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PRECAMBRIAN–SILURIAN GEOLOGY OF THE G. B. SCHLEY FJORD REGION, EASTERN PEARY LAND, NORTH GREENLAND

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Introduction

A structurally complex region of mainly sedimentary rocks lies north-east of the exposures of Silurian flysch in eastern Peary Land, in the vicinity of G. B. Schley Fjord (map 1). South-easterly structural and sedimentary trends follow the edge of the flysch belt in a general way, so that older rocks tend to be exposed north-eastwards, towards the coast. An irregular outcrop pattern results, however, principally from numerous major and minor faults that cut the land in virtually all directions. Three and possibly more geological sequences are present: (1) Precambrian rocks, comprising both sedimentary and volcanic types; (2) late Precambrian? to Silurian, beginning with a dolomite formation and ending with flysch sandstone; and (3) late Palaeozoic and younger rocks, forming part of the Wandel Sea Basin which occurs as down-faulted sedimentary outliers in the older terrains. The latter sequence is described by Håkansson, this report.

Prior to the present field season, the principal geological investigation of the G. B. Schley Fjord region was that by J. C. Troelsen, a member of the Danish Peary Land Expedition (1947–1950). Troelsen (1956a) established the presence of several of the rock units discussed below. Additional remarks were published by Troelsen (1956b) and Peel, Dawes & Troelsen (1974).

Stratigraphy

Rocks of Precambrian, Cambrian, Ordovician and Silurian age are exposed in the G. B. Schley Fjord region. Permo-Carboniferous and younger beds of the Wandel Sea Basin occur east of G. B. Schley Fjord; these rocks are described more fully in this report by E. Håkansson.

The Precambrian terrain comprises gently folded sedimentary and volcanic rocks and forms a basement in the G. B. Schley Fjord region. In the description that follows, possibly older and possibly younger Precambrian sequences are distinguished. Late Precambrian or Cambrian to Silurian sedimentary rocks unconformably overlie the older Precambrian as a conformable sequence that was deposited in a platformal region adjacent to the North Greenland (Franklinian) geosyncline. The conformable sequence begins with the unfossiliferous Portfjeld Formation; following upward are the Cambrian Buen Formation composed of clastic rocks, the Brønlund Fjord Formation (elevated to a group by Peel, this report) of dolomite, and the Wandel Valley Formation, and overlying dolomite and lime-

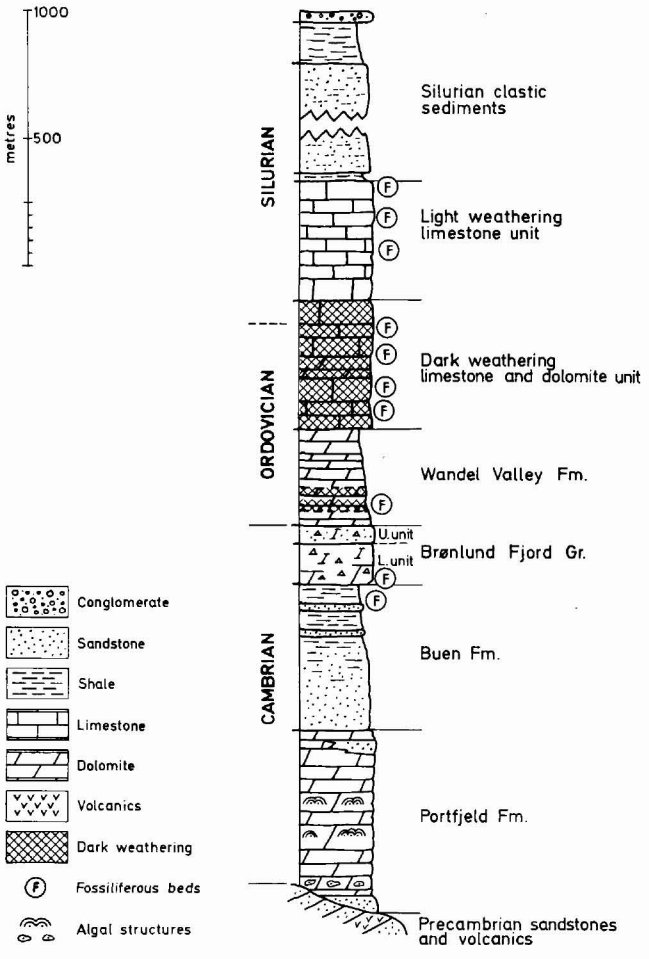

Fig. 23. Composite stratigraphic section of Lower Palaeozoic rocks in the G. B. Schley Fjord region.

stone units of Ordovician and Silurian age. The youngest unit of the Palaeozoic sequence is a monotonous sandy flysch formation of uncertain thickness and Silurian age. The flysch overlies the carbonate beds abruptly and marks a change from quiet, platform sedimentation to more active, basinal deposition (see fig. 23 and 24).

Precambrian rocks – ? older units

Competent white quartzites and dark volcanic rocks form striking light and dark mountains in an irregular inland, south-east trending belt. The quartzites are white weathering, often with a pinkish cast, and are usually nearly massive. At least 1000 m is present, judging only from the topographic relief of the quartzite mountains. Closely associated with the quartzites are poorly bedded, dark green-grey weathering volcanic rocks in units hundreds of metres thick. The volcanic rocks are slightly altered by chlorite-epidote mineralization to 'greenstone' and have the appearance of andesites. They are fine-grained and uniform but

some breccias, tuffs and amygdaloidal rocks are associated. Certain volcanic rocks and quartzites appear interbedded. East of G. B. Schley Fjord, a thick volcanic sequence appears to form higher ground and may form the youngest element of a quartzite-volcanic group.

West of G. B. Schley Fjord this unit appears to be predominantly quartzite, although a well-bedded sequence that was observed but not visited may be volcanogenic. The quartzites are exposed in a narrow, linear belt of prominant mountains to form a tectonically high 'quartzite range'.

The quartzites and volcanic rocks are similar in a general way to the quartzites, sandstones, and basalts of the platform region to the south of Peary Land (J. C. Christensen Land and Mylius-Erichsen Land, described by Collinson and Jepsen & Kalsbeek), and may be broadly correlative.

The quartzite units (and possible also the volcanic) are intruded by sills of dolerite tens of metres thick.

Bedding structures in the older rocks are generally inconspicuous except where accentuated by sills. The quartzites and volcanic rocks are only mildly distorted so that flat to gentle dips prevail. Both the lithological and structural characters suggest that the region was a continental platform during deposition of these older Precambrian units.

Precambrian rocks – ? younger units

A sedimentary terrain exposed in a limited area south-east of Depotbugt is overlain by the Portfjeld Formation (late Precambrian–Cambrian ?) with very slight angular unconformity. The rocks of this lower sequence are thin-bedded to laminated slates, dolomitic mudstones, sandstones, and sandy tuffs(*?*). Weathering colours are dark green-grey, red-brown, and brown. The thickness of sedimentary rocks in this area is unknown.

The relationship between the supposed 'older' and 'younger' sequences is not known. The two groups occupy similar stratigraphic and structural positions. Both are unconformably overlain by the Portfjeld Formation. They are lithologically dissimilar, however, and the rocks south-east of Depotbugt are assigned an age closer to that of the overlying Portfjeld Formation from the relatively close structural concordance of the two sedimentary units.

A third sedimentary sequence, north-east of Depotbugt, is of unknown relationship to other rocks and may be of Precambrian age. This group comprises thin-bedded sandstone, shale, carbonate, quartzite, and phyllite. Weathering colours include brown and black for shales, sooty black to orange for carbonates, and brown to grey for quartzites. The beds are severely folded and distorted, with west-north-west trends and dips ranging from moderate to vertical. The strong structural trends lie oblique to the relatively massive ('quartzite range' and are truncated by a lineament that follows the northern edge of the range.

Portfjeld Formation

The Portfjeld Formation (late Precambrian – Cambrian*?*) was defined by Jepsen (1971), who measured and described sections from the Jørgen Brønlund Fjord area. The formation unconformably overlies the Eocambrian Moræneso Formation of tillite, dolomite, and sandstone conglomerate, and is followed with structural conformity by the Cambrian Buen Formation. At the type locality the Portfjeld Formation is 206 m thick.

In the G. B. Schley Fjord region, some 400 to 700 m of beds are assigned to the Portfjeld Formation. These beds unconformably overlie the volcanic terrain east of G. B. Schley Fjord and dark, banded slates and tuffs(?) near Depotbugt. The formation is a conformable sequence of grey and very light grey weathering, thin bedded dolomites. Portfjeld Formation beds are variably competent. East of G. B. Schley Fjord, members of the unit form cuestas in lowlands, whereas south-east of Depotbugt the formation is moderately recessive and forms rounded hills with rubbly, light grey slopes.

The dolomites are characterized by oolitic and pisolitic structures, algal-laminae, and spherical, domal, and columnar algal structures. The unconformity on the volcanic terrain is one of considerable relief – many tens of metres – and is marked locally by white, cross-bedded quartzite. However, the basal bed of the Portfjeld Formation near Depotbugt consists of about 20 m of light purple and orange weathering dolomite-boulder conglomerate.

Buen Formation

The name Buen Formation was given by Jepsen (1971) for shale and sandstone beds that overlie dolomites of the Portfjeld Formation in the Jørgen Brønlund Fjord region. The Buen Formation is 425 m thick at the type section.

Previously, strata of this age have been referred to as the Schley Fjord Formation (Troelsen, 1956a; Poulsen, 1974; Dawes, 1976). No intention exists at this time to discuss which of the two available terms is to be preferred. However, the map accompanying this report includes only reference to the Buen Formation, and that name is therefore employed in the present context. The Buen Formation in the G. B. Schley Fjord region is 400 to 600 m thick, and comprises dark weathering quartzites, sandstones, siltstones, slates, and shales. Early Cambrian trilobites occur in the uppermost grey-green, shaly mudstones. Some beds are micaceous and characterised by flyschoid bottom features. The Buen Formation is composed of relatively recessive beds which usually form rubbly slopes and rounded hills.

A white, cross-bedded quartzite unit about 100 m thick overlies similar quartzite and sandy dolomite of the Portfjeld Formation east of G. B. Schley Fjord and could be considered a transitional member between the light coloured platform rocks (Portfjeld) below and dark rocks of the Buen Formation above. West of G. B. Schley Fjord, the transition from light dolomites to dark quartzites and slates is abrupt. The Buen Formation appears conformable to both the underlying Portfjeld and the overlying Brønlund Fjord Group.

Brønlund Fjord Group

Peel (this report) elevated the Brønlund Fjord Formation of Troelsen (1949) to the status of a group, recognising four constituent formations in the Adams Gletscher region of western Peary Land. The former Brønlund Fjord Formation in its type area around Jørgen Brønlund Fjord was correlated with the two lowest of these formations. Correlation of Peel's formations with strata in the G. B. Schley Fjord region is not yet established, and the Brønlund Fjord Group is discussed here in terms of two units. In the Adams Gletscher region, the Brønlund Fjord Group is of Early–Middle Cambrian age, of which only the Early Cambrian remains at Jørgen Brønlund Fjord. In the G. B. Schley Fjord region, as elsewhere in Peary Land, the group conformably overlies dark, recessive beds of the Buen Formation.

The presence of oolitic dolomite in the upper unit may suggest a possible correlation of this unit with the Tavsens Iskappe Group of largely Late Cambrian age described by Peel (this report) from western Peary Land. However, in the absence of confirmatory fossil evidence, this unit is tentatively referred to the Brønlund Fjord Group.

Lower unit

East of G. B. Schley Fjord, this sequence begins with a 16 m lower member of enigmatic mottled dolomite breccia, followed by some 35 m of recessive, dark sandy dolomite beds. The overlying, principal dolomite breccia sequence is about 100 m thick; a 1 m thick, black chert bed may often be found at the base of this. The dolomite breccias are light grey-weathering, competent rocks that tend to form cliffs and bluffs. The peculiar breccia structures characteristic of the Brønlund Fjord Group at Børglum Elv (Christie & Peel, 1977) are consistently present, with variations, as far north as the coastal exposures east of Hellefiskefjord and the north-easternmost island of G. B. Schley Fjord.

Upper unit

The upper part of the lower unit becomes sandy to quartzitic at some localities and apparently grades into a second enigmatic breccia sequence up to 100 m thick. These rocks consist of thick-bedded, yellowish-weathering quartzose dolomite to dolomitic quartzite containing angular fragments of quartzite. Certain fragments in the breccia appear clearly to have been, originally, quartzite rock, whereas others appear to be former carbonate rocks, which have now been more or less silicified. Equidimensional to flake-like fragments of normal clastic appearance are present and, in addition, tilted slabs or disturbed masses of quartzite some metres or tens of metres in size may be observed. Such structures suggest slumping and other diagenetic tectonic processes that may also have affected the underlying dolomite breccias of the lower unit. Minor oolitic dolomite is associated with the quartzite-dolomite breccias just to the east of G. B. Schley Fjord.

Both the lower and the upper unit thin considerably west of G. B. Schley Fjord, where the total thickness of these beds does not exceed 115 m.

Wandel Valley Formation

The name Wandel Valley was introduced by Troelsen (1949) for limestone or dolomite beds that overlie the Brønlund Fjord Formation (now Group) north of Jørgen Brønlund Fjord. He subsequently recognised the presence of the formation in the G. B. Schley Fjord region (Troelsen, 1956b). The three-part, light-dark-light unit, of Early and Middle Ordovician age, is about 320 m thick in the type area (Christie & Peel, 1977).

The Wandel Valley Formation forms banded, recessive grey slopes near G. B. Schley Fjord, little changed from the Jørgen Brønlund Fjord region. A thickness of about 350 m was measured in 1978. The dark, middle member is, however, relatively thin and inconspicuous. The Wandel Valley Formation near G. B. Schley Fjord comprises thin-bedded, light grey-weathering, fine-grained, laminated dolomites with black chert lenses and thin chert beds. Many laminae are of algal origin. The dark-weathering beds are characterized by

deep mottling and a few silicified gastropod and cephalopod fossils. The dark member, about one third of the unit's thickness from the base, forms a distinctive marker unit east of G. B. Schley Fjord, but thins to the west to become an inconspicuous dark band in the recessive slopes. West of G. B. Schley Fjord, in Hans Egede Land, the upper part of the Wandel Valley Formation changes in character with the appearance of micritic limestones in the upper 100 m of the formation.

Ordovician and Silurian carbonates

Three mappable carbonate units overlying the Wandel Valley Formation were distinguished by Christie & Peel (1977) in the region of Børglum Elv, but only two could be distinguished as a result of the reconnaissance work carried out at G. B. Schley Fjord. The combined thickness of the units is similar in the two regions. Some 900 m of limestone and dolomite lie between the top of the Wandel Valley Formation (middle Ordovician in age) and the base of an un-named Silurian black shale formation (Wenlock) at Børglum Elv, and about 1000 m is estimated for the same interval at G. B. Schley Fjord.

The Børglum Elv section begins with 430 m of dark-weathering, mainly thick-bedded competent limestone of the Børglum River Formation. This is succeeded by 150 m of medium-bedded dolomite of mainly Silurian age with contrasting lower light and upper dark colours (un-named Silurian ? dolomite formation). An un-named Silurian limestone formation of 320 m of variable, often fossiliferous grey and yellow-weathering limestone occurs above the dolomite. The entire section at G. B. Schley Fjord is dominated by limestone, the lower half dark-weathering and the upper, light-weathering. The boundary between the lower and upper units is diffused by an alternation of light and dark beds (see fig. 24).

Dark weathering limestone and dolomite unit

Strata placed here include rocks referred to the Børglum River Formation by Troelsen (1956b) and Peel, Dawes & Troelsen (1974). On the map 1 these rocks are indicated as 'Børglum River Formation (and correlatives)'. The dark weathering, competent limestone and dolomite beds overlie the light weathering Wandel Valley Formation with apparent conformity. About 500 m of dark beds is estimated to be present. The lowest beds are dark limestone which pass upward into dark, mottled, more dolomitic beds with Arctic Ordovician-type fossils, including *Maclurites* and *Receptaculites.*

Upper dark beds contain abundant pentamerid (?) brachiopods and presumably are Silurian in age. The pentamerid-bearing part of the sequence is alternately light yellow-grey weathering and dark grey, mottled, and forms dark coloured slopes with light bands. As such, this interval may be equivalent to the un-named Silurian ? dolomite formation of the Børglum Elv area (Christie & Peel, 1977).

Light weathering limestone unit

In the accompanying map, this unit is mapped as the un-named Silurian limestone formation, to which it is at least partly equivalent. The limestones weather with a uniform, light yellow-grey, scoriaceous surface. They are relatively competent, and in places are massively

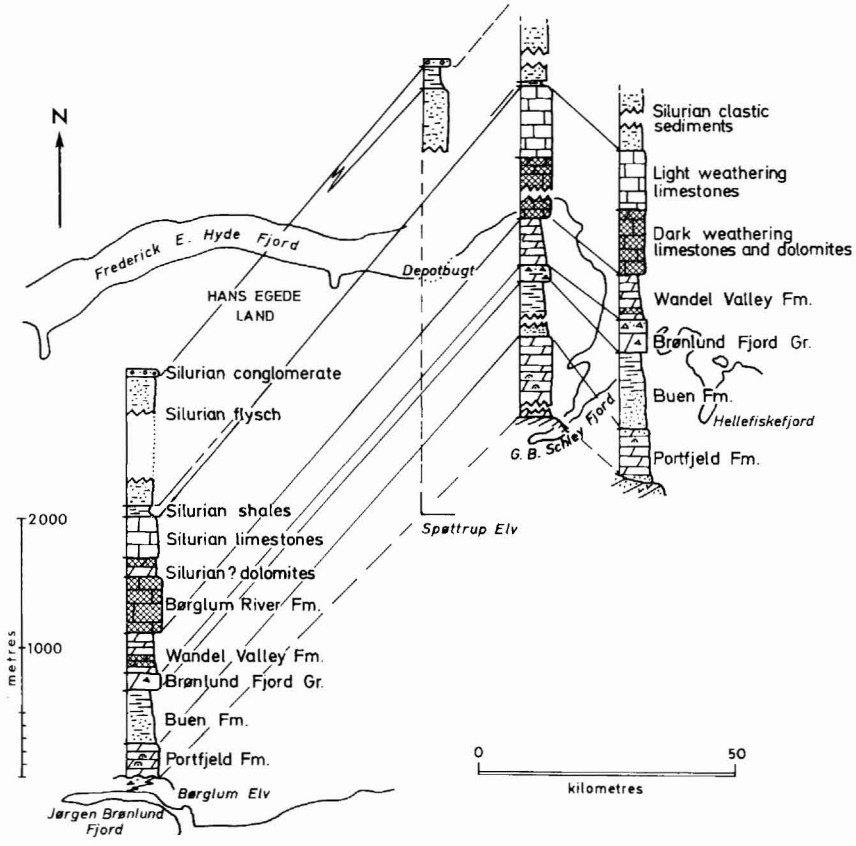

Fig. 24. Stratigraphic sections of Lower Palaeozoic sequences in Jørgen Brønlund Fjord and G. B. Schley Fjord regions, eastern Peary Land. Lithological units as in fig. 23.

bedded to form extremely competent rock. A thickness of about 500 m is present. Pentamerid brachiopods occur in much of the section; the uppermost few metres (*c.* 30 m *?*) are thin-bedded silty limestone containing trilobites.

An apparently tectonic feature of uncertain origin is the presence of innumerable carbonate veins in certain limestones to form tectonized masses. The resulting rocks are relatively competent and form geomorphological features similar to reefs, although it is not certain from their internal structure that they are truly reefal in origin. In some cases, the 'reef-like' masses appear to have considerable vertical extent (hundreds of metres). In others, a lensoid shape seems probable. Certain masses apparently had positive relief during the deposition of the calcareous sandstones and siltstones of the Silurian flysch formation as these rocks appear to be onlapping the massive Silurian limestone.

Silurian clastic sediments

The uppermost Silurian shaly limestone beds are overlain by a thin (10 to 20 m estimated) black shale unit equivalent to the un-named Silurian shale of the Børglum Elv area (Christie

& Peel, 1977) that grades upward into yellow weathering, black shaly siltstone and calcareous siltstone. These are the lowest beds of the thick, un-named Silurian flysch formation. The flysch in the vicinity of G. B. Schley Fjord appears to be relatively fine-grained; silty rather than sandy, when compared to beds near Spøttrup Elv or Børglum Elv. Thin-bedded, flyschoid calcareous siltstones and fine-grained sandstones seem to be associated with the Silurian 'reef-like masses'.

A great thickness – possible some thousands of metres – of flysch beds appears to be present. The flyschoid sandstones and shales are mainly southward facing, with moderate dips near the north-eastern border of the basin and gently dipping to flat beds to the south.

Flat lying shale and conglomerate units high in the sequence form conspicuous mesas about 20 km south-west of the head of G. B. Schley Fjord and may be the youngest clastic beds observed. This shale unit, about 160 m thick, comprises recessive, thin-bedded shale, siltstone, and minor fine sandstone; weathering colours are dark green-grey to black. Graptolites and a single brachiopod were collected from the base of the unit.

The mesas are capped by competent conglomerate beds, of which at least 30 m thickness remains. The pebbles are well rounded and mainly chert, although quartzite pebbles also form an appreciable proportion of the conglomerate.

In the accompanying map (map 1), small outliers of these Silurian clastic sediments in the G. B. Schley Fjord area are mapped as the un-named Silurian flysch formation.

Structural geology

Sedimentary formations conform in a general way with the south-east trends of the flysch sequence to the south, but the region has been so cut and disturbed by almost random faulting and flexuring that probable early south-easterly trends are obscured. Several strong lineaments are oriented south-easterly; one group or zone of such lineaments forms much of the boundary of the flysch outcrop, so that these rocks appear relatively depressed while the older rocks are uplifted. A prominent, horst-like series of uplifts results in the mountains of the Precambrian quartzite volcanic terrain to the east of G. B. Schley Fjord. Late Precambrian and lower Palaeozoic rocks are preserved in a near-coastal, down faulted (graben) belt. A strong north-east trending lineament along the west side of G. B. Schley Fjord must be due to faulting. The late Precambrian *?* – lower Palaeozoic terrain forms the fjord bottom in contrast to the high standing Precambrian quartzite mountains to the west.

The deformed, possibly Precambrian sedimentary terrain north-east of Depotbugt may mark the southern edge of the Peary Land fold zone. The change in structural style is abrupt. Probable late Precambrian rocks south of the horst-like quartzite range are nearly flat-lying, and a strong lineament separates the northerly, folded rocks from the massive, but probably little-disturbed quartzite range of Precambrian rocks.

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