UNIVERSITY OF KEELE

THE STRATIGRAPHY AND SEDIMENTOLOGY OF THE BRØNLUND FJORD
AND TAVSENS ISKAPPE GROUPS (CAMBRIAN) OF PEARY LAND,
EASTERN NORTH GREENLAND

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ABSTRACT

Proterozoic and Lower Palaeozoic strata in eastern North Greenland record two contrasting depositional regimes: a cratonic shelf bounded to the north by a deep-water basin.   The shelf strata include the Brønlund Fjord and Tavsens Iskappe Groups, a carbonate-dominated succession up to 900m thick with an age range from late Early Cambrian to earliest Ordovician.   The Brønlund Fjord Group is subdivided into eight formations; the Tavsens Iskappe Group comprises seven formations.

Twenty-four lithofacies are recognized and grouped into four associations.   Association A consists of glauconitic, phosphoritic skeletal carbonates representing deposition on a sediment-starved, carbonate ramp.   Association B comprises dark, argillaceous, nodular carbonates, graded carbonates and carbonate breccia beds representing deposition from suspension, turbidity currents and debris flows in a low-energy, open marine environment; an outer shelf-slope setting is envisaged.   Evidence of early-diagenetic, submarine nodular cementation and slope creep processes is abundant.   Cross-bedded ooidal grainstones characterize Association C which represents a high-energy, shallow-water environment at a carbonate platform margin.   Foreslope facies in this association typically show inclined bedding ($\leqslant 30°$) and interdigitate with outer shelf rocks.   Facies assigned to Association D are burrowed dolomites, flat-pebble conglomerates, algal laminites and bioturbated, cross-bedded sandstones reflecting deposition in shallow subtidal and intertidal environments on a low-energy, restricted platform.

The vertical and lateral relationships between these associations outline a regressive sedimentation pattern, involving northward progradation of inner shelf, shallow-water facies (Associations C, D) over outer shelf facies (Associations A, B) and resulting in progressive exposure of the shelf.   Evidence of intermittent platform progradation and discrete episodes of outer shelf instability probably record periods of differential shelf subsidence related to basin development.

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Proterozoic and Lower Palaeozoic strata in eastern North Greenland record two contrasting depositional regimes: a cratonic shelf bounded to the north by a deep-water basin. The shelf strata include the Brønlund Fjord and Tavsens Iskappe Groups, a carbonate-dominated succession up to 900m thick with an age range from late Early Cambrian to earliest Ordovician. The Brønlund Fjord Group is subdivided into eight formations; the Tavsens Iskappe Group comprises seven formations.

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CONTENTS

✳ Owing to initial confusion concerning the official spelling, Perssuak is spelt incorrectly throughout this thesis; the version now recognised by the Greenland Names Commission is Perssuaq.

SECTION I: <u>INTRODUCTION AND GEOLOGICAL SETTING</u>.

CHAPTER 1: <u>INTRODUCTION</u>

1.1.   <u>Location and physiography</u>.

Greenland has a surface area of nearly 2.2 million km^2 but over three-quarters of the island is permanently ice-covered. The central ice-cap (Inland Ice, Fig. 1.1) dominates Greenland and exposure of bedrock is restricted to the mountainous coastal fringe. One of the most extensive areas of outcrop is in northern Greenland, where the 'ice-free' strip is up to 250 km wide (Fig. 1.1).

Peary Land, the study area for this thesis, forms part of this 'ice-free' zone in eastern North Greenland, flanked by Johannes V. Jensen Land and Nansen Land to the north, Freuchen Land to the west and J.C. Christensen Land, Valdemar Glückstadt Land and Kronprins Christian Land to the south and south-east; major fjords and glaciers form the boundaries between these geographical regions (Fig. 1.1). Although relatively ice-free, Peary Land possesses a number of minor ice-caps, the largest being Hans Tavsens Iskappe in west Peary Land (Fig. 1.1).

The physiography of eastern North Greenland closely reflects the bedrock geology (2.1). Peary Land, Freuchen Land, J.C. Christensen Land and Valdemar Glückstadt Land are composed mainly of sub-horizontal or homoclinal shelf strata which form a relatively low-relief plateau, locally pierced by large sea fjords and dissected by major river valleys (Figs. 1.2 and 1.3). In contrast, Johannes V. Jensen Land and Kronprins Christian Land are within the North Greenland and East Greenland fold belts, respectively, and have a more rugged, alpine topography (Fig. 1.4).
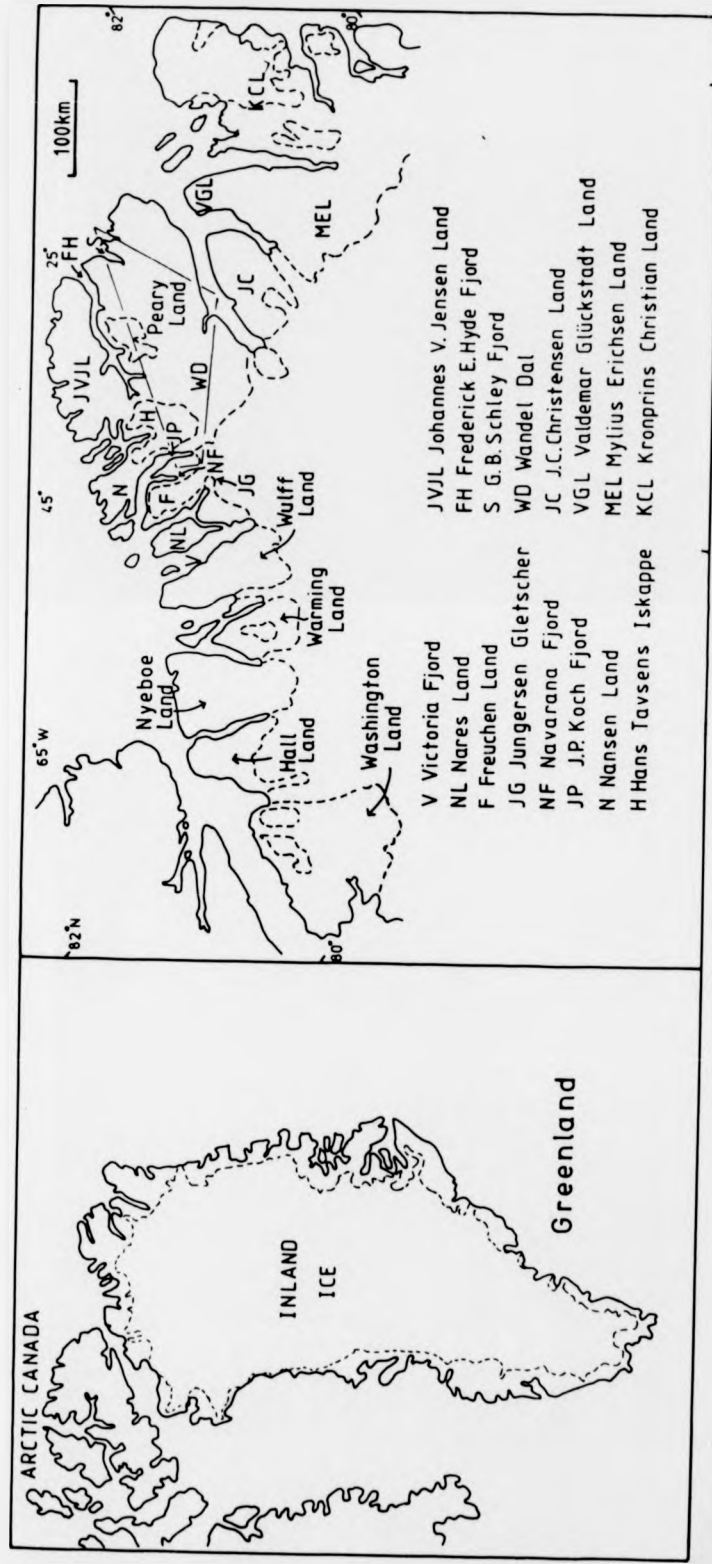
Figure 1.1. Location map of North Greenland showing its relationship with Arctic Canada. Outline delimits study area.
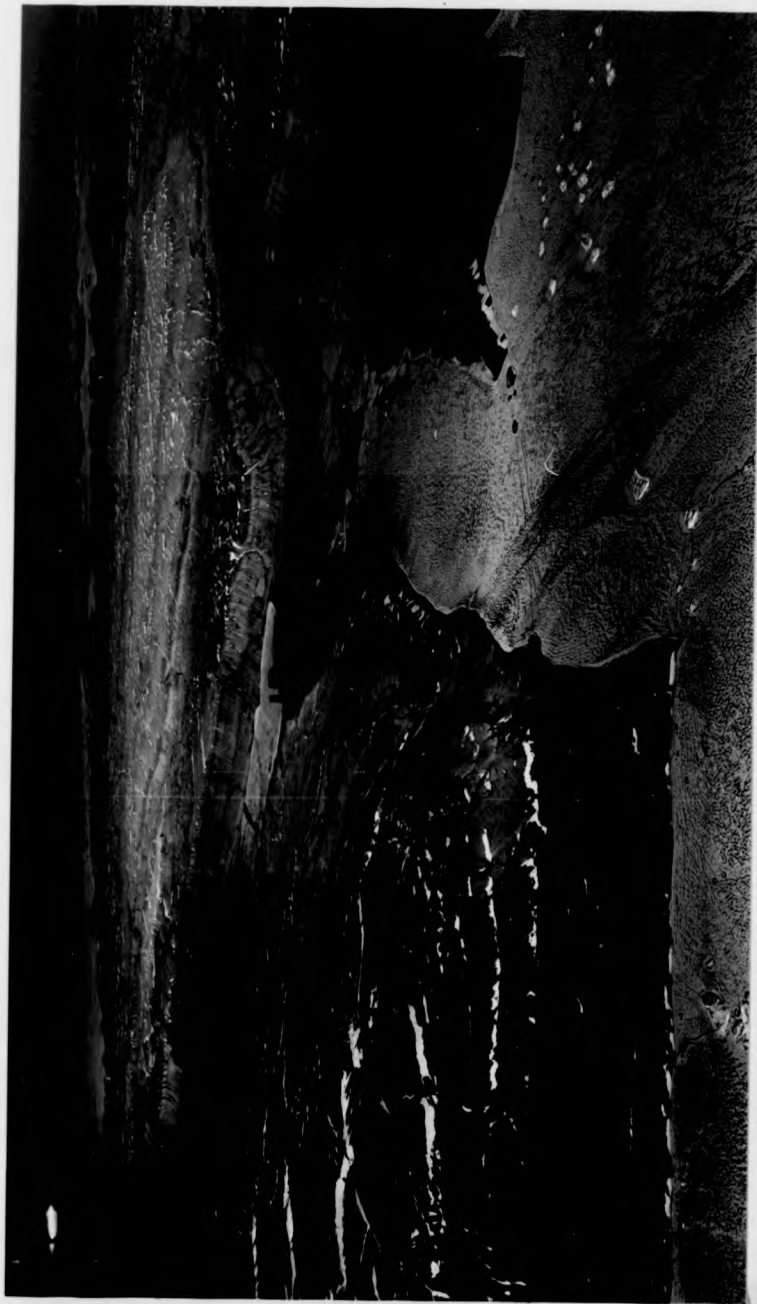
Figure 1.2. South Peary Land, viewed towards the north-west. Gently-dipping Lower Palaeozoic shelf strata form the dissected plateau; Cambro-Ordovician carbonates form the striped cliffs flanking Børglum Elv. B: Buen; JB: Jørgen Brønlund Fjord; BE: Børglum Elv; W: Wandel Dal. (Oblique air photograph; copyright Geodætisk Institut, Denmark).

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Figure 1.3. West Peary Land, viewed towards the east. Cambro-Ordovician strata form the steep cliffs along J.P. Koch Fjord. JP: J.P. Koch Fjord; F: Fimbuldal; H: Hans Tavsens Iskappe; P: Perssuak Gletscher; G: Gustav Holm Dal. (Oblique air photograph; copyright Geodætisk Institut, Denmark).

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Figure 1.4. North-east Peary Land and the Arctic Ocean, viewed towards the north. Faulted Lower Palaeozoic rocks form the foreground; prominent striped rocks (centre left) are the Wandel Valley Formation (Lower-Middle Ordovician). Cambrian carbonates (Brønlund Fjord Group) are exposed at the confluence of the three rivers (lower centre; Fig. 3.66, locality Y). Pale Upper Palaeozoic sedimentary rocks (centre right) rest unconformably on Cambrian strata. Distant mountains, beyond Frederick E. Hyde Fjord, are within the North Greenland fold belt. S: G.B. Schley Fjord; W: Wyckoff Land; H: Hans Egede Land; F: Frederick E. Hyde Fjord. (Oblique air photograph; copyright Geodætisk Institut, Denmark.)

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Although outcrop is widespread in Peary Land, inland exposure is commonly restricted by scree and solifluxion debris. Bedrock is superbly exposed, however, in a number of major river valleys and fjords (Figs. 1.2, 1.3 and 1.4).

1.2.   Previous investigations

The first recorded sighting of Peary Land was by Robert Peary in 1892. Although initially thought to be a separate island, subsequent exploration by Peary (1895 and 1900), by the ill-fated Danmark Expedition (1906-08) and by Knud Rasmussen and Peter Freuchen in 1912 established the major geographical features of the region. The earliest significant geological investigations were undertaken in 1921 by Lauge Koch during the Danish Bicentenary Expedition to Peary Land. Koch travelled widely in North Greenland between 1916 and 1923 and was principally responsible for the early understanding of the regional geology. A detailed account of the early history of geological exploration in North Greenland, and particularly the work of Lauge Koch, was given by Dawes & Haller (1979).

No further geological work was done in Peary Land until 1947 when Troelsen visited southern Peary Land as a member of the Danish Peary Land Expedition. Between 1947 and 1950, Troelsen developed a lithostratigraphic scheme for the Jørgen Brønlund Fjord region and made important observations elsewhere in Peary Land (see 3.2). This work was continued by Jepsen in 1966 and 1968 under the auspices of the 4th and 5th Danish Peary Land Expeditions.

The present phase of study by the Geological Survey of Greenland (GGU) was preceded by three pilot studies in the late 1960's and early 1970's. In 1969, Dawes and Soper traversed the North Greenland fold belt and produced a preliminary stratigraphy and structural cross-section (Dawes & Soper 1973). In 1974, Christie & Peel studied the Lower Palaeozoic stratigraphy in the Børglum Elv region (Christie & Peel 1977) and in 1975 Dawes measured a reconnaisance section in west Peary Land (Dawes 1976b). A review of the development of the lithostratigraphy of Peary Land is given in Chapter 3 (3.2.)

1.3.   Aims and methods

The Lower Palaeozoic sedimentary rocks of North Greenland represent deposition in two major settings: a cratonic shelf and a deep-water basin at or near the continental margin (see 2.1.) This thesis is concerned primarily with Cambrian shelf strata; the aim was to deduce the depositional processes and environments represented by the Brønlund Fjord and Tavsens Iskappe Groups and hence to gain an understanding of shelf evolution during the Cambrian. Clearly, a detailed stratigraphic framework is essential to such a study, and the lithostratigraphy became a necessary part of the project.

This thesis is based mainly on data collected during an eight-week field season in 1979, but also includes information acquired while engaged in regional mapping in north-east Peary Land (1978) and Kronprins Christian Land (1980). Field camps were spaced across southern Peary Land to obtain regional coverage from J.P. Koch Fjord in the west to Jørgen Brønlund Fjord in the east (Fig. 1.1).

Composite stratigraphical and sedimentological logs were measured at twenty-six localities. The Tavsens Iskappe Group is only recognized in south-west Peary Land, and consequently over two-thirds of the measured sections involve the Brønlund Fjord Group alone. Furthermore, the upper levels of the Tavsens Iskappe Group are commonly inaccessible or poorly exposed in Peary Land; further work on this interval to the west of Peary Land would be valuable. Sections were often measured in narrow gullies with lateral access of only a few metres. Study of large-scale lateral variation in vertical cliff sections was carried out from helicopters. The scale of measurement in the field was dependent on the nature of the facies and the field logistics. Representative detailed sections were measured through most lithofacies, but bed-by-bed measurement was not undertaken in every section through repetitive, thin-bedded facies (e.g. Fig. 3.44). Stratigraphical and sedimentological logs were measured using a combination of tape and Abney level; rapid reconnaisance logs were measured by level and/or hand-held barometer. The grain size of carbonate breccia beds was determined using the method described by Surlyk (1978). Where coarsely recrystallized, accurate measurement of clast size was often impossible and the average clast size of the coarse fraction was estimated.

Field description and identification of facies was supported by laboratory study of polished or etched slabs, stained acetate peels and stained thin sections; the staining procedure of Dickson (1965) was adopted. The aim of the laboratory work was to ascertain, as far as possible, the primary depositional characteristics of the rock. Hence, the

diagenesis has only been studied in detail where the early diagenetic evolution of the sediment intimately reflects its depositional environment. Point counts of the terrigenous rocks and a number of the undolomitized grainstones and packstones were carried out to determine the relative proportions of grain types. Palaeocurrent measurements from areas where the structural dip exceeds 5°, were re-oriented using the stereographic procedure of Phillips (1971).

1.4. Terminology

1.4.1. Rock classification

Limestones are classified according to the scheme of Dunham (1962) as modified by Embry & Klovan (1971). Where recognition of the lime precursor is possible, dolomites are also classified on the Dunham scheme, e.g. dolomitized skeletal grainstone, dolomitized wackestone. For simplicity, this has been shortened on some diagrams to dolomite grainstone, dolomite wackestone. It should be emphasized, however, that dolomitization was a secondary, replacive process and a 'dolomite grainstone' does not represent an accumulation of detrital dolomite grains. The term 'dolostone' is not used; both the mineral and the rock are referred to as dolomite. Dolomite crystalline fabrics are described according to the size-scale of Folk (1965).

Siliciclastic rocks are classified according to the Udden-Wentworth grain-size scale and the sandstone classification of Pettijohn (1954) as modified by Dott (1964).

1.4.2.   Environments

Following the work of Ahr (1973) and Wilson (1975) there is general
acceptance of two distinct carbonate depositional settings – the ramp and
the rimmed shelf/platform (see Ginsburg & James 1974; Read 1982; James &
Mountjoy 1983).

Carbonate ramps are gently sloping surfaces (slopes < 1°) on which
shallow-water, high-energy nearshore deposits pass gradually offshore into
deeper-water, low-energy facies (Ahr 1973).   Read (1982) subdivided the
ramp model into homoclinal and distally-steepened ramps (Fig. 1.5).   The
former is characterized by uniform slopes and scarce sediment gravity flow
deposits in coeval deep-water deposits.   The latter shows an abrupt break
in slope that occurs in relatively deep water and thus, although gravity
flow deposits are common in contemporaneous deep-water environments, they
rarely contain clasts of shoal-water carbonates (Read 1982).

The rimmed carbonate shelf or platform is characterized by an
extensive, low-relief, shallow-water environment that passes offshore into
deep water via an abrupt slope break (Fig. 1.5).   The break in slope is
typically marked by a semi-continuous or continuous rim or barrier, composed
of reefs or carbonate sand banks; margin slopes may range from a few degrees
to sub-vertical (Read 1982; James & Mountjoy 1983). Mass flow deposits in
adjacent deep-water environments contain abundant clasts derived from the
shallow-water environments at the slope break (Read 1982).

These models represent two distinct geomorphological settings and,
contrary to some recent studies (e.g. Markello & Read 1981, 1982; Hurst &
Surlyk 1983), are considered here to be mutually exclusive.

Deep ramp
(low energy)

Shallow ramp
(high energy)

Carbonate ramp

Low depositional slopes (<1°)

Margin
(high energy)

Interior
(low energy)

Carbonate platform

Sloping margin

OUTER SHELF

INNER SHELF

Carbonate platform

Platform-outer shelf
complex
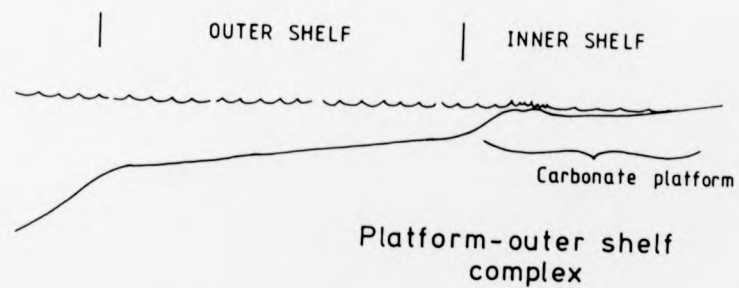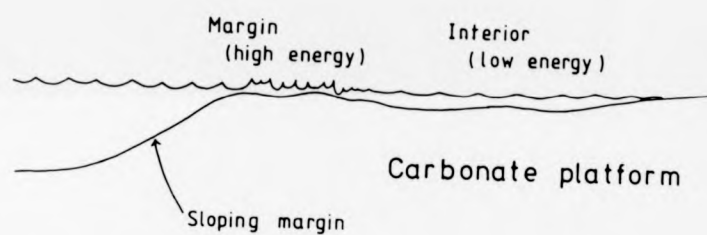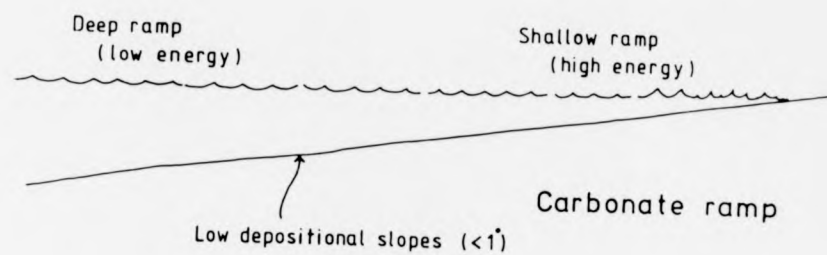
Figure 1.5   Environmental classification.

The terms 'platform' and 'shelf' are used widely in carbonate sedimentology but there is little consistency in their usage (e.g. compare Davies 1977, Read 1982 with Wilson 1975, Smith 1977). In this study, the terminology follows that of Wilson (1975) and Sellwood (1978). The marine shelf refers here to a flat or gently inclined surface bordered to landward by the shoreline and seaward by a break in slope at the transition into deep-marine environments. A similar definition was adopted by Smith (1977) and Hurst & Surlyk (1983) and it has the advantage of closely resembling the definition of the modern continental shelf (Vanney & Stanley 1983). This usage is also compatible with that adopted in the study of ancient siliciclastic marine sequences which avoids semantic problems in mixed carbonate-siliciclastic sequences. A carbonate shelf, therefore, may comprise a carbonate ramp, a carbonate platform or a carbonate platform-outer shelf complex (Fig. 1.5).

'Platform' and 'shelf' have also been used interchangeably in a regional, tectonic context to describe the stable, cratonic margin of North Greenland (e.g. Dawes 1976a; Hurst & Surlyk 1983). The 'platform' refers here to a distinct carbonate environment, as defined above; the 'shelf' is used to describe both the marine environment (see above) and the regional, tectonic setting.

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CHAPTER 2: GEOLOGICAL SETTING

2.1. Regional Geological Framework.

The regional geology of North Greenland has been reviewed by Dawes (1976a), Dawes & Peel (1981) and Peel (1982b); this brief account is taken from those reviews and from the results of recent fieldwork, published in GGU Reports 88, 99 and 106.

The geology of North Greenland falls into three major stratigraphic divisions: 1. Precambrian gneissic basement, 2. Proterozoic - Lower Palaeozoic sedimentary and volcanic rocks and 3. Upper Palaeozoic - Tertiary sedimentary and volcanic rocks.

2.1.1. Precambrian basement.

Metamorphic rocks of the Greenland Shield crop out in a limited area at the head of Victoria Fjord, Wulff Land (Fig. 2.1). They comprise amphibolite-facies granite gneiss and amphibolite and are overlain unconformably by strata of Late Proterozoic (?) or Cambrian age (Hurst & Peel 1979). An Archaean or Early Proterozoic metamorphic age for the gneisses is probable, by analogy with the rocks of northern West Greenland (Larsen & Dawes 1974). Comparable basement gneisses occur as exotic blocks in intrusive breccia pipes in the North Greenland fold belt (Soper *et al.* 1980) and within the East Greenland fold belt (Jepsen & Kalsbeek 1981).

2.1.2. Proterozoic - Lower Palaeozoic strata

The geology of North Greenland is dominated by Proterozoic and Lower Palaeozoic strata which crop out in a continuous belt from Washington Land in the east to Kronprins Christian Land in the west (Fig. 2.1). Three provinces are recognized (Fig. 2.1): the *shelf zone*
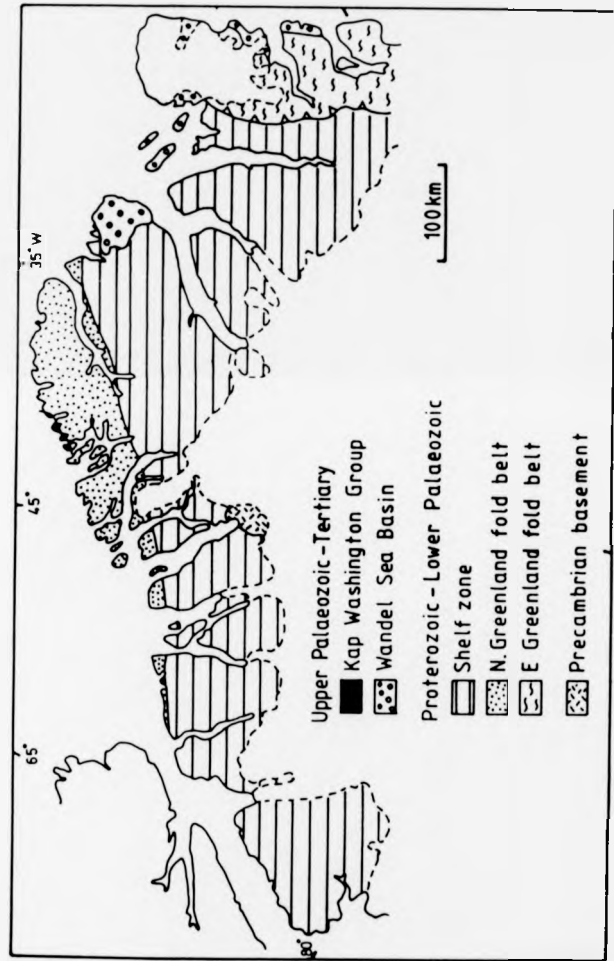
Figure 2.1. Geological sketch map of North Greenland (after Peel 1982b).
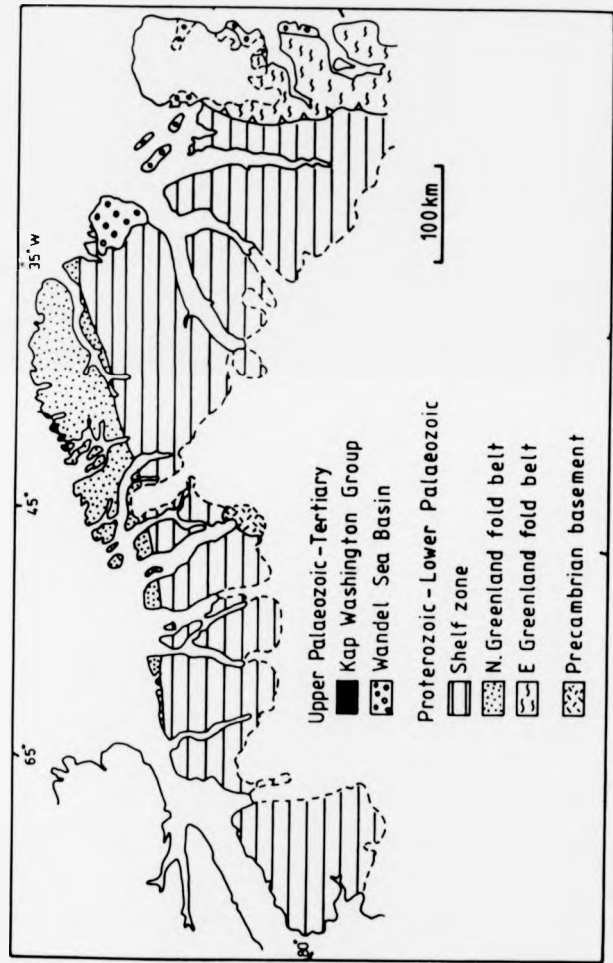
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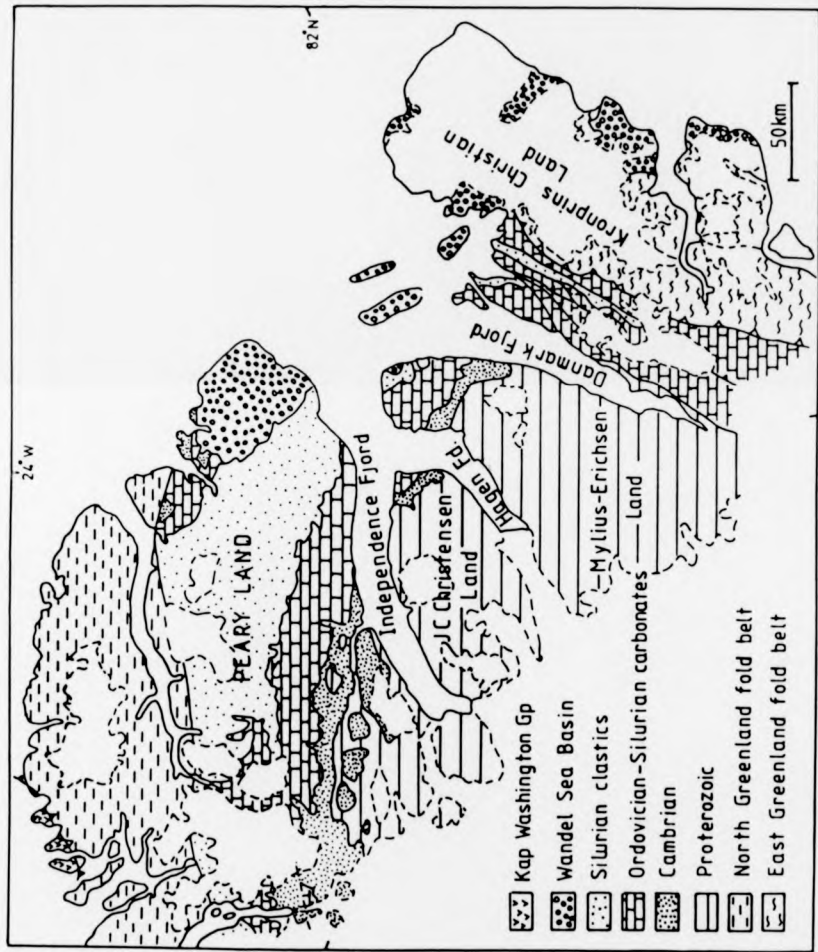
Figure 2.2. Geological sketch map of eastern North Greenland (after Peel, in press).

an undeformed homoclinal sequence of shallow-marine or continental
sedimentary rocks; the *North Greenland fold belt,* a moderately to
highly deformed marine sedimentary sequence of deep-water aspect; and
the *East Greenland fold belt* , a thrust-fold belt involving rocks of
both shallow-marine and deep-water aspect.

2.1.2.1. Shelf zone

Proterozoic and Lower Palaeozoic shelf strata extend across the
width of North Greenland and form the continuation of the Arctic Platform
of Canada (Peel & Christie 1982).   In central North Greenland they
unconformably overlie Precambrian gneissic basement (Fig. 2.1).   Farther
north they grade into the contemporaneous deep-water strata of the North
Greenland fold belt, whereas in eastern North Greenland they form the
foreland to the Caledonian thrust-fold belt (Fig. 2.1).   The shelf zone
is structurally simple; gentle northerly dips (typically <10°) predominate
over much of the region and the succession youngs northwards (Fig. 2.2).
In eastern North Greenland, adjacent to the north-south trending East
Greenland fold belt, the shelf strata dip gently to the east.

Proterozoic shelf sediments and volcanics crop out extensively
between southern Peary Land and Kronprins Christian Land and are up to
4500m thick in J. C. Christensen Land and Mylius Erichsen Land (Peel 1982b).
The sandstones, mudstones and carbonates of this succession represent non-
marine, marginal-marine and shallow-marine environments; the sequence
includes several intrabasinal unconformities (e.g. Collinson 1983).   These
Proterozoic sediments thin westwards and where basement rocks are exposed
in Wulff Land, overlying sediments of ?Proterozoic age are less than
100m thick (Jepsen 1984).   It has been suggested that this thinning reflects
a structural high in central North Greenland during the late Proterozoic
(the Victoria Fjord arch of Dawes & Soper 1973).

Shelf strata of Early Palaeozoic age have a combined thickness of nearly 4000m and an age range of earliest Cambrian to Late Silurian; extension into the earliest Devonian is likely but not yet proven (Peel 1982b). Cambrian strata rest unconformably on Proterozoic rocks and a regional unconformity occurs at the base of the Ordovician succession in eastern North Greenland (see 2.2). The Lower Palaeozoic shelf succession is carbonate-dominated and represents mainly shallow-marine depositional environments. The shelf sequence passes northwards into rocks of deep-water aspect which mainly lie within the North Greenland fold belt. Where observed or accurately inferred the transition may be gradational, representing a gentle slope or ramp-like margin (Hurst 1981), or abrupt, representing a steep escarpment (Hurst & Surlyk 1983). Carbonate mounds are common at or near this transition in strata of Silurian age (Hurst 1980). Strata of Wenlock and Ludlow age in eastern North Greenland and Ludlow age in west North Greenland form a thick pile of turbiditic sandstones and mudstones. This upward transition from shallow-marine carbonates to turbidites reflects foundering of the carbonate shelf and southward expansion of the deep-water basin (Surlyk et al. 1980).

2.1.2.2. North Greenland fold belt.

The east-west trending North Greenland fold belt (Fig. 2.1) is composed of ?Upper Proterozoic to Silurian clastic sedimentary rocks that were deformed and metamorphosed during the Ellesmerian orogeny (Devonian) with localized overprinting during the Eurekan orogeny (Tertiary) (Dawes & Soper 1973; Higgins et al. 1981). The North Greenland fold belt is the eastern continuation of the Innuitian orogenic system of Arctic Canada. The clastic rocks comprise a thick succession (>7500m) of turbiditic sandstones and mudstones with subordinate carbonate and chert conglomerates. They represent the fill of a deep-water basin (called the Hazen Trough in Arctic Canada) that lay to the north of the shelf zone. The margin of the fold belt roughly corresponds to the

transition from basinal to shelf facies.

On stratigraphic grounds, the Ellesmerian orogenic episode is confined between the Early Devonian and the Early Carboniferous (Dawes & Peel 1981). The intensity of deformation and metamorphism attributed to this event, increases northwards from the margin of the shelf zone in northern Peary Land to the northern coastline of Greenland. The transition from shelf zone to fold belt is gradational and is not delineated by major dislocation planes. Flexured and block faulted strata at the transition, grade northwards into a zone of open, symmetrical folds. Farther north, folds become tight to isoclinal and asymmetric, typically showing northerly vergence. Three main coaxial fold phases are recognized (Dawes & Soper 1973; Soper *et al.* 1980; Higgins *et al.* 1982); east-west or NE-SW axial trends dominate. The sense of tectonic transport is northwards and the shelf zone forms the hinterland to the North Greenland fold belt. The northward increase in deformation is accompanied by an increase in metamorphic grade which reaches low amphibolite-facies in northernmost Greenland.

Structures attributed to the Tertiary Eurekan orogeny include a major south-dipping thrust (Kap Cannon Thrust) on the north coast of Johannes V. Jensen Land (Dawes 1971, 1976a) and a set of NW-SE or E-W trending faults (Higgins *et al.* 1981).

2.1.2.3. East Greenland fold belt

The Caledonian fold belt of East Greenland extends northwards as far as Kronprins Christian Land (Fig. 2.1). The detailed relationship between this orogenic belt and the North Greenland fold belt is not known since the junction, if present, occurs offshore, to the east of Peary Land. The age of the main orogenic episode is similar to that of

the North Greenland fold belt (i.e. Late Silurian-Devonian) but the
two fold belts show markedly different tectonic styles. In Kronprins
Christian Land, the East Greenland fold belt consists of an inner
(western) belt of moderately deformed but essentially autochthonous
foreland rocks, and an outer, allochthonous belt composed of a number
of major nappes. The foreland sequence consists mainly of Lower
Palaeozoic shelf carbonates as represented on the shelf zone farther
west. These rocks young eastwards but are repeated by north-south
trending high-angle thrust faults and associated folds. The sense
of tectonic transport on minor thrust faults and major slides is westwards,
towards the craton. The outer allochthonous zone consists of three
major nappes composed of Upper Proterozoic to Lower Palaeozoic sedimentary
rocks (Hurst & McKerrow 1981). Hurst *et al.* (1983) suggested derivation
of these nappes from an area about 150 km to the east of their present
location.

2.1.2.4. Early Palaeozoic palaeolatitude and tectonic setting.

Palaeolatitude

In the Early Palaeozoic, Greenland and North America,
together with northern Britain, western Spitzbergen and western
Newfoundland, formed the Laurentia continental block. Palaeomagnetic
evidence indicates that this block was situated mainly within the
tropics and reconstructions for the Cambro-Ordovician show north Greenland
and Arctic Canada lying at or within 10° of the palaeoequator
(Smith *et al* .1981). Such an equatorial, or at least tropical,
position during the Early Palaeozoic is supported by the thick shelf
carbonate sequences which include reef tracts, evaporites, phosphorites
and cherts (*cf*. Frakes 1979).

Plate tectonic setting

Greenland formed part of the Laurentian continental block during

the Early Palaeozoic and was flanked on its northern and eastern
margins by two tectonically active belts, now represented by the
North Greenland and East Greenland fold belts. The Caledonian
orogen, of which the East Greenland fold belt forms the northern
extension, has been studied exhaustively in Europe and eastern North
America (e.g. Harris *et al.* 1979; Gee & Sturt, in press). Although
the details are still under debate, it is generally agreed that the
Caledonian episode resulted from continental collision, following
closure of the Iapetus Ocean (Anderton *et al.* 1979). Northern
East Greenland was situated along a passive margin bordering the
Iapetus Ocean during the Early Palaeozoic (Hurst *et al.*1983).

The regional tectonic setting of the northern margin of Greenland
during the Early Palaeozoic is poorly understood. The progressive
development of the deep-water basin during this period reflects a phase
of rapid subsidence, possibly related to rifting and crustal extension
(Surlyk & Hurst 1983, 1984). The northern margin of the deep-water
basin is not exposed in North Greenland, however, and there is no
direct evidence for the existence of a landmass to the north of the
basin during the Early Palaeozoic. Indirect evidence of a northern
barrier is provided by the east-to-west palaeocurrent pattern,
parallel to the basin margin (Surlyk 1982).

The nature of the crust underlying the basin can only be inferred.
Several small volcanic centres occur just north of Frederick E. Hyde
Fjord in Johannes V. Jensen Land (Fig. 2.2). They consist of intrusive
volcanic breccia which contains exotic blocks of amphibolite-facies gneiss
and acid intrusives, suggesting that the basin was ensialic even though
close to a continental margin (Soper *et al.* 1980; Parsons 1981).
Serpentinite and spilitic volcanic blocks are also present, however, and
Surlyk & Hurst (1984) suggested the presence of highly attenuated crust,

of transitional type, beneath the basin. However, the volcanic centres occur in the southern part of the fold belt, near the inferred margin of the basin, and the nature of the crust farther north is unknown.

Surlyk & Hurst (1983, 1984) envisaged two possible tectonic situations: 1. The North Greenland basin was a true ocean basin, deposited on oceanic crust, with the ocean ridge forming the northern barrier. 2. It was an ensialic basin formed under an extensional regime between the stable craton and a northern continental block. This may have been an aulacogen, related to the north-south trending East Greenland continental margin (Surlyk 1982) or an incipient marginal basin, as proposed for the laterally equivalent Hazen Trough in Arctic Canada (Trettin & Balkwill 1979).

2.1.3. Upper Palaeozoic - Tertiary strata.

2.1.3.1. Wandel Sea Basin

Outliers of relatively undeformed sedimentary rocks of Carboniferous to Tertiary age (the Wandel Sea Basin) rest unconformably on the Proterozoic and Early Palaeozoic rocks in eastern North Greenland (Fig. 2.2). The succession has a composite thickness of 7000m and an age range from Early Carboniferous to Palaeocene (Håkansson *et al.* 1981). It comprises a highly varied sequence of conglomerates, sandstones, limestones and evaporites, representing deposition in non-marine and marine shallow-shelf environments (Håkansson 1979; Håkansson *et al.* 1981). The succession includes a number of localized angular unconformities and rapid lateral facies changes related to syndepositional faults (Håkansson 1979).

2.1.3.2. Kap Washington Group

The Kap Washington Group is composed mainly of volcanic rocks

which crop out on the north coast of Johannes V. Jensen Land, in
thrust contact with Lower Palaeozoic metasediments of the North Greenland
fold belt (Fig. 2.2). The group consists of basic and acid lavas and
pyroclastic rocks including coarse breccias, airfall tuffs and welded
ash-flow tuffs (Brown & Parsons 1981; Batten *et al.* 1981). Intercalated
sediments yielded a macro- and microflora indicative of a latest
Cretaceous age (Batten *et al.* 1981). The volcanics show peralkaline
affinities and were probably generated in a continental rift environment
prior to break-up of the Laurasian plate in the Arctic region
(Batten *et al.* 1981).

2.2   Upper Proterozoic-Lower Palaeozoic stratigraphy of eastern North Greenland.

Fieldwork in eastern North Greenland since 1978 has led to
extensive modification and revision of the early stratigraphic framework.
The schemes shown in Figs. 2.3, 2.4 and 2.5 are based mainly on field
reports (*Rapp. Grønlands geol. Unders.* 88, 99 and 106); a review of
the stratigraphy of Lower Palaeozoic strata in eastern North Greenland
was presented by Peel (in press).

2.2.1.   Shelf zone.

2.2.1.1.   Upper Proterozoic-Cambrian.

The Upper Proterozoic and Cambrian strata of southern Peary Land,
J. C. Christensen Land and Mylius Erichsen Land form three major
stratigraphic units, bounded by regional unconformities (Fig. 2.3).
1. The oldest of these is made up of the Independence Fjord Group
and the Zig-Zag Dal Basalt Formation which flank the Inland Ice in
Heilprin Land, J. C. Christensen Land and Mylius Erichsen Land
(Fig. 2.2) and are also recognized in north-east Peary Land

| NW | PEARY LAND | J.C.CHRISTENSEN LAND–MYLIUS ERICHSEN LAND | SE |
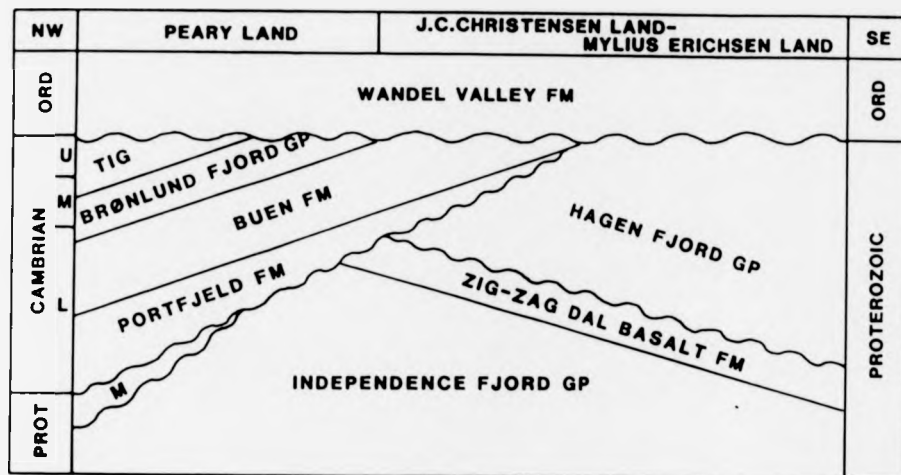
TIG–TAVSENS ISKAPPE GROUP

M–MORÆNESØ FM

Figure 2.3   Stratigraphy of the Proterozoic-Cambrian shelf sequence
(adapted from Peel 1982 and unpublished sources).

| | PEARY LAND | KRONPRINS CHRISTIAN LAND |
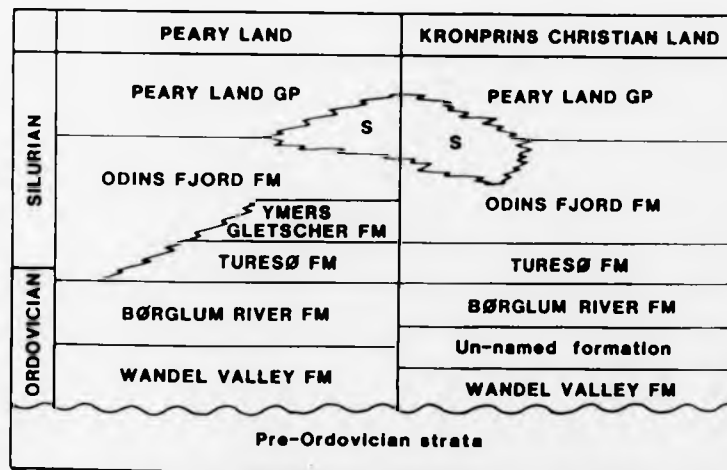
S– SAMUELSEN HØJ FM

Figure 2.4   Stratigraphy of the Lower Palaeozoic shelf sequence
(after Christie & Peel 1977; Peel et al. 1981; Hurst 1984).

(Christie & Ineson 1979); Collinson 1980; Jepsen *et al.* 1980).
The *Independence Fjord Group* is a thick (>1800m) succession of
mainly alluvial sandstones with several persistent red siltstone units,
which typically overlie unconformity surfaces (Collinson 1979, 1980,
1983). Intrusive sheets of dolerite and granophyre are common,
particularly in the Independence Fjord region. Radiometric dating
of both sediments and intrusives indicates a Middle Proterozoic age
for the group (Collinson 1983). The *Zig-Zag Dal Basalt Formation*
conformably overlies the Independence Fjord Group and is overlain
unconformably by the Hagan Fjord Group. It comprises up to 1350m
of tholeiitic basalts with rare acid flows; evidence of both subaqueous
and subaerial eruption is present.

2. The *Hagan Fjord Group* and its lateral correlative the
Moraenesø Formation rest unconformably on the Independence Fjord
Group or the Zig-Zag Dal Basalt Formation; the unconformity is planar
in most areas, although the Moraenesø Formation of northern Heilprin Land
is preserved in valleys and hollows. The Hagan Fjord Group is best
developed in J. C. Christensen Land and Mylius Erichsen Land where it
has a maximum thickness of about 1000m and is subdivided into six
formations. It comprises a varied sequence of clastics and carbonates
of probable shallow-marine origin (Clemmensen 1979); stromatolites
are typically well-developed in the carbonate intervals and locally
form extensive biostromal complexes. The Moraenesø Formation has a
patchy distribution in Heilprin Land and southern Peary Land and has a
maximum thickness of 75m. It is dominated by sandstones and conglomerates
with subordinate stromatolitic dolomites and diamictites of inferred
glacial origin (Clemmensen 1979).

3. Cambrian strata are restricted to western and central parts of
eastern North Greenland (Figs 2.2 and 2.3) and are absent from
Kronprins Christian Land. The basal Cambrian formation, the Portfjeld

Formation, rests unconformably on peneplained, faulted Precambrian rocks
(Jepsen & Suthren 1979). The stratigraphy of the Cambrian strata is
covered in detail in Chapter 3.

2.2.1.2. Ordovician-Silurian

Shelf strata of Ordovician and Silurian age form a thick
conformable sequence (c.2200m) that crops out extensively in
Peary Land, Kronprins Christian Land and Northern Valdemar Glückstadt
Land (Fig. 2.2). Ordovician and Lower Silurian platform carbonates
and bioherms are subdivided into seven formations, four of which are
recognized throughout the shelf zone of eastern North Greenland
(Fig. 2.4). The Turesø and Ymers Gletscher Formations are not recognized
in north-east Peary Land (Christie & Ineson 1979), whilst in Kronprins
Christian Land the Ymers Gletscher Formation is absent and an un-named
formation is recognized between the Wandel Valley and Børglum River
Formations (Peel *et al*. 1981). Middle and Upper Silurian turbiditic
sandstones and mudstones are assigned to the Peary Land Group which is
also recognized within the North Greenland fold belt (Fig. 2.5).

2.2.2. Fold belt.

The basinal strata of the North Greenland fold belt in
Johannes V. Jensen Land are subdivided into six stratigraphic groups
(Fig. 2.5; Friderichsen *et al*. 1982; Hurst & Surlyk 1982). Faunal
data are scarce, particularly in the Skagen and Paradisfjeld Groups,
but the approximate age ranges and shelf equivalents are shown on
Fig. 2.5.

	SHELF	BASIN
SILURIAN	PEARY LAND GP	
	ODINS FJORD FM	PEARY LAND GP
	YMERS GLETSCHER FM	
	TURESØ FM	
ORDOVICIAN	BØRGLUM RIVER FM	AMUNDSEN LAND GP
	WANDEL VALLEY FM	
CAMBRIAN	TAVSENS ISKAPPE GP	VØLVEDAL GP
	BRØNLUND FJORD GP	
	BUEN FM	POLKORRIDOREN GP
	PORTFJELD FM	PARADISFJELD GP
	Precambrian strata	SKAGEN GP

Figure 2.5   Stratigraphy of the Proterozoic-Lower Palaeozic basinal succession (after Surlyk *et al*. 1980; Friderichsen *et al*. 1982).

SECTION II: STRATIGRAPHY

CHAPTER 3: LITHOSTRATIGRAPHY

3.1.   Introduction.

The stratigraphy of the Lower Palaeozoic succession of Peary Land
has been broadly outlined in Chapter 2.   In this section, the lithostrati-
graphy of the Cambrian strata is described in more detail.   The recent phase
of field work in Peary Land has resulted in changes to the established
stratigraphic framework (Troelsen 1949; Jepsen 1971), which to date have
only been discussed informally (Peel 1979; Ineson & Peel 1980).   The
revised stratigraphy will be formally defined in the publications of the
Geological Survey of Greenland in the near future, and is described here
using the formal stratigraphic framework in preparation for that publica-
tion.   It is recognized, however, that the presentation of a stratigraphic
scheme in an unpublished thesis does not constitute a formal definition
(Hedberg 1976).   Furthermore, the stratigraphy presented here was
initiated by and developed in co-operation with Dr. J.S. Peel (GGU), and
thus is not the unaided work of the author.   It is described here to
facilitate discussion of the sedimentology, in the absence of a full,
published, stratigraphic account, and should be regarded as a preliminary
version of the formal lithostratigraphy (Ineson & Peel, in preparation).

Cambrian strata of the shelf zone (see Chapter 2) occur in two
main areas of Peary Land (Fig.1.1).   In south Peary Land they crop out
in a continuous belt that stretches from the northern shores of Indepen-
dence Fjord, westwards along Wandel Dal to J.P. Koch Fjord, south-west

Peary Land and into Freuchen Land (Figs. 1.1, 1.2, & 1.3).

Cambrian strata also occur in the highly faulted terrain around G.B. Schley Fjord in north-east Peary Land (Figs. 1.1 & 1.4). These two outcrop areas are dealt with separately.

3.2.   Previous Work.

The early expeditions to Peary Land (see 1.3), were concerned primarily with geographical exploration and contributed little to geological knowledge of the area.   The first detailed geological observations were made by Lauge Koch during the Danish Bicentennial Expedition in 1921 (Koch 1923a,b).   He established a basic strati- graphy for the area around Independence Fjord and Jørgen Brønlund Fjord (Fig. 3.1; Koch 1923a,b) which was modified in later publications (Koch 1929, 1935) in the light of observations from western North Greenland.   Detailed discussions of the work of Lauge Koch in Peary Land are given by Troelsen (1949), Jepsen (1971) and Dawes (1971).

Troelsen visited Peary Land as a member of the Danish Peary Land Expedition (1947-1950), working predominantly in the area around Jørgen Brønlund Fjord in central Peary Land (Fig. 1.1), but also making brief visits to south-west and north-east Peary Land (Troelsen 1949, 1956).   During a short season in the summer of 1947, he studied the exposures in the Brønlund Fjord area (Figs. 1.1 & 1.2) and, building on the earlier stratigraphy of Koch (1923a,b), he divided the sequence into four stratigraphic units (Fig. 3.1).   He recognized an older sequence of sandstones with intrusions, overlain by dolomites, sandstones

Figure 3.1. Historical development of the lithostratigraphy of southern Peary Land.

M–Morænesø Fm

	Koch 1923 1929 1935	Troelsen 1949	Troelsen 1956	Jepsen 1971	Christie & Peel 1977	Dawes 1976b	Peel 1979 & this thesis	
ORDOVICIAN	Grey limestones	Wandel Valley Limestone	Wandel Valley Limestone		Wandel Valley Fm	H	Wandel Valley Fm	ORDOVICIAN
CAMBRIAN	White limestone	Brønlund Fjord Dolomite	Brønlund Fjord Dolomite	Brønlund Fjord Dolomite	Brønlund Fjord Fm	G / F / E	Tavsens Iskappe Gp / Brønlund Fjord Gp	U / M / L CAMBRIAN
EOCAMBRIAN	Cryptzoon limestone	Thule Gp	Thule Gp	Buen Fm / Portfjeld Fm / Inuiteq Sø Fm	Buen Fm / Portfjeld Fm	C,D / A,B	Buen Fm / Portfjeld Fm	
PRECAMBRIAN	Thule Fm		Tillite / Sandstones with Intrusions	M			M / Independence Fjord Gp	PROTEROZOIC

and interlayered shales and sandstones. He termed this sequence the
Thule Group and referred it to the Eocambrian (Troelsen 1949). This
sequence is sharply overlain by a thick carbonate succession which
Troelsen divided into the Brønlund Fjord Dolomite, the Wandel Valley
Limestone and the Børglum River Limestone (Fig. 3.1; Troelsen 1949).
The Wandel Valley Limestone yielded a fauna indicative of a late
Lower Ordovician age, and the underlying Brønlund Fjord Dolomite was
tentatively assigned to the Cambrian by reason of its stratigraphic
position (Troelsen 1949).

Fieldwork during the subsequent years of the expedition
(1948-1949) led Troelsen to modify this stratigraphy (Fig. 3.1; Troel-
sen 1956). Poorly sorted conglomeratic sandstones, interpreted as
tillites, were correlated with the Varanger glaciation and thus were
assumed to define the base of the Eocambrian (Troelsen 1956). Con-
sequently, these beds were defined as forming the basal unit of the Thule
Group in this area and the underlying sandstones with basic intrusions
were assigned to the Upper Precambrian (Troelsen 1956).

The Brønlund Fjord Dolomite was defined from a section on the
west side of the mouth of Børglum Elv (Fig. 1.1; Troelsen 1949, Fig. 7)
and the type locality designated was the "north coast of Jørgen Brønlunds
Fjord in southern Peary Land" (Troelsen 1956). He described the for-
mation as a sequence of light grey to brown weathering, very massive and
thick-bedded, cliff-forming dolomite, totalling about 156 metres in
thickness (Troelsen 1956) and equivalent to the "white limestone 100m

thick, devoid of fossils" of Koch (1923). The base of the formation was described as a "simple erosional disconformity" on the sandstones and shales of the Thule Group (Troelsen 1949). The contact with the over-lying Lower Ordovician Wandel Valley Limestone was originally described only as "sharp and well-defined" (Troelsen 1949) but was later referred to as a simple erosional disconformity (Troelsen 1956).

The Brønlund Fjord Dolomite was initially thought to be entirely unfossiliferous and a Cambrian age was assumed from its stratigraphical position (Troelsen 1949), but olenellid trilobites and Salterella fragments were subsequently obtained from the basal beds, thus proving an Early Cambrian age for at least the lower beds of the formation (Troelsen 1956).

Troelsen journeyed west from Jørgen Brønlund Fjord along Wandel Dal and showed that the boundary between his Thule Group and the over-lying Lower Paleozoic carbonates could be readily traced along strike as far as J.P. Koch Fjord in south-west Peary Land (Fig. 1.1; Troelsen 1956 and unpublished field maps, GGU archives).

A reconnaissance sledging trip around the north-east coast of Peary Land during 1949 proved the existence of Cambrian strata in the vicinity of G.B. Schley Fjord (Fig. 1.1; Troelsen 1956). Grey shales at two localities in this area yielded olenellid trilobites indicative of an Early Cambrian age (Troelsen 1956; see also Poulsen 1974). Troelsen assigned these beds to a new formation, the Schley Fjord Shale,

which he defined as being approximately 100m thick and characterized
by medium grey, hard, fine-grained shale (Troelsen 1956).   The base was
not observed, but the formation was thought to overlie Eocambrian
sandstones and shales and to be overlain with simple erosional dis-
conformity by the Wandel Valley Limestone (Troelsen 1956).   The Schley
Fjord Shale was regarded as equivalent to the Brønlund Fjord Dolomite of
southern Peary Land on the grounds of stratigraphical position and
faunal similarity (Troelsen 1956; see also Cowie 1961; Poulsen 1974).

The sequence stratigraphically below the Brønlund Fjord Dolomite
in southern Peary Land was studied by Jepsen (1966, 1969, 1971) during
the 4th and 5th Danish Peary Land expeditions in 1966 and 1968.
Jepsen (1971) defined four formations stratigraphically below the Brøn-
lund Fjord Dolomites: the Inuiteq Sø, Moræ nesø, Portfjeld and Buen
Formations, in ascending stratigraphical order (Fig. 3.1).   The Inuiteq
Sø Formation is equivalent to the Upper Precambrian sandstones of
Troelsen (1956); the overlying three formations comprise the Thule
Group of Troelsen (*op.cit.*), but Jepsen abandoned the term "Thule
Group" and its use is now restricted to the type area in western North
Greenland (Dawes 1971).   The Moræ nesø Formation, which includes the
tillites of Troelsen (1956), unconformably overlies the Inuiteq Sø
Formation and according to Jepsen (1971) is unconformably overlain by
the Portfjeld Formation.   The boundary between the Portfjeld and the
Buen Formations was not observed and, following Troelsen (1956), Jepsen
described the boundary between the Buen Formation and the Brønlund Fjord
Dolomite as an erosional unconformity (Jepsen 1971).

Olenellid trilobites were recorded for the first time from the upper, dark mudstones of the Buen Formation which was assigned to the Early Cambrian; the underlying formations were considered to be of Eocambrian or possibly Early Cambrian age (Jepsen 1971).

Geologists of Greenarctic Consortium visited North Greenland between 1969 and 1973 to evaluate the economic potential of the area. The results of this survey remain largely unpublished, but Lower Cambrian trilobites from the Buen Formation in Børglum Elv (Fig. 1.1) were donated to GGU (see Poulsen 1974) and information from unpublished company reports was included by Dawes (1976a).

During the summer of 1974, the work of Jepsen was complemented by a study of the Lower Palaeozoic sequence in the Børglum Elv region of Peary Land by R.L. Christie and J.S. Peel (Peel and Christie 1975; Christie and Peel 1977). The Cambrian and Ordovician strata were described using the stratigraphy set up by Troelsen (1949) and Jepsen (1971) with nomenclatural modifications introduced by Cowie (1971) (Fig. 3.1). The overlying Silurian sediments, exposed around the head of Børglum Elv (Fig. 1.1), were divided into four formations but were not formally defined (Christie and Peel 1977).

Additional fossil collections from the Buen Formation in Børglum Elv confirmed the general Early Cambrian age conferred by earlier workers (Jepsen 1971; Poulsen 1974). The Brønlund Fjord Formation was divided into four informal members in the valley of Børglum Elv (Christie and Peel 1977). Fossils indicative of a general late Early Cambrian age

were obtained from the basal member (Member A) at a comparable strati-
graphical level to the collection made by Troelsen (1956), but uncertainty
remained as to the age of the overlying unfossiliferous members of the
formation (Christie & Peel 1977).

The most recent fieldwork which concerned Cambrian stratigraphy
in Peary Land (prior to the 1978-80 project) was undertaken by P.R. Dawes
during a three-day reconnaissance visit to the J.P. Koch Fjord area,
south-west Peary Land (Fig. 1.3; Dawes 1976b). He described a thick
sequence (c. 700m) of carbonate-dominated sediments conformably over-
lying strata correlated with the Buen Formation, and disconformably
overlain by carbonates correlated with the Wandel Valley Formation
(Fig. 3.1). Dawes divided this interval into three informal units
(Dawes 1976b, units E,F and G), tentatively correlating the lower one
with the Brønlund Fjord Formation of south-eastern Peary Land. Unit
F (Fig. 3.1) yielded a fauna including the agnostid trilobite *Peronopsis*,
indicative of a Middle Cambrian age and indicated the presence of a
thicker, more complete Cambrian sequence in western exposures than else-
where in Peary Land (Dawes 1976b).

The present phase of investigation began in the summer of 1978,
as described previously (Chapter 1). Cambrian sediments of south-
west Peary Land were studied by J.S. Peel during regional geological
mapping at a scale of 1:100,000. He recognized the Portfjeld and Buen
Formations as described from central south Peary Land (Jepsen 1971) and,
following Dawes (1976), described a thick, carbonate-dominated succession
of Early-Late Cambrian age which conformably overlies the Buen Formation

and is unconformably overlain by the Wandel Valley Formation (Peel
1979). A stratigraphic scheme was presented (Peel 1979) in which
this sequence was subdivided into two groups, the Brønlund Fjord and
Tavsens Iskappe Groups (Fig. 3.1). Comparable strata in eastern expo-
sures, originally assigned to the Brønlund Fjord Formation (Troelsen 1949;
Christie & Peel 1977), were included in the Brønlund Fjord Group and the
Brønlund Fjord Formation was no longer recognized at the rank of forma-
tion (Peel 1979).

Further stratigraphic study and detailed mapping during the
following two seasons (1979, 1980) led to the development of a regionally
applicable stratigraphic scheme (Fig. 3.2; Ineson & Peel 1980) which is
described below.

The Cambrian sediments of north-east Peary Land were also en-
countered during regional mapping in 1978 (Christie & Ineson 1979).
The Cambro-Ordovician stratigraphy described from southern Peary Land
(Troelsen 1949; Jepsen 1971) as modified by Peel (1979) was recognized
in the faulted exposures around G.B. Schley Fjord (Fig.1.1). The
Schley Fjord Shale of Troelsen (1956) was included in the Buen Formation
for mapping purposes, although no decision on stratigraphic preference
was made at that time (Christie & Ineson 1979). The stratigraphy of
Cambrian sediments in the G.B. Schley Fjord area is discussed briefly
in section 3.4.

3.3   Cambrian lithostratigraphy of southern Peary Land.
       The stratigraphic scheme is presented in Fig. 3.2; lithostrati-
graphic units are described in ascending order where possible. The

Figure 3.2. Cambrian lithostratigraphy of Peary Land and eastern Freuchen Land.

and interlayered shales and sandstones. He termed this sequence the
Thule Group and referred it to the Eocambrian (Troelsen 1949). This
sequence is sharply overlain by a thick carbonate succession which
Troelsen divided into the Brønlund Fjord Dolomite, the Wandel Valley
Limestone and the Børglum River Limestone (Fig. 3.1; Troelsen 1949).
The Wandel Valley Limestone yielded a fauna indicative of a late
Lower Ordovician age, and the underlying Brønlund Fjord Dolomite was
tentatively assigned to the Cambrian by reason of its stratigraphic
position (Troelsen 1949).

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sen 1956). Poorly sorted conglomeratic sandstones, interpreted as
tillites, were correlated with the Varanger glaciation and thus were
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sequently, these beds were defined as forming the basal unit of the Thule
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Fjord in southern Peary Land" (Troelsen 1956). He described the for-
mation as a sequence of light grey to brown weathering, very massive and
thick-bedded, cliff-forming dolomite, totalling about 156 metres in
thickness (Troelsen 1956) and equivalent to the "white limestone 100m

thick, devoid of fossils" of Koch (1923). The base of the formation
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Dal and showed that the boundary between his Thule Group and the over-
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The sequence stratigraphically below the Brønlund Fjord Dolomite in southern Peary Land was studied by Jepsen (1966, 1969, 1971) during the 4th and 5th Danish Peary Land expeditions in 1966 and 1968. Jepsen (1971) defined four formations stratigraphically below the Brøn- lund Fjord Dolomites: the Inuiteq Sø, Moræ nesø, Portfjeld and Buen Formations, in ascending stratigraphical order (Fig. 3.1). The Inuiteq Sø Formation is equivalent to the Upper Precambrian sandstones of Troelsen (1956); the overlying three formations comprise the Thule Group of Troelsen (*op.cit.*), but Jepsen abandoned the term "Thule Group" and its use is now restricted to the type area in western North Greenland (Dawes 1971). The Moræ nesø Formation, which includes the tillites of Troelsen (1956), unconformably overlies the Inuiteq Sø Formation and according to Jepsen (1971) is unconformably overlain by the Portfjeld Formation. The boundary between the Portfjeld and the Buen Formations was not observed and, following Troelsen (1956), Jepsen described the boundary between the Buen Formation and the Brønlund Fjord Dolomite as an erosional unconformity (Jepsen 1971).

Olenellid trilobites were recorded for the first time from the upper, dark mudstones of the Buen Formation which was assigned to the Early Cambrian; the underlying formations were considered to be of Eocambrian or possibly Early Cambrian age (Jepsen 1971).

Geologists of Greenarctic Consortium visited North Greenland between 1969 and 1973 to evaluate the economic potential of the area. The results of this survey remain largely unpublished, but Lower Cambrian trilobites from the Buen Formation in Børglum Elv (Fig. 1.1) were donated to GGU (see Poulsen 1974) and information from unpublished company reports was included by Dawes (1976a).

During the summer of 1974, the work of Jepsen was complemented by a study of the Lower Palaeozoic sequence in the Børglum Elv region of Peary Land by R.L. Christie and J.S. Peel (Peel and Christie 1975; Christie and Peel 1977). The Cambrian and Ordovician strata were described using the stratigraphy set up by Troelsen (1949) and Jepsen (1971) with nomenclatural modifications introduced by Cowie (1971) (Fig. 3.1). The overlying Silurian sediments, exposed around the head of Børglum Elv (Fig. 1.1), were divided into four formations but were not formally defined (Christie and Peel 1977).

Additional fossil collections from the Buen Formation in Børglum Elv confirmed the general Early Cambrian age conferred by earlier workers (Jepsen 1971; Poulsen 1974). The Brønlund Fjord Formation was divided into four informal members in the valley of Børglum Elv (Christie and Peel 1977). Fossils indicative of a general late Early Cambrian age

were obtained from the basal member (Member A) at a comparable strati-
graphical level to the collection made by Troelsen (1956), but uncertainty
remained as to the age of the overlying unfossiliferous members of the
formation (Christie & Peel 1977).

The most recent fieldwork which concerned Cambrian stratigraphy
in Peary Land (prior to the 1978-80 project) was undertaken by P.R. Dawes
during a three-day reconnaissance visit to the J.P. Koch Fjord area,
south-west Peary Land (Fig. 1.3; Dawes 1976b). He described a thick
sequence (c. 700m) of carbonate-dominated sediments conformably over-
lying strata correlated with the Buen Formation, and disconformably
overlain by carbonates correlated with the Wandel Valley Formation
(Fig. 3.1). Dawes divided this interval into three informal units
(Dawes 1976b, units E,F and G), tentatively correlating the lower one
with the Brønlund Fjord Formation of south-eastern Peary Land. Unit
F (Fig. 3.1) yielded a fauna including the agnostid trilobite *Peronopsis*,
indicative of a Middle Cambrian age and indicated the presence of a
thicker, more complete Cambrian sequence in western exposures than else-
where in Peary Land (Dawes 1976b).

The present phase of investigation began in the summer of 1978,
as described previously (Chapter 1). Cambrian sediments of south-
west Peary Land were studied by J.S. Peel during regional geological
mapping at a scale of 1:100,000. He recognized the Portfjeld and Buen
Formations as described from central south Peary Land (Jepsen 1971) and,
following Dawes (1976), described a thick, carbonate-dominated succession
of Early-Late Cambrian age which conformably overlies the Buen Formation

and is unconformably overlain by the Wandel Valley Formation (Peel 1979). A stratigraphic scheme was presented (Peel 1979) in which this sequence was subdivided into two groups, the Brønlund Fjord and Tavsens Iskappe Groups (Fig. 3.1). Comparable strata in eastern exposures, originally assigned to the Brønlund Fjord Formation (Troelsen 1949; Christie & Peel 1977), were included in the Brønlund Fjord Group and the Brønlund Fjord Formation was no longer recognized at the rank of formation (Peel 1979).

Further stratigraphic study and detailed mapping during the following two seasons (1979, 1980) led to the development of a regionally applicable stratigraphic scheme (Fig. 3.2; Ineson & Peel 1980) which is described below.

The Cambrian sediments of north-east Peary Land were also encountered during regional mapping in 1978 (Christie & Ineson 1979). The Cambro-Ordovician stratigraphy described from southern Peary Land (Troelsen 1949; Jepsen 1971) as modified by Peel (1979) was recognized in the faulted exposures around G.B. Schley Fjord (Fig.1.1). The Schley Fjord Shale of Troelsen (1956) was included in the Buen Formation for mapping purposes, although no decision on stratigraphic preference was made at that time (Christie & Ineson 1979). The stratigraphy of Cambrian sediments in the G.B. Schley Fjord area is discussed briefly in section 3.4.

3.3   Cambrian lithostratigraphy of southern Peary Land.

The stratigraphic scheme is presented in Fig. 3.2; lithostratigraphic units are described in ascending order where possible. The

Figure 3.2. Cambrian lithostratigraphy of Peary Land and eastern Freuchen Land.

component formations of the Brønlund Fjord and Tavsens Iskappe Groups described separately, with the western sequence of formations being described first.   A detailed biostratigraphic analysis is not attempted here; the geological ages presented are based primarily on collections made during the 1978-1980 field seasons, predominantly by J.S. Peel, but including material collected by R.L. Christie, P. Frykman, J.R. Ineson, P.D. Lane and A.T. Thomas.   Preliminary faunal determinations have been made by J.S. Peel, A.R. Palmer and R.A. Robison (see Peel 1979, 1982a; Palmer & Peel 1979; Robison 1981, 1984).   A discussion of previous reports of Cambrian fossils from Peary Land is given by Palmer & Peel (1979).

3.3.1. Portfjeld Formation.

The formation was defined by Jepsen (1971) and has subsequently been discussed by O'Connor (1979) and Peel (1979, 1980b).   It is 206m thick at the type section (Portfjeld, SW Frysefjeld (Fig. 3.3; Jepsen 1971) and thickens westward to a maximum measured thickness of 290m near Sydpasset, west of Øvre Midsommersø (Fig. 1.1; O'Connor 1979). The formation thins to the south-east (O'Connor 1979) and is not recognized south of northern Valdemar Glückstadt Land (Fig. 1.1; Peel et al., 1981).   The Portfjeld Formation is also recognized in northeast Peary Land around G.B. Schley Fjord (Christie & Ineson 1979).

The formation is characterized by grey-buff weathering, thin- to medium-bedded dolomites, which commonly include flat-pebble conglomerates, cross-stratified oolitic, intraclastic dolomites and stromatolitic dolomites.   A persistent unit of dark cherty dolomite forms
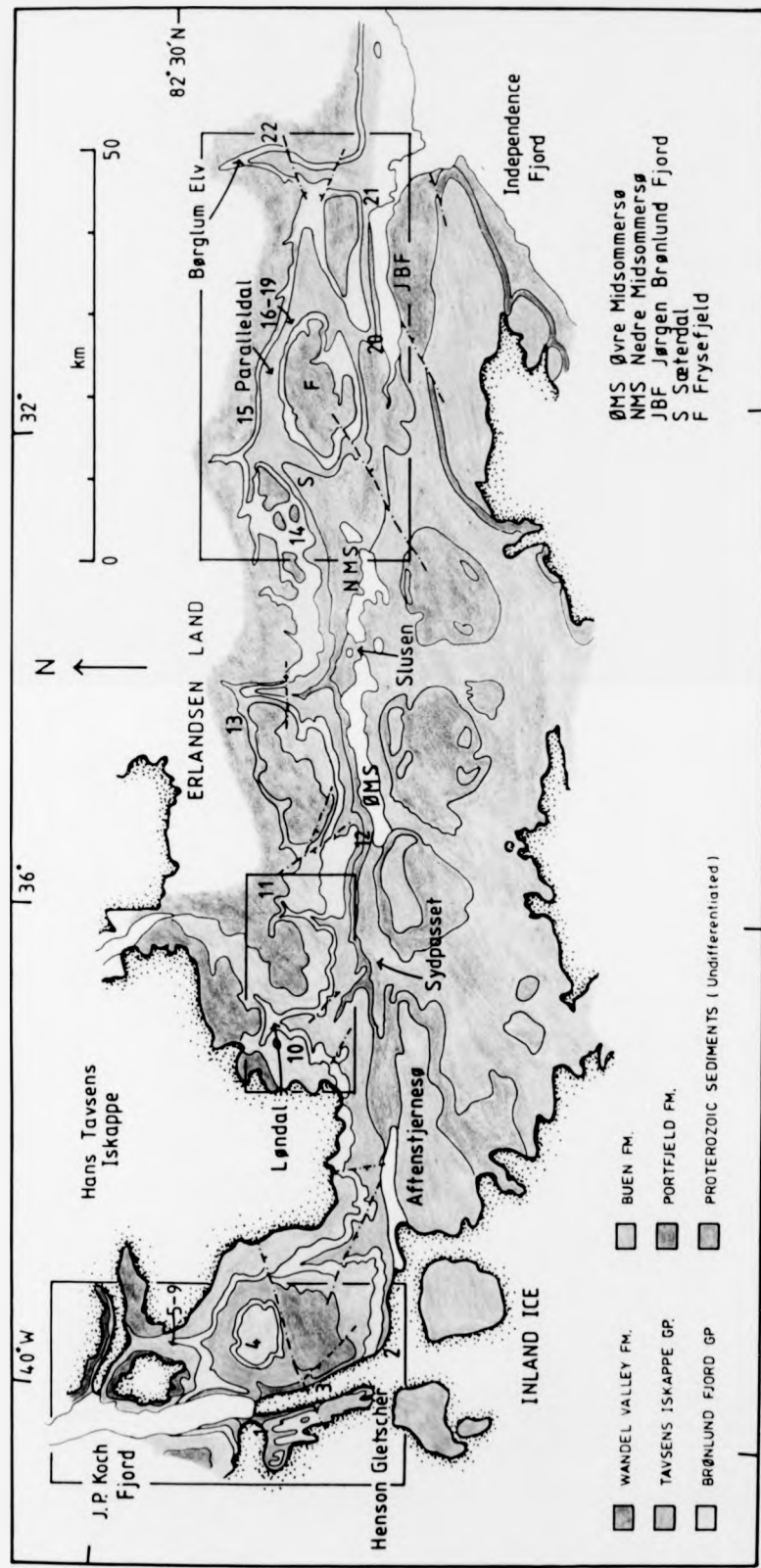
Figure 3.3. Geological sketch map of southern Peary Land; outlined areas shown in more detail in Figs 3.4., 3.28. & 3.56. (Drawn from preliminary map accompanying GGU Rapport 88 and unpublished data).

a distinctive marker in southern Peary Land (O'Connor 1979).   A
more detailed lithological description of the formation is given in
Chapter 4.

In south Peary Land, the Portfjeld Formation rests unconformably
on the Inuiteq Sø Formation and the localized Morænesø Formation (Jepsen
1971; Collinson 1980); it is overlain abruptly but conformably by the
Buen Formation (O'Connor 1979).

The formation is generally unfossiliferous, yielding only sparse
microfossils and has been regarded as of Eocambrian or Early Cambrian age
on account of its stratigraphic position between the Morænesø Formation
of presumed Eocambrian age and the Lower Cambrian Buen Formation (Jepsen
1971; Dawes 1976).   Pedersen (1970) recorded microfossils from the
Portfjeld Formation which he compared with Late Precambrian floras from
Australia, but microfossils obtained recently from near the base of the
formation indicate a probable Early Cambrian age for the formation
(Peel 1980b).

3.3.2. Buen Formation

The Buen Formation was defined by Jepsen (1971) from a type
locality at Buen, on the northern shore of Jørgen Brønlund Fjord (Fig.
1.1).   The formation is generally poorly exposed and complete sections
are rare, but a thickness of 425m was recorded at the type locality and
the formation is known to thin towards the west (Jepsen *op cit*.; Peel 1979).

Rusty-brown weathering, sandstone-dominated units occur at the
base and near the middle of the formation and form prominent crags separated

by darker, recessive units dominated by siltstones and mudstones with thin sandstone interbeds. The cliff-forming medium- to coarse-grained sandstones commonly show tabular and trough cross-stratification in medium- to large-scale sets. The upper half of the formation comprises fossiliferous, grey-green mudstones and bioturbated siltstones interbedded with thin, sharp-based beds of fine- to medium-grained, glauconitic, micaceous sandstone. The proportion of sandstone in the upper half of the formation increases noticeably from west to east across south Peary Land (Frykman 1980). A more detailed lithological description of the formation is given in Chapter 4.

The Buen Formation rests conformably on the Portfjeld Formation in southern Peary Land and is overlain by the Brønlund Fjord Group (Peel 1979). The upper boundary appears sharp and has been described as an erosional disconformity or unconformity (Troelsen 1956; Jepsen 1971) but is gradational in detail and, although locally erosional, is regarded as a conformable sedimentary contact (Frykman 1980).

Dark fissile mudstones in the upper half of the formation yielded rich olenellid faunas, indicative of a medial Early Cambrian age (Palmer & Peel 1979). The majority of these fossils have been collected from central southern Peary Land, around Jørgen Brønlund Fjord, but fragmentary specimens have been collected at a similar stratigraphic level from south-west Peary Land (Peel 1979). Lower beds of the formation are unfossiliferous and may be of early or medial Early Cambrian age.

3.3.3. Brønlund Fjord Group.

Underline History.

Peel (1979) raised the Brønlund Fjord Formation of previous usage (Troelsen 1949; Christie & Peel 1977) to the rank of group and recognized four unnamed formations in the J.P. Koch Fjord area of south-west Peary Land. The former Brønlund Fjord Formation in the Jørgen Brønlund Fjord area was tentatively correlated with the lower two formations described from south-west Peary Land (Peel 1979).

A correlation was established between these two areas during the 1979 field season (Ineson & Peel 1980) which necessitated the description of a further two formations within the Brønlund Fjord Group in central south Peary Land (Fig. 3.2).

Name.

From Jørgen Brønlund Fjord, south Peary Land (Fig. 3.3).

Type Area.

Peel (1979) designated the north side of Jørgen Brønlund Fjord as the type area of the group in accordance with the type area of the former Brønlund Fjord Formation (Troelsen 1949). A reference area and section was defined on the west side of Henson Gletscher in easternmost Freuchen Land (Figs. 3.4 & 3.5), where the group is well exposed and fully developed (Peel 1979).

Thickness.

About 175m in the type area; the group thickens westwards due to the eastward overstep of the unconformably overlying Wandel Valley
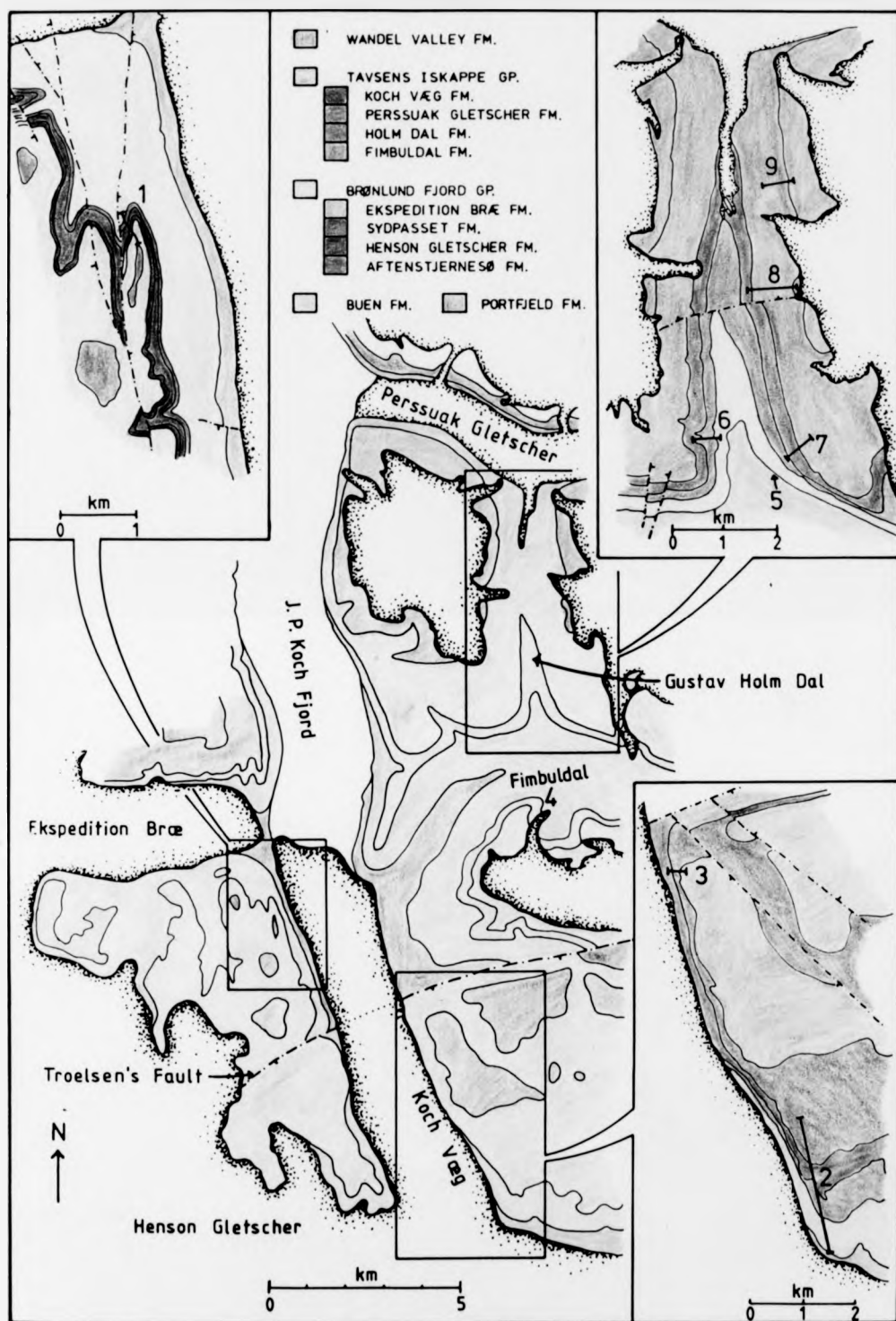
Figure 3.4   Geological sketch map of the J.P. Koch Fjord region; insets
show position of type localities, type sections and reference
sections (Drawn from unpublished field data - JSP/JRI).

Figure 3.5 Type locality of the Aftenstjerneső Formation (A), the
Henson Gletscher Formation (H) and the Sydpasset Formation
(S).   Note the massive pale breccia beds at the base and
top of the Aftenstjerneső Formation and the pale sandstones
in the middle of the Henson Gletscher Formation.   Locality 1,
east Freuchen Land.

Figure 3.6 Typical exposure of the Brønlund Fjord Group, showing the promi-
nent crags of the Aftenstjerneső and Sydpasset Formations (A and S)
and the recessive-weathering Henson Gletscher and Ekspedition
Bræ Formations (H and E). F: Fimbuldal Formation (Tavsens
Iskappe Group).   East Freuchen Land.

Figure 3.5   Type locality of the Aftenstjernesø Formation (A), the
Henson Gletscher Formation (H) and the Sydpasset Formation
(S).   Note the massive pale breccia beds at the base and
top of the Aftenstjernesø Formation and the pale sandstones
in the middle of the Henson Gletscher Formation.   Locality 1,
east Freuchen Land.

Figure 3.6   Typical exposure of the Brønlund Fjord Group, showing the promi-
nent crags of the Aftenstjernesø and Sydpasset Formations (A and S)
and the recessive-weathering Henson Gletscher and Ekspedition
Bræ Formations (H and E). F: Fimbuldal Formation (Tavsens
Iskappe Group).   East Freuchen Land.

Formation (Fig. 3.2) and, where fully developed in south-west
Peary Land, it reaches a maximum measured thickness of about 240m
(Fig. 3.7).

Dominant Lithology.

In the type area, the group is composed of yellow-brown
weathering, cliff-forming dolomite which includes dark, laminated and
graded dolomites and thick dolomite breccia beds.   Pale-cream weather-
ing, structureless or cross-stratified dolomite forms the upper unit
of the group in the type area (Fig. 1.2).
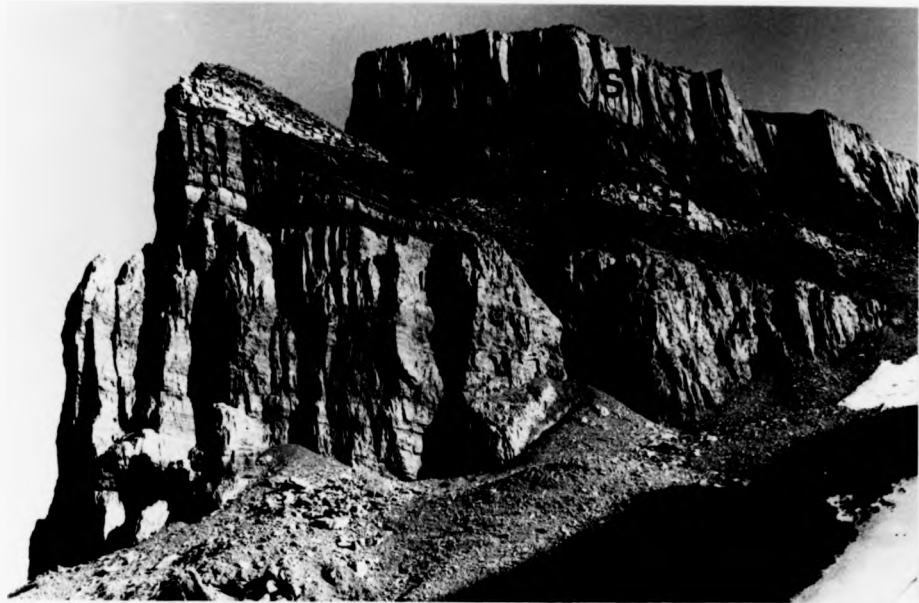
In the reference area, the group comprises a more varied sequence
of pale weathering, cliff-forming dolomites which commonly include
thick breccia beds and dark, graded and laminated dolomites, inter-
bedded with recessive intervals of platy, bituminous, cherty dolomites
and limestones, and thin-bedded, argillaceous limestones (Fig. 3.6).
Cream, fine-grained, dolomitic sandstones and dark siltstones form a
minor part of the group in northern exposures (Figs. 3.7 & 3.8), but
thicken southwards and form a distinctive, pale stripe in cliff sections
along Henson Gletscher.

Boundaries.

The Brønlund Fjord Group conformably overlies the Buen Formation
and, in western exposures, is conformably overlain by the Tavsens Iskappe
Group (Figs 3.2 & 3.8; Peel 1979).   Eastwards from Henson Gletscher,
the Wandel Valley Formation (Early-Middle Ordovician) progressively
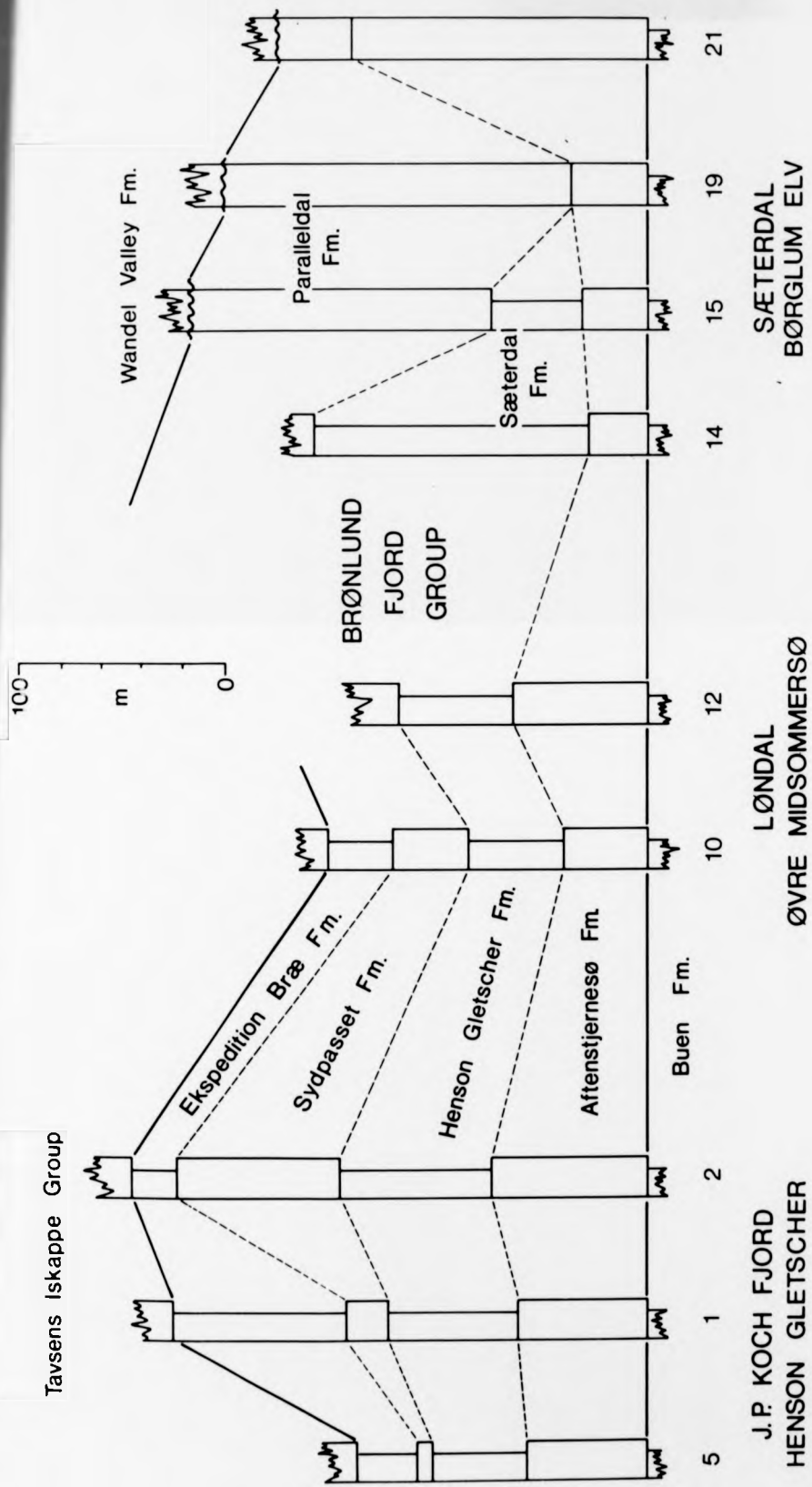
Figure 3.7. Stratigraphic correlation within the Brønlund Fjord Group across south Peary Land. Numbers refer to localities shown on Fig. 3.3.; lateral spacing of sections not to scale.

Figure 3.8. Cambrian succession on the north side of Fimbuldal, just east of Gustav Holm Dal, west Peary Land. Bu: Buen Formation. Brønlund Fjord Group:- A: Aftenstjernesø Formation; H: Henson Gletscher Formation; S: Sydpasset Formation; E: Ekspedition Bræ Formation. Tavsens Iskappe Group: F: Fimbuldal Formation; HD: Holm Dal Formation; P: Perssuak Gletscher Formation.

Figure 3.8. Cambrian succession on the north side of Fimbuldal, just east of Gustav Holm Dal, west Peary Land. Brønlund Fjord Group:- A: Aftenstjernesø Formation; H: Henson Gletscher Formation; S: Sydpasset Formation; E: Ekspedition Bræ Formation. Tavsens Iskappe Group: F: Fimbuldal Formation; HD: Holm Dal Formation; P: Perssuak Gletscher Formation. Bu: Buen Formation.

oversteps the Tavsens Iskappe Group and, to the east of Øvre Mid-
sommersø, the Wandel Valley Formation rests unconformably on the Brønlund
Fjord Group (Fig. 3.7).

Distribution.

The group crops out continuously across southern Peary Land from
Henson Gletscher in the west to the shores of Independence Fjord in the
east (Fig. 3.3).   The group has recently been shown to extend west
across Freuchen Land as far as Jungersen Gletscher.   The Brønlund
Fjord Group is recognized in north-east Peary Land (see 3.4) but is
absent south of Independence Fjord (Fig. 3.3) due to overstep by the
Wandel Valley Formation (Peel 1980c).

Geological Age.

Early-Middle Cambrian.

Subdivision.

The group comprises four formations in south-west Peary Land:
the Aftenstjernesø Formation, the Henson Gletscher Formation, the Syd-
passet Formation and the Ekspedition Bræ Formation (Fig.3.2).   The
Aftenstjernesø Formation is recognized throughout southern Peary Land,
but east of Øvre Midsommersø the Henson Gletscher, Sydpasset and
Ekspedition Bræ Formations are not recognized and the Aftenstjernesø
Formation is followed conformably by the Sæ terdal and Paralleldal
Formations (Fig. 3.2).   In north-east Peary Land, the group is made
up of the Wyckoff Bjerg and Hellefiskefjord Formations (3.4).

3.3.3.1.   Aftenstjernesø Formation.

History.

Strata assigned here to the Aftenstjernesø Formation have been described informally as formation 1 of the Brønlund Fjord Group (Peel 1979; Ineson & Peel 1980).   In the Jørgen Brønlund Fjord area the formation is equivalent to Members A, B and C of the Brønlund Fjord Formation of Christie and Peel (1977).   In south-west Peary Land the formation is equivalent to the "Basal sub-unit" of Unit E of Dawes (1976b).

Name.

After Aftenstjernesø, the elongate lake at the western end of Wandel Dal, south-west Peary Land (Fig. 3.3).

Type Section.

Fig. 3.9; 3 kilometres south of the snout of Ekspedition Bræ , along the east side of the gully (Fig. 3.4, locality 1; Fig. 3.5).

Thickness.

About 62m at the type locality.   The base is not exposed at the type section, but is estimated to be within one metre of the base of the measured section (Fig. 3.9).   The formation thins eastward from Henson Gletscher to a minimum of 30m in the Sæterdal area (Fig. 3.7). Farther east again, the formation thickens to about 130m in the Børglum Elv valley.

LEGEND

Lithology

Dolomite
Dolomitic limestone
Limestone
Argillaceous lmst/dol
Interbedded lmst/mudstone
Sandstone (pebbly)
Silty sandstone
Siltstone / mudstone
Mudstone
Chert

Detailed sections

Grainstone
Packstone
Mudstone/wackestone

g   glauconite
    trilobite
    hyolithid
    brachiopod

Structures

Cross-bedding

Trough   Cross-lamination
Planar   Herring-bone
Hummocky   Wave ripples

Parallel lamination
Thin wavy irregular bedding
Platy nodular bedding (brecciated)
Breccia
Slump structures
Fibrous calcite
Graded bedding
Concretion
Desiccation cracks
Stromatolites
Flat-pebble conglomerate
Oncolites

Bioturbation

?   weak
??   moderate
???   intense
burrow-mottling

Structureless dolomite
K-Karstic solution breccia
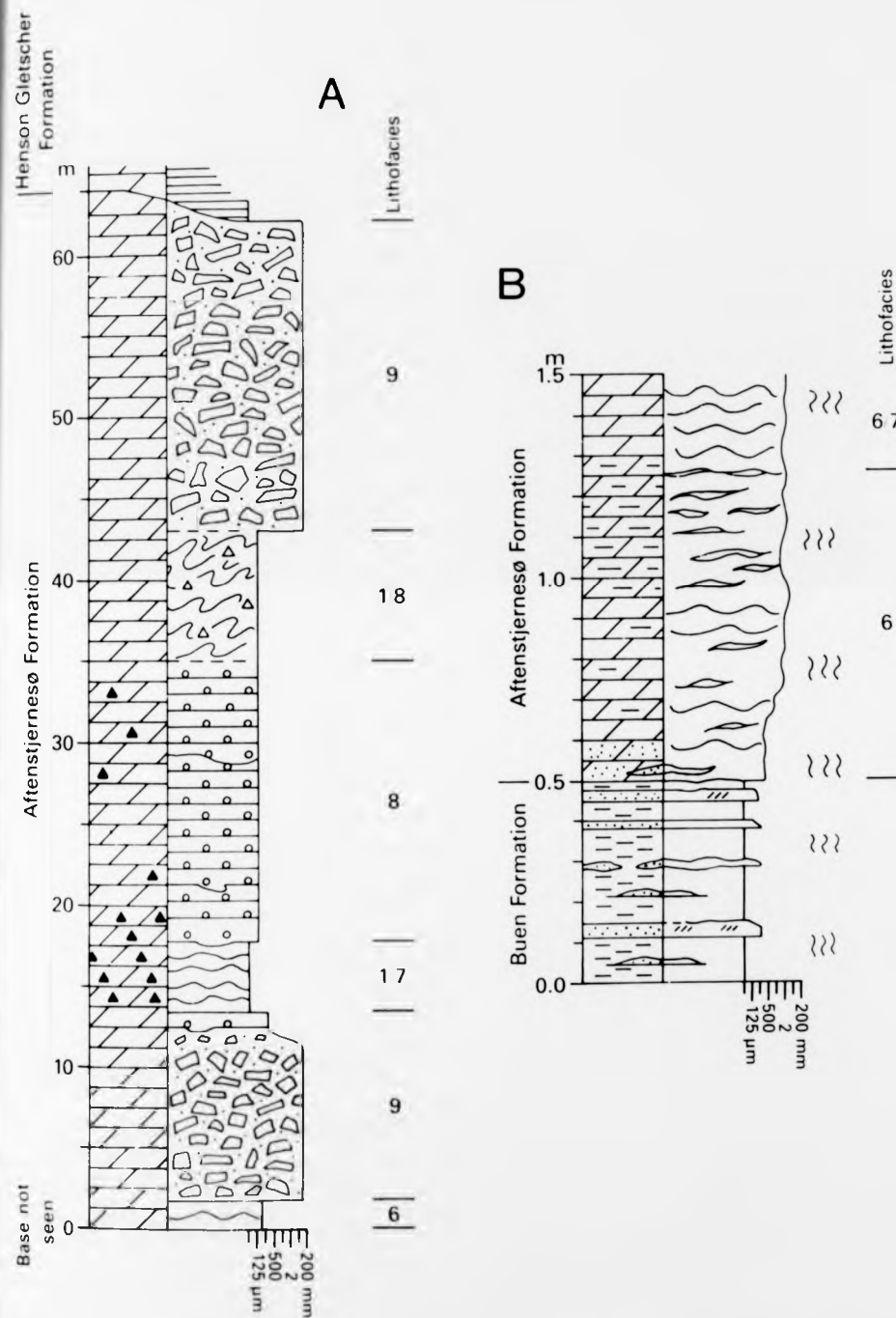
Figure 3.9   A.   Type section of the Aftenstjernesø Formation.   Locality 1, east Freuchen Land.   B. Section showing the base of the Aftenstjernø Formation.   Locality 2Q, south central Peary Land.   Legend on facing page covers all figured sections.   A grain-size profile is adopted for all siliciclastic rocks and resedimented coarse-grained carbonates. The section profile shown for the remaining carbonates indicates only their relative weathering characteristics.

Lithology.

The formation characteristically forms pale, yellow-brown weathering cliffs above the recessive slopes of the subjacent Buen Formation. It is composed almost entirely of dolomite, but in one section at locality 10, on the east side of Hans Tavsens Iskappe (Fig. 3.3), limestones and dolomitic limestones are preserved in the lower 10m of the formation.

In the type section (Figs. 3.5 & 3.9), the formation is composed of glauconitic, phosphoritic dolomites, prominent thick breccia beds, dark cherty, wavy-bedded and parallel-laminated dolomites, and thin- to medium-bedded, graded dolomites.

The basal beds (c. 2m) are iron-grey weathering dolomites, in thin to medium stylolitic beds, with thin, argillaceous interbeds and wispy partings in the lower metre. Brown-black phosphorite seams up to 20mm thick are common and are associated with dolomite rich in glauconite, phosphatic bioclasts and phosphorite shell moulds. This distinctive basal unit has been recognized throughout southern Peary Land and is equivalent to Member A of Christie & Peel (1977; see also Frykman 1980). At locality 10, this interval is undolomitized or only partially dolomitized, and includes bioturbated, glauconitic, skeletal wackestones, packstones and grainstones.

Dolomitized matrix- and clast-supported carbonate breccia beds are a characteristic feature of the formation, and in the type section form striking, massive pale weathering bands near the base

and at the top of the formation (Figs. 3.5 & 3.9; Ineson 1980).
They range between 0.5 and 20m in thickness and are composed of
pale grey dolomite clasts, commonly elongate with average dimensions
of 15 x 5cm in a matrix of finer-grained, pale fragments and dark
bituminous dolomite (see Ineson 1980; Christie & Peel 1977, Fig.8).

Thin to medium, parallel-bedded dolomites, exhibiting a crude
colour grading, form the middle unit of the formation at the type section
(Fig. 3.10); in some beds relict grain-size grading and the Bouma sequence
of sedimentary structures are preserved (Fig. 3.11).

The formation is lithologically uniform south and east of the
type locality, although the graded beds are less common in southerly
exposures, and platy, nodular and bioturbated, mid-dark grey dolomites
dominate.   Pull-aparts, angular slump folds and thin, discontinuous,
brecciated horizons are common features of the formation throughout its
outcrop, as are dolomite spar-lined vugs and sheet cracks.

Boundaries.

The lower boundary is taken at the first carbonate bed, confor-
mably overlying the sandstones, siltstones and mudstones of the Buen
Formation (Fig. 3.12).   Troelsen (1949) proposed the existence of a
"simple erosional disconformity" at the base of his Brønlund Fjord
Dolomite, but commonly the lithological change is gradational (Fig.
3.9B), and only at one locality (Fig. 3.3 locality 21) could an erosive
contact be demonstrated (Fig. 3.13; Frykman 1980).
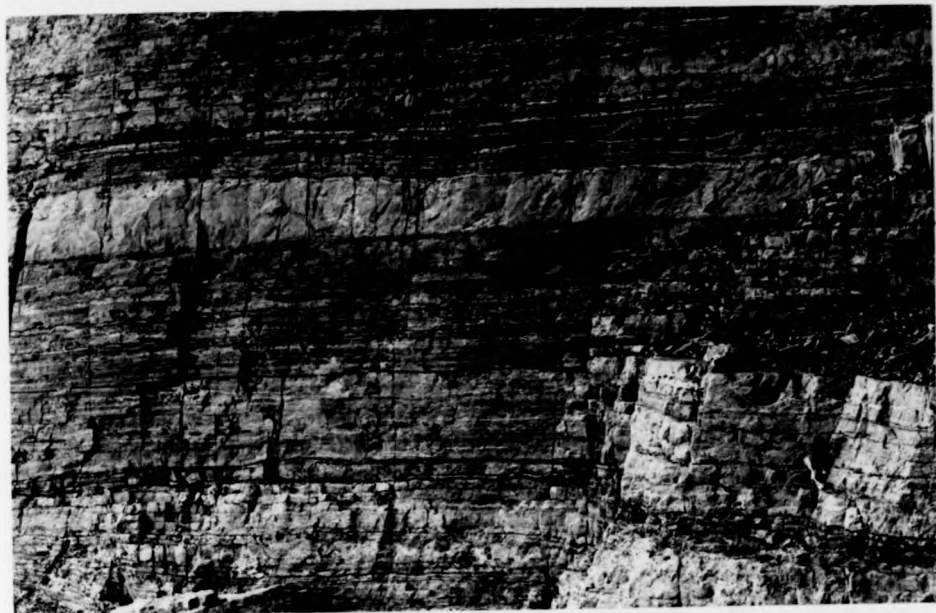
Figure 3.10. Thin, parallel-bedded dolomites (Lithofacies (LF.)8) of the
Aftenstjernesø Formation in its type section. Note lateral
persistence of bedding and presence of occasional massive
thicker beds. Hammer (centre right) for scale. Locality 1,
east Freuchen Land.

Scales in field photos:- Hammer is 28cm long, with 15cm head;
lens cap diameter = 5cm; steel rule housing = 5cm across.

Figure 3.11. 0.2m dolomite bed (LF.8), base and top arrowed, in the
Aftenstjernesø Formation type section. Note weak parallel
lamination in lower half and ripple-drift cross-lamination
in upper half. Locality 1, east Freuchen Land.

Figure 3.10. Thin, parallel-bedded dolomites (Lithofacies (LF.)8) of the Aftenstjernesø Formation in its type section. Note lateral persistence of bedding and presence of occasional massive thicker beds. Hammer (centre right) for scale. Locality 1, east Freuchen Land.

Scales in field photos:- Hammer is 28cm long, with 15cm head; lens cap diameter = 5cm; steel rule housing = 5cm across.

Figure 3.11. 0.2m dolomite bed (LF.8), base and top arrowed, in the Aftenstjernesø Formation type section. Note weak parallel lamination in lower half and ripple-drift cross-lamination in upper half. Locality 1, east Freuchen Land.

Figure 3.12. Dolomitic limestones and dolomites of the Aftenstjernesø
Formation (light) overlying dark silty mudstones and thin-
bedded sandstones of the Buen Formation.   Eastern bank of
Lønelv, locality 10, west Peary Land.

Figure 3.13. Erosional contact (arrowed) between rubbly dolomites of the
Aftenstjernesø Formation and the uppermost pale massive
sandstones of the Buen Formation (see Fig. 5.3B).   Locality
21, south central Peary Land.

Figure 3.12. Dolomitic limestones and dolomites of the Aftenstjernesø
Formation (light) overlying dark silty mudstones and thin-
bedded sandstones of the Buen Formation.   Eastern bank of
Lønelv, locality 10, west Peary Land.
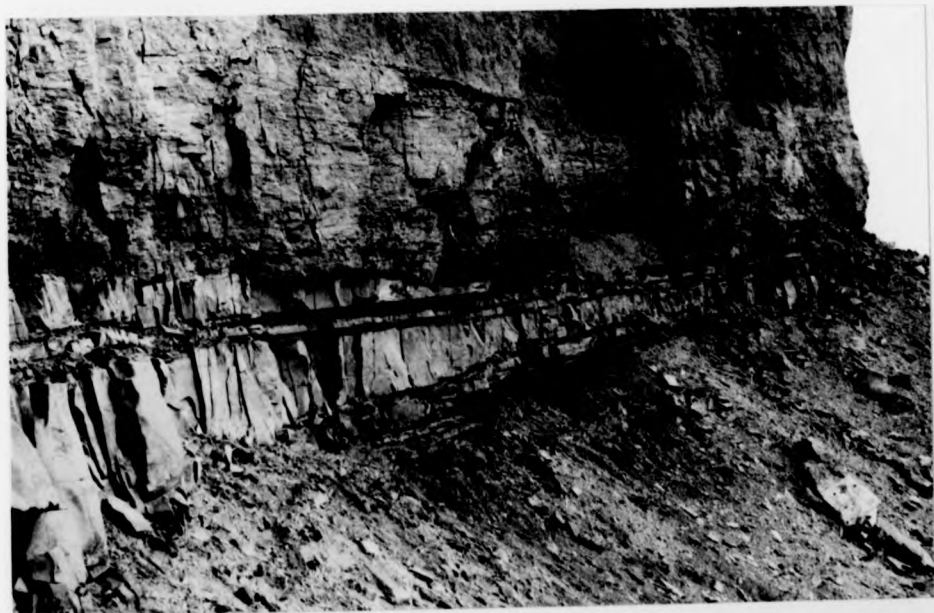
Figure 3.13. Erosional contact (arrowed) between rubbly dolomites of the
Aftenstjernesø Formation and the uppermost pale massive
sandstones of the Buen Formation (see Fig. 5.3B).   Locality
21, south central Peary Land.

From east Freuchen Land to Øvre Midsommersø (Fig.3.3), the
Aftenstjernesø Formation is conformably overlain by dark, recessive
weathering limestones, dolomites and pale sandstones of the Henson
Gletscher Formation (Fig. 3.14). The contact is sharp; black, platy
carbonates overlie or drape the planar or hummocky upper surface of
the capping breccia bed of the Aftenstjernesø Formation.

In central Peary Land, from the eastern end of Øvre Midsommersø
to Sæterdal (Fig. 3.3), the upper boundary is similarly sharp, but the
formation is conformably overlain by the dominantly siliclastic Sæterdal
Formation (Figs. 3.7 & 3.15). The Sæterdal Formation pinches out to
the south and east from Sæterdal, so that in Paralleldal and on the
south side of Frysefjeld, the Aftenstjernesø Formation is conformably
overlain by pale weathering carbonates of the Paralleldal Formation
(Fig. 3.7). In the cliffs along Børglum Elv, the upper boundary of the
Aftenstjernesø Formation is less obvious than elsewhere, but it taken
at the change from massive, slumped dolomites of the upper Aftenstjernesø
Formation into the pale cross-stratified dolomites of the Paralleldal
Formation.

Distribution.

The formation crops out from Freuchen Land across southern Peary
Land to Independence Fjord (Fig. 3.3), forming conspicuous cliffs to the
north of Aftenstjernesø and along the northern side of Wandel Dal.
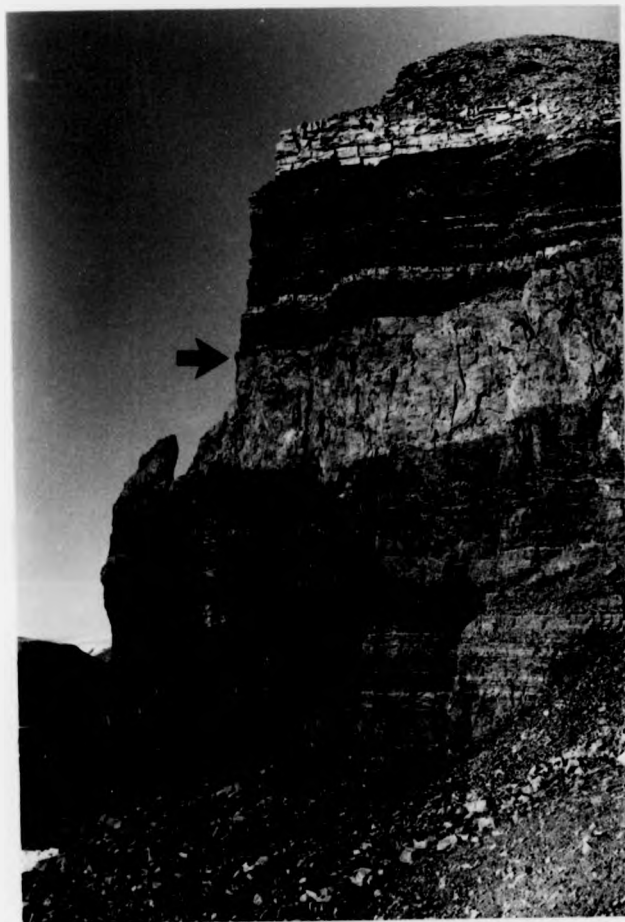
Figure 3.14. Aftenstjernesø and Henson Gletscher Formations at their type
           locality.   Irregular top (arrowed) of the upper breccia bed
           of the Aftenstjernesø Formation draped by dark dolomites of
           the Henson Gletscher Formation.   Pale sandstones in the
           middle of the Henson Gletscher Formation cap the exposure.
           Cliff is about 70m high.
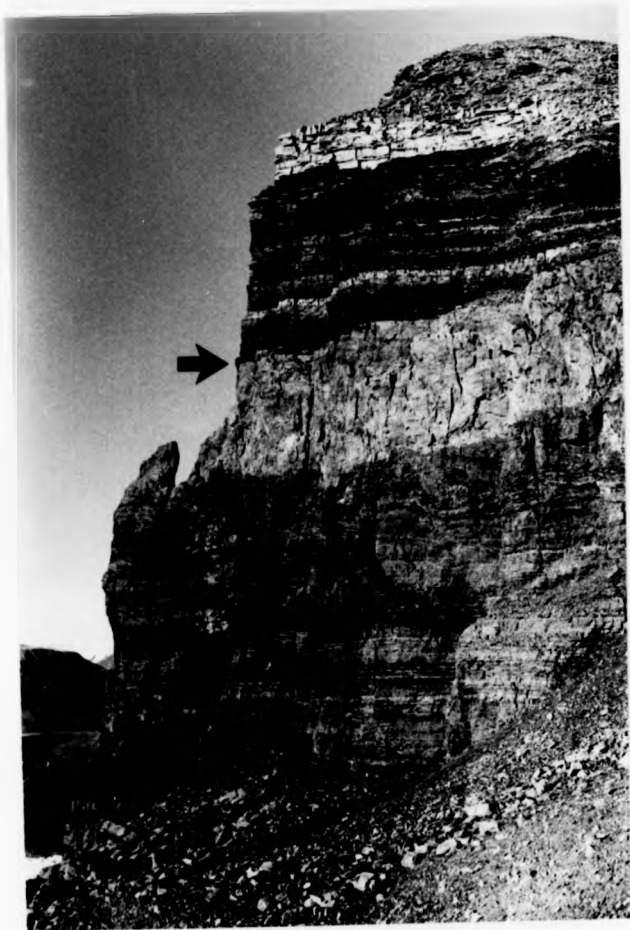
Figure 3.14. Aftenstjernesø and Henson Gletscher Formations at their type
locality.   Irregular top (arrowed) of the upper breccia bed
of the Aftenstjernesø Formation draped by dark dolomites of
the Henson Gletscher Formation.   Pale sandstones in the
middle of the Henson Gletscher Formation cap the exposure.
Cliff is about 70m high.

Figure 3.15. Brønlund Fjord Group on the north-west side of Sæterdal,
south central Peary Land.   B: Buen Formation.   A: Aftenst-
jernesø Formation; S: Sæterdal Formation; P: Paralleldal
Formation; W: Wandel Valley Formation.

Figure 3.15. Brønlund Fjord Group on the north-west side of Sæterdal,
south central Peary Land.   B: Buen Formation.   A: Aftenst-
jernesø Formation; S: Sæterdal Formation; P: Paralleldal
Formation; W: Wandel Valley Formation.

Recent work has demonstrated that the formation extends across
Freuchen Land as far west as Jungersen Gletscher (Fig. 1.1;
J.S. Peel, pers. comm. 1984).

The formation is well exposed and accessible at the type section
and at numerous other localities (e.g. Figs. 3.3, 3.4, 3.28 & 3.56,
localities 2, 4, 10, 12, 15 & 21).

Fauna and Geological Age.

Fossils are only found in the basal phosphoritic carbonates of
the formation, Member A of the Brønlund Fjord Formation of Christie
& Peel (1977). A diverse fauna has been recorded (Troelsen 1949;
Christie & Peel 1977; Palmer & Peel 1979), including *Bonnia, Calodiscus*
and fragments of *Wanneria*, indicative of the *Bonnia-Olenellus* Zone,
the uppermost zone of the Early Cambrian (Palmer & Peel *op. cit.*).
The Henson Gletscher, Sæterdal and Paralleldal Formations, which
overlie the Aftenstjerneø Formation, also yield Early Cambrian faunas,
at least in their lower beds, and the unfossiliferous dolomites of the
upper Aftenstjerneø Formation are thus assigned a similar late Early
Cambrian Age.

3.3.3.2. Henson Gletscher Formation.

History.

This formation has been described informally as formation 2 of
the Brønlund Fjord Group (Peel 1979; Ineson & Peel 1980) and is equivalent

to the middle sub-unit of unit E of Dawes (1976b; see also Peel *op.cit.*).

Name

After Henson Gletscher, the northerly extension of the Inland Ice, south of J.P. Koch Fjord (Fig. 3.4). This name has been used on recent maps (U.S.A.M.S. maps; see also Peel 1979) for the small glacier flowing east into J.P. Koch Fjord (recently named Ekspedition Bræ) but this does not comply with Lauge Koch's original field maps (Buchwaldt G.I., pers. comm. to GGU) and the correct location of Henson Gletscher is as shown on Fig. 3.4.

Type Section.

Fig. 3.16A; 3km south of the snout of Ekspedition Bræ (Fig. 3.4, locality 1) east Freuchen Land, along the east side of the gully (Fig. 3.9).

Reference Sections.

Fig. 3.16B; south Koch Væg, west Peary Land (Fig. 3.4, locality 2).

Fig. 3.17A; Løndal, east side of Hans Tavsens Iskappe (Fig.3.56, locality 10).

Thickness.

62m at the type locality, thinning north and east, but thickening southwards to a maximum measured thickness of 73m at locality 2 (Fig. 3.7).

Lithology

The Henson Gletscher Formation forms dark grey-black weathering, recessive slopes between the cliff-forming Aftenstjernesø Formation below
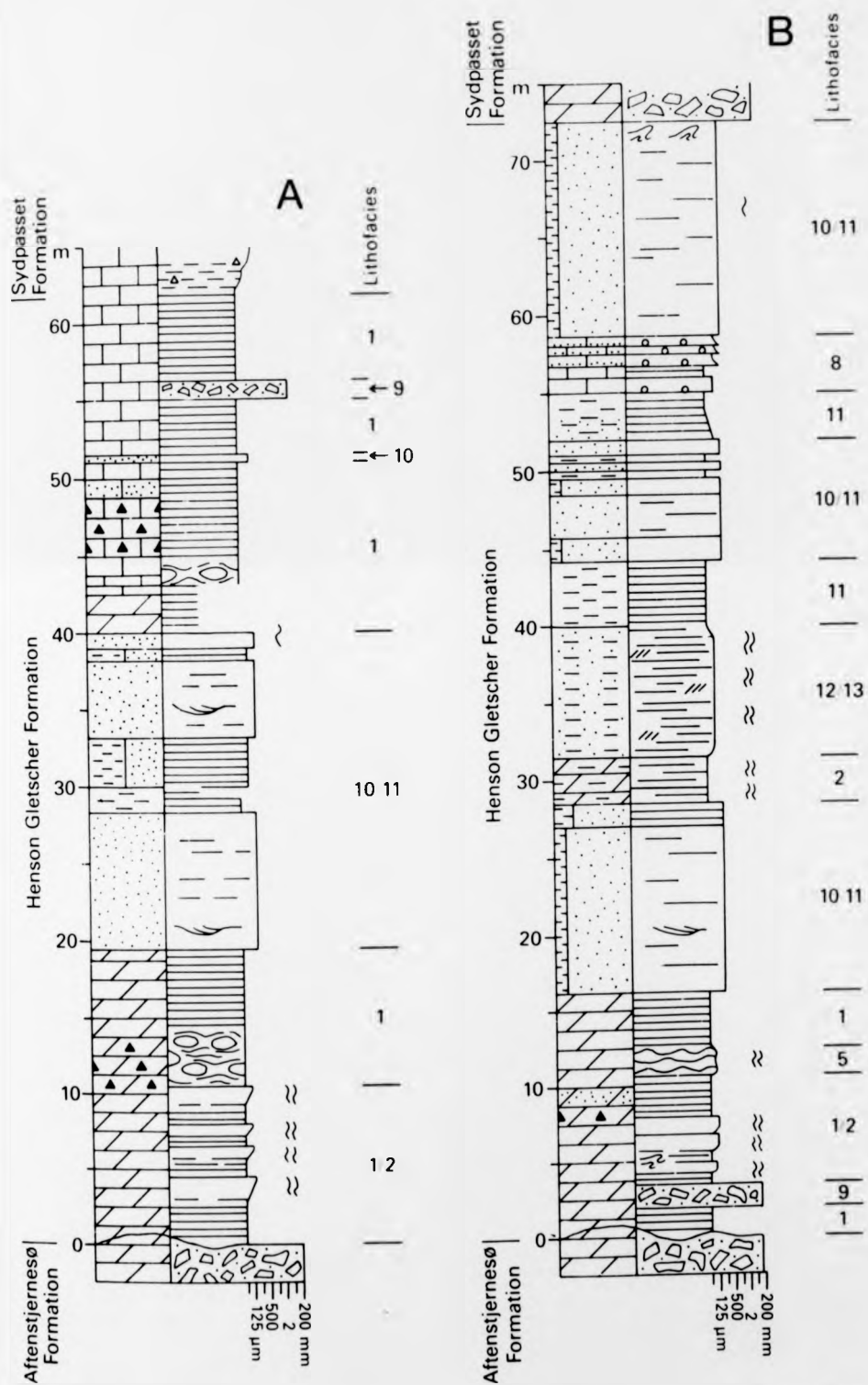
Figure 3.16 A. Henson Gletscher Formation type section. Locality 1, east Freuchen Land. B. Henson Gletscher Formation reference section. Locality 2, west Peary Land.
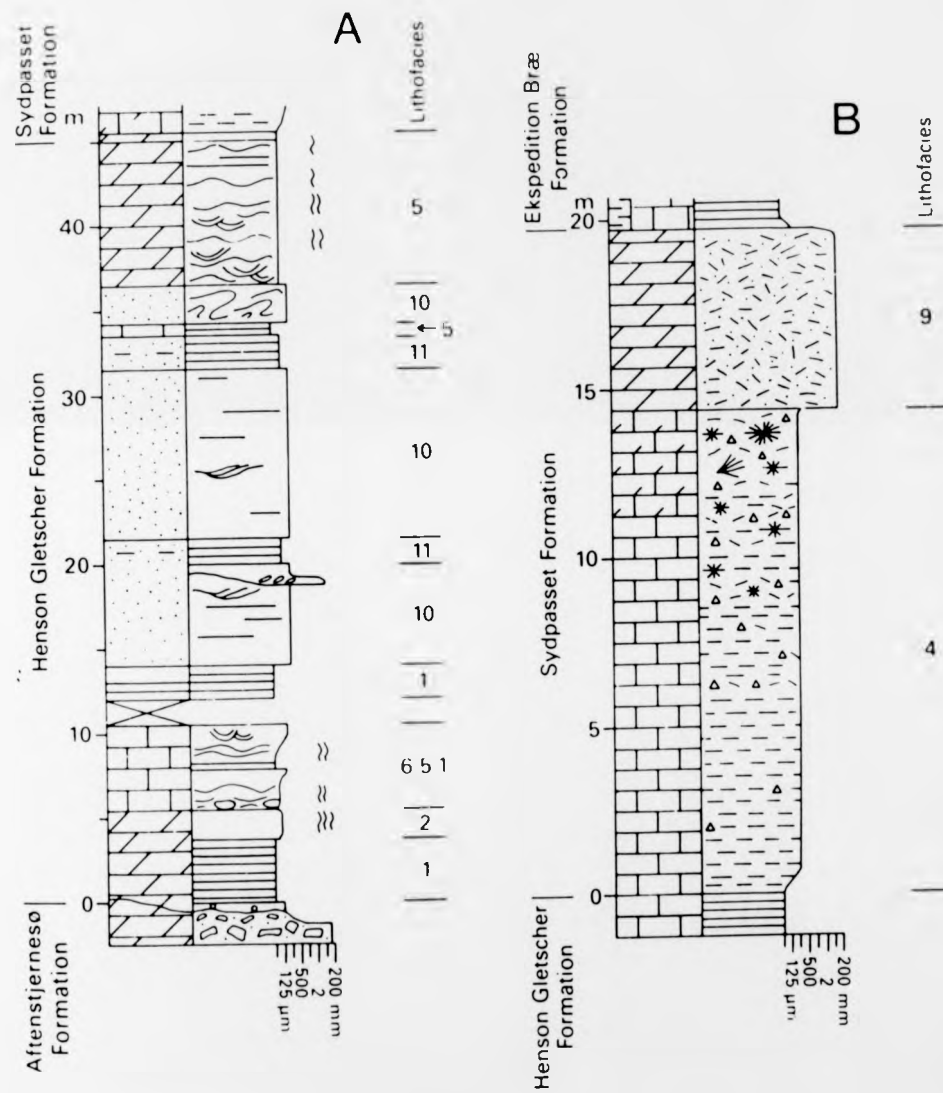
Figure 3.17. A. Henson Gletscher Formation reference section. Locality 10, west Peary Land. B. Sydpasset Formation type section. Locality 1, east Freuchen Land.

and the Sydpasset Formation above (Figs. 3.5 & 3.6). It is composed of sooty weathering, bituminous, thin-bedded and finely laminated shaly dolomites and limestones and pale cream weathering, fine-grained sandstones and siltstones. In the more northerly localities (localities 1, 4 & 5), sandstones are subordinate to carbonates which characteristically show parallel lamination, well-developed concretions (Fig. 3.18) and contain lenses, stringers and continuous beds of black chert.

In the type section (Fig. 3.16A), bituminous fissile cherty dolomites dominate the lower third of the formation, interbedded with pale weathering horizons of bioturbated dolomite (Fig. 3.14). The carbonates of the upper third of the formation at the type section are largely undolomitized and include parallel-laminated, spicular lime mudstones, shelly wackestones, normally graded beds of peloidal and bioclastic packstone and grainstone, and a prominant limestone breccia bed, approximately 1m thick.

Dolomitic sandstones and siltstones form a pale cream weathering unit in the middle of the formation, which thickens markedly south of the type section and dominates the formation at Koch Væg (Figs. 3.16B & 3.7). The well-sorted, fine-grained sandstones occur in 0.1-4m thick, parallel-sided sheets with sharp boundaries. They are generally structureless or faintly laminated but may show low-angle cross-stratification, internal erosion surfaces and bed amalgamation. Interbedded with the sand sheets are parallel-laminated and bioturbated silty sandstones and siltstones, which exhibit ripple cross-lamination in southern exposures (Fig. 3.16B).
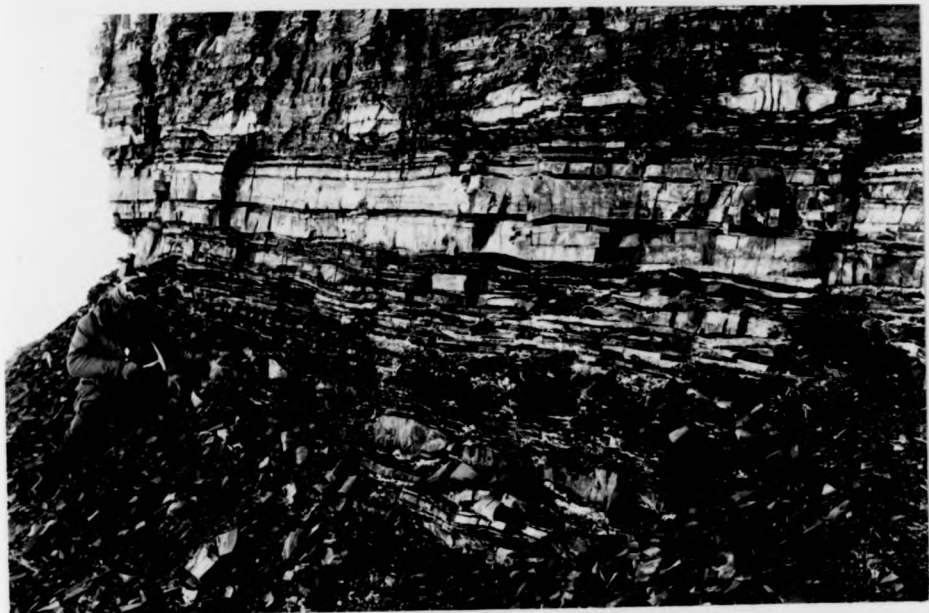
Figure 3.18. Bituminous, laminated cherty dolomites (LF.1) of the Henson
Gletscher Formation at the type section. Locality 1, east
Freuchen Land.
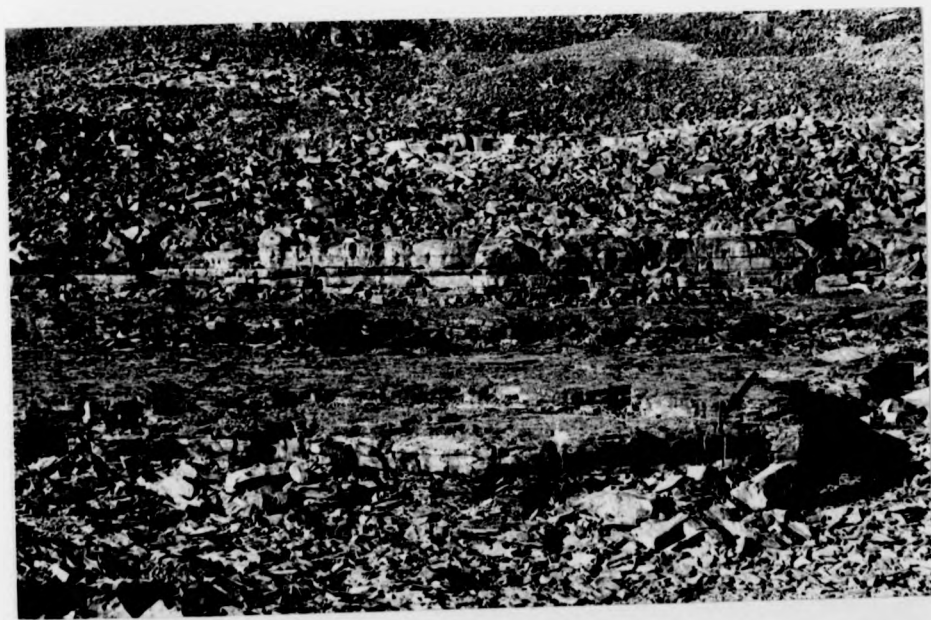
Figure 3.19. Glauconitic, skeletal grainstones in the lower half of the
Henson Gletscher Formation in Løndal (locality 10, west
Peary Land)(see Fig. 3.17A).   The grainstones cap coarsening-
upward sequences (top of sequences arrowed; see also Fig. 6.81)
Hammer for scale (small arrow).

Figure 3.18. Bituminous, laminated cherty dolomites (LF.1) of the Henson
Gletscher Formation at the type section. Locality 1, east
Freuchen Land.
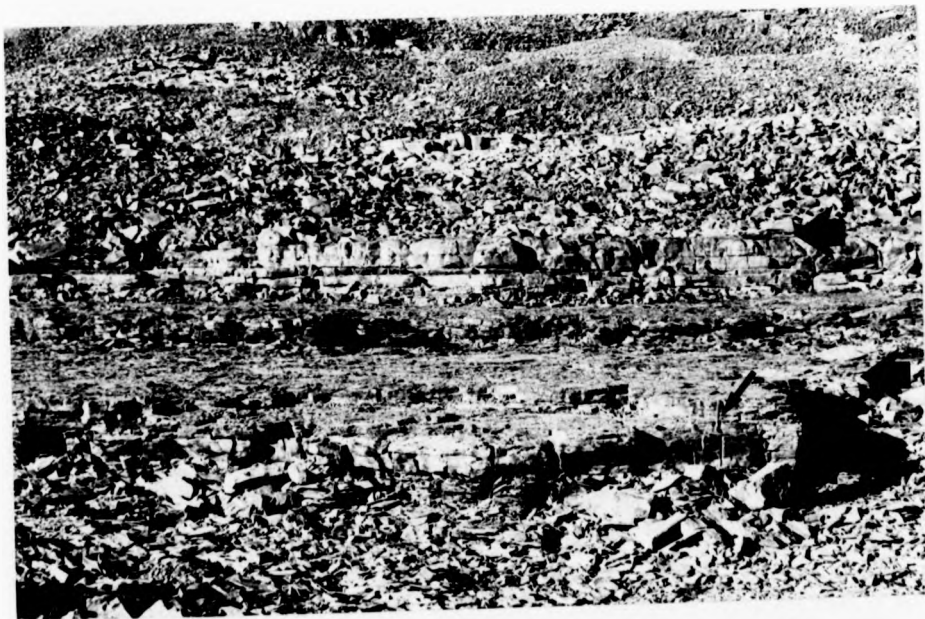
Figure 3.19. Glauconitic, skeletal grainstones in the lower half of the
Henson Gletscher Formation in Løndal (locality 10, west
Peary Land)(see Fig. 3.17A). The grainstones cap coarsening-
upward sequences (top of sequences arrowed; see also Fig. 6.81)
Hammer for scale (small arrow).

At locality 10, east of Hans Tavsens Iskappe, medium-bedded, coarse skeletal glauconitic packstones and grainstones form pale weathering ledges near the base of the formation (Fig. 3.19). Similar beds can be identified at this stratigraphic level at localities further to the east, but are represented by pale weathering, glauconitic, medium-coarse crystalline dolomites. At the same locality and in other southern exposures, small-scale trough cross-stratification is observed in mid-grey weathering skeletal dolomites, near the top of the Henson Gletscher Formation.

Boundaries

The formation overlies the Aftenstjernesø Formation with apparent conformity. The boundary is sharp and often irregular where dark re-cessive carbonates of the Henson Gletscher Formation drape the uppermost hummocky breccia bed of the Aftenstjernesø Formation (Figs. 3.14 & 3.16A).

The upper boundary is gradational in detail, although the over-lying Sydpasset Formation commonly forms a pale weathering vertical cliff and the boundary is readily defined at the break of slope for mapping purposes. At the type locality, and generally in northern exposures, the boundary is placed where dark weathering, shaly carbonates are overlain by more resistant platy, nodular carbonates of the Sydpasset Formation (Fig. 3.20). In southern exposures (e.g. at locality 2, Fig. 3.16B), the upper boundary is placed where recessive sandstones and siltstones are sharply overlain by cliff-forming dolomites of varied lithology which are assigned to the Sydpasset Formation.
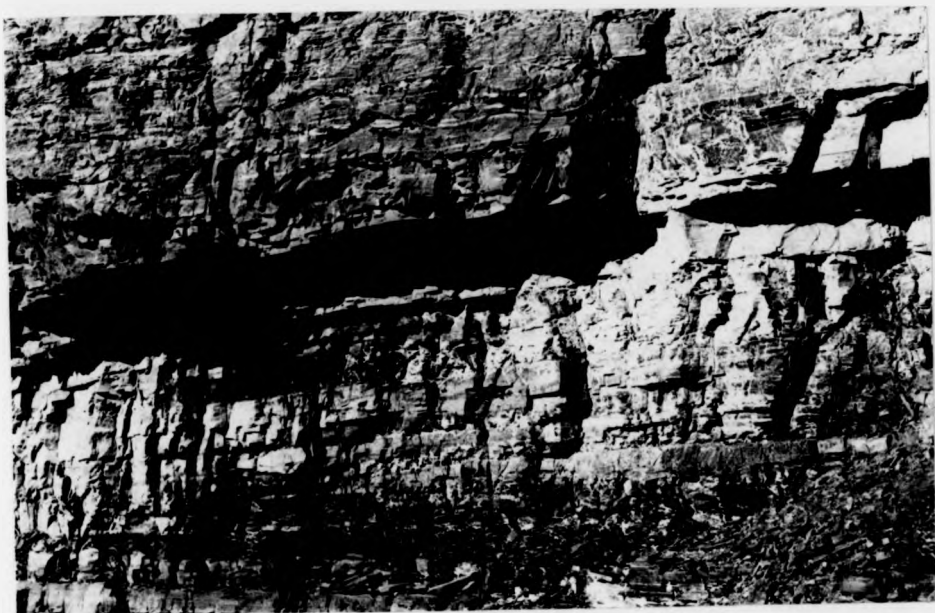
Figure 3.20. Boundary (top of hammer shaft, centre right) between bituminous
limestones of the Henson Gletscher Formation and platy nodular
limestones of the Sydpasset Formation.   Locality 1, east
Freuchen Land.

Figure 3.22. Characteristic cliff-forming exposure of the Sydpasset Formation,
underlain and overlain by recessive-weathering carbonates.
Note massive breccia bed (base and top arrowed; c. 5m thick)
capping formation.   Locality 1, east Freuchen Land.

Figure 3.20. Boundary (top of hammer shaft, centre right) between bituminous
limestones of the Henson Gletscher Formation and platy nodular
limestones of the Sydpasset Formation.   Locality 1, east
Freuchen Land.

Figure 3.22. Characteristic cliff-forming exposure of the Sydpasset Formation,
underlain and overlain by recessive-weathering carbonates.
Note massive breccia bed (base and top arrowed; c. 5m thick)
capping formation.   Locality 1, east Freuchen Land.

Distribution

The Henson Gletscher Formation crops out from Freuchen Land, eastwards across southern Peary Land to Øvre Midsommersø (Fig. 3.3). The formation is not recognized east of an arbitrary north-south line at the eastern end of Øvre Midsommersø.   In Sæterdal, to the east of this line, the Aftenstjernesø Formation is conformably overlain by a thick siliciclastic dominated formation (Sæterdal Formation) which is the lateral equivalent, in part at least, of the Henson Gletscher Formation. The formation is well exposed in west Peary Land and is best studied at the type locality (Fig. 3.4, locality 1) and at localities 2, 5 and 10 (Figs. 3.4 & 3.56).

Fauna and Geological Age

The Henson Gletscher Formation is richly fossiliferous and Palmer & Peel (1979) recorded two distinct faunas within the formation.   The lower carbonates in most sections yield rich olenellid faunas, including *Olenellus, Bonnia, Ogygopsis* and a distinctive species of *Kootenia,* indicative of the *Bonnia-Olenellus* zone, the latest zone of the Early Cambrian (Palmer & Peel 1979).   Rich agnostoid faunas from higher in the formation include species of *Peronopsis* and *Ptychagnostus* that are indicative of the *Ptychagnostus gibbus* Zone of the medial Middle Cambrian (Palmer and Peel 1979; Robison 1981, 1984).

Early Middle Cambrian faunas have not been recorded from Peary Land and Palmer & Peel (1979) proposed the presence of a discontinuity within the Henson Gletscher Formation to explain the apparent absence of early Middle Cambrian strata.   Fieldwork in 1979 attempted to identify this anomalous discontinuity on lithological grounds but without success.

Furthermore, additional fossil collections indicated a greater proportion of Lower Cambrian strata in the formation than previously thought (Ineson & Peel 1980). In the majority of sections, Middle Cambrian faunas are obtained only from the upper beds of the formation, above the sandstone unit. In Fig. 3.17A, for example, the highest Early Cambrian faunas were collected at 34m above the base, near the top of the sandstones. Middle Cambrian faunas were obtained within the upper metre of the formation in this section, thus bracketing the discontinuity to within 10 metres.

At the type section, however, Early Cambrian faunas have not been found, and Palmer (1979) recorded the presence of the genus *Spencella*, indicative of the medial Middle Cambrian, in a collection from just below the sandstone interval. The upper limestones yield rich agnostoid faunas indicative of the *Ptychagnostus gibbus* Zone of the medial Middle Cambrian (Palmer & Peel 1979; Robison 1984). If this identification is valid, then the discontinuity is beneath the sandstones at this locality (see Peel 1982b), contrary to all other studied sections, and thus the sandstones are diachronous and cannot be correlated as a time-equivalent unit.

It is interesting to note that a similar hiatus or discontinuity has been described from numerous localities in the Appalachian region (Palmer & James 1980). In western Newfoundland and in mainland Canada, a regressive event (termed the Hawke Bay Event by Palmer & James (*op. cit.*)) is thought to have begun in latest Early Cambrian time. In shallow-water sections, this event is marked by a thick clastic wedge of Late Early

Cambrian age (the Hawke Bay Formation in the autochthon of west New-
foundland) which is followed by carbonates that are no older than medial
Middle Cambrian (Palmer & James *op.cit.*).   In deeper-water sections,
early Middle Cambrian faunas are absent and the latest Early Cambrian
faunas may be separated from medial Middle Cambrian faunas by as little
as 20m, which, according to Palmer & James, is insufficient to accomodate
the "missing" early Middle Cambrian beds.

In the Henson Gletscher Formation, the late Early Cambrian and
medial Middle Cambrian faunas may be separated by as little as 10m and,
in the majority of sections, the latest Early Cambrian is represented by
a siliciclastic sequence overlain by carbonates yielding medial Middle
Cambrian faunas.   However, the possibility that the sandstones are dia-
chronous and may overlie the discontinuity appears to preclude a direct
comparison with the Appalachian "Hawke Bay Event" of Palmer & James.
This problem is discussed further in Chapter 6.

In any case, the formation is from late Early to medial Middle
Cambrian in most sections, with the possible exception of the more southern
exposures (e.g. localities 2 and 12, Fig. 3.16B) where only Early Cambrian
faunas have been found, and the formation may be entirely of late Early
Cambrian age.

3.3.3.3. Sydpasset Formation.

History.

Previously described informally as formation 3 of the Brønlund Fjord Group (Peel 1979; Ineson & Peel 1980), the formation is equivalent to the upper sub-unit of Unit E of Dawes (1976b).

Name

After Sydpasset at the western end of Øvre Midsommersø, south Peary Land (Fig. 3.3).

Type Section.

Fig. 3.17B; 3km south of snout of Ekspedition Bræ (Fig. 3.4, locality 1), along the eastern side of the gully (Fig. 3.5).

Reference Section.

Fig. 3.21; south Koch Væg, west Peary Land (Fig. 3.4, locality 2).

Thickness.

20m at the type locality (Fig. 3.17B), thinning northwards (Fig. 3.7). The formation is generally thicker in southern exposures, and in west Peary Land the formation thickens rapidly south of Troelsen's Fault (Fig. 3.4), reaching a maximum measured thickness of 77m at locality 2 (Fig. 3.21).

Lithology.

Pale weathering, cliff-forming carbonates of the Sydpasset Formation form a distinctive mapping unit between the recessive for-
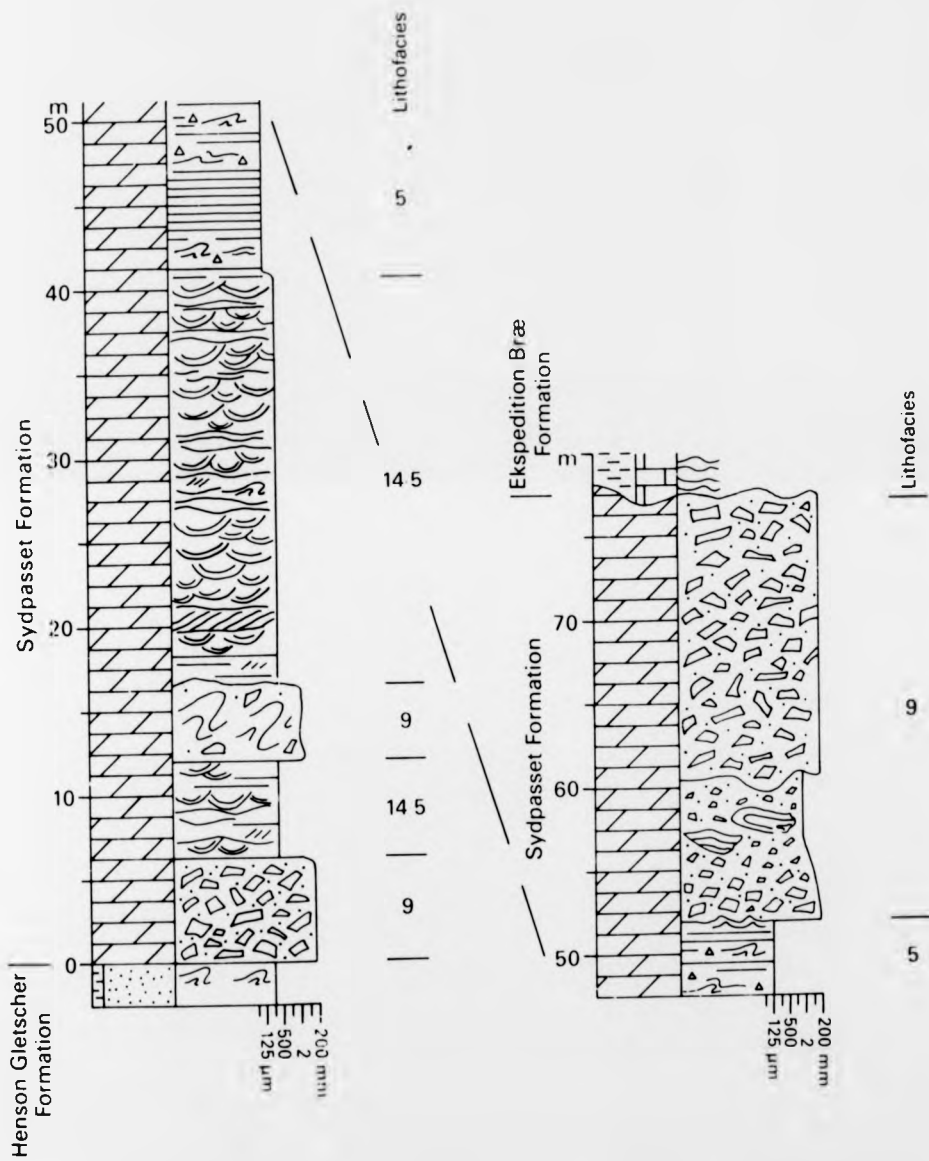
Figure 3.21. Sydpasset Formation reference section.   Locality 2, west
Peary Land.

mations above and below (Fig. 3.22). In northern exposures (localities 1, 5 & 10, Fig. 3.17B) distinctive platy, nodular limestones (microsparites), dolomitic limestones and dolomites dominate the formation. Pale grey weathering, 5-10mm thick, faintly laminated sheet-like, lenticular, ellipsoidal and spherical nodules are interbanded with and enclosed by dark grey, laminated carbonate (Fig. 3.23). Coarse, fibrous, replacive calcite is often intimately associated with the nodules, radiating from or enclosing the pale nodular forms and locally forming spectacular radial-fibrous, oval or spherical concretions up to 0.2m across (Fig. 3.24).

The Sydpasset Formation is capped by one or more carbonate breccia beds at all exposures studied (Fig. 3.22). In the type section and other northern exposures, the breccia bed is thin (c. 5m), commonly dolomitized, and is composed of flat, platy, pale weathering clasts comparable to the underlying *in situ* nodular carbonates.

The formation changes character in southern localities, thickening considerably (Fig. 3.7) and is variably composed of mid-grey, cross-stratified skeletal dolomites, dark grey, laminated dolomites and wavy bedded, bioturbated dolomites (Fig. 3.21). The capping breccia beds are thick, sometimes composite (Fig. 3.21) and locally contain pale, cross-stratified dolomite clasts up to   tens of metres across.

Boundaries.

The lower boundary of the formation is marked by a distinct break in slope where the cliff-forming carbonates of the Sydpasset Formation

Figure 3.23. Platy nodular dolomitic limestones (LF.4). Note the 'matrix' lamination enveloping nodules and the compactional warping and fracturing of pale nodules. Sydpasset Formation type section, locality 1, east Freuchen Land.

Figure 3.24. Radial fibrous calcite, in the Sydpasset Formation type section, showing two distinct phases of development. Locality 1, east Freuchen Land.

Figure 3.23. Platy nodular dolomitic limestones (LF.4). Note the 'matrix' lamination enveloping nodules and the compactional warping and fracturing of pale nodules. Sydpasset Formation type section, locality 1, east Freuchen Land.

Figure 3.24. Radial fibrous calcite, in the Sydpasset Formation type section, showing two distinct phases of development. Locality 1, east Freuchen Land.

Figure 3.23. Platy nodular dolomitic limestones (LF.4). Note the 'matrix' lamination enveloping nodules and the compactional warping and fracturing of pale nodules. Sydpasset Formation type section, locality 1, east Freuchen Land.

Figure 3.24. Radial fibrous calcite, in the Sydpasset Formation type section, showing two distinct phases of development. Locality 1, east Freuchen Land.

conformably overlie the recessive carbonates and clastics of the Henson
Gletscher Formation.   At the type locality (Figs. 3.17B, 3.20 & 3.22)
and in other northern sections, the boundary is placed where the bitu-
minous shaly limestones of the Henson Gletscher Formation are overlain
by more prominent-weathering, platy, nodular or thin wavy-bedded dark
carbonates.   At Koch Væg (locality 2) and along the northern side of
Wandel Dal, the lower boundary is marked by an abrupt lithological change
from fine-grained, pale cream sandstones into resistant dolomites
(Fig. 3.21).

West of the western end of Øvre Midsommersø (Fig. 3.3), the
Sydpasset Formation is conformably overlain by the uppermost formation
of the Brønlund Fjord Group, i.e. the Ekspedition Bræ Formation.   East
of this point, which is defined by the western limit of the Lønelv Forma-
tion (Figs. 3.7 & 3.2), the Sydpasset Formation forms the uppermost forma-
tion of the Brønlund Fjord Group and is overlain conformably by the
Erlandsen Land Formation, the basal formation of the Tavsens Iskappe
Group in this area.   In both cases, the upper boundary is sharp, although
often irregular, the uppermost breccia of the Sydpasset Formation being
overlain by recessive, thin-bedded dark dolomites and lime mudstones
(Fig. 3.22).

Distribution.

The Sydpasset Formation crops out from Freuchen Land in the west
to the eastern end of Øvre Midsommersø (Fig. 3.3), where an arbitrary
north-south line forms the limit of the formation.   Jungersen Gletscher
forms the western limit of the formation (J.S. Peel, pers. comm. 1984).

It is well exposed around the head of J.P. Koch Fjord, in Fimbuldal, along Koch Væg and along the banks of Lønelv on the east side of Hans Tavsens Iskappe (Figs. 3.4 & 3.56).   The formation can be traced as a well-defined feature on the north side of Sydpasset and Øvre Midsommersø.

Fauna and Geological Age.

The formation is characteristically unfossiliferous, but fragments of inarticulate brachiopods (cf. *Linnarssonia*) and *Hyolithus* have been recorded from basal bioclastic dolomites at locality 2 (Fig. 3.21) (Peel 1979; Palmer & Peel 1979).   This fauna was also collected by Dawes (1976) and was thought to indicate an Early Cambrian age, by comparison with Early Cambrian faunas from the basal beds of the Aftenstjernesø Formation.   This assignment was changed (Peel 1979) after fieldwork in 1978 showed the presence of Middle Cambrian faunas in the subjacent Henson Gletscher Formation in northern exposures (localities 1, 5 & 10), and the Sydpasset Formation was assigned a Middle Cambrian age on account of its stratigraphic position.   In northern localities the formation is of undoubted medial Middle Cambrian age by reason of the faunas obtained from adjacent formations, but at locality 2, where the meagre fauna was obtained, the Sydpasset Formation is much thickened with respect to northerly outcrops, the underlying Henson Gletscher Formation yields only Lower Cambrian faunas, and the first unambiguous Middle Cambrian faunas occur in the overlying Ekspedition Bræ Formation (Palmer & Peel 1979).   It is possible, therefore, that the lowest carbonates assigned to the Sydpasset Formation at this locality are of

Early Cambrian age.   In the majority of sections, however, the discon-
tinuity which apparently defines the Early-Middle Cambrian boundary
(see previous discussion) occurs approximately at or below the top of
the sandstone unit of the Henson Gletscher Formation and Early Cambrian
faunas have not been obtained from carbonates above this level; it is
probable, therefore, that the Sydpasset Formation is everywhere of
Middle Cambrian age.

3.3.3.4.   Ekspedition Bræ Formation.

History.

        The formation has been previously referred to as formation 4 of
the Brønlund Fjord Group (Peel 1979; Ineson & Peel 1980) and is equiva-
lent in part to Unit F of Dawes (1976b). After the initial fieldwork
in 1978, a thick sequence of thin-bedded limestones and dolomites (the
whole of Unit F of Dawes (*op. cit.*)) was assigned to this formation at
Koch Væg (locality 2) (Peel 1979).   The formation was later restricted
to include only the lower argillaceous carbonates, the overlying beds
being referred to the basal formation of the Tavsens Iskappe Group
(Ineson & Peel 1980).

Name.

        After Ekspedition Bræ , the small glacier flowing east into the
head of J.P. Koch Fjord, east Freuchen Land (Fig. 3.4).

Type Section.

        Fig. 3.25A; 3 kilometres south of the snout of Ekspedition Brae
(Fig. 3.4) up the east side of the gully and south along the crest of
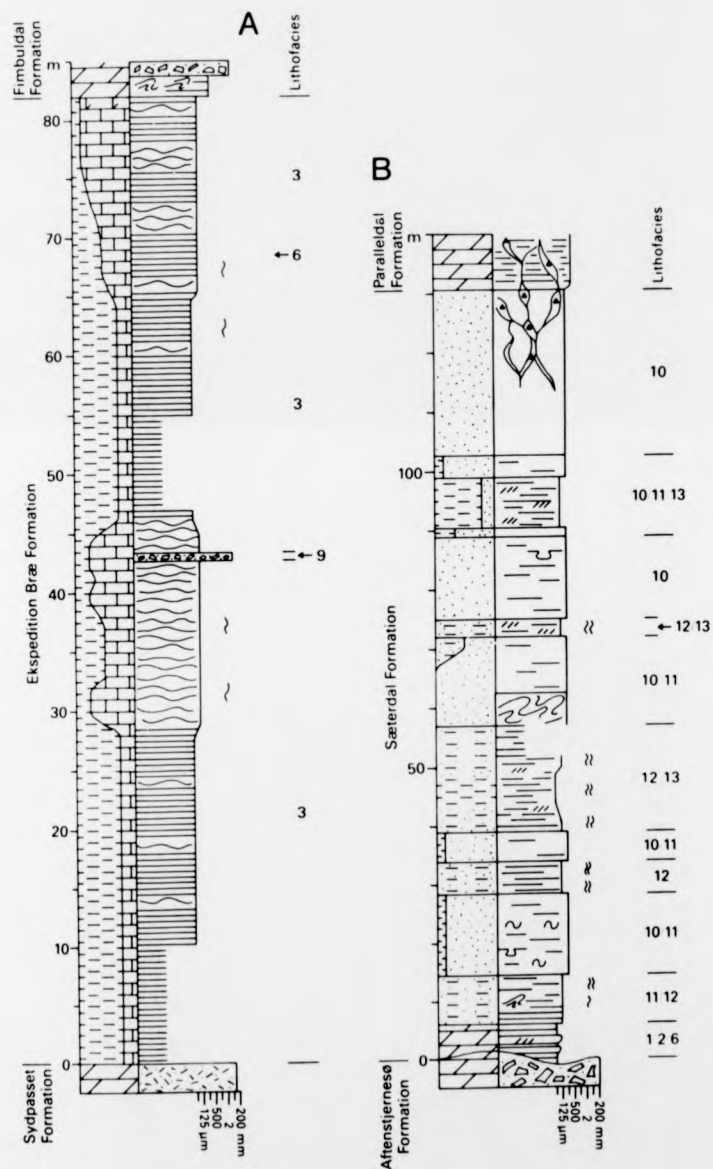
Figure 3.25. A. Ekspedition Bræ Formation type section. Locality 1, east
Freuchen Land. B. Sæterdal Formation type section.
Locality 14, central Peary Land.

the ridge.

Thickness.

82m at the type locality, thinning east and south to about 30m at localities 2 and 5 (Fig. 3.7).

Lithology.

The Ekspedition Bræ Formation commonly forms recessive, grey weathering slopes between cliff-forming formations above and below (Fig. 3.6). At the type section, the formation is dominated by pale weathering, thin-bedded, dark grey lime rudstones and skeletal wackestones, interbedded with grey-green, shaly, calcareous mudstones (Fig. 3.26). Bedding is parallel or slightly wavy and the lime mudstones commonly show a diffuse parallel lamination and are locally bioturbated. Skeletal, peloidal packstones and grainstones form about 5% of the type section and are sometimes normally graded with erosive and channelled bases. A prominent limestone breccia bed occurs in a carbonate-dominated interval roughly halfway up the section (Fig. 3.25A). It is composed of tabular lime mudstone clasts (average dimensions 0.03 x 0.1m) in a dark, dolomitic lime mudstone matrix.

The formation thins but is lithologically identical on the eastern side of J.P. Koch Fjord (localities 4 & 5, Fig. 3.7). Farther south (locality 2), the argillite content decreases, occurring as thin interbeds and partings between irregular, wavy beds of bioturbated lime mudstone, wackestone, cross-laminated skeletal grainstone and packstone. Slumped beds and limestone breccia beds occur frequently in these sections.

Figure 3.26. Thin-bedded argillaceous lime mudtones (LF.3) of the
Ekspedition Bræ Formation in its type section. Hammer
(top right) for scale. Locality 1, east Freuchen Land.

Figure 3.27. Abrupt boundary between thin-bedded, argillaceous limestones
of the Ekspedition Bræ Formation and massive dolomite breccias
of the Fimbuldal Formation. Massive bed at base of Fimbuldal
Formation is approx 2m thick. Locality 1, east Freuchen Land.

Figure 3.26. Thin-bedded argillaceous lime mudtones (LF.3) of the Ekspedition Bræ Formation in its type section. Hammer (top right) for scale. Locality 1, east Freuchen Land.

Figure 3.27. Abrupt boundary between thin-bedded, argillaceous limestones of the Ekspedition Bræ Formation and massive dolomite breccias of the Fimbuldal Formation. Massive bed at base of Fimbuldal Formation is approx 2m thick. Locality 1, east Freuchen Land.

Boundaries.

The Ekspedition Bræ Formation conformably overlies the massive carbonate breccia beds of the upper Sydpasset Formation with a sharp contact, which may be planar or hummocky (Figs. 3.21 & 3.22).

The formation is conformably overlain by the basal beds of the Tavsens Iskappe Group: the Fimbuldal Formation to the west of Hans Tavsens Iskappe and the Lønelv Formation to the east of the icecap (Fig. 3.7). At the type section, the boundary is sharp (Fig. 3.27) where the recessive argillaceous carbonates are overlain abruptly by cliff-forming dolomites of the Fimbuldal Formation.   Elsewhere the boundary is less distinct.   On the east side of J.P. Koch Fjord (locality 5), the Ekspedition Bræ Formation is overlain by cliff-forming, argillaceous, platy, nodular limestones assigned to the Fimbuldal Formation, and the boundary is taken at the first appearance of the nodular limestones, which approximately coincides with the break of slope.   At Koch Væg (locality 2), the upper boundary is placed where argillaceous limestones and dolomitic limestones are overlain by pale cream weathering, laminated and slumped dolomites of the Fimbuldal Formation.

East of Hans Tavsens Iskappe, in Løndal (locality 10), argillaceous limestones of the Ekspedition Brae Formation are overlain abruptly by cliff-forming, yellow weathering dolomite breccia, the basal bed of the Lønelv Formation (Fig. 3.7).

Distribution.

The Ekspedition Bræ Formation crops out in Freuchen Land, in the J.P. Koch Fjord-Henson Gletscher region and in Løndal on the east

side of Hans Tavsens Iskappe (Figs. 3.3, 3.4 & 3.56). Jungersen
Gletscher forms the western limit of the formation (J.S. Peel, pers.
comm. 1984). The formation is not recognized east of a point to the
north of Sydpasset (Fig. 3.3). Here, the overlying Lønelv Formation
pinches out (Figs. 3.2, 3.7 & 3.37), so that the recessive carbonates
of the Ekspedition Bræ Formation coalesce with the lithologically
similar Erlandsen Land Formation. Farther east, it is no longer
possible to map these similar carbonates as two separate formations, so
the combined unit is assigned, somewhat arbitrarily, to the Erlandsen Land
Formation.

The Ekspedition Brae Formation is generally recessive weathering
and is only consistently exposed in vertical cliffs, for example along
the walls of J.P. Koch Fjord and the cliffs of Fimduldal and Koch Væg
(Figs. 1.3 & 3.8). Near complete, accessible sections can be studied
at the type locality and at localities 2,5 and 10 (Figs. 3.4 & 3.56).

Fauna and Geological Age.

The Ekspedition Bræ Formation is richly fossiliferous, yielding
well-preserved faunas of agnostid and ptychoparoid trilobites, helcio-
nellaceans and inarticulate brachiopods, indicative of the medial Middle
Cambrian (Palmer & Peel 1979). The trilobite genera include *Peronopsis*,
Ptychagnostus, *Elrathina* and *Elrathia*, an assemblage which is thought to
indicate a maximum age range from high *Ptychagnostus gibbus* Zone to
high *Ptychagnostus atavus* Zone (Robison 1981).

3.3.3.5.   Sæterdal Formation.

History.

The formation has been referred to informally as formation 5 of the Brønlund Fjord Group (Palmer & Peel 1979; Ineson & Peel 1980).

Name.

After Sæterdal, central Peary Land, the NE-SW trending valley that meets Wandel Dal at the eastern end of Nedre Midsommersø (Fig. 3.28).

Type Section.

Fig. 3.25B; the type section is on the east side of a stream valley (Fig. 3.29) on the north-western side of Sæterdal (Fig. 3.28, locality 14).

Thickness.

Approximately 130m at the type section (Figs. 3.7, 3.25B & 3.29), thinning west along the north side of Wandel Dal to the western limit of the formation north of Slusen (Fig. 3.3).   The Sæterdal Formation thins rapidly east and south of the type section, eventually pinching out about eighteen kilometres east of the type locality (Fig. 3.7).

Lithology.

The clastic-dominated formation forms banded recessive slopes between the cliff-forming carbonate formations above and below (Fig. 3.15). At the type section (Fig. 3.29), units dominated by cream weathering, thin- to thick-bedded, fine-grained sandstones alternate with dark, re-cessive units dominated by parallel-laminated, ripple cross-laminated
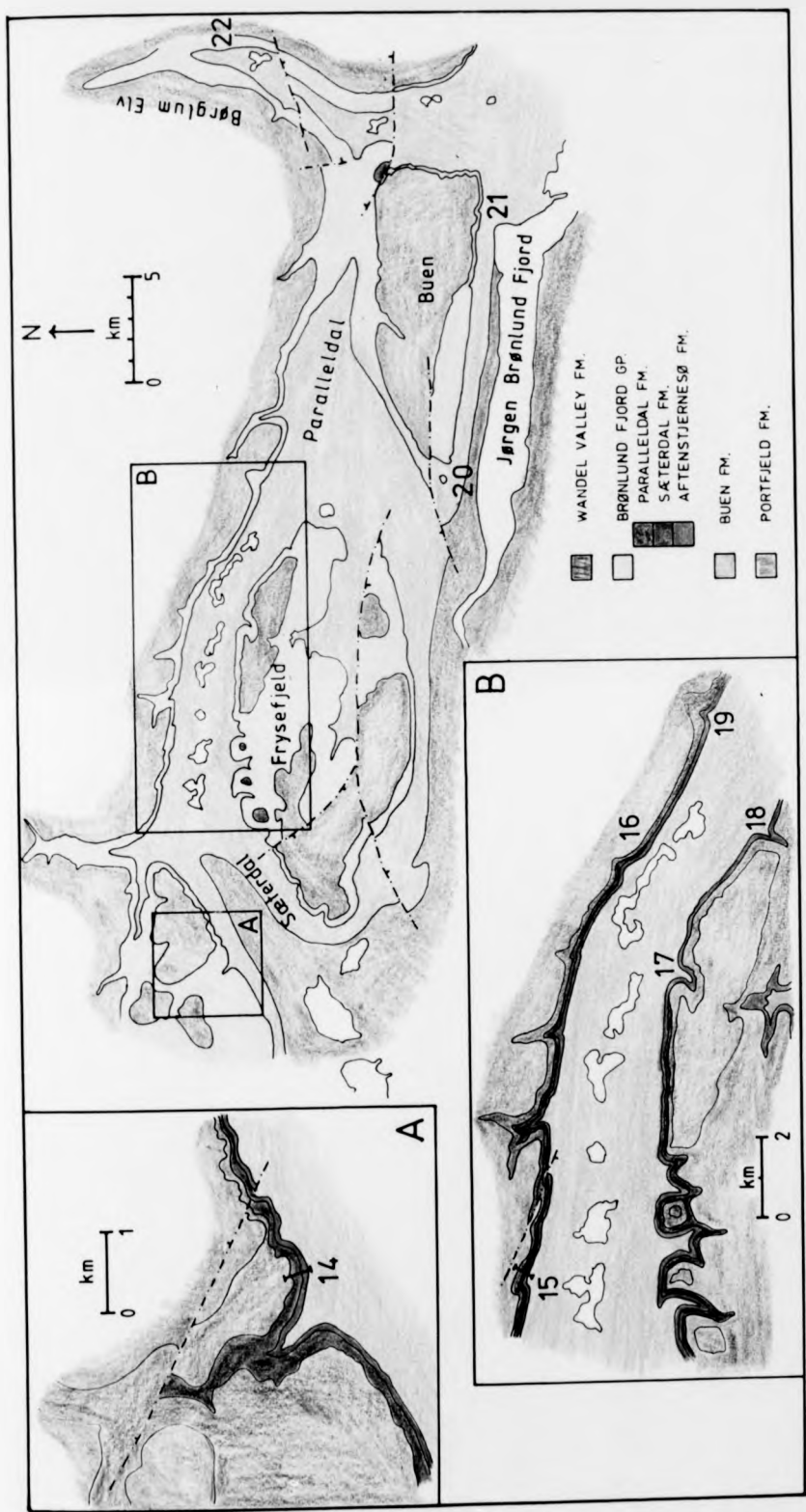
Figure 3.28. Geological sketch map of the Sæterdal – Børglum Elv region, central Peary Land. Insets show positions of type localities and sections. Note that the Sæterdal Formation pinches out at locality 16. (Drawn from Jepsen (1971) and unpublished field data – JRI/JSP)

Figure 3.29. Type locality of the Sæterdal Formation(S); base and top of type section arrowed. A: Aftenstjernesø Formation; P: Paralleldal Formation. Locality 14, central Peary Land.

Figure 3.30. Thin-bedded, structureless, fine-grained sandstones (LF.10) with siltstone interbeds (LF.11). Note the sharp, planar boundaries. Sæterdal Formation, locality 15, central Peary Land.
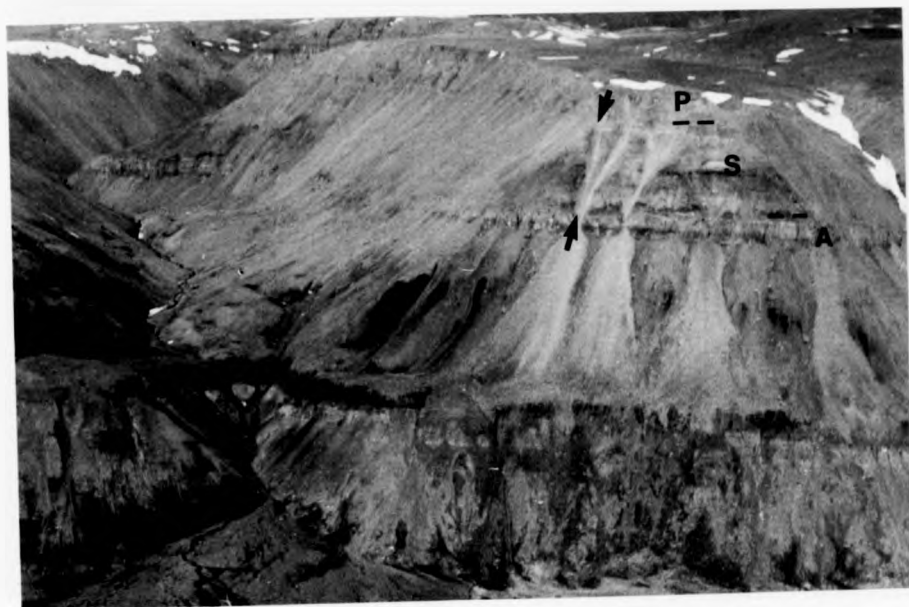
Figure 3.29. Type locality of the Sæterdal Formation(S); base and top of type section arrowed. A: Aftenstjernesø Formation; P: Paralleldal Formation. Locality 14, central Peary Land.

Figure 3.30. Thin-bedded, structureless, fine-grained sandstones (LF.10) with siltstone interbeds (LF.11). Note the sharp, planar boundaries. Sæterdal Formation, locality 15, central Peary Land.

and bioturbated siltstones and silty sandstones (Fig. 3.25B). The
pale sandstones are well sorted, although locally containing shell
fragments and outsize siltstone clasts. They form laterally persistent
beds, 0.1 - 1m thick (Fig. 3.30); erosive contacts and bed amalgamation
are observed locally. Internally, the beds are commonly structureless
or show a diffuse parallel lamination, but locally exhibit normal grading,
low angle cross-stratification, internal erosion surfaces and convolute
lamination. Slump folds are a common feature of the formation at the
type section. Dark, laminated, bioturbated and glauconitic skeletal
dolomites occur at the base of the formation (Fig. 3.25B).

The sand-dominated intervals thin east and west of the type section,
concomitant with the thinning of the formation (Fig. 3.7), but the overall
lithological character varies little throughout its outcrop.

Boundaries.

The formation conformably overlies the Aftenstjernesø Formation
and is conformably overlain by the Paralleldal Formation. The lower
boundary is sharp, planar or irregular and at the type section is placed
where cliff-forming dolomites of the Aftenstjernesø Formation are overlain
by recessive black, platy dolomites (Figs. 3.25B & 3.15).

The upper boundary is defined at the abrupt change from recessive
weathering clastics to the overlying cliff-forming carbonates (Fig. 3.15).
At the type section, this boundary is somewhat blurred by diagenetic
mottling, fracturing, brecciation and geopetal cavity fills; features
which are interpreted as the result of karstic processes at the sub-

Wandel Valley Formation unconformity. At locality 15, however, the boundary is planar and sharp where cliff-forming carbonate breccia overlies recessive dolomitic sandstones and dolomites (Fig. 3.31).

Distribution.

The Sæterdal Formation crops out from the western arbitrarily defined limit, north of Slusen, eastwards along the northern side of Wandel Dal, on both sides of Sæterdal and the eastern end of Paralleldal (Figs. 3.3 & 3.28). The formation pinches out to the south and east of Sæterdal, and thus does not occur on the south side of Frysefjeld, nor east of locality 16 in Paralleldal (Fig. 3.28).

The formation is poorly exposed along the north side of Wandel Dal and over much of Frysefjeld and, where well exposed on the north side of Sæterdal, is commonly inaccessible. The formation can be studied at the type locality and at locality 15.

Fauna and Geological Age.

The formation is poorly fossiliferous in general, but sandstone beds locally yield a diverse fauna including phosphatic inarticulate brachiopods and moulds of trilobites and articulate brachiopods. Palmer & Peel (1979) recorded a distinctive 7-spined *Kootenia* (also found in the lower beds of the Henson Gletscher Formation) along with *Bonnia, Olenellus* and *Nisusia*, an assemblage indicative of the *Bonnia-Olenellus* Zone of the Early Cambrian. The fossils occur at various stratigraphic horizons, the highest being about 20 metres from the top of the formation, so it seems likely that the whole formation is of late Early Cambrian age.

3.3.3.6. Paralleldal Formation.

History.

The formation has been described informally as formation 6 of the Brønlund Fjord Group (Ineson & Peel 1980).   It forms the uppermost formation of the Brønlund Fjord Group in the Sæterdal-Børglum Elv region of central southern Peary Land (Fig. 3.2 & 3.3) and, in Børglum Elv, is equivalent to Member D of the Brønlund Fjord Formation of Christie & Peel (1977).

Name.

After Paralleldal, central southern Peary Land, the east-west trending valley between the north-east end of Sæterdal and Børglum Elv (Fig. 3.28).

Type Section.

Fig. 3.31; the type section was measured up a steep gully on the north side of Paralleldal (Fig.3.32), approximately 2km east of Sæterdal (Fig. 3.28, locality 15).

Thickness.

141m at the type locality (Fig. 3.31).   It thins to the east along Sæterdal, although complete sections are unobtainable east of locality 14.   The formation thickens eastwards from the type section, as the subjacent Sæterdal Formation thins, reaching a maximum measured thickness of 165m at locality 19 (Fig. 3.7).   In the Børglum Elv valley, the formation is approximately 40m thick (Fig. 3.7).
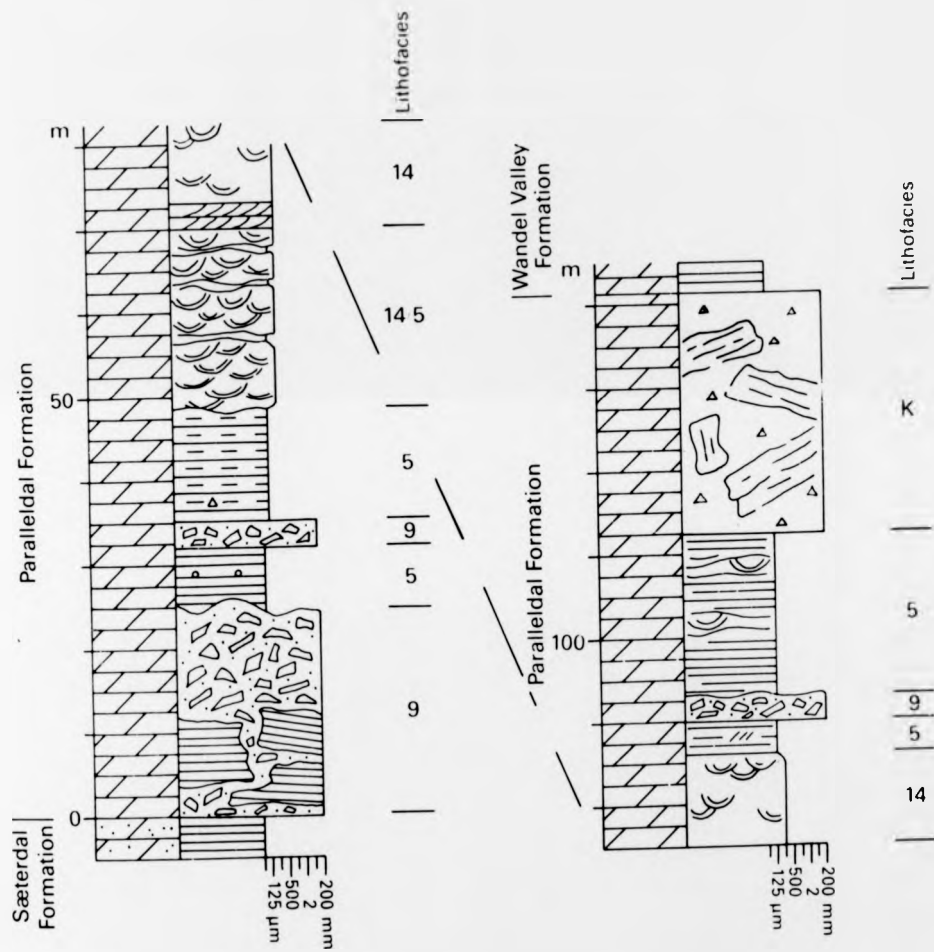
Figure 3.31. Paralleldal Formation type section. Locality 15, central Peary Land.

Figure 3.33. Thin-bedded, laminated skeletal dolomites (LF.5) in the
Paralleldal Formation type section. Locality 15, central
Peary Land.

Figure 3.32. Type locality of the Paralleldal Formation(P) on the north
side of Paralleldal; type section arrowed. A: Aftenstjernesø
Formation; S: Saeterdal Formation; W: Wandel Valley Formation.
Locality 15, central Peary Land.

Figure 3.33. Thin-bedded, laminated skeletal dolomites (LF.5) in the
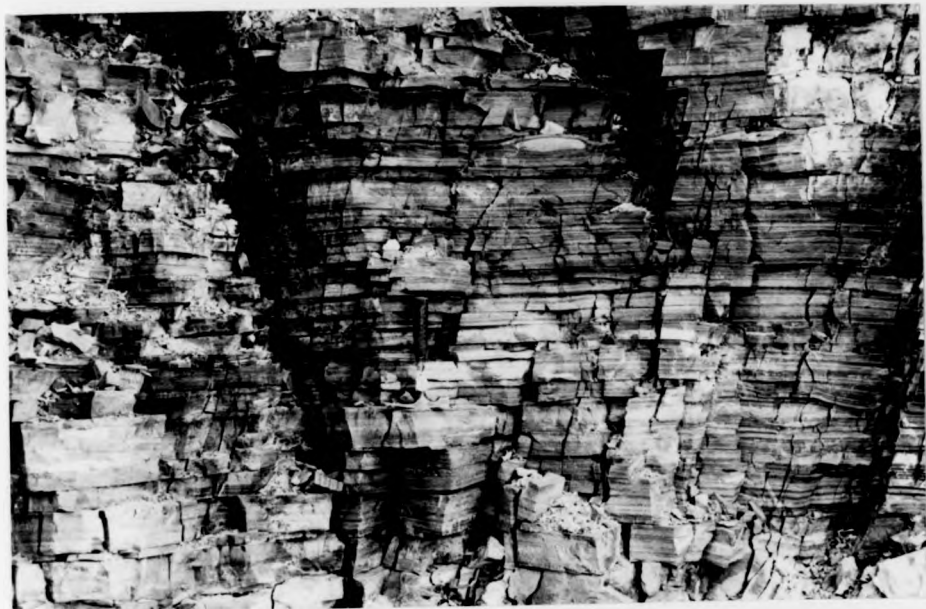Paralleldal Formation type section. Locality 15, central
Peary Land.

Figure 3.32. Type locality of the Paralleldal Formation(P) on the north
side of Paralleldal; type section arrowed. A: Aftenstjernesø
Formation; S: Saeterdal Formation; W: Wandel Valley Formation.
Locality 15, central Peary Land.

Lithology.

The dolomites of the formation commonly form steep cliffs above
the recessive Sæterdal Formation and below the pale recessive dolomites
of the Lower Member of the Wandel Valley Formation (Fig. 3.15).   At the
type section (Fig. 3.31), the lower third of the formation shows grey-
brown weathering colours and is composed of dark grey, laminated, nodular
and graded dolomites (Fig. 3.33), interbedded with thick breccia beds
which locally contain rafts of thin-bedded dolomite up to 5m thick.   The
remainder of the formation at the type section weathers orange-brown or
pale yellow and is composed of oolitic, bioclastic, intraclastic and
peloidal dolomites showing medium- to small-scale trough and tabular cross-
stratification, interbedded with parallel-laminated dolomites and rare
dolomite breccia beds.   The upper 30m of the formation at the type section
comprise pale medium-coarse crystalline dolomite which is predominantly
structureless but locally,large tilted blocks of pale, medium- to thick-
bedded, cross stratified dolomite can be identified (Fig. 3.31); this upper
brecciated interval is thought to be of karstic origin.

Farther east and south of the type section (localities 17, 18 & 19),
the lower darker weathering interval comprises dark grey-black, silty,
laminated, bioturbated and burrow-mottled dolomites with thin silicified
bioclastic horizons near the base, which yield a diverse fauna of trilo-
bites, molluscs and archaeocyathids (Fig. 3.7).   These dark dolomites
are overlain by and southwards interdigitate with massive, pale cream
weathering, fine-coarse crystalline dolomites.   Locally, granular cross-
stratified varieties can be differentiated from fine crystalline mottled,

Lithology.

The dolomites of the formation commonly form steep cliffs above the recessive Sæterdal Formation and below the pale recessive dolomites of the Lower Member of the Wandel Valley Formation (Fig. 3.15). At the type section (Fig. 3.31), the lower third of the formation shows grey-brown weathering colours and is composed of dark grey, laminated, nodular and graded dolomites (Fig. 3.33), interbedded with thick breccia beds which locally contain rafts of thin-bedded dolomite up to 5m thick. The remainder of the formation at the type section weathers orange-brown or pale yellow and is composed of oolitic, bioclastic, intraclastic and peloidal dolomites showing medium- to small-scale trough and tabular cross-stratification, interbedded with parallel-laminated dolomites and rare dolomite breccia beds. The upper 30m of the formation at the type section comprise pale medium-coarse crystalline dolomite which is predominantly structureless but locally, large tilted blocks of pale, medium- to thick-bedded, cross stratified dolomite can be identified (Fig. 3.31); this upper brecciated interval is thought to be of karstic origin.

Farther east and south of the type section (localities 17, 18 & 19), the lower darker weathering interval comprises dark grey-black, silty, laminated, bioturbated and burrow-mottled dolomites with thin silicified bioclastic horizons near the base, which yield a diverse fauna of trilo-bites, molluscs and archaeocyathids (Fig. 3.7). These dark dolomites are overlain by and southwards interdigitate with massive, pale cream weathering, fine-coarse crystalline dolomites. Locally, granular cross-stratified varieties can be differentiated from fine crystalline mottled,

shelly dolomites (wackestone texture) containing archaeocyathids
(Fig. 3.34), but more commonly these dolomites are structureless,
vuggy and highly recrystallized. In the Børglum Elv region (localities
21 & 22), the formation is characterized by pale yellow weathering, sugary
dolomites showing trough cross-stratification in sets up to 0.3m thick
(Fig. 3.35).

Boundaries.

In its western outcrop, the formation conformably overlies the
Sæterdal Formation. The boundary is sharp and planar and is placed
where fine-grained sandstones and silty sandstones are overlain by
dolomites (Fig. 3.15). In eastern Paralleldal and on the southern side
of Frysefjeld (Fig. 3.28), the Paralleldal Formation conformably overlies
the Aftenstjernesø Formation (Figs. 3.7 & 3.36). In Paralleldal the
boundary is sharp and is defined by the incoming of dark shaly, recessive
dolomites which overlie cliff-forming, grey-brown weathering, thin-
bedded dolomites and breccia beds of the Aftenstjernesø Formation (Fig. 3.36).
In the Børglum Elv valley, however, the lower boundary is less distinct and,
for mapping purposes, is taken at the change in weathering colour, from
brownish-grey to pale yellow. In outcrop, the boundary is taken as the
first recognizable cross-stratified dolomite bed overlying structureless,
slumped (?) dolomites, assigned here to the Aftenstjernesø Formation.

The formation is unconformably overlain by the Wandel Valley
Formation with a sharp and planar contact, marked by a change from pale
yellow weathering, sugary, cliff-forming dolomites into recessive, pale
grey, fine crystalline dolomites (Figs. 3.15 & 3.36).

Figure 3.34. Silicified archaeocyathids (LF.15). Paralleldal Formation, locality 19, central Peary Land.

Figure 3.35 Trough cross-bedded dolomites (LF.14). Paralleldal Formation, locality 22, east Peary Land.

Figure 3.34. Silicified archaeocyathids (LF.15). Paralleldal Formation, locality 19, central Peary Land.

Figure 3.35 Trough cross-bedded dolomites (LF.14). Paralleldal Formation, locality 22, east Peary Land.

Figure 3.36. Paralleldal Formation (P; c. 160m thick) on the north-east
side of Frysefjeld, viewed towards the south-west. Dark
carbonates dominate the lower third and are progressively
replaced upwards by pale, massive dolomites. A: Aftenstjernesø
Formation; W: Wandel Valley Formation. Locality 18, central
Peary Land.

Figure 3.36. Paralleldal Formation (P; c. 160m thick) on the north-east
side of Frysefjeld, viewed towards the south-west. Dark
carbonates dominate the lower third and are progressively
replaced upwards by pale, massive dolomites. A: Aftenstjernesø
Formation; W: Wandel Valley Formation. Locality 18, central
Peary Land.

Distribution.

The western limit of the formation is arbitrarily defined at a line running north from Slusen (Fig. 3.3). East from this line it crops out along the north side of Wandel Dal, along Sæterdal, Paralleldal and the Børglum Elv valley and runs out at the shores of Independence Fjord (Fig. 3.3). The formation is poorly exposed west of Sæterdal but well exposed in Paralleldal and the Børglum Elv valley, and accessible sections can be studied at localities 15, 17, 19 and 21 (Fig. 3.28).

Fauna and Geological Age.

The formation is generally poorly fossiliferous, yielding only indeterminate, poorly-preserved trilobites and inarticulate brachiopods at the type section. A diverse fauna has been collected from the lower half of the formation at locality 19, however, including regular archaeocyathids, olenellid trilobites, *Salterella*, brachiopods and varied molluscs, an assemblage indicative of the late Early Cambrian. Poorly preserved archaeocyathid "ghosts" can be recognized locally in the upper pale, massive dolomites and, as archaeocyathids only rarely extend into the Middle Cambrian (Hill 1972), it is likely that the entire formation is of late Early Cambrian age.

3.3.4. Tavsens Iskappe Group.

History.

Peel (1979) erected the Tavsens Iskappe Group to describe the sediments which conformably overlie the Brønlund Fjord Group and are over-lain unconformably by the Wandel Valley Formation in west Peary Land.

Four informal formations were described from Gustav Holm Dal, west of
Hans Tavsens Iskappe (Fig. 3.4) and a thickness of about 900m was
suggested for the group.   Correlation between this locality and ex-
posures of the group further south and to the east of the icecap was not
attempted.

Fieldwork in 1979 led to slight redefinition of the formations of
Peel (1979) and the total thickness of the group was given as about 700m
(Ineson & Peel 1980).   Seven formations were recognized within the
Tavsens Iskappe Group, four in the Henson Gletscher-J.P. Koch Fjord region
and three to the east of Hans Tavsens Iskappe (Fig. 3.2).

At the southern end of Koch Væg (Fig. 3.4, locality 2), the
Tavsens Iskappe Group is equivalent to the upper beds of Unit F and Unit G
of Dawes (1976b).

Name.

After Hans Tavsens Iskappe, south-west Peary Land (Fig. 3.3).

Type Area.

Henson Gletscher-J.P. Koch Fjord region, south-west Peary Land.

Thickness.

Approximately 700m in Holm Dal, east of J.P. Koch Fjord, thinning
to an estimated 400m at Koch Væg and about 300m in Løndal on the east side
of Hans Tavsens Iskappe (Fig. 3.37).   The group apparently thins east from
Løndal due to the south-easterly overstep of the overlying Wandel Valley
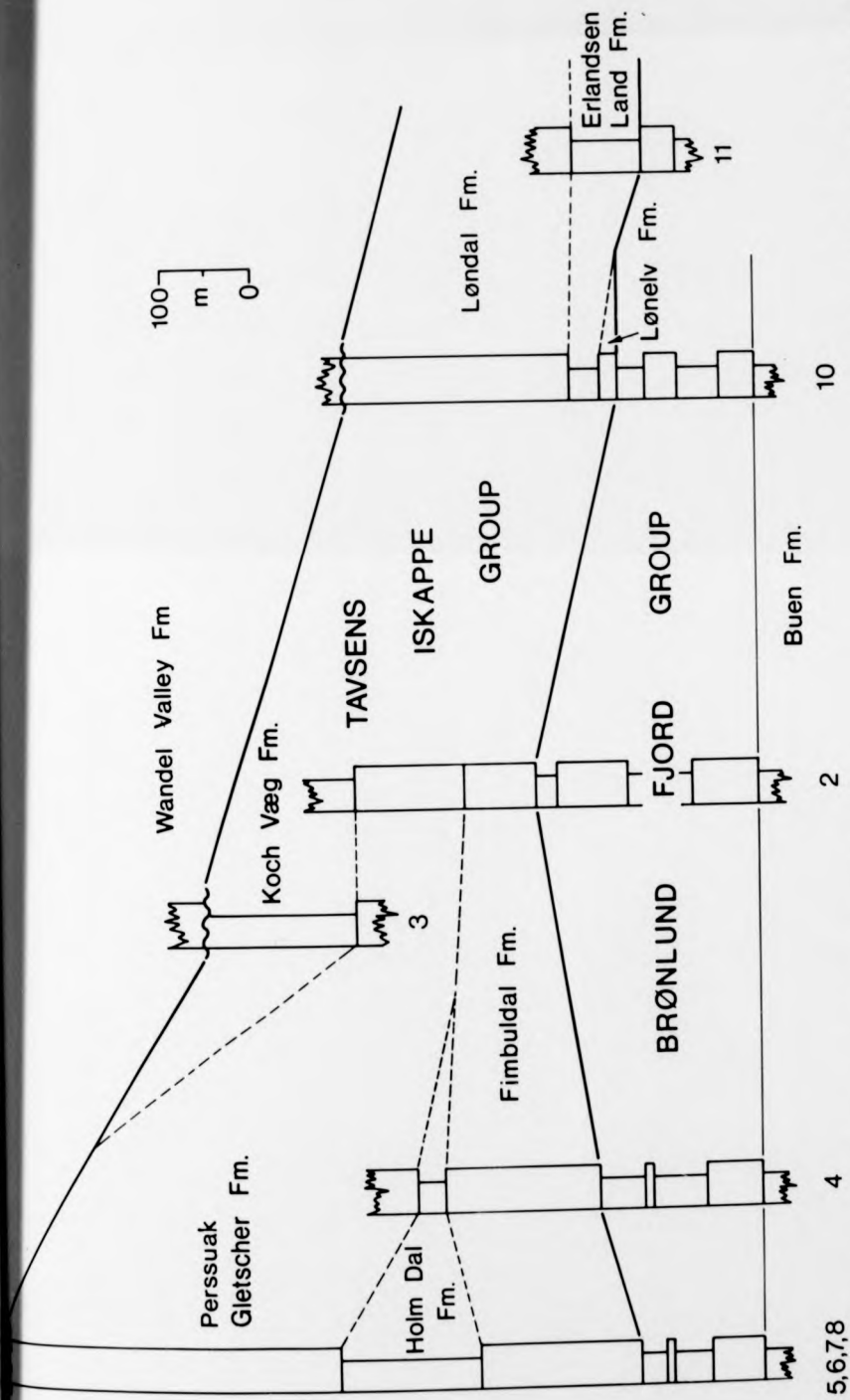
Figure 3.37. Stratigraphic correlation within the Tavsens Iskappe Group across southern Peary Land. Numbers refer to localities shown on Fig. 3.3.; lateral spacing of sections not to scale.

Formation, but exposure is poor and complete sections through the group are unobtainable.

Dominant Lithology.

The group consists of a varied sequence of dark recessive limestones, pale weathering dolomites, dolomitic sandstones and white quartzitic sandstones (quartz arenites). In the J.P. Koch Fjord region, the group commences with platy, nodular and thin-bedded argillaceous limestones inter-bedded with prominent dolomitized breccia beds. These are overlain by mixed sandstone-dolomite breccia beds, cross-stratified and bioturbated dolomitic sandstones and quartz arenites. At Henson Gletscher and to the east of Hans Tavsens Iskappe, the group commences with dark thin-bedded dolomites and argillaceous limestones, interbedded with dolomitized breccia beds. These are followed by prominent pale weathering, cross-stratified dolomites that are commonly oolitic and locally show depositional dips.

At Koch Væg, the group is capped by a sequence of thin- to medium-bedded, burrowed, argillaceous dolomites, algal-laminated dolomites and cross-stratified bioturbated sandstones.

Boundaries.

The Tavsens Iskappe Group conformably overlies the Brønlund Fjord Group (Figs. 3.2,3.8 & 3.37) and is unconformably overlain by the Wandel Valley Formation (Peel 1979).

Distribution.

The group occurs in Freuchen Land, in the Henson Gletscher-J.P. Koch Fjord region and crops out from Løndal at the eastern margin of Hans

Tavsens Iskappe, eastwards to the valley north of Slusen (Fig. 3.3)
where the group is finally overstepped by the Wandel Valley Formation.
Westwards the group has been traced across Freuchen Land and into southern
Nares Land (J.S. Peel, pers. comm. 1984).

Geological Age.

Middle-Late Cambrian.

Subdivision.

Four formations are recognized to the west of Hans Tavsens Iskappe:
the Fimbuldal Formation, the Holm Dal Formation, the Perssuak Gletscher
Formation and the Koch Væg Formation.   To the east of the icecap, the
group comprises the Lønelv Formation, the Erlandsen Land Formation and
the Løndal Formation (Fig. 3.2).

3.3.4.1. Fimbuldal Formation.

History.

This is equivalent to the informal formation T1 of Ineson & Peel
(1980) and approximately equivalent to formation 1 of Peel (1979).   At Koch
Væg (locality 2), the formation is equivalent to the upper part of Unit F
of Dawes (1976b),beds which were initially included in formation 4 of the
Brønlund Fjord Group (Peel 1979).

Name.

After Fimbuldal, the valley which links the head of J.P. Koch Fjord
to Wandel Dal, west Peary Land (Fig. 3.4).

Type Section.

Fig. 3.38; gully on the west side of Gustav Holm Dal, south-west Peary Land (Fig. 3.4, locality 6; Fig. 3.39).

Thickness.

Approximately 180m at the type locality, thinning south to about 80m at locality 2 (Fig. 3.37).

Lithology.

Alternating units of dark weathering, recessive and pale weathering, cliff-forming carbonates produce characteristic terraced exposures (Fig. 3.39) above the recessive, argillaceous carbonates of the Ekspedition Bræ Formation.

In northern exposures (localities 4 & 6), the formation comprises a varied sequence of platy, nodular limestones (microsparites) and dolomites, bituminous parallel-laminated lime mudstones, skeletal wackestones and thin, graded beds of intraclastic peloidal lime grainstone, interbedded with pale weathering carbonate breccia beds (Fig. 3.38). Platy, nodular carbonates dominate the lower half of the type section and exhibit undulatory bedding, pull-aparts and discontinuous brecciated horizons (Fig. 3.40). The clast-supported breccia beds range from less than a metre to 40m in thickness and are commonly dolomitized together with adjacent, thin-bedded carbonates. Clasts are mostly tabular (average dimensions of 0.02 x 0.1m) and, where undolomitized, are composed of lime mudstone, wackestone and peloidal packstone in a lime mudstone matrix. Pale weathering blocks of

Figure 3.38. Fimbuldal Formation type section. Locality 6, west Peary Land.
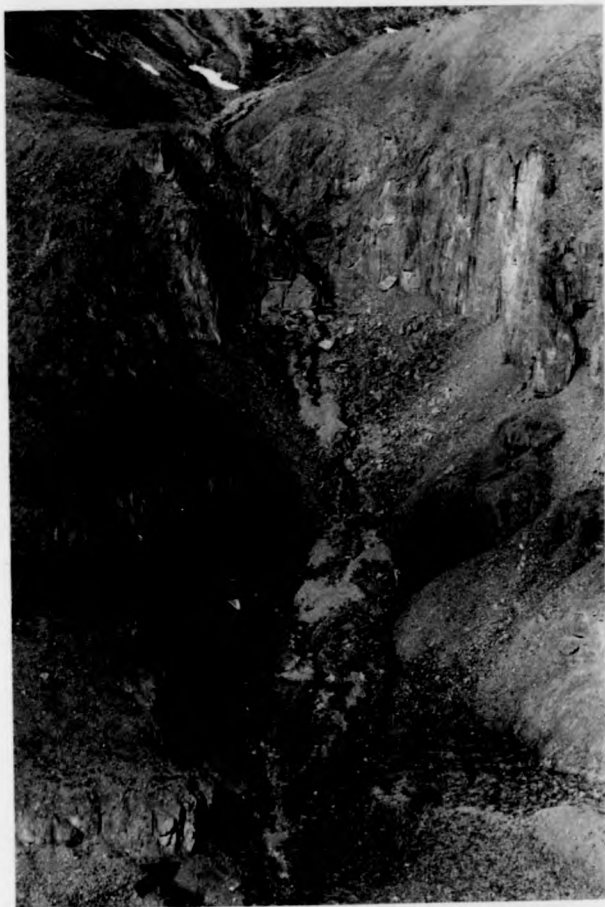
Figure 3.39. Type locality of the Fimbuldal Formation; base and top of type section arrowed. Note the characteristic stepped profile. Locality 6, west Peary Land.

Figure 3.39. Type locality of the Fimbuldal Formation; base and top of type section arrowed. Note the characteristic stepped profile. Locality 6, west Peary Land.

Figure 3.40. Platy nodular dolomites (LF.4) of the Fimbuldal Formation.
Note undulating bedding and fractured, disrupted nodules.
Locality 6, west Peary Land.

Figure 3.40. Platy nodular dolomites (LF.4) of the Fimbuldal Formation.
Note undulating bedding and fractured, disrupted nodules.
Locality 6, west Peary Land.

ooidal grainstone occur sporadically in the breccia beds (Fig. 3.41) and locally are of house-sized proportions.

South of Ekspedition Bræ and in the Henson Gletscher area, the formation is made up of thin-bedded dolomites, interbedded with dolomite breccia beds. At Koch Væg (locality 2), the formation is 80m thick and comprises a lower pale weathering interval (c. 30m) of laminated, locally slumped dolomite, interbedded with dolomite breccia beds (0.5-2m thick), overlain by about 50m of thin wavy-bedded, dark grey dolomites (Fig. 3.37).

Boundaries.

The Fimbuldal Formation conformably overlies the Ekspedition Bræ Formation. The boundary is not exposed at the type locality, but at locality 5 (Fig. 3.4) it is placed at the first appearance of prominent weathering, platy, nodular limestones above the recessive lime mudstones and calcareous mudstones of the Ekspedition Bræ Formation (Figs. 3.8 & 3.27). At Koch Væg (locality 2), the boundary is placed where pale yellow weathering dolomites of the Fimbuldal Formation overlie recessive argillaceous carbonates of the Ekspedition Bræ Formation (Fig. 3.37).

In the Henson Gletscher area (Fig. 3.4), the formation is conformably overlain by cliff-forming ooidal dolomites assigned to the Perssuak Gletscher Formation (Fig. 3.37). The boundary is placed at the base of the first cream weathering, ooidal dolomite bed. The Perssuak Gletscher Formation is strongly diachronous from south to north (Figs. 3.2 & 3.37) and consequently, to the north of the head of J.P. Koch Fjord, the Fimbuldal Formation is con-

Figure 3.41. Limestone breccia (LF.9) composed mainly of dark lime mudstone clasts with a lime mud matrix, with occasional large blocks of white ooidal grainstone. Fimbuldal Formation, locality 5, west Peary Land.
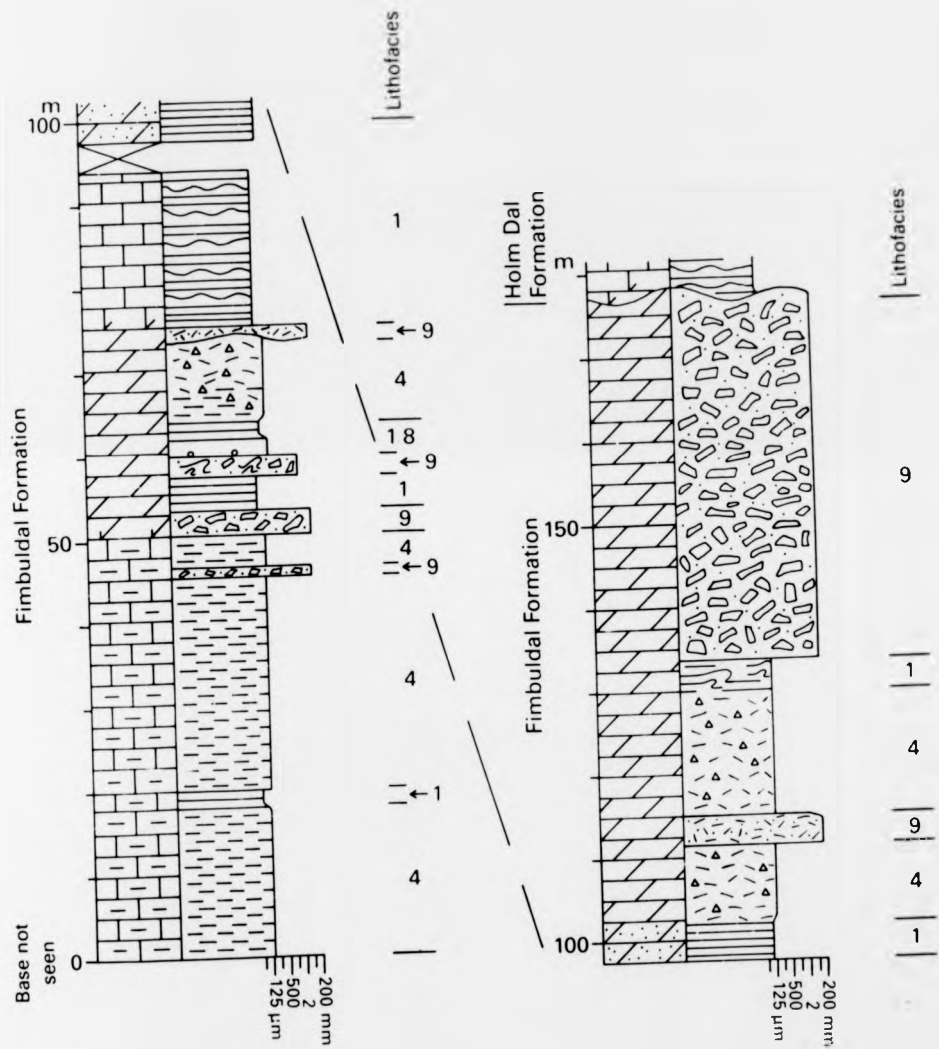

Figure 3.43. Type locality of the Holm Dal Formation; base and top of type section arrowed. B: Brønlund Fjord Group; F: Fimbuldal Formation; H: Holm Dal Formation; P: Perssuak Gletscher Formation. Locality 7, west Peary Land.

Figure 3.41. Limestone breccia (LF.9) composed mainly of dark lime mudstone clasts with a lime mud matrix, with occasional large blocks of white ooidal grainstone. Fimbuldal Formation, locality 5, west Peary Land.

Figure 3.43. Type locality of the Holm Dal Formation; base and top of type section arrowed. B: Brønlund Fjord Group; F: Fimbuldal Formation; H: Holm Dal Formation; P: Perssuak Gletscher Formation. Locality 7, west Peary Land.

formably overlain by the Holm Dal Formation which, in turn, is overlain by the Perssuak Gletscher Formation (Figs. 3.2 & 3.8). The boundary is sharp and is placed where dark recessive, thin-bedded carbonates of the Holm Dal Formation overlie the uppermost cliff-forming carbonate breccia bed of the Fimbuldal Formation (Figs. 3.38, 3.39 & 3.8). The boundary may be planar or hummocky and locally has a relief of up to 5m.

Distribution.

The formation crops out to the west of Hans Tavsens Iskappe, south-west Peary Land, especially around the head of J.P. Koch Fjord and along Henson Gletscher (Fig. 3.4). The formation extends west across Freuchen Land, and is well-exposed in Navarana Fjord. In south-west Peary Land it is well exposed along northern Fimbuldal and Gustav Holm Dal and in the vertical cliffs flanking J.P. Koch Fjord and Henson Gletscher (Fig. 1.3). Accessible sections can be studied at localities 2, 4, 6 and 10, the type section being the most complete.

Fauna and Geological Age.

At the type section and locality 4, dark bituminous limestones (80-90m above the base) yield a diverse fauna of agnostoid and ptychoparoid trilobites, brachiopods and sponge spicules. The agnostoid trilobites include species that are indicative of the North American *Ptychagnostus punctuosus* Zone of the medial Middle Cambrian (Robison 1984; Peel 1982a). The remainder of the formation is unfossiliferous, but the basal beds of the overlying Holm Dal Formation yield faunas indicative of the latest Middle Cambrian (Palmer & Peel 1979; Robison 1984; Peel 1982a) and conse-

quently the upper beds of the Fimbuldal Formation are of probable late Middle Cambrian age.

In southern exposures (locality 2), the formation is unfossiliferous, but a medial Middle Cambrian age is suggested by its stratigraphic position.

3.3.4.2. Holm Dal Formation.

History.

The formation has been described informally as formation 2 and formation T2 of the Tavsens Iskappe Group (Peel 1979; Ineson & Peel 1980).

Name.

After Gustav Holm Dal, the north-south valley linking Fimbuldal with Perssuak Gletscher, south-west Peary Land (Fig. 3.4).

Type Section.

Fig. 3.42; north of the prominent gully on the east side of Gustav Holm Dal, at the junction with Fimbuldal (Fig. 3.4, locality 7; Fig. 3.43).

Thickness.

155m at the type locality, thinning south to about 30m at locality 4 and pinching out altogether a few kilometres south of this locality (Fig. 3.37). The formation appears to thicken northwards from the type section, but exposure is inaccessible.
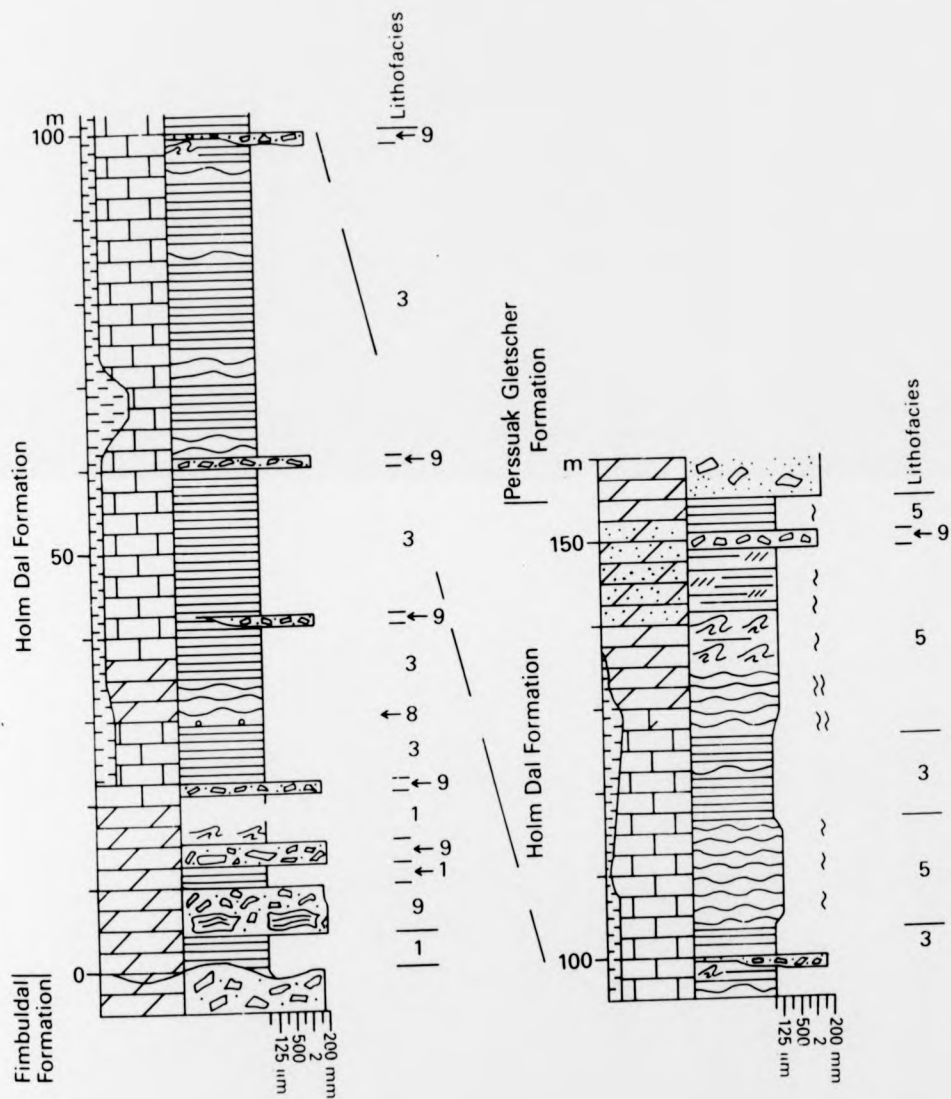
Figure 3.42. Holm Dal Formation type section.   Locality 7, west Peary Land.

Lithology.

The formation forms recessive dark weathering slopes between the terraced Fimbuldal Formation below and the pale weathering Perssuak Gletscher Formation above (Fig. 3.43). At the type section it is dominated by a monotonous sequence of thin, parallel- and wavy-bedded, dark grey dolomites and lime mudstones with grey-green weathering, silty, calcareous mudstone partings and interbeds (Fig. 3.44). Parallel lamination is the dominant sedimentary structure and is defined locally by thin lenses and laminae (maximum thickness of 10mm) of skeletal lime packstone and grain-stone. About 1km north of the type section, richly fossiliferous skeletal lime grainstones are associated with black phosphoritic layers near the base of the formation.

Wavy-bedded peloidal and skeletal lime grainstones, packstones and wackestones become important in the upper third of the formation, forming a prominent bench approximately 110m above the base of the formation (Fig. 3.42). The upper beds are dolomitized in the type section and include an interval of parallel-laminated and bioturbated, fine-grained, dolomitic sand-stones which locally show small-scale cross-stratification and rippled bedding planes. Slumped, brecciated horizons and carbonate breccia beds up to 5m thick occur frequently near the base and top of the formation (Fig. 3.45).

Boundaries.

The formation overlies the Fimbuldal Formation with a sharp, but apparently conformable boundary (Figs. 3.42 & 3.43). Along Gustav Holm Dal, this boundary undulates markedly with a relief of up to 5m, but else-

Figure 3.44. Thin-bedded, argillaceous lime mudstones (LF.3) near the middle of the Holm Dal Formation type section. Locality 7, west Peary Land.

Figure 3.45. Lenticular, channelled limestone breccia bed (LF.9; margins outlined) interbedded with argillaceous lime mudstones (LF.3). Locality 7, west Peary Land.

Figure 3.44. Thin-bedded, argillaceous lime mudstones (LF.3) near the middle
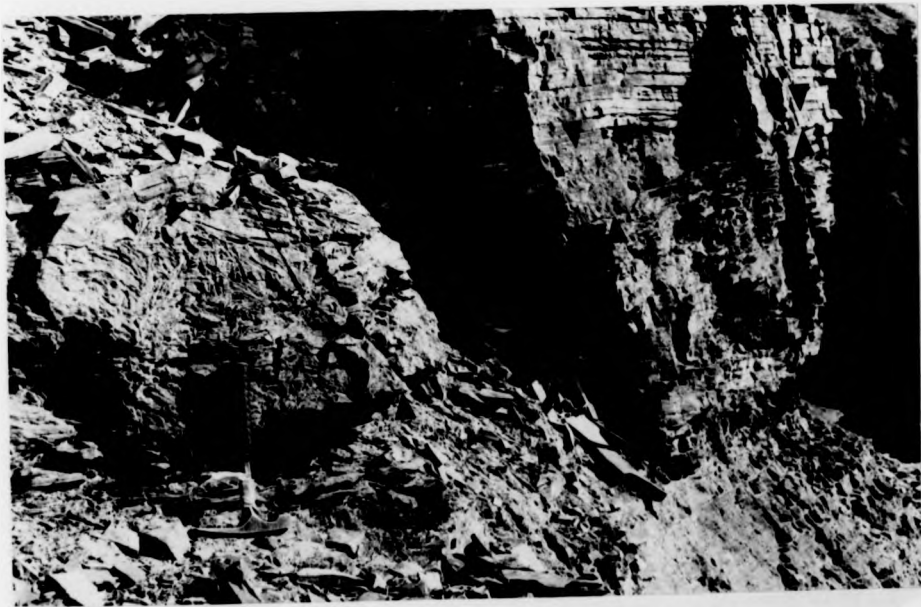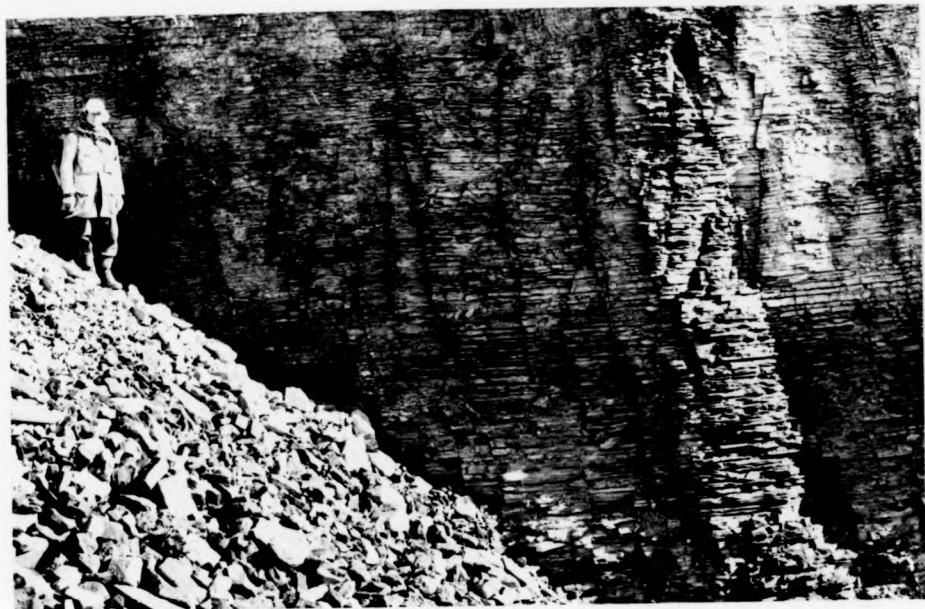of the Holm Dal Formation type section. Locality 7, west
Peary Land.
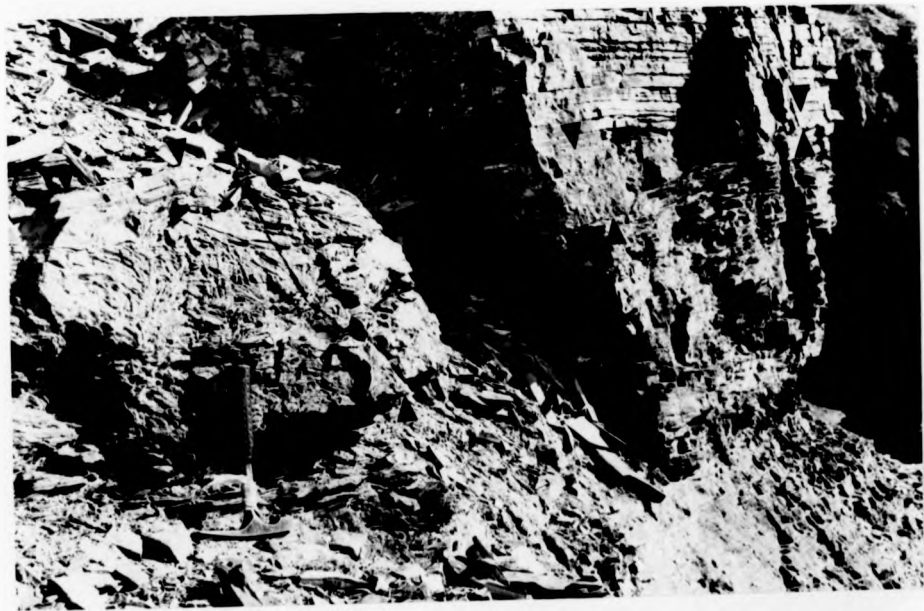
Figure 3.45. Lenticular, channelled limestone breccia bed (LF.9; margins
outlined) interbedded with argillaceous lime mudstones (LF.3).
Locality 7, west Peary Land.

where it is planar.

The Holm Dal Formation is conformably overlain by the Perssuak Gletscher Formation (Fig. 3.8 & 3.43). At the type locality the boundary is placed where recessive laminated, dark carbonates are abruptly overlain by a massive cliff-forming dolomite breccia bed (Fig. 3.46). The boundary between these formations is a facies front that progrades northwards (Fig. 3.37). Pale wedge-shaped units of dolomites and sandstones, assigned to the Perssuak Gletscher Formation, thin northwards, interdigitating with dark thin-bedded carbonates (Figs. 3.47 & 3.48) and eventually pinch out into the underlying Holm Dal Formation. For simplicity, the zone of interdigitation is included in the Perssuak Gletscher Formation (Fig. 3.47).

Distribution.

The formation crops out around the head of J.P. Koch Fjord in south-west Peary Land and east Freuchen Land. It pinches out approximately 2km south of locality 4, and is not recognized south of the head of J.P. Koch Fjord (Fig. 3.4).

The Holm Dal Formation is well exposed in cliffs along J.P. Koch Fjord, Navarana Fjord and around the junction of Fimbuldal and Gustav Holm Dal (Figs. 3.8 & 3.47), but accessible exposures are rare, the type section being the most complete.

where it is planar.

The Holm Dal Formation is conformably overlain by the Perssuak Gletscher Formation (Fig. 3.8 & 3.43). At the type locality the boundary is placed where recessive laminated, dark carbonates are abruptly overlain by a massive cliff-forming dolomite breccia bed (Fig. 3.46). The boundary between these formations is a facies front that progrades northwards (Fig. 3.37). Pale wedge-shaped units of dolomites and sandstones, assigned to the Perssuak Gletscher Formation, thin northwards, interdigitating with dark thin-bedded carbonates (Figs. 3.47 & 3.48) and eventually pinch out into the underlying Holm Dal Formation. For simplicity, the zone of interdigitation is included in the Perssuak Gletscher Formation (Fig. 3.47).

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The Holm Dal Formation is well exposed in cliffs along J.P. Koch Fjord, Navarana Fjord and around the junction of Fimbuldal and Gustav Holm Dal (Figs. 3.8 & 3.47), but accessible exposures are rare, the type section being the most complete.

Figure 3.46. Boundary (arrowed) between the uppermost thin-bedded dolomites of the Holm Dal Formation and massive dolomite breccias of the overlying Perssuak Gletscher Formation.
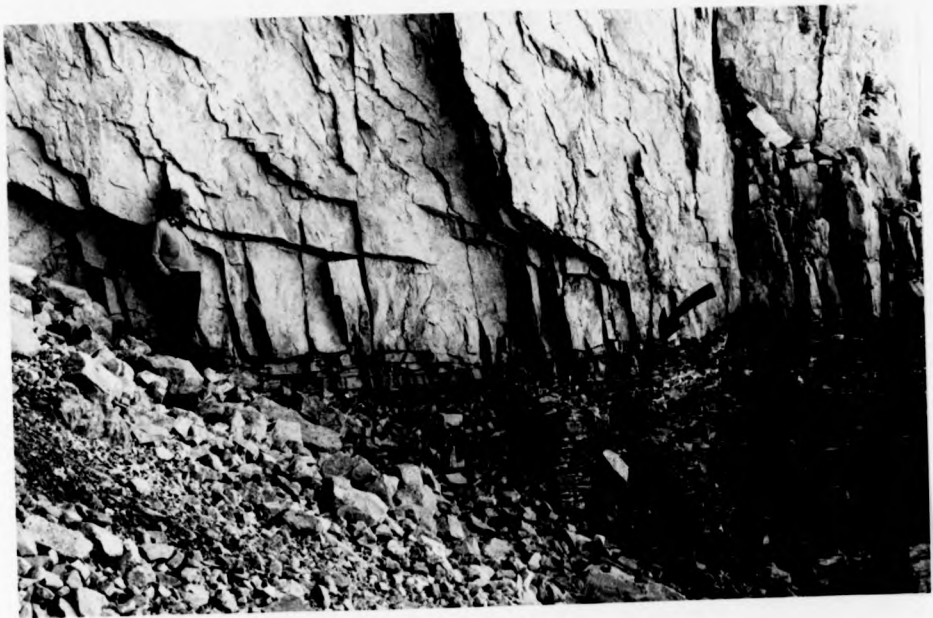
Figure 3.46. Boundary (arrowed) between the uppermost thin-bedded dolomites
of the Holm Dal Formation and massive dolomite breccias of the
overlying Perssuak Gletscher Formation.

Figure 3.47. Tavsens Iskappe Group on the east side of inner J.P. Koch Fjord, viewed towards the north-west. F: Fimbuldal Formation; H: Holm Dal Formation; P: Perssuak Gletscher Formation; W: Wandel Valley Formation; U: unconformity. Note the northward-dipping depositional surfaces passing from the pale facies (inner shelf) into the dark carbonates (outer shelf). The hummocky lenticular units within the outer shelf facies (e.g. X, Y) probably represent mass-flow breccia sheets. Cliff is about 800m high.

Figure 3.47. Tavsens Iskappe Group on the east side of inner J.P. Koch Fjord, viewed towards the north-west. F: Fimbuldal Formation; H: Holm Dal Formation; P: Perssuak Gletscher Formation; W: Wandel Valley Formation; U: unconformity. Note the northward-dipping depositional surfaces passing from the pale facies (inner shelf) into the dark carbonates (outer shelf). The hummocky lenticular units within the outer shelf facies (e.g. X, Y) probably represent mass-flow breccia sheets. Cliff is about 800m high.

Fauna and Geological Age.

The lower two-thirds of the formation are richly fossiliferous and yield a diverse fauna of agnostoid and other trilobites, molluscs and brachiopods (Peel 1979; Ineson & Peel 1980). Preliminary analysis of the trilobite collections demonstrated that the basal beds of the formation contained species of *Hypagnostus* and *Lejopyge* that indicated the *Lejopyge laevigata* Zone of the latest Middle Cambrian whereas succeeding collections were typified by *Kormagnostus* and *Agnostus pisiformis*, forms that are referable to the *Agnostus pisiformis* Zone of the Late Cambrian (Dresbachian of North America). Hence the Middle-Upper Cambrian boundary was tentatively placed near the base of the formation (Palmer & Peel 1979; Peel 1982a). Recent work by Robison (1984), however, has demonstrated that the faunas of the *Lejopyge laevigata* Zone, the uppermost zone of the Middle Cambrian, extend throughout the fossiliferous part of the formation; clearly, the Dresbachian Stage is partly of Middle Cambrian age (Robison 1984). Thus most of the formation in Gustav Holm Dal is of latest Middle Cambrian age; the upper levels of the formation may extend into the Late Cambrian.

3.3.4.3. Perssuak Gletscher Formation.

History.

This formation is equivalent to formations 3 and 4 of Peel (1979) and formation T3 of Ineson & Peel (1980). It is equivalent to Unit G of Dawes (1976b), at the southern end of Koch Væg (locality 2).

Name.

After Perssuak Gletscher, a distributary of Hans Tavsens Iskappe, which flows west into J.P. Koch Fjord in south-west Peary Land (Fig. 3.4).

Type Area and Type Section.

East side of Gustav Holm Dal, south-west Peary Land (Fig. 3.4).
The formation is poorly exposed in accessible terrain and lateral varia-
tion is great, so the formation is defined here from a composite section
made up of three sections along the east side of Gustav Holm Dal.   To-
gether, these sections illustrate the main features of the formation in
the type area, but following Hedberg (1976), the section at locality
8 (Fig. 3.48B) is designated the type section (holostratotype); the
sections at localities 7 and 9 (Fig. 3.48, A & C) are thus reference
sections (parastratotypes).

Thickness.

Approximately 400m at the type section (Fig. 3.48).   The forma-
tion apparently thins northwards in Gustav Holm Dal, as the underlying
Holm Dal Formation thickens, but exposures north and west of the type
area are inaccessible, so an accurate measure is impossible.

At the south end of Koch Væg, the formation is 120-150m thick.

Lithology.

The cliff-forming, yellow-brown weathering formation is composed
of cross-stratified dolomites, dolomitic sandstones and quartzites,
interbedded with slumped intervals and breccia beds.   At the type sec-
tion, the lower half of the formation comprises fine- to medium-grained
sandstones interbedded with breccia beds which range from 0.5 to 40m in
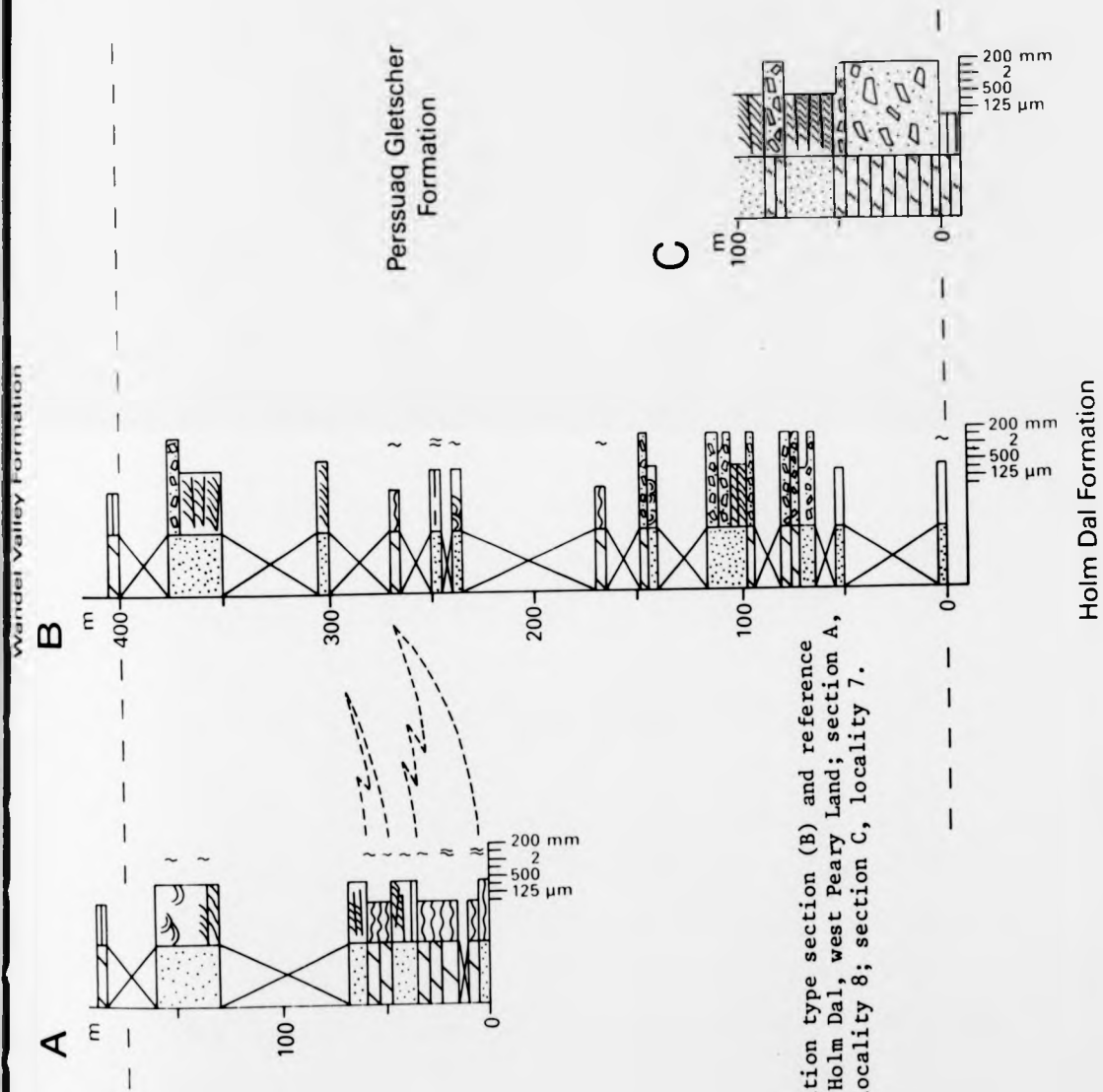thickness.   In the lower 100m of the formation, the breccias are composed

Figure 3.48.

Perssuak Gletscher Formation type section (B) and reference
sections (A,C). Gustav Holm Dal, west Peary Land; section A,
locality 9; section B, locality 8; section C, locality 7.

predominantly of dolomite , but quartz sand forms an increasing propor-
tion of both matrix and clasts up the sequence (Fig. 3.49).   The sand-
stones commonly show tabular and trough cross-stratification (0.1-1m sets),
convolute bedding and parallel lamination.   Parallel-laminated and
small-scale cross-stratified sandstones (Fig. 3.50), bioturbated dolo-
mitic sandstones and burrow-mottled pale dolomites make up the upper half
of the formation at the type locality (Fig. 3.48).

At the northern end of Holm Dal (Fig. 3.48A), dark grey-brown
weathering wedge-shaped units of dark grey, thin, wavy-bedded silty dolo-
mites are intercalated with the pale sediments which typify the formation.
The dark recessive units pinch out southwards and are not represented
in the type section, but thicken markedly to the north with concomitant
attenuation and eventual pinching out of the intercalated pale units, which
locally show northerly depositional dips.   This interdigitation is well
illustrated in the cliffs along J.P. Koch Fjord (Fig. 3.47).

South of the type area, the formation is composed of pale yellow,
structureless and cross-stratified, medium- to thick-bedded, medium-coarse
crystalline dolomite, in which ooids and bioclasts are locally recognizable.
Along Koch Væg, lenticular bodies of ooidal dolomite, intercalated with
darker weathering dolomites, define northerly depositional dips up to
30° (Fig. 3.51).
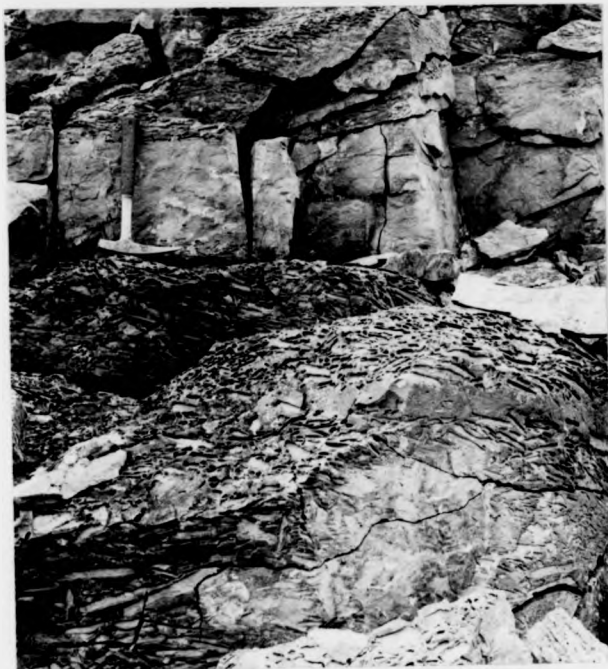
Figure 3.49. Sandstone-dolomite breccia beds (LF.9) in the Perssuak Gletscher
Formation type section. Note subparallel orientation of
dolomite clasts in medium-to coarse-grained dolomitic sandstone
matrix, grading normally into structureless sandstone cap.
Base of succeeding bed near top of hammer shaft. Locality 8,
west Peary Land.

Figure 3.50. Small-scale tabular cross-bedding in medium-grained sandstones
(LF.18) of the Perssuak Gletscher Formation. Locality 8, west
Peary Land.

Figure 3.49. Sandstone-dolomite breccia beds (LF.9) in the Perssuak Gletscher
Formation type section. Note subparallel orientation of
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Base of succeeding bed near top of hammer shaft. Locality 8,
west Peary Land.

Figure 3.50. Small-scale tabular cross-bedding in medium-grained sandstones
(LF.18) of the Perssuak Gletscher Formation. Locality 8, west
Peary Land.

Boundaries.

North of the head of J.P. Koch Fjord, the formation conformably overlies the Holm Dal Formation (Figs. 3.8 & 3.47). The boundary is poorly exposed at the type section and is defined at the south-east corner of Gustav Holm Dal (Fig. 3.48C), where cliff-forming dolomite breccias rest with a sharp planar contact on dark recessive laminated dolomites of the underlying Hol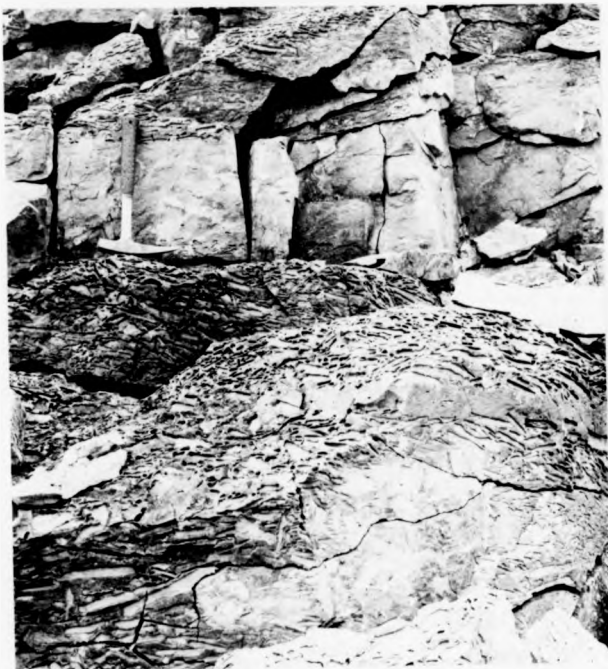m Dal Formation (Fig. 3.46). The Perssuak Gletscher Formation interfingers with the Holm Dal Formation as described previously and, for mapping purposes, the zone of interdigitation is included in the Perssuak Gletscher Formation (Fig. 3.47).

South of the head of J.P. Koch Fjord, the Holm Dal Formation is not recognized and the Perssuak Gletscher Formation conformably overlies the Fimbuldal Formation (Figs. 3.2 & 3.37). At locality 2, dark thin-bedded dolomites assigned to the Fimbuldal Formation are overlain by pale ooidal dolomite of the Perssuak Gletscher Formation. The change is gradational, the two rock types being interbedded over a 10m interval and the boundary is placed at the base of the first discrete pale bed of ooidal dolomite.

North of Troelsen's Fault, the formation is unconformably over-lain by late Lower Ordovician dolomites of the Wandel Valley Formation. The contact is nowhere exposed in accessible sections, and even in cliff sections, the unconformity is commonly delineated by a recessive, scree-covered ledge (Fig. 3.47). The boundary is apparently sharp and planar and, although bedding is commonly sub-parallel, an angular discordance of up to 15° can be demonstrated locally where the underlying Perssuak Gletscher sediments exhibit depositional dips (Fig. 3.47).

Boundaries.

North of the head of J.P. Koch Fjord, the formation conformably overlies the Holm Dal Formation (Figs. 3.8 & 3.47). The boundary is poorly exposed at the type section and is defined at the south-east corner of Gustav Holm Dal (Fig. 3.48C), where cliff-forming dolomite breccias rest with a sharp planar contact on dark recessive laminated dolomites of the underlying Holm Dal Formation (Fig. 3.46). The Perssuak Gletscher Formation interfingers with the Holm Dal Formation as described previously and, for mapping purposes, the zone of interdigitation is included in the Perssuak Gletscher Formation (Fig. 3.47).

South of the head of J.P. Koch Fjord, the Holm Dal Formation is not recognized and the Perssuak Gletscher Formation conformably overlies the Fimbuldal Formation (Figs. 3.2 & 3.37). At locality 2, dark thin-bedded dolomites assigned to the Fimbuldal Formation are overlain by pale ooidal dolomite of the Perssuak Gletscher Formation. The change is gradational, the two rock types being interbedded over a 10m interval and the boundary is placed at the base of the first discrete pale bed of ooidal dolomite.

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South of Troelsen's Fault, the cliff-forming thick-bedded dolomites of the Perssuak Gletscher Formation are overlain conformably by recessive pale weathering dolomites, argillaceous dolomites and sandstones of the Koch Væg Formation (Fig. 3.51). The boundary appears sharp in cliff section, but at locality 2 (Fig. 3.4), the lithological change is gradational, cross-stratified ooidal and sandy dolomites giving way to faintly laminated and burrow-mottled dolomites. At the type section of the Koch Væg Formation (locality 3), the boundary is placed at the change from pale to dark weathering dolomites (Fig. 3.52) which approximately corresponds to the break in slope.

Distribution.

The formation is restricted to south-west Peary Land and Freuchen Land, west of Hans Tavsens Iskappe. It crops out along Navarana Fjord, south J.P. Koch Fjord and Henson Gletscher (Figs.3.3 & 3.4) and extends east to the western margin of Hans Tavsens Iskappe.

The Perssuak Gletscher Formation is exposed in excellent cliff sections along the fjords and Henson Gletscher, but accessible sections with adequate exposure are scarce. It is best examined in Gustav Holm Dal and along the southern edge of Koch Væg.

Fauna and Geological Age.

The formation is characteristically unfossiliferous, but mottled dolomites near the top of the formation in Gustav Holm Dal yielded a poorly silicified fauna of monoplacophorans (*cf. Proplina*) and hyperstrophic onychochilacean gastropods (Ineson & Peel 1980); a fauna which supports the general Late Cambrian age that is suggested on stratigraphic grounds in the type area. Simple conodonts have been obtained from dark dolomites

at the north end of Gustav Holm Dal, indicating a latest Cambrian or possible early Ordovician age (Peel 1982a).

The age of the formation south of Troelsen's Fault is less certain. At locality 2, the youngest Cambrian faunas obtained are of medial Middle Cambrian age from the Ekspedition Bræ Formation of the Brønlund Fjord Group (Fig. 3.2, Palmer & Peel 1979). It can be demonstrated in northern exposures that the base of the Perssuak Gletscher Formation is strongly diachronous from south to north (Figs. 3.2 & 3.37) and thus, although the formation is of Late Cambrian age in the type area, it may be wholly or in part of Middle Cambrian age in southern exposures.

3.3.4.4. Koch Væg Formation.

History.

Previously described informally as formation T4 of the Tavsens Iskappe Group (Ineson & Peel 1980), the Koch Væg Formation is equivalent to the "medium-grained dolomite and limestone" forming the upper beds of Unit G of Dawes (1976b).

Name.

After Koch Væg, the vertical, west-facing cliff along the northern extension of Henson Gletscher, south-west Peary Land (Fig. 3.51).

Type Area and Type Section.

Koch Væg, on the east side of Henson Gletscher, south-west Peary Land. The type section (Fig. 3.52A) is defined at locality 3, just south

Figure 3.51. Tavsens Iskappe Group at Koch Væg, west Peary Land, viewed towards the south-east. Base and top of the type section of the Koch Væg Formation arrowed. P: Perssuak Gletscher Formation; K: Koch Væg Formation; W: Wandel Valley Formation; D: basaltic dyke. Cliff is about 400m high. Northward-dipping depositional surfaces within the Perssuak Gletscher Formation produce a large-scale cross-bedded appearance. Note the dome-shaped dolomite mass (M) at the southern end of Koch Væg, draped by well-bedded strata of the Koch Væg Formation.

Figure 3.51.   Tavsens Iskappe Group at Koch Væg, west Peary Land, viewed towards the south-east.   Base and top of the type section of the Koch Væg Formation arrowed.   P: Perssuak Gletscher Formation; K: Koch Væg Formation; W: Wandel Valley Formation; D: basaltic dyke.   Cliff is about 400m high.   Northward-dipping depositional surfaces within the Perssuak Gletscher Formation produce a large-scale cross-bedded appearance.   Note the dome-shaped dolomite mass (M) at the southern end of Koch Væg, draped by well-bedded strata of the Koch Væg Formation.
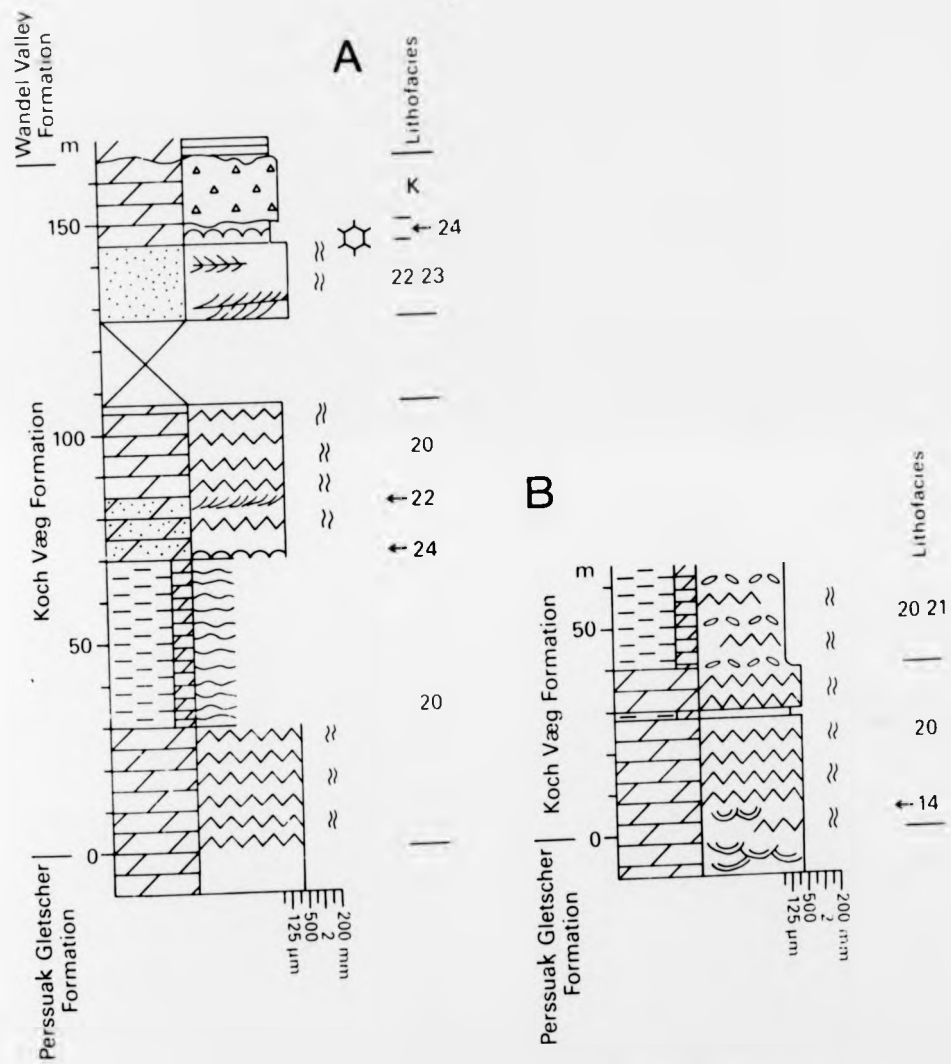
Figure 3.52. A. Koch Vaeg Formation type section. Locality 3, west Peary Land. B. Koch Vaeg Formation reference section. Locality 2, west Peary Land.

of the major east-west trending fault (Troelsen's Fault) (Figs. 3.4 & 3.51). Owing to heavily weathered and locally inaccessible exposures, the type section alone does not characterize the formation. Thus, following Hedberg (1976), the formation is defined here from a composite section comprising the type section and a reference section at locality 2 at the south end of Koch Væg (Fig. 3.52).

Thickness.

The thickness of this formation is poorly known. Accessible sections are rare and generally poorly exposed, but the formation is about 165m thick at the type section. Thickness estimates from cliff sections further south yield similar values between 150-200m.

Lithology.

The Koch Væg Formation is composed of generally pale weathering dolomites, argillaceous dolomites and sandstones. It is divisible into three units. The lower unit is about 40m thick at locality 2, and comprises medium- to thick-bedded, light cream and yellow-brown weathering, medium-coarse crystalline dolomites. Mottling is common, often delineating burrows (Fig. 3.53), and is defined by variation in colour, porosity and crystal size and locally by chert blebs and stringers. A prominent, dark grey weathering interval (c.10m thick) of intensely bioturbated dolomite caps this basal unit and forms a distinctive marker along Koch Væg (Fig. 3.51).

The middle unit is a recessive thin-bedded sequence (c. 40m at locality 3) of flaggy, pale weathering bioturbated dolomites interbedded with green-grey weathering silty mudstones and thin (0.03-0.2m) beds of

Figure 3.53. Burrow-mottled dolomites (LF.20), bedding plane surface. Koch Væg Formation, locality 2, west Peary Land.

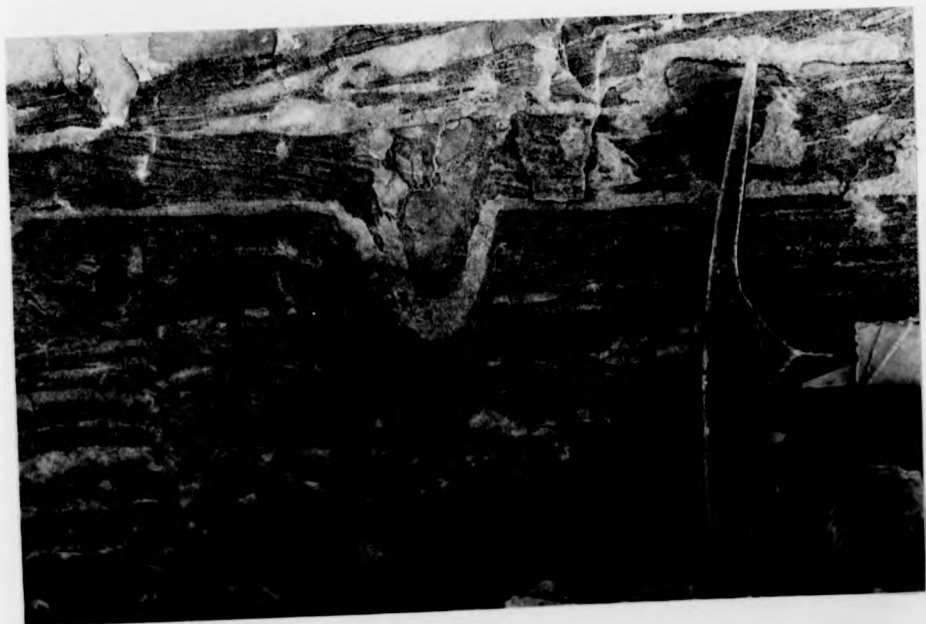Figure 3.54. Cross-bedded, fine-grained sandstones (LF.22) with *Monocraterion* burrows. Koch Væg Formation, locality 3, west Peary Land.

Figure 3.53. Burrow-mottled dolomites (LF.20), bedding plane surface. Koch
Væg Formation, locality 2, west Peary Land.

Figure 3.54. Cross-bedded, fine-grained sandstones (LF.22) with *Monocraterion*
burrows. Koch Væg Formation, locality 3, west Peary Land.

flat-pebble conglomerate.   This interval is poorly exposed at the type
section.

The remainder of the formation (c. 100m) consists of an alternation
of cross-stratified and bioturbated sandstones, sandy dolomites and silty
pale green weathering, algal-laminated dolomites.   Grey-green silty mud-
stones form thin recessive interbeds and partings throughout.   The fine-
to medium-grained dolomitic sandstones show parallel lamination and tabular
or trough cross-stratification in 0.02-0.1m sets (Fig. 3.54).   They are
commonly burrowed (Fig. 3.54) and are interbedded with mottled or structure-
less bioturbated dolomitic sandstones and sandy dolomites.   Units of
algal-laminated dolomite, 0.2-1.5m thick, occur more frequently towards
the top of the formation.   Planar or crinkly lamination is dominant, but
small domal stromatolites are represented (Fig. 3.55).   The formation is
capped by a pale weathering massive, brecciated horizon, about 20m thick,
with an irregular base and hummocky top.   It is composed of angular dolo-
mite and sandstone clasts up to 0.3m across in a vuggy matrix of chert and
coarse crystalline dolomite.

Boundaries.

The Koch Væg Formation conformably overlies the Perssuak Gletscher
Formation (Fig. 3.51). The boundary appears sharp in cliff sections, but
at outcrop the lithological change is gradational, from pale ooidal dolo-
mites of the Perssuak Gletscher Formation into bioturbated, darker weather-
ing dolomites of the Koch Væg Formation.   At the type section, the
boundary is placed at the first appearance of grey, burrow-mottled, fine

Figure 3.55. Algal-laminated dolomites (LF.24) in the Koch Væg Formation
type section. Note local disruption of lamination (arrow)
possibly due to desiccation. Locality 3, west Peary Land.

Figure 3.55. Algal-laminated dolomites (LF.24) in the Koch Væg Formation
type section. Note local disruption of lamination (arrow)
possibly due to desiccation. Locality 3, west Peary Land.

Figure 3.55. Algal-laminated dolomites (LF.24) in the Koch Væg Formation
type section. Note local disruption of lamination (arrow)
possibly due to desiccation. Locality 3, west Peary Land.

to medium crystalline dolomites (Fig. 3.52A).

The formation is overlain unconformably by late Lower Ordovician
dolomites of the Wandel Valley Formation (Peel 1979).   The unconformity
is planar on a large scale (Fig. 3.51) and bedding is typically sub-
parallel, although an angular discordance is discernible along Koch Væg,
where the upper beds of the Koch Væg Formation are locally thrown into
open folds which are not apparent in the Ordovician dolomites above the
unconformity.   At the type section, the upper beds of the Koch Væg
Formation are intensely brecciated to a depth of 20m below the unconformity
and the plane of the unconformity is irregular and hummocky, with a relief
of up to a few metres, draped by the pale grey, thin-bedded and laminated,
cherty dolomites of the Wandel Valley Formation.

Distribution.

The formation has a restricted distribution and is only recognized
south of Troelsen's Fault, west of Hans Tavsens Iskappe in south-west
Peary Land (Fig. 3.4).   It crops out from the east side of Henson Gletscher
to Fimbuldal, near the western margin of Hans Tavsens Iskappe.   It is
well exposed along the east wall of the glacier (Fig. 3.51), but the only
accessible sections are at localities 2 and 3.

Fauna and Geological Age.

The formation is apparently unfossiliferous.   It conformably over-
lies the Perssuak Gletscher Formation which is considered to be of Middle-
Late Cambrian age in this area, and is unconformably overlain by the Lower

Ordovician Wandel Valley Formation. On stratigraphic grounds, therefore, the formation could extend down into the Middle Cambrian and up into the earliest Ordovician. On the basis of facies reconstructions, considering the diachroneity of the underlying Perssuak Gletscher Formation, a late Middle or early Late Cambrian age is thought most likely, the lowest beds at southerly exposures (locality 2) probably being older than the basal beds assigned to the formation at the type locality (Fig. 3.37).

3.3.4.5. Lønelv Formation.

History.

Previously described informally as formation T5 of the Tavsens Iskappe Group (Ineson & Peel 1980).

Name.

After Lønelv, the south-flowing river near the south-eastern margin of Hans Tavsens Iskappe, south-west Peary Land (Fig. 3.56).

Type Section.

Fig. 3.57; west side of Løndal, south-west Peary Land (Fig. 3.56, locality 10; Fig. 3.58).

Thickness.

15-30m at the type locality. The top of the formation is locally highly irregular, but the formation is estimated to have an average thickness of 15-20m. It thins and pinches out completely about 9km south-east of the type locality (Fig. 3.37).
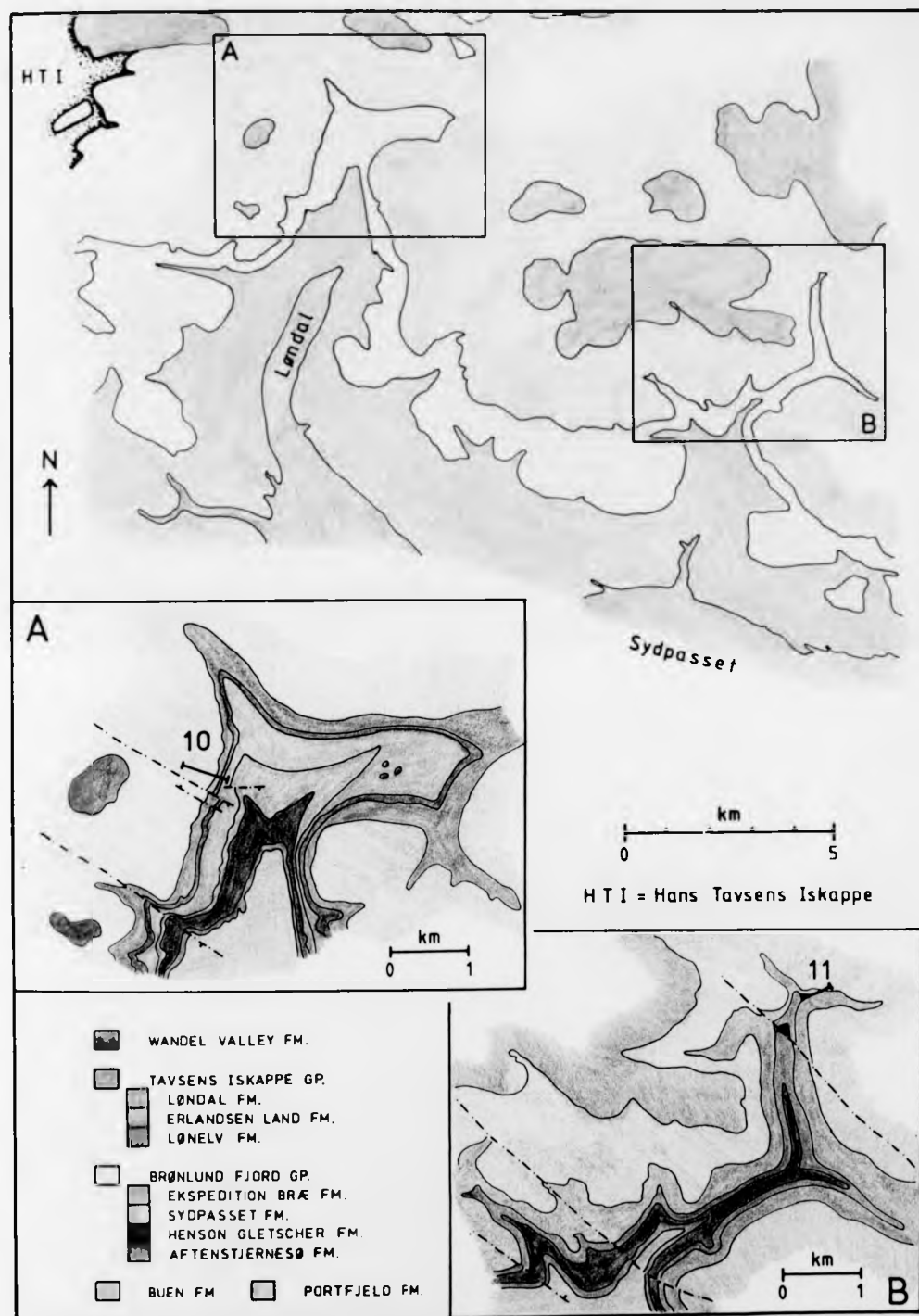
Figure 3.56. Geological sketch map of the Løndal region, west Peary Land.
Insets show the position of type and reference sections.
(Drawn from unpublished field data — JSP/JRI).
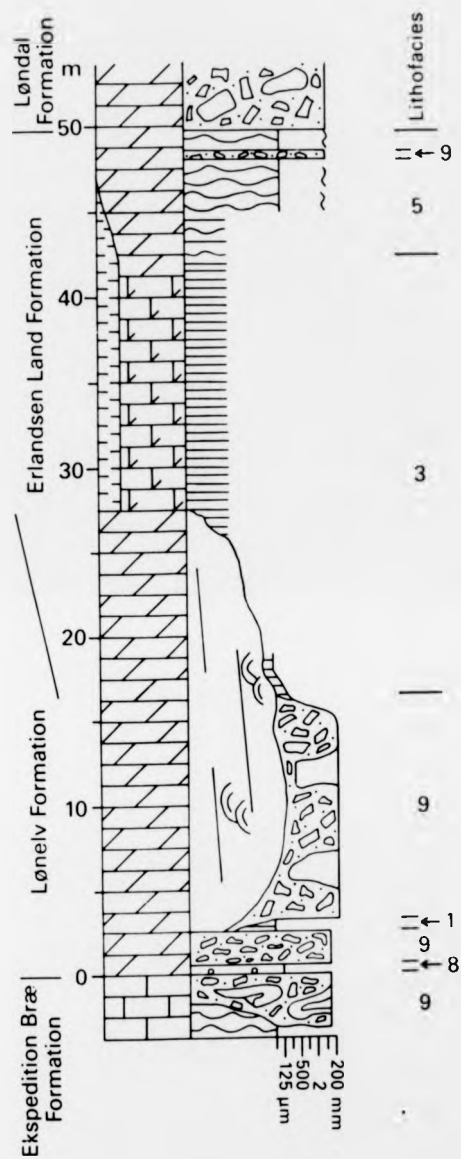
Figure 3.57. Type sections of the Lønelv and Erlandsen Land Formations. Locality 10, west Peary Land.

Figure 3.58. Type locality of the Lønelv (L), Erlandsen Land (E) and Løndal (LD)
Formations. EK: Ekspedition Bræ Formation. Pale mounds in the
Lønelv Formation (A and B) are large, pale dolomite clasts in
a breccia bed. Lønelv Formation is about 20m thick. Locality 10,
west Peary Land.

Figure 3.59. Thin-bedded, dark dolomites sandwiched between two massive
breccia beds. Lønelv Formation type section, locality 10, west
Peary Land.

Figure 3.58. Type locality of the Lønelv (L), Erlandsen Land (E) and Løndal (LD) Formations. EK: Ekspedition Bræ Formation. Pale mounds in the Lønelv Formation (A and B) are large, pale dolomite clasts in a breccia bed. Lønelv Formation is about 20m thick. Locality 10, west Peary Land.
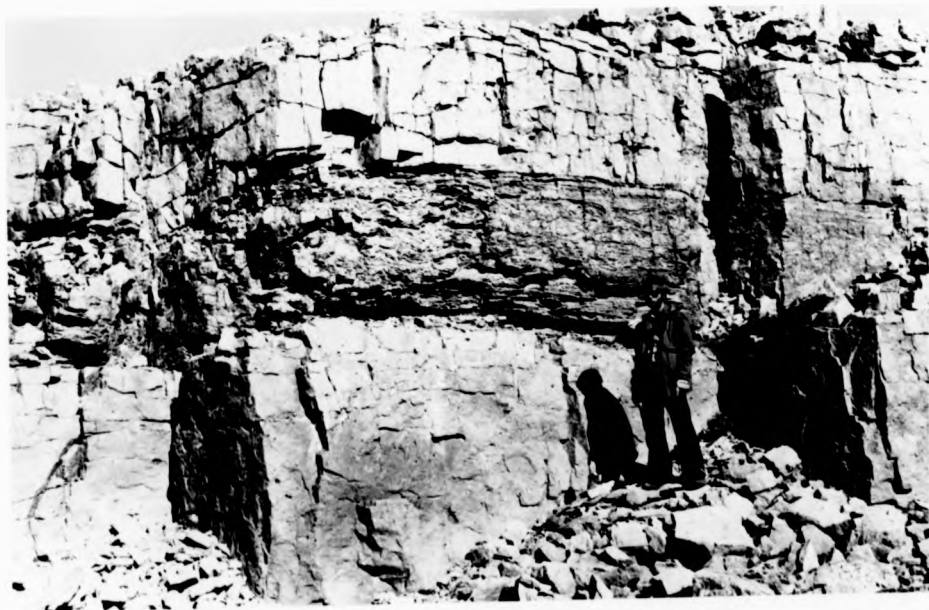

Figure 3.59. Thin-bedded, dark dolomites sandwiched between two massive breccia beds. Lønelv Formation type section, locality 10, west Peary Land.

Lithology.

The pale yellow or cream weathering dolomites of the Lønelv
Formation form a prominent line of crags between the recessive Ekspedition
Bræ and Erlandsen Land Formations (Fig. 3.58).   At the type section, the
formation is dominated by two breccia beds, sandwiching a thin interval
(0-1.2m thick) of thin-bedded, parallel laminated, dark grey, medium
crystalline dolomite, which is commonly distorted and locally absent
(Figs. 3.57 & 3.59).   A thin interval (c. 0.5m) of medium- to thick-
bedded, pale, faintly laminated and graded dolomite is present at the base
of the formation at the type section.   The breccia beds are composed mainly
of elongate and equidimensional, angular to sub-rounded clasts of pale,
medium-coarse crystalline dolomite which locally shows cross-stratification,
"ghost" ooids and a crude bedding which is often at high angles to true
bedding.   Elongate, folded, dark grey dolomite slabs form a minor propor-
tion of the clasts.   The pale clasts range from a few centimetres in dia-
meter to huge blocks, 30m across, which locally protrude up to 12m from the
top of the upper breccia bed, producing the irregular top of the Lønelv
Formation (Fig. 3.58).

Boundaries.

The formation conformably overlies the Ekspedition Bræ Formation
with a sharp planar contact.   At the type section, the lower boundary is
placed where cliff-forming pale weathering dolomites overlie the uppermost
breccia bed of the Ekspedition Bræ Formation (Fig. 3.57).

The Lønelv Formation is overlain, apparently conformably, by the
Erlandsen Land Formation.   The boundary is sharp and locally irregular,
with a relief of 12m at the type section.   Dark grey, recessive weathering,

thin-bedded dolomites drape the upper pale breccia of the Lønelv

Formation.

Distribution.

The formation is only recognized on the east side of Hans Tavsens
Iskappe in the vicinity of Løndal (Fig. 3.56).   It crops out from the
margin of the icecap, east into Løndal and pinches out approximately 9km
south-east of the type section (Fig. 3.56 & 3.37).   It is best exposed
along the west side of Løndal.

Fauna and Geological Age.

The Lønelv Formation is unfossiliferous, but is considered to be
of medial Middle Cambrian age on account of its stratigraphic position
between the Ekspedition Bræ and Erlandsen Land Formations, both of which
yield medial Middle Cambrian faunas.

3.3.4.6.   Erlandsen Land Formation.

History.

The Erlandsen Land Formation has been informally described as formation
T6 of the Tavsens Iskappe Group (Ineson & Peel 1980).

Name.

After Erlandsen Land, south central Peary Land (Fig. 3.3).

Type Section.

Fig. 3.57; west side of Løndal, south-west Peary Land (Fig. 3.56,
locality 10; Fig. 3.58).

Reference Section.

Fig. 3.60; east side of steep valley, 13 kilometres east of type section (Fig. 3.56, locality 11;Fig. 3.61).

Thickness.

22-33m at the type locality. The base is highly irregular at the type locality and consequently the thickness of the formation is variable, but it is estimated to have an average thickness of 25m in Løndal. At locality 11 (Fig. 3.56), the Lønelv Formation is not recognized and beds assigned to the Erlandsen Land Formation conformably overlie the Sydpasset Formation (Figs. 3.2 & 3.37) and attain a thickness of 75m (Fig. 3.61).

Lithology.

The Erlandsen Land Formation is characterized by dark grey to yellow-brown weathering, thin-bedded carbonates that form recessive slopes between the cliff-forming formations above and below (Fig. 3.58). At the type locality, the basal beds are parallel-laminated and bioturbated, dark grey, fine to medium crystalline, calcareous dolomites with argillaceous partings, which pass up into thin, parallel-bedded, argillaceous lime mudstones that show a faint parallel lamination , locally defined by skeletal packstone and grainstone laminae. The middle of the formation is poorly exposed at the type section, and the lithological data were obtained from frost-heaved blocks and float. Fine to medium crystalline dolomites at the top of the formation exhibit thin, irregular wavy bedding (Fig. 3.62) and a discontinuous wispy lamination and faint mottling attributable to bioturbation. A thin (0.5m), clast-supported breccia bed near the top of the formation in the type section is composed of tabular, dark grey dolomite clasts
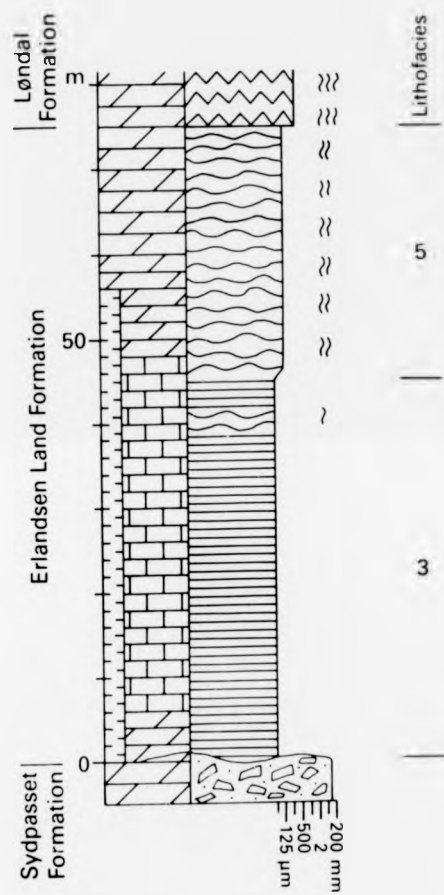
Figure 3.60. Erlandsen Land Formation reference section. Locality 11, central Peary Land.

Figure 3.61. Thinly-bedded dark dolomites and limestones (LF.3, 5) of the
Erlandsen Land Formation (E) in its reference section. S:
Sydpasset Formation; L: Løndal Formation. Figure (arrowed) for
scale. Locality 11, central Peary Land.

Figure 3.61. Thinly-bedded dark dolomites and limestones (LF.3, 5) of the
Erlandsen Land Formation (E) in its reference section. S:
Sydpasset Formation; L: Løndal Formation. Figure (arrowed) for
scale. Locality 11, central Peary Land.

Figure 3.62. Thin wavy-bedded dolomites (LF.5) near the top of the Erlandsen Land Formation type section. Locality 10, west Peary Land.

Figure 3.63. Parallel, thin-bedded argillaceous lime mudstones (LF.3). Erlandsen Land Formation, locality 11, central Peary Land.

Figure 3.62. Thin wavy-bedded dolomites (LF.5) near the top of the Erlandsen Land Formation type section. Locality 10, west Peary Land.

Figure 3.63. Parallel, thin-bedded argillaceous lime mudstones (LF.3). Erlandsen Land Formation, locality 11, central Peary Land.

(average dimensions 0.03 x 0.1m) in an argillaceous dolomite matrix.

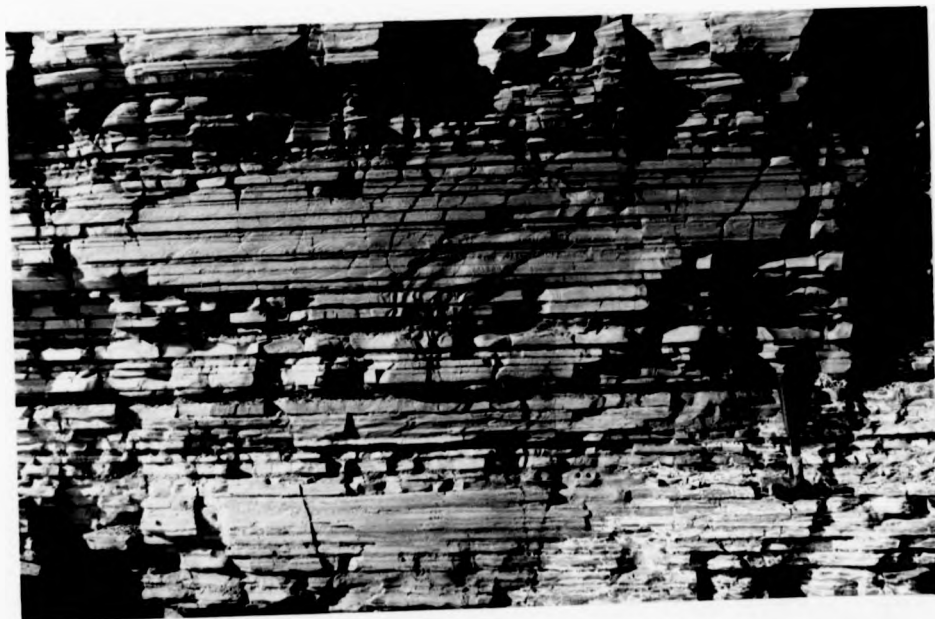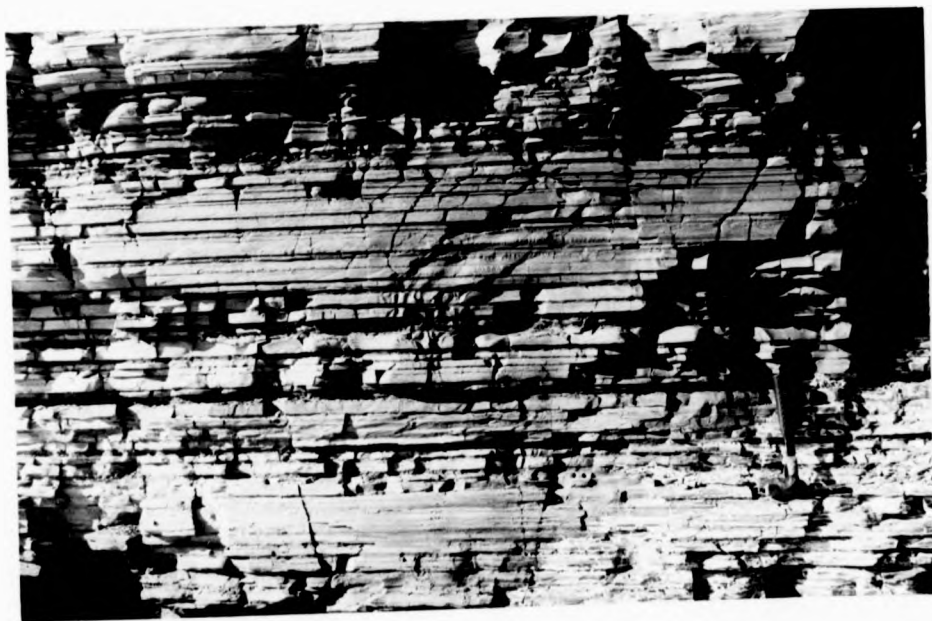The Erlandsen Land Formation is lithologically uniform to the east of the type locality, and in the ravine north of Øvre Midsommersø it comprises a thick sequence of thin, parallel-bedded, argillaceous lime mudstones (Fig. 3.63) and platy or wavy bedded, bioturbated dark grey dolomites (Fig. 3.60).

Boundaries.

The base is sharp but highly irregular at the type section, where the formation overlies the Lønelv Formation with apparent conformity. The boundary is placed where the pale weathering, massive dolomites of the Lønelv Formation are overlain by thin-bedded, dark grey dolomites. The Lønelv Formation pinches out approximately 9km south-east of locality 10 (Fig. 3.56), and the carbonates of the Ekspedition Bræ and Erlandsen Land Formations coalesce into one indivisible sequence of dark weathering, re-cessive, thin-bedded carbonates which conformably overlie the Sydpasset Formation (Fig. 3.37). This sequence is assigned to the Erlandsen Land Formation, and consequently the Ekspedition Bræ Formation is not recog-nized to the east of this point, and the Erlandsen Land Formation of the Tavsens Iskappe Group conformably overlies the Sydpasset Formation of the Brønlund Fjord Group (Figs. 3.2 & 3.37). The boundary is sharp and often hummocky and is placed where platy, dark grey, recessive weathering dolo-mites overlie pale cream weathering, cliff-forming dolomites of the upper Sydpasset Formation (Fig. 3.61).

The Erlandsen Land Formation is conformably overlain by the Løndal Formation. In the type section, the boundary is sharp and planar where the upper wavy bedded dolomites are abruptly overlain by a massive, grey-brown weathering dolomite breccia bed (Figs. 3.57 & 3.58). At locality 11, the boundary is placed at the break of slope, where thin, wavy bedded dark grey dolomites are overlain by yellow-brown weathering, cliff-forming dolomites showing faint sub-horizontal burrow-mottling (Figs. 3.60 & 3.61).

Distribution.

The formation is recognized to the east of Hans Tavsens Iskappe and crops out from the eastern margin of the icecap, east across Erlandsen Land to the limit of outcrop of the Tavsens Iskappe Group, about 8km north of the eastern end of Øvre Midsommersø (Fig. 3.3).

Exposure is poor in central Erlandsen Land, the best exposed areas being around Løndal, and accessible sections with reasonable exposure are obtainable at the type locality and in the narrow ravine at locality 11 (Fig. 3.56).

Fauna and Geological Age.

Fossils are locally abundant and include brachiopods, molluscs and trilobites, indicative of a medial Middle Cambrian age (Palmer 1979; Robison 1981)

3.3.4.7. Løndal Formation.

History.

The Løndal Formation has been informally described as formation T7 of the Tavsens Iskappe Group (Ineson & Peel 1980).

Name.

After Løndal, the north-south valley near the eastern margin of Hans Tavsens Iskappe, south-west Peary Land (Fig. 3.56).

Type Section.

Fig. 3.64; on the west side of Løndal, south-west Peary Land (Fig. 3.56, locality 11; Fig. 3.58).

Thickness.

Approximately 250m at the type section.   The upper third of the formation is poorly exposed at the type section and the thickness given is an estimate.

Lithology.

The Løndal Formation is composed of cliff-forming dolomites showing pale yellow, golden brown and dark grey-brown weathering colours.   At the type section (Figs. 3.64 & 3.58), the lower 50m of the formation is dominated by dolomite breccia beds interbedded with dark grey, fetid, thin-bedded and parallel-laminated dolomites.   The breccia beds range from 0.5m to 30m in thickness and are composed of a mixture of tabular, dark, laminated clasts
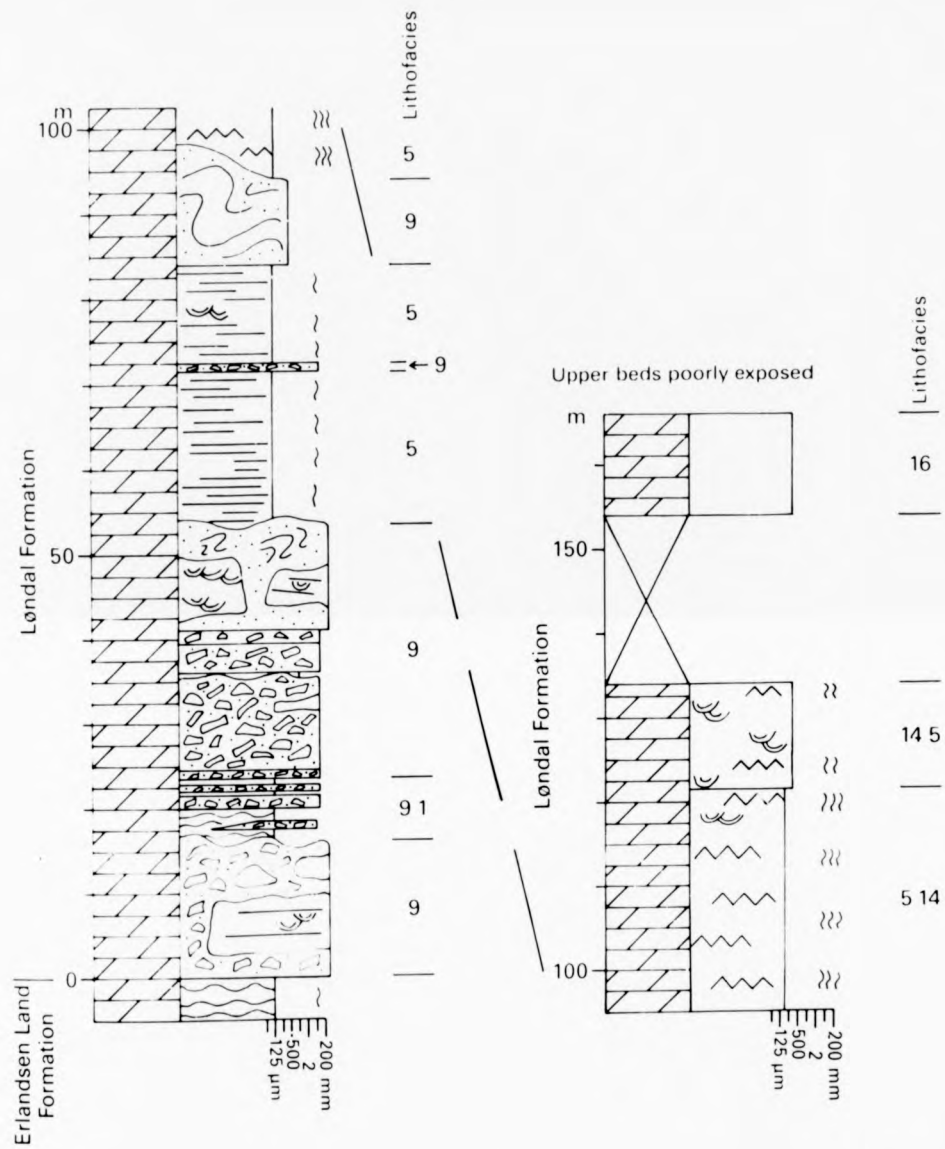
Figure 3.64. Løndal Formation type section. Locality 10, west Peary Land.

and boulders and slabs of pale yellow weathering ooidal and coarse crystalline dolomite in a darker dolomite matrix (Fig. 3.65). The basal breccia bed is variable in thickness laterally and locally contains huge pale dolomite slabs up to 100m long.

The breccia-dominated basal unit is overlain by a sequence of thin-bedded, yellow-brown weathering, medium to fine crystalline dolomites; pale laminae and thin graded beds (5-20mm thick) alternate with darker grey-brown weathering dolomite. Bioturbation increases up the formation and the thin-bedded and laminated dolomites give way to grey-brown weathering, mottled, medium- to thick-bedded dolomites in which lamination is commonly absent or discontinuous.

Pale cream weathering, medium to coarse crystalline dolomites become common near the middle, and dominate the upper half of the Løndal Formation in the type section. They are commonly medium-bedded and structureless, but slumped beds, intraclastic, oncolitic and ooidal horizons and cross-stratification are recognizable locally.

Lateral facies variation within the Løndal Formation is clearly evident in Løndal. North of the type section, the upper pale dolomites interdigitate with dark, grey-brown weathering, bioturbated dolomites which form a progressively larger proportion of the formation in northern Løndal. This north-south facies variation is recognizable throughout the outcrop area, the more southerly exposures showing a dominance of pale

Figure 3.65. Chaotic dolomite breccia (LF.9) containing large pale clasts (arrowed). Figure (centre right) for scale. Løndal Formation, locality 10, west Peary Land.

Figure 3.65. Chaotic dolomite breccia (LF.9) containing large pale clasts (arrowed). Figure (centre right) for scale. Løndal Formation, locality 10, west Peary Land.

weathering ooidal dolomites whereas, in northern exposures, the Løndal

Formation is dominated by darker weathering dolomites which include bio-

turbated dolomites, parallel-laminated, graded dolomites and dolomite

breccia beds.

Boundaries.

The cliff-forming formation conformably overlies recessive, dark

weathering carbonates of the Erlandsen Land Formation.   At the type

locality, the base is sharp and planar and is placed where wavy-bedded,

dark grey dolomites are overlain by a prominent dolomite breccia bed.   At

locality 11, the base of the formation is defined at the change in weather-

ing colour and break of slope, where yellow-brown weathering, medium-

bedded, burrow-mottled dolomites overlie thin, wavy-bedded dark grey

dolomites (Fig. 3.61).

The Løndal Formation is overlain unconformably by the Wandel Valley

Formation.   The upper beds of the formation are poorly exposed throughout

Erlandsen Land and exposure of the unconformity has not been observed.

The upper beds of the Løndal Formation are pale weathering dolomites, which

are grossly similar to the overlying Wandel Valley Formation, so the

boundary is often difficult to locate in poor exposure.   Similarly, the

unconformable nature of the boundary is not demonstrable but is assumed by

correlation with adjacent areas (Fig. 3.2).

Distribution.

The formation crops out from the eastern margin of Hans Tavsens

Iskappe, east across Erlandsen Land to the eastern limit of the Tavsens

Iskappe Group, north of Slusen (Fig. 3.3). It is best exposed and accessible along the west side of Løndal and in the ravine at locality 11 (Fig. 3.56).

Fauna and Geological Age.

The Løndal Formation is generally unfossiliferous, but dark dolomites near the base of the formation yield phosphatic brachiopods which resemble the Middle Cambrian acrotretid *Prototreta* (Palmer 1979; Palmer & Peel 1979). On the basis of this meagre fauna and the stratigraphic position, a late Middle Cambrian age is indicated, although the upper beds may be of early Late Cambrian age.

3.4   Cambrian lithostratigraphy of north-east Peary Land.

Cambrian strata in the highly faulted G.B. Schley Fjord area (Fig. 1.4) define a broken, discontinous outcrop pattern (Fig. 3.66) and, unfortunately, sections are commonly incomplete. It was generally possible, however, to gain a moderately accurate assessment of stratigraphic thickness and lithology, sufficient to confidently assign these rocks to the stratigraphic scheme defined in southern Peary Land (Fig. 3.2; Christie & Ineson 1979).

3.4.1.   Portfjeld Formation.

The Portfjeld Formation is substantially thicker in the G.B. Schley Fjord area than in the type area of southern Peary Land (Jepsen 1971). It comprises between 400 and 700m of dolomites with localised developments of
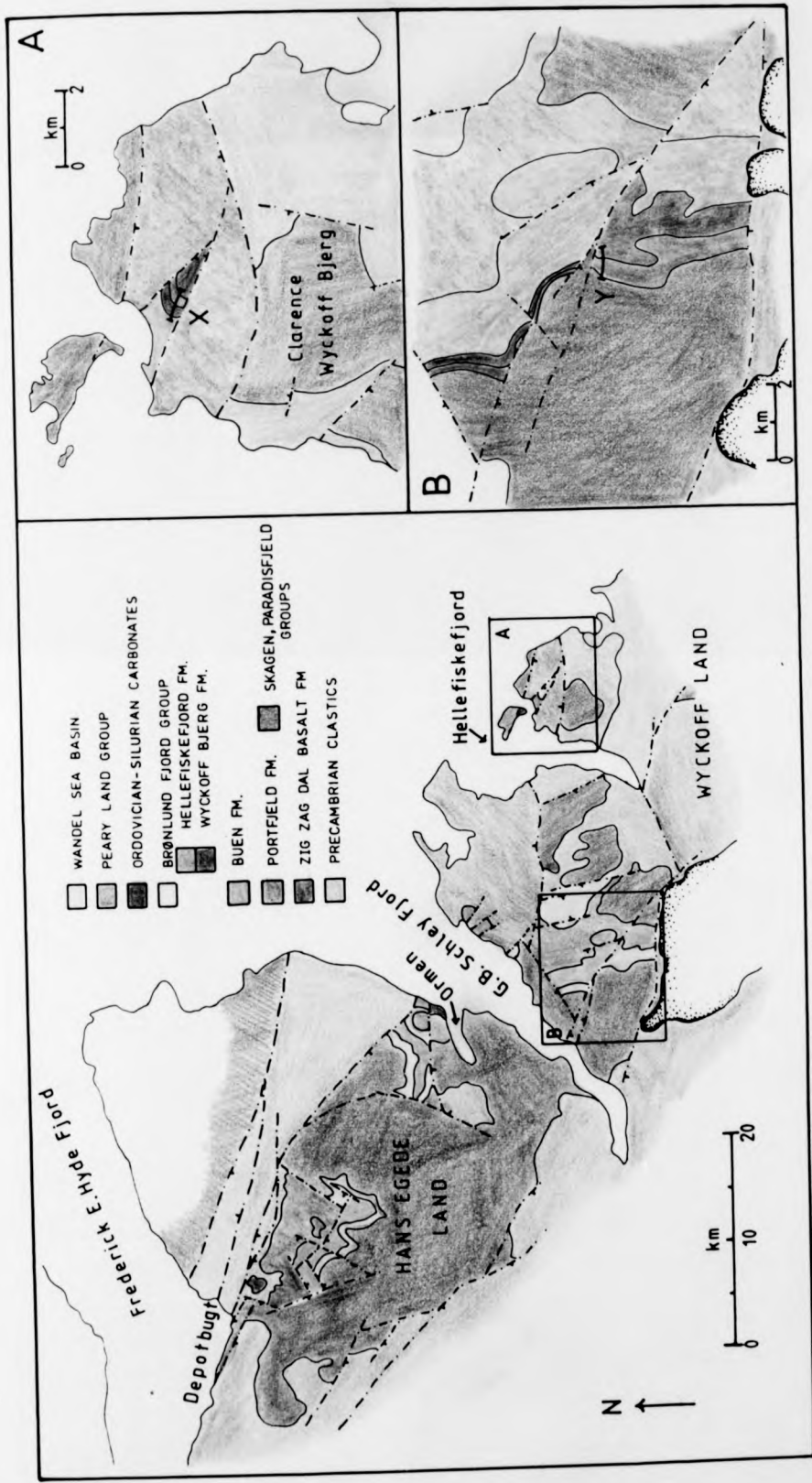
Figure 3.66. Geological sketch map of the G.B. Schley Fjord region, north-east Peary Land. Insets show the position of type and reference sections. (Drawn from unpublished field data – RLC/JRI).

quartz-arenitic sandstones. East of G.B. Schley Fjord, the formation un-
conformably overlies Precambrian volcanic rocks, correlatives of the Zig-
Zag Dal Basalt Formation of Mylius Erichsen Land (Jepsen *et al.* 1980).
The unconformity is irregular and often displays considerable relief;
trough cross-bedded sandstones locally form the basal unit (max. 40m) of
the Portfjeld Formation, flanking basement highs.   West of G.B. Schley
Fjord, the formation overlies dark, thin-bedded Precambrian sandstones,
siltstones, and mudstones, with slight angular unconformity (Christie
& Ineson 1979).

The Portfjeld Formation is overlain conformably by sandstones and
siltstones, assigned to the Buen Formation.   Following Jepsen (1971), the
top of the formation is defined at the uppermost carbonate unit; hence,
sandstones and sandy dolomites interbedded with the typical pale weathering
dolomites towards the top of the carbonate sequence are included in the
Portfjeld Formation.

The formation is typified by mid-pale grey weathering dolomites
displaying relict cross-bedding, ooid-intraclast grainstone fabrics, columnar,
digitate, planar, and domal stromatolites and thin beds of flat pebble
conglomerate.   Pisolitic and oncolitic dolomites occur at some levels.
West of G.B. Schley Fjord, the basal 50m of the formation comprises a
varied succession of purple and orange weathering, sandy dolomite breccias
and conglomerates, rippled and cross-bedded dolomitic sandstones and dark
quartz-cemented sandstones.

3.4.2.   Buen Formation.

Troelsen (1956) described olenellid trilobite-bearing, grey shales from two localities in the vicinity of G.B. Schley Fjord, and assigned these beds to a new formation, the Schley Fjord Shale (renamed the Schley Fjord Formation by Cowie (1961)).   The stratigraphic relationships of this formation were poorly known at that time (see 3.2). Recent work (Christie & Ineson 1979) has demonstrated that these shaly mudstones form the uppermost unit of a thick conformable siliciclastic succession, which is lithologically comparable with, and occupies the same stratigraphic position as, the Buen Formation, defined in southern Peary Land (Jepsen 1971).   Thus, the Schley Fjord Shale is no longer recognized at the level of formation, and in this study is regarded informally as the upper, mudstone-dominated member of the Buen Formation in the G.B. Schley Fjord area.   Formal subdivision of the Buen Formation awaits completion of fieldwork in central North Greenland.

The Buen Formation forms recessive, dark brown weathering slopes in the G.B. Schley Fjord area, and continuous sections are rare; a total thickness of 400-600m was estimated from a number of incomplete sections. It is overlain abruptly, but conformably, by the grey carbonates of the Brønlund Fjord Group; carbonate concretions are developed locally in the upper few metres of the Buen Formation.

In crude terms, the formation comprises a single, large-scale, fining upward sequence: medium- to fine-grained sandstones at the base pass upwards into thinly interbedded, fine-grained sandstones and siltstones

which give way to a thick monotonous succession of dark weathering mud-
stones and siltstones. The upper half of the formation displays a range
of weathering colours from deep red to green, and a tentative correlation
has been proposed between these rocks and the purple and green Frigg
Fjord Mudstones of the North Greenland basin (Hurst & Surlyk 1980).

On the eastern side of G.B. Schley Fjord, the basal sandstones of
the Buen Formation grade laterally from cross-bedded, white sandstones
(quartz-arenites) near the head of the fjord to brown, micaceous, silty
sandstones and siltstones further north. West of the fjord, the basal,
sandy division comprises brown or dark grey, micaceous, fine-grained sand-
stones interbedded with dark, shaly mudstones.

The dark mudstone-dominated succession (Schley Fjord Shale), which
caps the formation, thickens towards the north-west and is up to 200m thick
in Hans Egede Land (Fig.3.66). This interval is locally richly fossili-
ferous (Poulsen 1974), particularly in the top 10m of the formation.

3.4.3. Brønlund Fjord Group.

The siliciclastic Buen Formation is overlain conformably by a
succession of dark laminated dolomites and limestones, pale weathering
dolomite breccias, and sandy breccias. These rocks are assigned to the
Brønlund Fjord Group, which is defined in southern Peary Land (Peel 1979;
Ineson & Peel 1980; see 3.3). The group is 230-265m thick to the east of
G.B. Schley Fjord and thins north-westwards into Hans Egede Land where it
has a measured thickness of 115m. It is overlain by the Wandel Valley

Formation of late Early-Middle Ordovician age.   The group is subdivided
into two formations, the Wyckoff Bjerg and Hellefiskefjord Formations
(Fig. 3.2).

3.4.3.1.   Wyckoff Bjerg Formation.

History.

Described informally as the "lower unit" of the Brønlund Fjord
Group (Christie & Ineson 1979).

Name.

After Clarence Wyckoff Bjerg, a prominent peak in eastern Wyckoff
Land (Fig. 3.66).

Type Section.

Fig. 3.67A; east side of narrow valley, approx. 500m south of shore-
line, east Wyckoff Land (Fig. 3.66, locality X).

Reference Section.

Fig. 3.67B; south side of north-westerly trending river valley,
approx. 13km east of the head of G.B. Schley Fjord, Wyckoff Land (Fig. 3.66,
locality Y).

Thickness.

105m at the type section.   The formation is at least 125m thick at
the reference section (Fig. 3.67B) but thins rapidly towards the north-west
across G.B. Schley Fjord and is only 35m thick in the measured section in
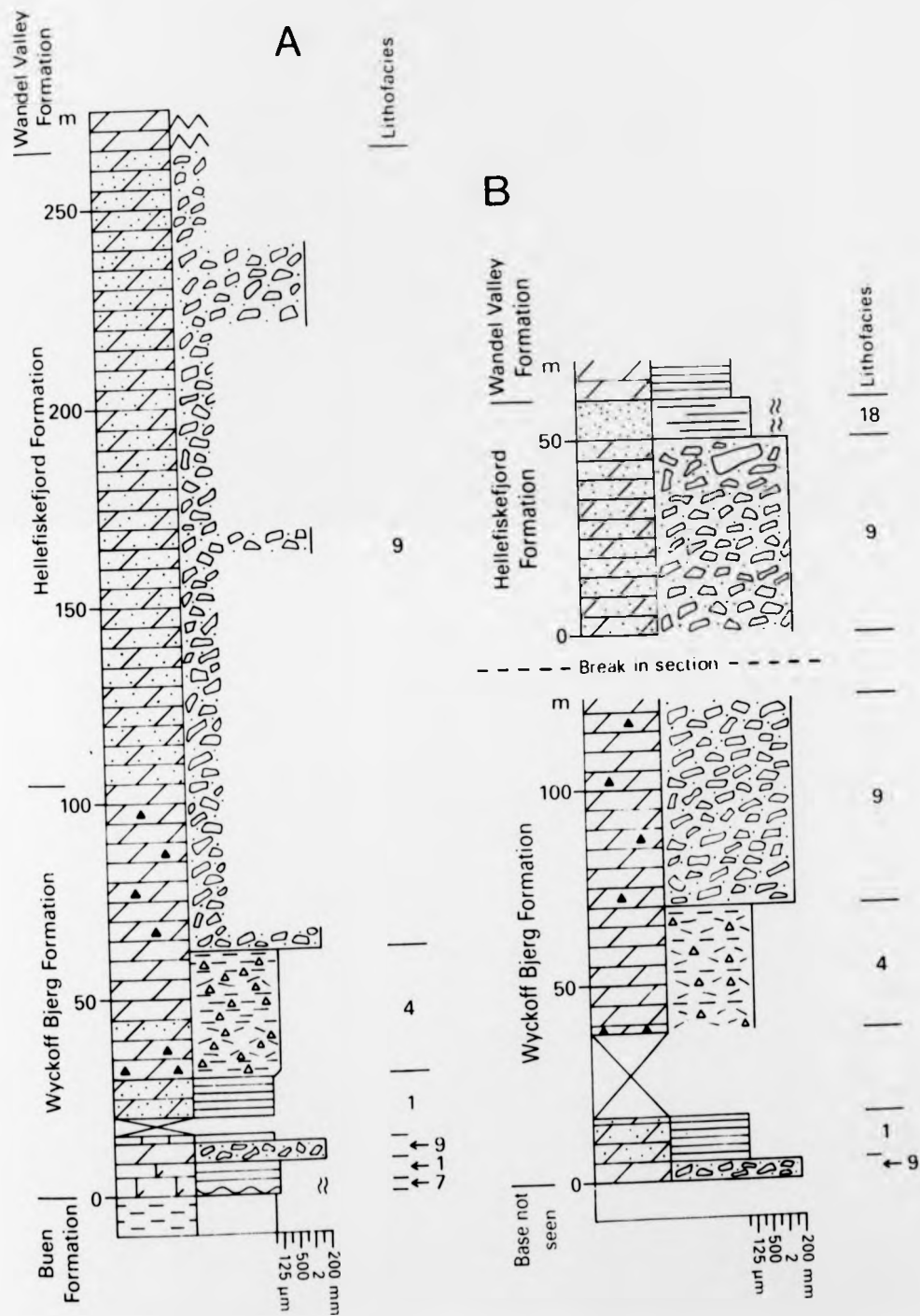Hans Egede Land.

Figure 3.67. A. Type sections of the Wyckoff Bjerg and Hellefiskefjord Formations. Locality X, north-east Peary Land.
B. Reference sections of the Wyckoff Bjerg and Hellefiskefjord Formations. Locality Y, north-east Peary Land.

Lithology.

The formation typically comprises pale grey weathering, cliff-forming, dolomite breccias and platy, nodular dolomites alternating with intervals of sooty black, laminated dolomites and rare limestones. At the type section, grey-green fossiliferous mudstones of the Buen Formation are succeeded by a thin interval (4.4m) of bioturbated, dolomitic, skeletal wackestones and packstones rich in trilobite bioclasts. Pyrite and argillaceous partings are common. These beds pass upwards into parallel-laminated, dark grey-black, silty, sandy limestones (lime mudstone, peloidal wackestone) and dolomites, which locally display small-scale synsedimentary deformation structures, interstratal pull aparts, and minor slump folds. A massive, clast-supported dolomite breccia bed (4.6m) forms a prominent ledge in these recessive sediments at the type section (Fig. 3.67A).

The upper 75m of the formation are composed of prominent, pale grey weathering, medium to coarse crystalline dolomites. Platy nodular dolomites, showing abundant evidence of *in situ* brecciation, are overlain by chaotic dolomite breccia comprising randomly oriented clasts (commonly 5-20cm) in a pale, vuggy, dolomite matrix. Chert is common, forming up to 10% of the rock. A discrete black chert bed, up to 1m thick, occurs at the base of the platy nodular dolomites but, in general, the chert is more widely disseminated, replacing platy nodules and breccia clasts.

West of G.B. Schley Fjord, the Wyckoff Bjerg Formation is poorly exposed but is apparently composed mainly of chaotic dolomite breccia comprising platy, tabular clasts (5-15cm) in a pale grey, locally sandy, dolomite matrix.

Boundaries.

The Wyckoff Bjerg Formation conformably overlies the Buen Formation and, in turn, is overlain conformably by the Hellefiskefjord Formation. The lower boundary is abrupt and is defined where grey-green, shaly mudstones (Buen Fm.) are overlain by pale, locally rusty-brown weathering, dolomitic limestones.

Pale grey, cherty dolomite breccias of the Wyckoff Bjerg Formation pass gradationally upwards into golden-brown weathering, dolomite-sandstone breccias of the Hellefiskefjord Formation. The boundary is taken at the change in weathering colour from pale grey to golden-brown; this is a distinctive, readily-mapped junction and, at outcrop coincides with a rapid increase in the silica content of the rock (replacive chert and primary sand grains) from less than 10% to over 50%.

Distribution.

Between G.B. Schley Fjord and Hellefiskefjord, the main outcrop of the formation trends approximately north-south, bounded by major faults which juxtapose the Cambrian rocks with Silurian carbonates and clastics (Fig. 3.66). The type section, east of Hellefiskefjord, occurs in a fault-bounded outlier, surrounded by older Cambrian and Precambrian rocks (Fig. 3.66).

West of G.B. Schley Fjord, the formation crops out in two areas: north of Ormen and in a discontinous NW-SE trending belt, south-east of

Depotbugt (Fig. 3.66). Dips are variable and faults numerous, but in general the succession youngs towards the south or south-west.

Fauna and Geological age.

No fossils were obtained from the Wyckoff Bjerg Formation; it conformably overlies argillaceous rocks of the Buen Formation, which contain rich Lower Cambrian trilobite faunas (Poulsen 1974; Palmer & Peel 1979) and hence is assigned a similar late Early Cambrian age.

3.4.3.2. Hellefiskefjord Formation.

History.

Informally described as the "upper unit" of the Brønlund Fjord Group (Christie & Ineson 1979).

Name.

After Hellefiskefjord, the north-south trending fjord east of G.B. Schley Fjord (Fig. 3.66).

Type Section.

Fig. 3.67A; east side of narrow valley, traversing fault-bounded outlier of Cambro-Ordovician rocks (Fig. 3.66, locality X). The intermittent exposures and frost-heaved float of the type section provide a measure of formation thickness, and a crude indication of lithological variation. Elsewhere, superior exposure is marred by limited stratigraphic extent and probable fault complications.

Reference Section.

Fig. 3.67B; steep western slopes of north-south trending river valley, approx. 12km east of the head of G.B. Schley Fjord (Fig. 3.66, locality Y).

Thickness.

150m at the type section.   The formation thins towards the north-west into Hans Egede Land where it has a measured thickness of 80m.

Lithology.

The Hellefiskefjord Formation weathers a characteristic golden-brown colour, in sharp contrast to the pale grey carbonates of the under-lying Wyckoff Bjerg and overlying Wandel Valley Formations.   It comprises a thick amalgamated succession of clast-supported chaotic breccia beds which are generally indivisible in the poor exposures available, and original bed thicknesses are unknown.   The breccias are composed of rectangular slabs (commonly 0.05-0.3m) of brown weathering, dolomitic sandstone and silicified laminated dolomite, set in a pale grey, cherty dolomite or sandy dolomite matrix.   The sandstone clasts are medium- to fine-grained, display cross-bedding, parallel lamination and bioturbation, and in places are up to 4m thick and 15m long.

Trough cross-bedded, sandy, ooidal dolomites occur interbedded with sandstone-dolomite breccias in a frost-heaved section a few kilometres east of G.B. Schley Fjord (Fig. 1.4).

Boundaries.

The Hellefiskefjord Formation conformably overlies the Wyckoff Bjerg Formation; the boundary is placed at the weathering colour change (grey to golden-brown) which coincides with an abrupt increase in the proportion of chert and quartz sand.

The formation is overlain by pale grey, laminated dolomites of the Wandel Valley Formation (late Early-Middle Ordovician). Although poorly exposed in the type section, the boundary is sharp and planar in the reference section and placed at the junction between laminated, bioturbated sandstones and pale grey, silty dolomites (Fig. 3.67). No evidence of angular discordance was found, and in the absence of faunal control the stratigraphic implications of this boundary are equivocal. However, in view of the regional nature of the sub Wandel Valley Formation unconformity elsewhere in eastern North Greenland (Fig. 3.2; Peel 1980c, 1982b), it is likely that the Hellefiskefjord Formation - Wandel Valley Formation boundary represents a major stratigraphic discontinuity.

Distribution.

The outcrop of the Hellefiskefjord Formation closely follows that of the subjacent Wyckoff Bjerg Formation (see 3.4.3.1.).

Fauna and Geological age.

The formation is unfossiliferous and its age is loosely confined. It conformably overlies the Wyckoff Bjerg Formation of probable Early Cambrian age and is overlain, with inferred unconformity, by the late Lower-Middle Ordovician Wandel Valley Formation. A late Early Cambrian or

Middle Cambrian age is considered most likely.

On lithological grounds, a possible correlation was considered between this formation and the Tavsens Iskappe Group of west Peary Land (Christie & Ineson 1979).   However, lateral facies variation is a common feature of both the Brønlund Fjord and Tavsens Iskappe Groups (Ineson 1980), and in the absence of faunal evidence such a correlation is untenable.