Formation.

Nansen Formation

The Nansen Formation was named by Thorsteinsson and Tozer (in press) for a well-bedded, uniform succession of limestones of late Pennsylvanian to early Permian age that rest on Borup Fiord and equivalent rocks. The formation is widespread in northern Axel Heiberg and northwestern Ellesmere Island and the type section was selected on the north side of Hare Fiord, northwestern Ellesmere Island, where the formation is about 7,800 feet thick. According to Thorsteinsson (oral comm.) the lithological character of the formation varies from place to place within the Sverdrup Basin and, at some places near the eastern margin of the basin, on western Ellesmere Island, a high proportion of quartzose clastic rocks is included in the lower half of the unit.

The Nansen Formation is exposed in steep cliffs on both sides of the major valley that trends northwest from Yelverton Pass. It was examined at two localities on the north side of the valley: one 13 miles northwest of Yelverton Lake; the other 3 miles north of the lake. At the northernmost locality the formation consists of about 800 feet of light grey weathering quartzose sandstone and chert-pebble conglomerate with minor limestone beds overlain by at least 1,400 feet of uniformly bedded limestone. At the southernmost locality only sandstone beds (Unit B of Christie, 1965) are preserved and these are directly overlain by sandstones of the Upper Triassic Heiberg Formation.

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[1] Identification by X-ray diffraction, by R. Delabio, Geological Survey of Canada.

Because of precipitous terrain only the clastic rocks and the lower 500 feet of limestones could be reached for careful study. Limestone beds are generally less than 3 feet thick and contain elongate, tuberous chert nodules with their long axes parallel to bedding. Solitary corals up to one foot in length, identified by E.W. Bamber as species of Caninia, are abundant in the cherty beds. Limestone is predominantly light grey, microcrystalline, and contains a few quartz, chert, and chamosite[1] grains. Thin, intercalated beds of dark grey, argillaceous limestone containing bryozoan and crinoid debris occur locally. Triticites was collected 100 feet above the base of the limestone at the northern locality (GSC loc. C1885); according to Thorsteinsson (pers. comm.), direct specific comparison is precluded by poor preservation, but the evolutionary development attained suggests a late Pennsylvanian age.

Diabase sills, generally less than 5 feet thick, are abundant near the middle of the limestone sequence.

Trold Fiord Formation

The Trold Fiord Formation was named by Thorsteinsson (in press) for green, glauconitic sandstone with minor skeletal limestone beds. The type section is in Canyon Fiord, Ellesmere Island,where the formation is 250 feet thick.

The Trold Fiord Formation is widespread and of variable thickness in the Sverdrup Basin. It is best developed near the southern and southeastern margins of the basin where it is pale green, glauconitic sandstone with some limestone and chert. The formation is known to post-date the late Lower Permian Assistance Formation at several places on Melville and southern Ellesmere Islands.

Which units may be the basinal equivalents of the Trold Fiord Formation is uncertain; fusulinids are absent from rocks of this age in the Sverdrup Basin and although brachiopod faunas are abundant, they have not been extensively studied. An Upper Permian (early Guadalupian) age is indicated for the Trold Fiord Formation because of its stratigraphic position above the Assistance Formation and because of the recovery of a single ammonoid, Neogoceras, from Trold Fiord rocks at Cameron Island (Nassichuk, Furnish, and Glenister, 1965).

About 200 feet of fossiliferous limestone with minor amounts of glauconitic sandstone overlie the Nansen Formation about 10 miles northwest of Yelverton Lake and are assigned to the Trold Fiord Formation. This is the youngest Paleozoic unit in the Tanquary Fiord-Yelverton Pass region.

The Trold Fiord Formation is separated from Triassic beds (Schei Point Formation) by a prominent disconformity. Cliffs prevented examination of more than the upper 50 feet of the Trold Fiord Formation and the nature of the lower contact is unknown.

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[1] Identification by R. Delabio, Geological Survey of Canada

The sandstone of the Trold Fiord Formation at the above locality is fine-grained, thin-bedded, and weathers pale green. Moderately well-rounded chert and quartz grains in about equal proportions predominate. Glauconite[1] occurs as fine, irregular pellets and as an interstitial mineral, and appears to be the source of a reddish orange alteration product resembling limonite. The sandstone is slightly calcareous.

The richly fossiliferous biogenic limestone is thick-bedded, sandy, and weathers dark grey. Brachiopods and bryozoans generally predominate, and coquinoid beds consist of fragments of these and other fossils. A brachiopod collection from the top of the Trold Fiord Formation 10 miles northwest of Yelverton Lake (GSC Loc.C1886) was examined by Dr. A. Logan who reported the following species:

Liosotella pseudohorrida var.
Spirifer sp. cf. *S. striatoparadoxus*
Licharewia (or *Pterospirifer*) sp.
Spirifer cf. *S. osborni*
Dictyoclostus neoinflatus
Linoproductus sp.
Derbyia cf. *D. grandis*
Stenoscisma sp.
Spiriferella rajah
Spiriferella sp. nov.
Cleiothridina sp.

According to Logan (pers. comm.), representatives of *Liosotella pseudohorrida* var. are identical with the smaller of the syntypes of *P. sulcatus* var. *borealis* described by Haughton (1857) from Permian strata at Hillock Point on northwestern Melville Island, near the southern margin of the Sverdrup Basin. The beds at Hillock Point are now included in the Trold Fiord Formation.

Triassic

Bjorne Formation

The Bjorne Formation was named by Tozer (1961, p. 9)[2] for a sequence of ferruginous, quartzose sandstone strata that lie disconformably on Permian rocks and underlie the Middle Triassic, Schei Point Formation. The type section is on Bjorne Peninsula of southwestern Ellesmere Island, where the formation is about 1,700 feet

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[1]Glauconite is used as a field term in the sense of Triplehorn (1966), for any small, greenish clay pellets found in sedimentary rocks. In a more refined sense the mineral glauconite is an iron-rich variety of the clay mineral illite. (See also Burst, 1958).

[2]The name Bjorne Formation appeared for the first time on GSC Prel. Map 21-1959. The formation was discussed at considerable length by Tozer (1960); the type section, however, was named later (Tozer, 1961).

thick. The Bjorne Formation outcrops extensively along the southern and southeastern margins of the Sverdrup Basin, and can be traced from Melville Island to northeastern Ellesmere Island. It is a marginal equivalent of the Blind Fiord Formation, which is a basinal facies. Although the Bjorne Formation has yielded few diagnostic fossils it is regarded by Tozer (1965) as early Triassic in age and to include his Griesbachian to Spathian stages, mainly on the basis of the presumed equivalence of Bjorne and Blind Fiord strata (see also Tozer, 1963a,1963b). The Bjorne Formation attains a maximum thickness of about 4,000 feet in the foothills of the Sawtooth Mountains of Fosheim Peninsula, western Ellesmere Island (Tozer, 1963b; the minimum recorded thickness occurs within the present map area. The formation appears to be in part, at least, non-marine.

The Bjorne Formation is apparently absent in the vicinity of Yelverton Pass. It outcrops east and northeast of the head of Tanquary Fiord where it lies conformably on the Lower Permian Sabine Bay Formation and ranges from 120 feet to 300 feet in thickness. The formation consists mainly of grey, thin-bedded, fine-grained quartzose sandstone and lesser amounts of siltstone and shale. Some outcrops consist of sandstone that is very resistant and weathers to brown and yellow colours, and intercalated siltstone that is less resistant and grey to yellowish grey. At or near the base of the formation is coarse-grained sandstone or poorly sorted breccia containing angular chert and brown-weathering dolomite fragments. Grain size decreases upward from sand grade to silt. In some places the upper one-third of the unit consists only of grey, calcareous siltstone.

Unidentifiable pelecypods are scattered throughout the siltstone. A sample of poorly consolidated sandstone collected seven miles northeast of the head of Tanquary Fiord (GSC Loc. 7066) has yielded the following spores, identified by D.C. McGregor:

?Aculeispores variabilis Jansonius
Aequitriradites minor Madler
Apiculatasporites sp.
?Fimbriaesporites fimbriatus Singh
Cycadopites sp.
Cycadopites nitidus sensu de Jersey non Balme
Gnetaceaepollenites sp.
Lophotriletes sp.
?Lueckisporites sp.
Monosulcites spp.
Planisporites sp.
Striatoabietites richteri sensu Hart non Klaus
Verrucosisporites sp.
cf. Verrucosisporites trisectus Balme and Hennelly

McGregor states that the few identifiable species in the a semblage indicate an age range of late Permian to early Middle Triassic.

Schei Point Formation

The Schei Point Formation was named by Tozer (1961)[1] for calcareous siltstone, limestone, and shale, with Middle and Upper Triassic marine fossils. The type section of the formation is on Bjorne Peninsula of Ellesmere Island, where it is about 600 feet thick. The Schei Point Formation is a near-shore facies equivalent of the Blaa Mountain Formation. Schei Point strata are exposed along the edge of the Sverdrup Basin, with occurrences on Borden and Prince Patrick Islands on the northwest, Melville, Cameron, Table, and Exmouth Islands on the south, and Ellesmere Island on the southeast (see Tozer, 1963a, 1963b; Tozer and Thorsteinsson, 1964).

The Schei Point Formation outcrops in two widely separated regions of the report area. The two occurrences will be described in the following paragraphs.

Some 10 miles northwest of Yelverton Lake, the Schei Point consists of grey, calcareous, thin- to medium-bedded quartzose sandstone, weathering brown. Certain beds are coquinoid. In this region the formation is 80 feet thick and lies disconformably on the Upper Permian Trold Fiord Formation. Pelecypods (GSC Loc. 75318) have been identified by E.T. Tozer as Plicatula cf. P. hekiensis Nakazawa. According to Tozer this form indicates a late Karnian age.

At the head of Tanquary Fiord the Schei Point Formation lies disconformably on the Bjorne Formation and consists of 80 feet of quartzose sandstone that is thick-bedded, coarse-grained, and yellowish weathering. According to Tozer (1963a, p. 16) who examined the locality, this unit represents the Karnian Gryphaea bed, or the uppermost part of more complete Schei Point sections elsewhere. The Gryphaea bed is thus transgressive in the Yelverton Pass region and the Anisian, Ladinian, and much of the Karnian parts of the Schei Point Formation are absent.

Triassic and (?) Lower Jurassic

Heiberg Formation

The Heiberg[2] Formation was named for sandstone and shale beds that overlie the Middle Triassic Blaa Mountain Formation and underlie Jurassic shales of the

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[1] The name Schei Point Formation appeared for the first time on GSC Prel. Map 21-1959. The formation was later mentioned in a discussion of Arctic Islands stratigraphy (Tozer, 1960), but no type section was named until 1961. (Tozer, 1961).

[2] The name Heiberg Formation appeared first on GSC Prel. Maps 21-1959 and 36-1959. The type section is in the second map-area. The formation was mentioned in a discussion of Arctic Islands stratigraphy (Tozer, 1960), and in 1961 the type section was specified and described in general terms (Tozer, 1961). A fuller description of the type section appeared in print later (Souther, 1963).

Savik Formation. The type section is at the southwest end of Buchanan Lake on Axel Heiberg Island and includes two distinctive members with a total thickness of about 5,000 feet: the lower member consists of thin-bedded sandstones with grey siltstone and shale interbeds; the upper member is thick-bedded sandstone, commonly cross-bedded and containing carbonaceous debris.

The Heiberg Formation is widespread in both marginal and axial regions of the Sverdrup Basin (see Tozer, 1961, p. 23; 1963a, p. 79). The thickness varies in these regions from about 100 feet at Cameron Island (see fig. 1) and (Tozer, 1963c, p. 643), near the southern margin of the basin, where the section evidently was much reduced by Mesozoic erosion, to about 5,000 feet at the type section.

Marine fossils of Norian (mid-Upper Triassic) age have been obtained from the lower member of the Heiberg Formation on Cornwall and Axel Heiberg Islands, (see Tozer, 1961, p. 25; 1963a, pp. 79-81). The fossiliferous beds on these islands are thin and are considered to represent marine incursions in an otherwise non-marine sequence. To date, the most reliable age of the upper member in the type area is based on a floral study by W. Fry (in Fortier et al., 1963, p. 434) which suggests a correlation with the flora of latest Triassic or earliest Jurassic beds at Scoresby Sound, East Greenland.

The Heiberg Formation in the Tanquary-Yelverton region comprises a lower, well-bedded sandstone and shale member and an upper, uniform and very competent sandstone member. Diabase sills are widespread in the formation, and the competence of these and the upper sandstone member provides a striking cliff and cuesta topography that dominates much of the mountain terrain in the area.

The relationship of Heiberg beds to underlying rocks varies from place to place across the Tanquary structural high (see fig. 3). Beginning at the section 10 miles northwest of Yelverton Lake and traversing southeastward to the head of Tanquary Fiord, one finds the following basal relationships: 10 miles northwest of Yelverton Lake, Heiberg beds rest conformably on the Schei Point Formation; 3 miles north of the lake, Heiberg overlie Nansen beds; 15 miles southeast of the lake, the Heiberg Formation rests paraconformably on thin, upper Paleozoic sandstone and limestone beds (presumably Nansen Formation); 15 miles north of the head of Tanquary Fiord, the Heiberg Formation unconformably overlies the folded Cape Rawson Group, here the basement of the Sverdrup Basin; and near the fiord, the Heiberg again conformably overlies the Schei Point or, where this is missing, the Bjorne Formation.

The lower member of the Heiberg Formation, at least 1,500 feet thick, is a monotonous series of thin to thick beds of dark grey to light grey, fine-grained quartzose sandstone alternating with dark grey to black argillaceous siltstones or silty shales. The rocks weather black, grey, yellowish or greenish grey and white, often resulting in dark cliffs and slopes. Contrasting black and white bands are conspicuous. The arenaceous beds are brittle and competent and produce steep cliffs with long slopes of sharp talus.

The sandstones and sandy siltstones are fine-grained to very fine-grained, dark grey to white, and commonly are finely and uniformly laminated with faint, darker colour bands, or marked by irregular carbonaceous streaks with random orientation. The forms resemble grassy leaves, flattened twigs, or woody fragments and consist of earthy to shining black carbonaceous material.

The siltstones and shaly siltstones are dark grey and thin-bedded. Bedding surfaces in these darker rocks are commonly ropy or lumpy, or otherwise irregularly marked. Black, silty to sandy, carbonaceous shales are characteristic of the Heiberg Formation, although this rock forms but a small part of the section. On many bedding surfaces are carbonaceous, grass-like plant remains.

Thin 'sand-pipe' structures are common, particularly in the greyer or more shaly rocks. They are generally 5 to 10 mm in diameter but some are 25 mm. The sand of the pipes is typically coarser than the enclosing rock, and the outer surface of the pipes is marked by a thin argillaceous coating. The pipes occur in dense 'swarms' in restricted groups of beds, commonly passing through 2 or 3 feet of thin-bedded shale and siltstone. Comparable structures have been found in the type Heiberg by Souther (1963, p. 433).

Much of the induration or 'sharpness' of the lower Heiberg beds examined in the region of the head of Tanquary Fiord is probably due to the thermal effect of an abundance of basic igneous sills. Some of the sedimentary rock adjacent to sills is now hornfels, but no consistent relationship between metamorphism and size or nearness of sill was determined. Sills are apparently not as numerous and thick on the north side of Yelverton Pass as elsewhere, and the lower Heiberg shale and sandstone beds, presumably less metamorphosed, are relatively soft and of more subdued colours.

Few of the coalified plant remains occurring throughout the lower member of the Heiberg Formation are sufficiently well preserved for identification. The following well preserved plant fossils were obtained, however, from beds high in the lower member of the formation at localities seven miles northeast of the head of Tanquary Fiord: from GSC Loc. 6873, 6876, *Neocalamites hoerensis* (Schimper) Hall; from GSC Loc. 6874, *Pterophyllum* cf. *P. nathorsti* (Schenk *non* Seward).

The identifications were made by W.A. Bell who remarks that *Neocalamites hoerensis* was long considered restricted to Rhaetic (latest Upper Triassic) floras, but that specimens from Liassic (Lower Jurassic) beds have recently been assigned to it, and that the enclosing Heiberg beds therefore could be of either late Triassic or early Jurassic age. Dr. Bell states that the *Pterophyllum* sp. florule is too scanty and fragmentary, and the venation too obscure for reliable identification, but that it resembles most closely *P. nathorsti* (Schenk) from Rhaetic floras, although differing in its straighter, narrower and more distantly spaced pinnae.

The upper member of the Heiberg Formation between Yelverton Pass and Tanquary Fiord consists of about 750 feet of thick-bedded to massive non-marine sandstones. The sandstones, medium- to fine-grained and highly quartzose, are variously white, light grey and dark grey on the fresh surface and weather to light yellow-brown, orange, or dark orange-brown. A few thin coal seams and plant fragments occur near the base and middle of the unit. Younger Jurassic shales and sandstones rest with structural conformity upon the upper, sandstone member of the Heiberg.

Marine fossils have not been found in the upper member in the area studied. Faunal and stratigraphic relationships of the upper Heiberg are uncertain, as is the case elsewhere in the Sverdrup Basin (see Souther, 1963; Tozer, 1961, 1963a).

Jurassic and Lower Cretaceous

A recessive sequence of black marine shale and lesser sandstone is intercalated between the Triassic Heiberg Formation and the lower Cretaceous Isachsen Formation. This sequence varies from 1,000 feet to 1,400 feet in thickness and is best exposed north of Ekblaw Lake. Paleontological evidence indicates that the shale-sandstone sequence includes correlatives of at least two formations that elsewhere in the Arctic Archipelago occur within this interval: the Savik and Deer Bay formations. In this report all strata between the Heiberg and Isachsen formations are considered to be a single unit, designated 'Jurassic-Cretaceous shales and sandstone'. A basal to near-basal sandstone member can be distinguished in several sections and is considered to be equivalent to the Jaeger Member (Formation) that occurs elsewhere in the Sverdrup Basin. The Jaeger Formation was named by H.R. Greiner (1963, p. 535) for a dusky red sandstone unit some 1,000 feet thick that conformably overlies the Heiberg Formation on Cornwall Island. The sandstones contain marine fossils of Toarcian and Callovian age. Tozer (1963b, p. 22) indicated, on the basis of faunal evidence, that the Jaeger sandstone on Fosheim Peninsula is equivalent to part of the Savik Formation on Axel Heiberg Island. The sandstone was consequently designated as the Jaeger Member, and considered to be a basin-margin facies that is both underlain and overlain by, and passes basinward into, Savik shales.

Continuity of the Jaeger Member between Fosheim Peninsula and the head of Tanquary Fiord is suggested by the presence, 30 miles southwest of the head of the fiord, of Jaeger sandstone with a characteristic late Toarcian fauna (Tozer, 1963b, p. 23).

In the area of study the Jaeger equivalent comprises dusky red or pale grey, thin-bedded, fine-grained, fossiliferous marine sandstone. Locally, black shale lies between the sandstone and the Heiberg Formation. The sandstone is uniformly bedded and at least 300 feet thick in its best exposures, north of Ekblaw Lake. The sandstone member thins westward to 150 feet near Air Force Glacier and thus may be a wedge-shaped "tongue" in the shale sequence, reflecting nearshore conditions of deposition or differential erosion. Both non-marine, coaly beds and marine, fossiliferous beds are present in the sandstone member.

The sandstone is mottled with dark brown matter, perhaps of organic origin, that occurs as streaks parallel to beddings planes. Under a microscope, the brown material appears as an interstitial coating on quartz grains. Deeper red to yellow colours of the fossiliferous beds suggests the presence of limonite.

Fossils recovered from various horizons in the basal sandstone member at several localities were identified by H.W. Frebold and E.T. Tozer, both of the Geological Survey of Canada:

North side of the lake at Yelverton Pass, about 30 feet above the Heiberg Formation (GSC loc. 58285)[1]:

Pseudolioceras aff. P. compactile (Simpson)
Catacoeloceras spinatum (Frebold)
Catacoeloceras polare (Frebold)
Pecten sp.
Age: Late Toarcian

South of the lake at Yelverton Pass; 20 feet above the Heiberg Formation (GSC loc. 58289)[1]:

Pseudolioceras aff. compactile (Simpson)
Catacoeloceras spinatum (Frebold)
Catacoeloceras polare (Frebold)
Inoceramus sp.
Pecten sp.
Age: Late Toarcian

East side of Air Force Glacier; lowermost 5 feet (GSC loc. 58294)[2]:

belemnite
harpoceratid
Age: Toarcian or lower Bajocian

East side of Air Force Glacier; about 50 feet above the base (GSC loc. 58290)[2]:

?Inoceramus sp.
harpoceratid
Age: Bajocian

East side of Air Force Glacier; about 100 feet above the base (GSC loc. 58293, 57133)[1]:

Grammoceras cf. G. boreale (Whiteaves)
Age: Late Toarcian

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[1]Identification by H.W. Frebold

[2]Identification by E.T. Tozer

North shore of Ekblaw Lake; in top 15 feet (GSC loc. 75320)[1]:

Arkelloceras tozeri (Frebold)
Inoceramus lucifer (Eichwald)
Inoceramus sp. indet.
Belemnoids (fragments)
Age: Middle Bajocian

Two miles north of Ekblaw Lake; 20 feet below top (GSC loc. 75319)[1]:

Abbasites sp. nov. ?
Ludwigia sp. indet.
Inoceramus sp.
Age: Early Bajocian

Black and grey, poorly consolidated shales with a few thin, concretionary red- and yellow-weathering sandstone beds overlie the basal sandstone member. Thicknesses measured vary from 800 to 1,300 feet. The lower three-quarters of the shale section is uniformly black to dark grey; the upper one-quarter, greenish grey. Weathered surfaces are commonly encrusted with white or yellow salts. Granular quartz forms an appreciable component of the shale, and flakes of mica also are evident. A substantial hiatus evidently occurs between the basal sandstone member and the overlying shales north of Ekblaw Lake. Early and middle Bajocian fossils (GSC loc. 75319, 75320, identified by H.W. Frebold) occur near the top of the sandstone, and Upper Oxfordian or Lower Kimmeridgian fossils (GSC loc. 75315) occur in the lower 100 feet of shales overlying the sandstone. Upper Bajocian, Bathonian, and Callovian beds are possibly missing, for no fossils of these ages have been found either here or elsewhere in the Tanquary-Yelverton region. A similar hiatus and probable disconformity - between beds with an early Bajocian fauna and immediately overlying beds with an early Oxfordian fauna - occurs at the type locality of the Savik Formation on Axel Heiberg Island (Tozer, 1963b, p. 19).

Fossils collected from the black shales overlying the basal sandstone member were identified by H.W. Frebold, J.A. Jeletzky, and T.P. Chamney, all of the Geological Survey of Canada:

North of the lake at Yelverton Pass; lowermost 30 feet (GSC loc. 58287)[2]:

Haplophragmoides cf. H. barrowensis Tappan 1955
Haplophragmoides cf. H. kingakensis Tappan 1955
Ammobaculites alaskensis Tappan 1955
Ammobaculites fontinensis Terquem 1870
Reophax cf. R. liasica Franke 1936
Gaudryina topogorukensis Tappan 1955
Lituotuba irregularis Tappan 1955
Ammodiscus aspera Terquem 1863
Trochammina sablei Tappan 1955
Age: Lower Jurassic, possibly Toarcian

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[1]Identification by H.W. Frebold
[2]Identification by T.P. Chamney

One mile north of Ekblaw Lake; lower 100 feet of the black shale sequence (GSC loc. 75315)[1]:

Amoeboceras sp. indet.
Buchia concentrica Sowerby s. lato
Age: Upper Oxfordian to Lower Kimmeridgian

Yelverton Pass; from top of 500-foot sequence of shales and sandstones overlying black shales of GSC loc. 58287; (GSC loc. 58288)[2]:

Ammonite, gen. et. sp. indet.
Buchia ex. gr. B. okensisunschensis (Poorly preserved and not identifiable as to species).
Buchia sp. ex. gr. B. fischeriana (d'Orbigny)

Jeletzky comments on this collection as follows:

"Lot No. 58288 definitely is from equivalents of that part of the Lower Deer Bay Formation which represents the boundary beds between the Jurassic and Cretaceous systems. It could hardly be older than the Upper Volgian (Upper Tithonian) Stage of the Jurassic system or younger than the Berriasian Stage of the Cretaceous System. The extremely poor preservation of all its fossils does not permit, however, any more precise dating beyond a somewhat greater likelihood of its being of the earliest Cretaceous (early Berriasian or Buchia okensis zone) age".

The lower part of the Jura-Cretaceous shale sequence almost certainly contains equivalents of the Jurassic Savik Formation, a unit defined on Axel Heiberg Island by J.G. Souther (1963, p. 435) and containing Upper Toarcian, Lower Bajocian, and Oxfordian (late Lower to middle Upper Jurassic) fossils at the type locality at Buchanan Lake. Upper Bajocian, Bathonian, and Callovian beds occur in the formation on western Axel Heiberg Island.

Lower Cretaceous

Isachsen Formation

The Lower Cretaceous Isachsen Formation was named by Heywood (1955) for a sequence of quartz sandstone, with interbedded shale and coal beds, that lies between the Deer Bay and Christopher shales on Ellef Ringnes Island. The type section is southeast of Isachsen weather station and is about 300 feet thick. The Isachsen Formation is widespread and remarkably uniform throughout the Sverdrup Basin; occurrences are known on Ellef Ringnes, Amund Ringnes, Melville, Mackenzie King, Stor, Prince Patrick, Eglinton, Axel Heiberg and Ellesmere Islands (Tozer, 1961;

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[1] Identification by H.W. Frebold

[2] Identification by J.A. Jeletzky

Tozer and Thorsteinsson, 1964). Perhaps the most distinctive feature of the formation is the presence of quartzose grits and conglomerates; basalt flows occur in the formation on northern Ellesmere and western Axel Heiberg Islands. The Isachsen is transgressive on west-central Ellesmere Island where, from west to east, basal beds of the unit rest on progressively older formations, usually with little or no angular discordance (see Heywood, 1955, 1957; Tozer 1963a, 1963b; Douglas et al., 1963; Tozer and Thorsteinsson, 1964).

In the Yelverton Pass region the Isachsen Formation is pale yellow-weathering sandstone, and is the youngest sedimentary bedrock unit recognized. It is best exposed in the vicinity of Ekblaw Lake where it is about 500 feet thick and is capped by a thick basalt flow. The unfossiliferous sandstone is structurally concordant with underlying shales and forms a resistant cover on isolated ridges. The Isachsen sandstone is thick-bedded to massive, highly quartzose, and generally fine-grained. A few beds are coarse-grained or conglomeratic.

IGNEOUS ROCKS

Sills and dykes of dark grey to greenish black basalt, diabase, and gabbro are widespread between Yelverton Pass and Tanquary Fiord (see fig. 4). Sills generally less than 5 feet thick were found in the Borup Fiord and Nansen formations northwest and west of Yelverton Pass but have not been observed in late Paleozoic rocks at the head of Tanquary Fiord, nearer the margin of the Sverdrup Basin. The greatest volume of igneous rocks is contained in the lower part of the Heiberg Formation and in the upper part of the Isachsen. The thick, competent sills and dykes in these formations result in striking cliffs and in cuesta and hogsback landforms. In one 2,000 foot section of the Lower Heiberg, 10 miles north of Tanquary Fiord, fourteen sills with a total thickness of nearly 500 feet were observed. The thickest sills in these formation are from 100 to 270 feet thick and may extend laterally for miles. Only one sill, about 40 feet thick, was observed in the Jura-Cretaceous shale beds.

Numerous thin dykes cut the Borup Fiord and Nansen formations north of Yelverton Pass. A thick, conspicuous dyke transects Jura-Cretaceous shales and sandstones at Yelverton Pass, and another cuts the same beds at Ekblaw Lake. The dyke at Yelverton Pass is a composite one and forms a branching ridge in the soft, surrounding shales.

FOLDING AND FAULTING

Fault-displacement of the gently folded upper Paleozoic and Mesozoic rocks is evident at several places in the Yelverton-Tanquary area. Slight angular discordance was detected between the Nansen and Heiberg formations in the immediate vicinity of Yelverton Pass; however, all other formational contacts appear to be structurally conformable and it is evident that the main period of folding and faulting post-dated the deposition of the Isachsen Formation, with relatively little tectonism having occurred in late Paleozoic or Mesozoic time. An exception to this is the postulated pre-Heiberg earth movement that uplifted and perhaps rotated a large block between the head of Tanquary Fiord and Yelverton Pass: the Tanquary high (discussed in a following section).

Most of the faults may be related to several major fault zones that trend northeast to east-northeast. A few faults trend northwesterly, transecting the regional structural grain.

Two prominent fault zones at the head of Tanquary Fiord appear to be related to and may be a continuation of the Lake Hazen fault zone (see Christie, 1964a, p. 65). One of these zones is nearly parallel with Tanquary Fiord and is marked by a deeply cut valley between the head of Tanquary Fiord and the eastern end of Ekblaw Lake. The second fault zone, two miles southeast of the head of Tanquary Fiord, trends east-northeast and is more nearly on trend with the Lake Hazen fault zone than is the first. Faults along both of these zones appear to be steep, north-dipping mountain front thrusts. Lower Paleozoic basement rocks on the north side of both fault zones have risen several thousand feet and form mountain ridges above upper Paleozoic and Mesozoic beds that now underlie valley bottoms along the zones.

The origin of certain structures associated with the two fault zones coverging near the head of Tanquary Fiord is not clear. The distribution of rocks on both sides of the fault zones suggests a broad, southwest plunging flexure in the basement. The considerable dips of Upper Paleozoic and younger rocks along the east side of the fault zone between Tanquary Fiord and Ekblaw Lake may indicate crumpling due to severe thrust pressures and tilting of the foot-wall block. Structural relationships in the area are to some extent a function of the convergence of fault zones.

A third major fault zone trends northeasterly across Yelverton Pass and has resulted in considerable stratigraphic displacement of upper Paleozoic and Mesozoic formations, although lower Paleozoic basement rocks are not exposed. Thus, immediately west of the pass, the Borup Fiord Formation appears to have been thrust over Jurassic black shales, and immediately north of the pass the Borup Fiord Formation is in thrust contact with sandstones, presumably of the Isachsen Formation. Thrusting appears here to be from the north or northwest.

Conspicuous thrust faults occur some 10 miles northwest of Yelverton Pass; there, a thick section comprising the Nansen, Trold Fiord, Schei Point and Heiberg formations was thrust over the Heiberg Formation from a southeastly direction, resulting in a partly repeated section.

THE SUB-HEIBERG UNCONFORMITY AND THE TANQUARY STRUCTURAL HIGH

Late Paleozoic and early Triassic formations are much reduced or absent in a region between the head of Tanquary Fiord and Yelverton Pass, as has been described in preceding sections of this report. This region, evidently a structural high during at least part of these periods preceding the deposition of the Heiberg Formation, is here named the Tanquary structural high (see sections, fig. 3, and map, fig. 4).

Carboniferous and Permian beds are about 5,000 feet thick only a few miles northwest of Yelverton Pass and are about 1,500 feet thick at the head of Tanquary Fiord. In contrast, only a few faulted outliers of these rocks, less than 200 feet thick and presumably remnants of parts of the Nansen or ? the Belcher Channel formations, are preserved over the intervening Tanquary high. Similarly, the early and middle Triassic Bjorne and Schei Point Formations, although thin and irregularly distributed outside the high, are entirely absent on it. Over much of the structurally high region, the Upper Triassic Heiberg Formation rests with prominent angular unconformity upon the lower Paleozoic, Cape Rawson Group basement rocks.

The Tanquary high is bounded by major faults, already noted, both on the southeast (at the head of Tanquary Fiord) and the northwest (Yelverton Pass); it is about 40 miles across, but the extensions and relationships to the northeast and southwest have not been determined because of the widespread ice cover. The high apparently does not extend to Lake Hazen, about 50 miles northeast of the area, where about 4,500 feet of sandstone, conglomerate, and limestone resting on Cape Rawson beds have been assigned to the Canyon Fiord, Belcher Channel, and Sabine Bay formations (see Nassichuk, 1967).

Three alternatives can be proposed to explain the relationships: a) the high was a region of non-deposition, remaining topographically high while the surrounding basin region sank; b) the high was a tectonic arch, upwarping in pre-Heiberg time so that already-deposited beds were stripped by erosion, then sinking again to allow deposition of the Heiberg Formation; or c) the high was elevated and tilted by pre-Heiberg, basement faults of considerable vertical displacement so that pre-Heiberg beds were removed locally, perhaps along a narrow welt, with continuing regional depression resulting in recommencement of deposition in Heiberg time.

Evidence supporting the first alternative would be: progressive thinning of formations near the high and onlap of younger beds as the period of relative uplift ended. The complete or near-complete sections immediately outside the margins of the high argue against this, although it is possible that stratigraphic thinning occurred and would be evident if the sections were better exposed or the relationships not obscured by faulting. Thus, the relationships of the thin 'outlier' sections of Nansen or Belcher Channel beds are uncertain because only fault contacts so far have been observed, and unknown also is the thickness of the pre-Heiberg section north of Yelverton Pass where the base is not exposed.

Truncation of pre-Heiberg beds owing to arching of earlier deposits also seems unlikely for similar reasons: there is no or uncertain evidence for progressive cutting out of the pre-Heiberg formations, although again this perhaps is masked by faulting.

The sub-Heiberg unconformity in the Yelverton-Tanquary region can be explained by supposing the pre-Heiberg beds there were uplifted and tilted by movement along faults such as the major fault zones now forming the boundaries of the high. Such movement, with considerable vertical displacement, could elevate a linear area or welt of sediments, allowing them to be stripped by subaerial erosion, and would leave complete or near-complete sections immediately beyond the margins of the high. The pre-Heiberg beds might be only slightly tilted, allowing later, near-conformable deposition of Heiberg beds. Indeed, as noted earlier, a slight angular discordance between Heiberg and underlying Nansen beds is evident in the cliffs northwest of Yelverton Pass.

On the other hand, syntectonic clastic rocks are conspicuously absent from the flanks of the high. Perhaps periodic uplift by small increments allowed dispersion of the sediments stripped from the uplifted area as thin clastic deposits beyond the flanks.

There is little doubt of the abrupt nature of the high immediately northeast of the head of Tanquary Fiord: the pre-Heiberg section is complete or nearly complete, and the beds are structurally conformable with Heiberg and overlying units southeast of the major fault along which lies the valley continuation of Tanquary Fiord; on the other hand, northwest of the fault, only 5 miles away, the entire pre-Heiberg succession is absent. The most plausible reconstruction is: Triassic fault movements with an important vertical component in Upper Triassic time resulting in local removal of Permo-Carboniferous and early Triassic deposits; continued sinking of the Sverdrup Basin and deposition of the Heiberg and overlying formations in Upper Triassic, Jurassic, and Cretaceous times; finally, re-activation of the Triassic faults, or movement on nearby faults during the regional, Tertiary orogeny.

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FIGURE 1

INDEX MAP SHOWING MAJOR GEOLOGICAL PROVINCES OF THE NORTHERN PART OF THE CANADIAN ARCTIC ARCHIPELAGO, AND LOCATION OF THE MAP-AREA.

LEGEND

Scale: Vti

0 50 100

Sverdrup Basin

Franklinian Miogeosyncline and bordering stable region

Franklinian ~~E~~ Eugeosyncline

Canadian Shield

Lake Hazen fault zone

TQ Fd
WWN/RLC
Oct/68

Figure 2 : Formations and Correlations

		FOSHEIM PENINSULA Tozer, 1963	TANQUARY FIORD Tozer 1963 Thorsteinsson, in press	TANQUARY FIORD – EKBLAW LAKE	TANQUARY STRUCTURAL HIGH (generalized)	NORTH OF YELVERTON PASS
Cretaceous		Isachsen	Isachsen	Isachsen	Isachsen	Isachsen
Jurassic	U	Deer Bay Awingak Upper Savik	Deer Bay Awingak Upper Savik	Jurassic – Lower Cretaceous shale and sandstone, undivided	Jurassic- Lower Cretaceous shale and sandstone, undivided	Jurassic- Lower Cretaceous shale and sandstone, undivided
	M	Jaeger Mbr Lower Savik	Jaeger Mbr Lower Savik			
	L	Borden Island	Borden Island			
Triassic	U	Heiberg	Heiberg	Upper Heiberg Lower Heiberg	Upper Heiberg Lower Heiberg	Upper Heiberg Lower Heiberg
		Blaa Mountain 'Gryphaea bed' Schei Point	Schei Point (Gryphaea bed)	Schei Point		Schei Point
	M		unconformity and overlap			
	L	Blind Fiord Bjorne	Bjorne	Bjorne		
Permian	U	no exposures	*Trold Fiord			*Trold Fiord
	L		Assistance Sabine Bay *Tanquary *Mount Bayley *Antoinette	Sabine Bay Belcher Channel	unconformity and overlap	— ? — ? — ? *Nansen
Pennsylvanian	U M L		Canyon Fiord	Canyon Fiord		*Borup Fiord
underlying beds			Cape Rawson Group	Cape Rawson Group	Cape Rawson Group	Silurian and ? older beds

* R. Thorsteinsson, in press

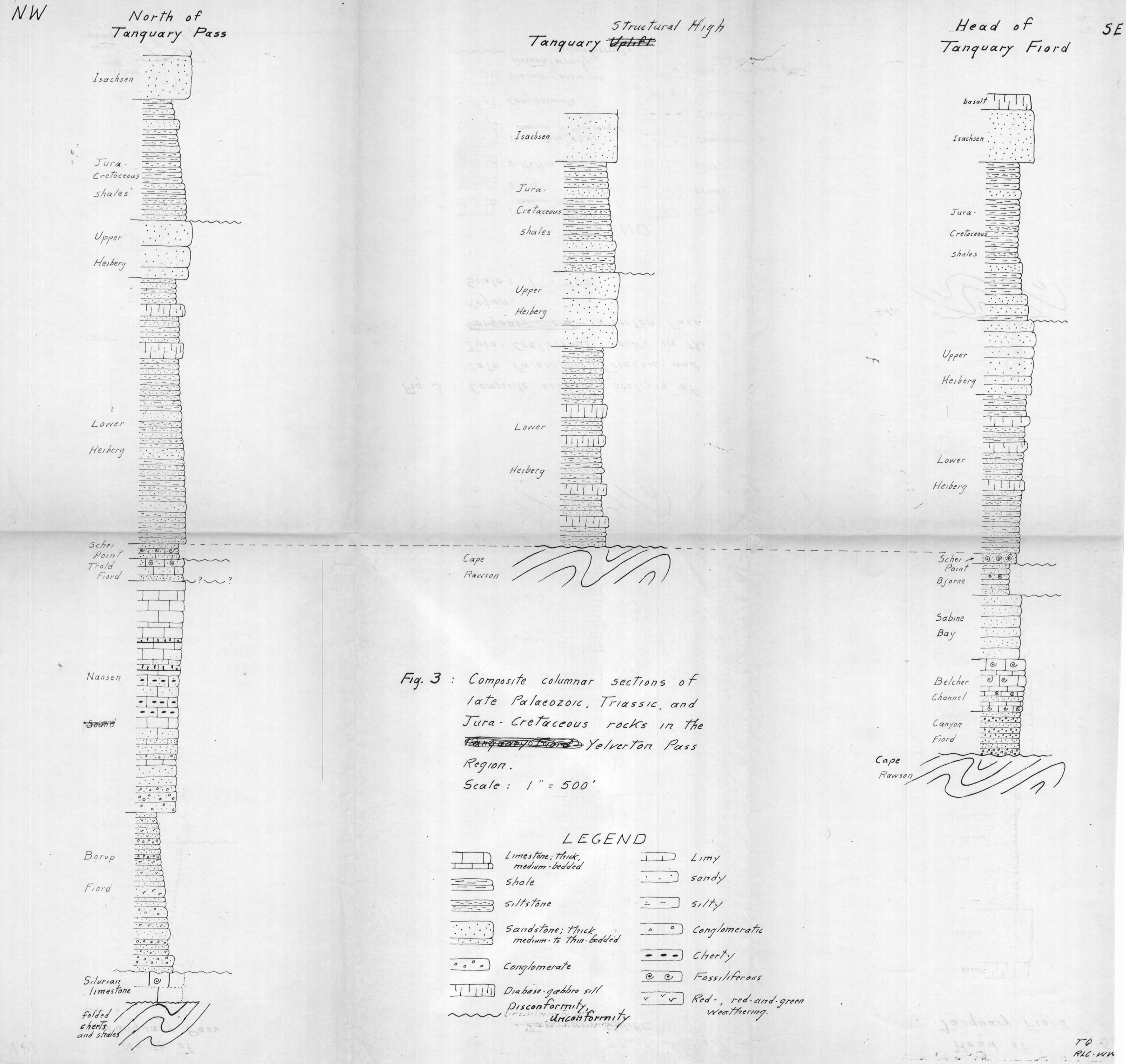


Fig. 3 : Composite columnar sections of late Palaeozoic, Triassic, and Jura-Cretaceous rocks in the ~~Tanquary Fiord~~ Yelverton Pass Region.
Scale : 1" = 500'

LEGEND

CENOZOIC

PLEISTOCENE AND RECENT

Q — Gravel, sand, silt, till, moraine

MESOZOIC

CRETACEOUS

LOWER CRETACEOUS

Ki — ISACHSEN FORMATION: sandstone

JURASSIC AND CRETACEOUS

LOWER JURASSIC TO LOWER CRETACEOUS

J — "JURASSIC-CRETACEOUS SHALES AND SANDSTONES": shale, minor sandstone

TRIASSIC AND (?) JURASSIC

UPPER TRIASSIC AND (?) LOWER JURASSIC

Ꞧhu / Ꞧhl — HEIBERG FORMATION: Ꞧ hu-Upper Heiberg sandstone; Ꞧhl-Lower Heiberg sandstone, shale; may include Trold Fiord and Schei Point beds north of Yelverton Pass

UPPER TRIASSIC

Ꞧsp — SCHEI POINT FORMATION: sandstone

LOWER TRIASSIC

Ꞧb — BJORNE FORMATION: sandstone, shale

PALEOZOIC

YELVERTON PASS REGION	TANQUARY FIORD REGION
PERMIAN UPPER PERMIAN Ptf — TROLD FIORD FORMATION: limestone, sandstone	
	LOWER PERMIAN Psb — SABINE BAY FORMATION: sandstone
	CARBONIFEROUS AND PERMIAN PENNSYLVANIAN AND LOWER PERMIAN Pbc — BELCHER CHANNEL FORMATION: limestone, minor sandstone
CARBONIFEROUS PENNSYLVANIAN Pn — NANSEN FORMATION: limestone, sandstone, conglomerate	PENNSYLVANIAN Pcf — CANYON FIORD FORMATION: sandstone, conglomerate, minor shale, limestone
Pbf — BORUP FIORD FORMATION: sandstone, conglomerate, shale	

PRE-CARBONIFEROUS

S — Lower Paleozoic basement rocks: sandstone, shale, chert, limestone.
Scr - "Cape Rawson Group"
Sls - Silurian limestone

IGNEOUS ROCKS

Diabase;
s - sill; d-dyke

SYMBOLS

Trends of bedding: fold-structures (traces on surface topography)

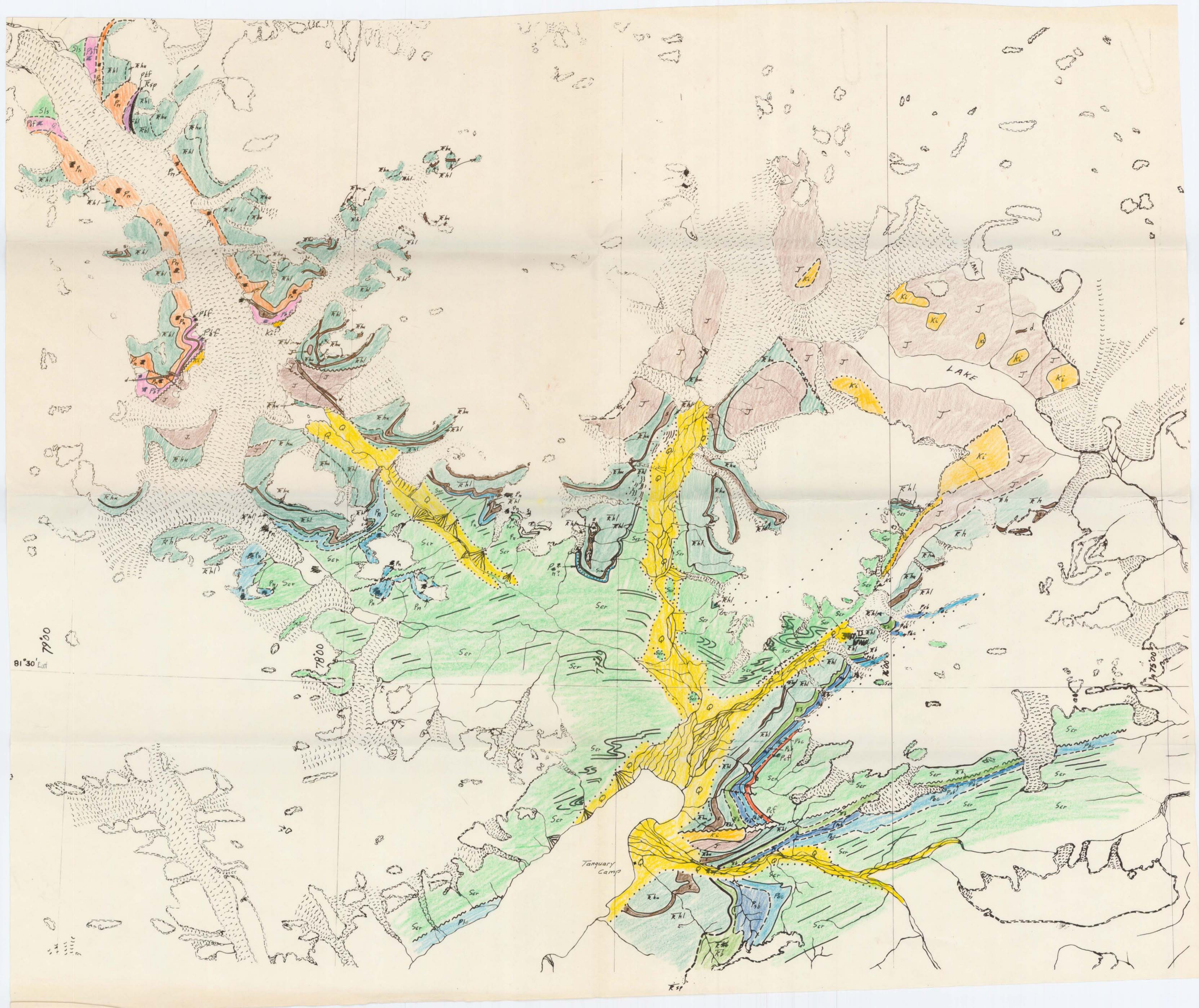
Fault: defined, assumed; dot on downthrown side

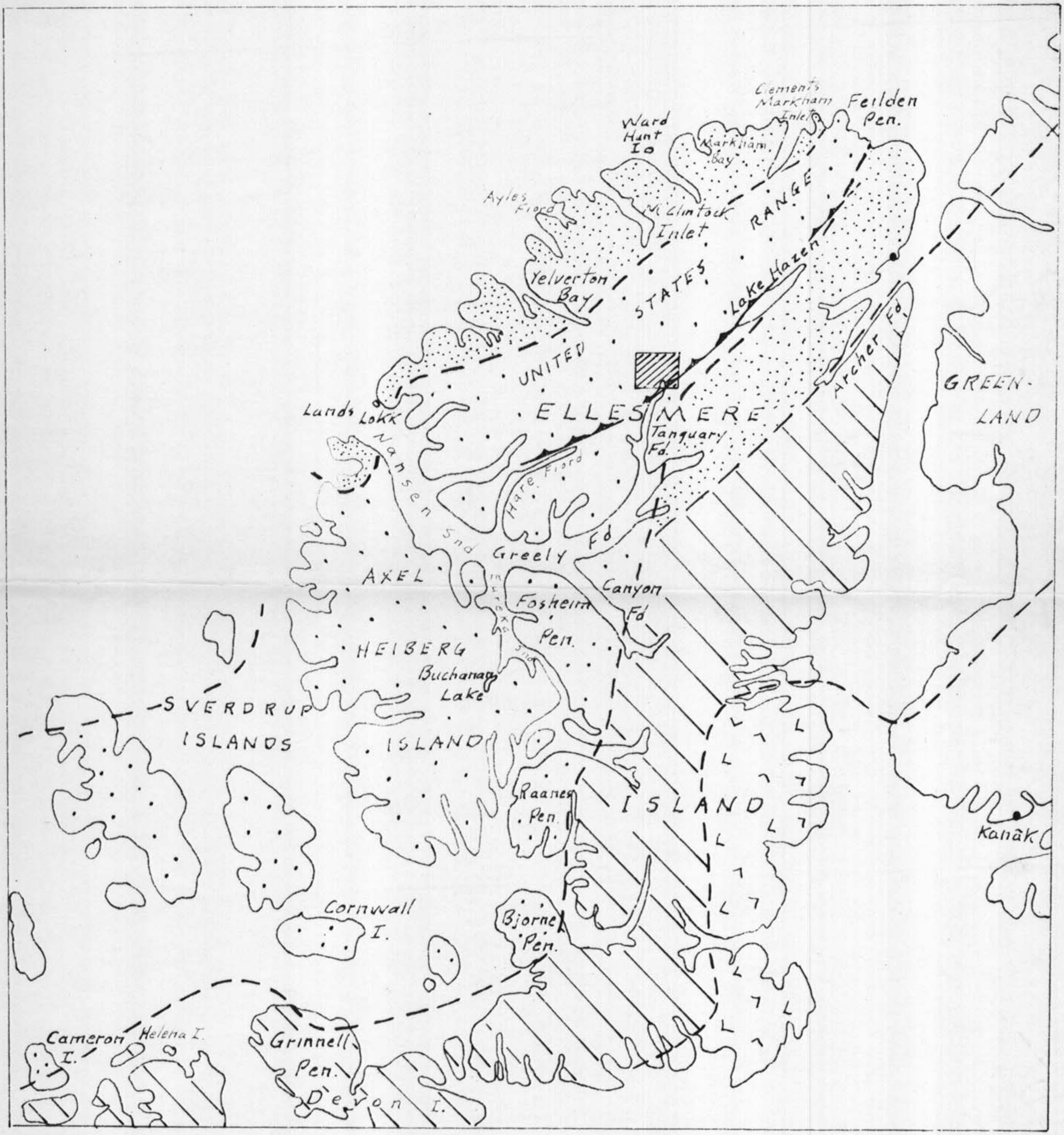
Geological boundary; defined, approximate, assumed

slumped bedrock

Geology by R.L. Christie, 1963; W.W. Nassichuk, 1963, 1966

FIG. 4. MAP; GEOLOGY OF THE YELVERTON PASS REGION


LAKE
Tanquary Camp
81°30' Lat
79°00
78°00
Scr
Q
J
Ki
Pn
Sls



Clements Markham Inlet
Feilden Pen.
Ward Hunt Io
Markham Bay
Ayles Fiord
McClintock Inlet
RANGE
Yelverton Bay
STATES
Lake Hazen
UNITED
Archer Fd
GREEN-LAND
Lands Lokk
ELLESMERE
Tanquary Fd.
Nansen Snd
Hare Fiord
Greely Fd
AXEL
Canyon Fd
Fosheim Pen.
HEIBERG
Buchanan Lake
SVERDRUP ISLANDS
ISLAND
Raanes Pen.
ISLAND
Kanāk
Cornwall I.
Bjorne Pen.
Cameron I.
Helena I.
Grinnell Pen.
Devon I.

1:4,000,000