Brønlund Fjord and Tavsens Iskappe Groups: southern outcrop belt

The Brønlund Fjord and Tavsens Iskappe Groups are best developed and most extensively exposed in the southern outcrop belt which stretches some 350 km from the northern shore of Independence Fjord, Peary Land, in the east, to Warming Land, in the west (Fig. 20). This approximately east–west section represents a strike-parallel to oblique transect through a complex, generally northward prograding platform to outer shelf succession (Fig. 8; see previous discussion). The resultant complex lateral variation in lithofacies from eastern Peary Land to Warming Land is reflected in the complexity of the lithostratigraphic scheme (Fig. 5).

As an aid to understanding, the lithostratigraphy of the southern outcrop belt is described here in terms of four regions, each of which displays a characteristic lithostratigraphic succession (Fig. 20). The Henson Gletscher region in west Peary Land and southern Lauge Koch Land is described first, since this includes the reference area of the Brønlund Fjord Group and the type area of the Tavsens Iskappe Group. Passing eastward, the Løndal and Paralleldal regions are described successively. The western development of the Brønlund Fjord Group, between Nordenskiöld Fjord and southern Warming Land, is described in the final section. Formations that extend across the boundaries of these arbitrary regions are formally described when first encountered and only briefly discussed in successively described regions. This approach allows an appreciation both of the full stratigraphic succession in any one region and of the lateral variation within persistent formations (e.g. the Aftenstjernesø Formation, Fig. 5).

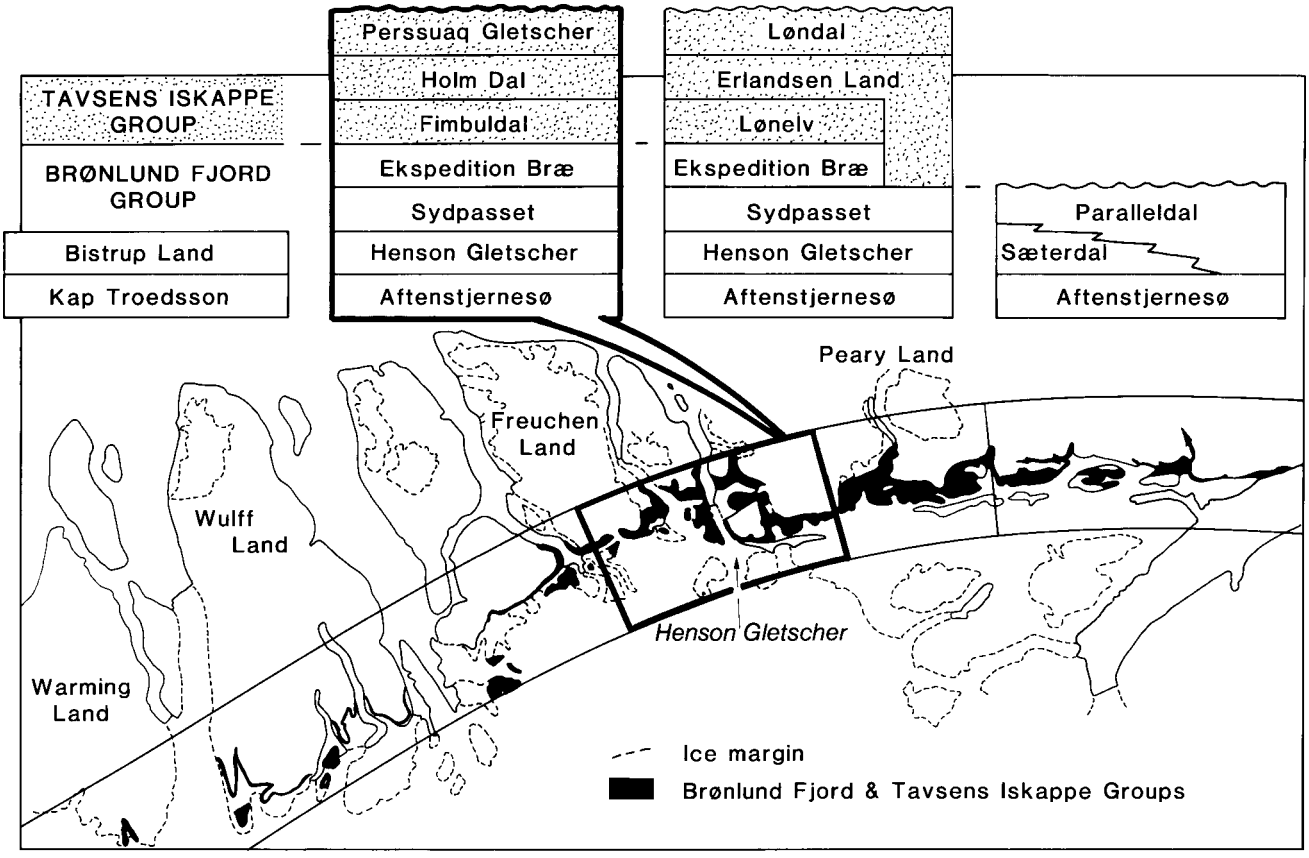

Fig. 20. Map showing the distribution and subdivision of the Brønlund Fjord Group and Tavsens Iskappe Group (stippled) in the Henson Gletscher region in relation to the regional stratigraphy of the southern outcrop belt.

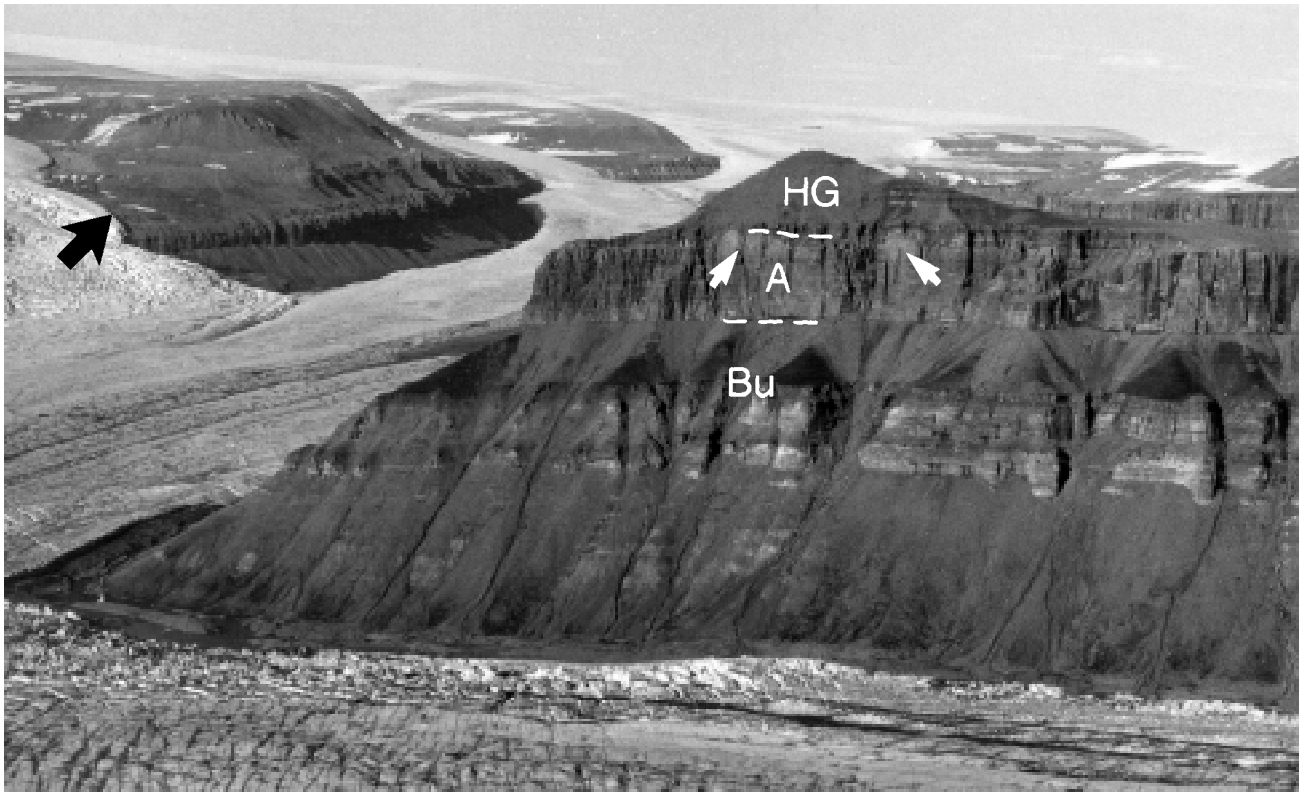

Fig. 21. View eastwards across Jungersen Gletscher (see Fig. 78 for location) of the Buen Formation (Bu) and Aftenstjernesø (A; *c.* 75 m thick) and Henson Gletscher Formations (HG) of the Brønlund Fjord Group near the western limit of the Henson Gletscher region. Note the large pale blocks of platform margin carbonate (small arrows) in the megabreccia bed that caps the Aftenstjernesø Formation. The reference section of the Henson Gletscher is indicated by the large arrow (see Figs 32, 33).

Henson Gletscher region

The region bordered by Hans Tavsen Iskappe to the east and Nordenskiöld Fjord to the west (Fig. 20) consists of a complex network of deeply incised fjords and glaciers (Figs 1, 2, 21) providing spectacular cliff sections through the Cambrian succession. As such, this exceptional area has formed the focus of much of the field endeavour and the reference and type areas for the Brønlund Fjord and Tavsens Iskappe Groups, respectively, occur within the area.

The Brønlund Fjord Group conformably overlies dark, recessive siliciclastic sediments of the Buen Formation and comprises the Aftenstjernesø, Henson Gletscher, Sydpasset and Ekspedition Bræ Formations, all of which have their type sections in the Henson Gletscher region (Figs 10, 22A, 23). The Tavsens Iskappe Group conformably succeeds the Brønlund Fjord Group and consists of the Fimbuldal, Holm Dal and Perssuaq Gletscher Formations (Fig. 22A). In southern localities, around Henson Gletscher, the Tavsens Iskappe Group is overlain conformably by the Koch Væg Formation of the Ryder Gletscher Group, that is described in a later section; elsewhere, the Tavsens Iskappe Group is unconformably overlain by the Wandel Valley Formation (Early – Middle Ordovician).

Brønlund Fjord Group

The Henson Gletscher region includes the reference area of the Brønlund Fjord Group, where the group is most fully developed (up to 240 m thick) and well-exposed.

Aftenstjernesø Formation

new formation

History. The strata assigned here to the Aftenstjernesø Formation have been described informally as formation 1 of the Brønlund Fjord Group (Peel, 1979; Ineson

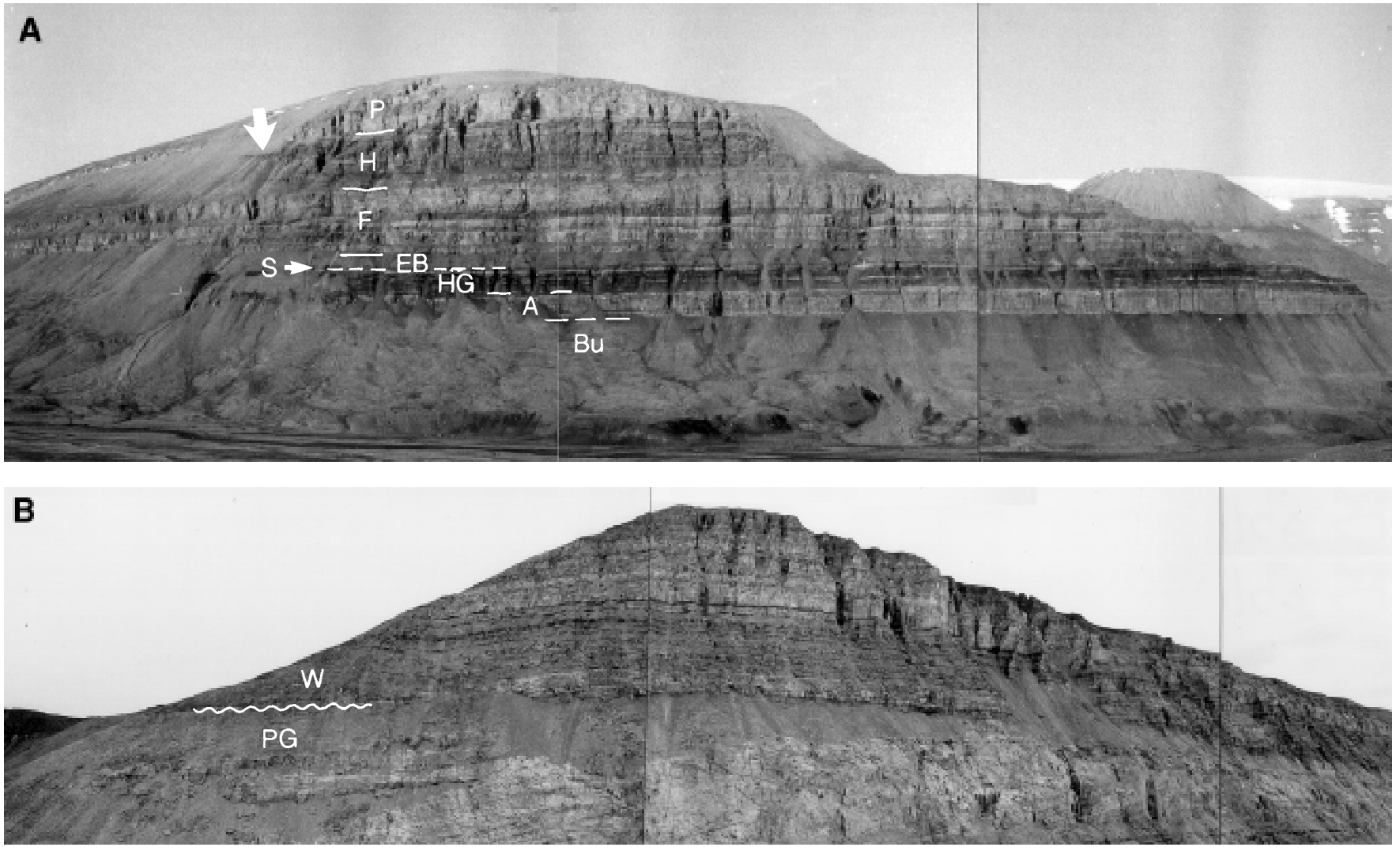

Fig. 22. **A**. Cambrian succession in west Peary Land on the north side of Fimbuldal, just east of the mouth of Gustav Holm Dal (left); the cliff is oriented roughly E–W, along depositional strike. The largely scree-covered Buen Formation (Bu) is succeeded by the Brønlund Fjord Group (A, Aftenstjernesø Formation; HG, Henson Gletscher Formation; S, Sydpasset Formation; EB, Ekspedition Bræ Formation) and the Tavsens Iskappe Group (F, Fimbuldal Formation; H, Holm Dal Formation; P, Perssuaq Gletscher Formation). In its type section (arrowed), the Holm Dal Formation is 155 m thick. **B**. Tavsens Iskappe Group on the east side of the glacier flowing into Navarana Fjord, Lauge Koch Land (Fig. 1). The pale-coloured sandstones and dolomites of the Perssuaq Gletscher Formation (PG) are overlain unconformably by banded dolomites of the Wandel Valley Formation (W). Note the complex clinoform geometry exhibited by the Perssuaq Gletscher Formation (see Fig. 19). The cliff is about 400 m high at the highest point and is oriented roughly N–S, parallel to depositional dip.

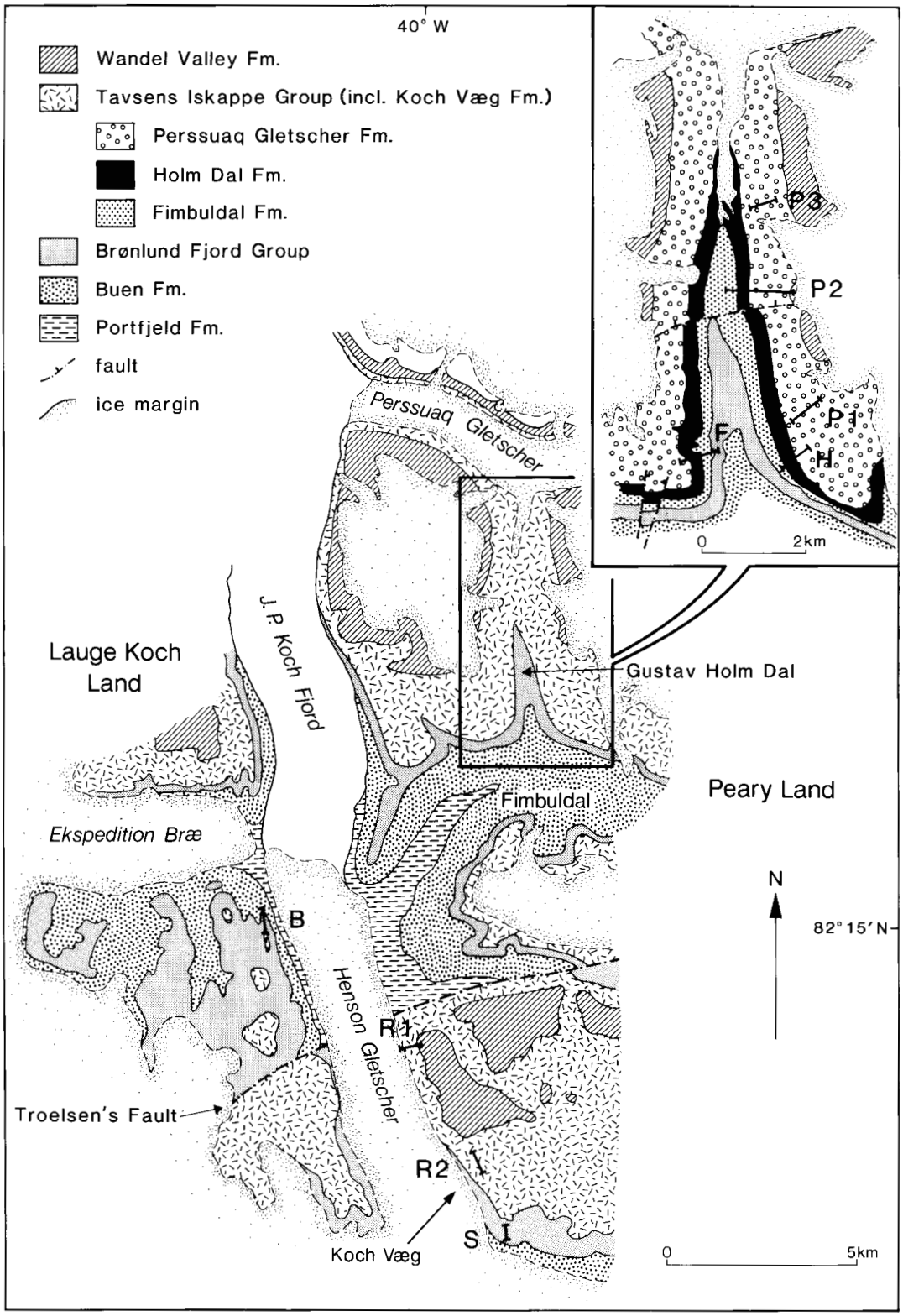

Fig. 23. Geological sketch map of the Henson Gletscher – J. P. Koch Fjord region, west Peary Land, showing the distribution of the Brønlund Fjord and Tavsens Iskappe Groups. B marks the location of the type sections of the Aftenstjernesø, Henson Gletscher, Sydpasset and Ekspedition Bræ Formations (Brønlund Fjord Group); section S is the reference section of the Sydpasset Formation. The locations of the type (and reference) sections of the Fimbuldal (F), Holm Dal (H) and Perssuaq Gletscher (P1-P3) Formations (Tavsens Iskappe Group) are shown in the inset map of Gustav Holm Dal. R1 and R2 indicate the type and reference sections, respectively, of the Koch Væg Formation (Ryder Gletscher Group). Modified from Ineson (1988).

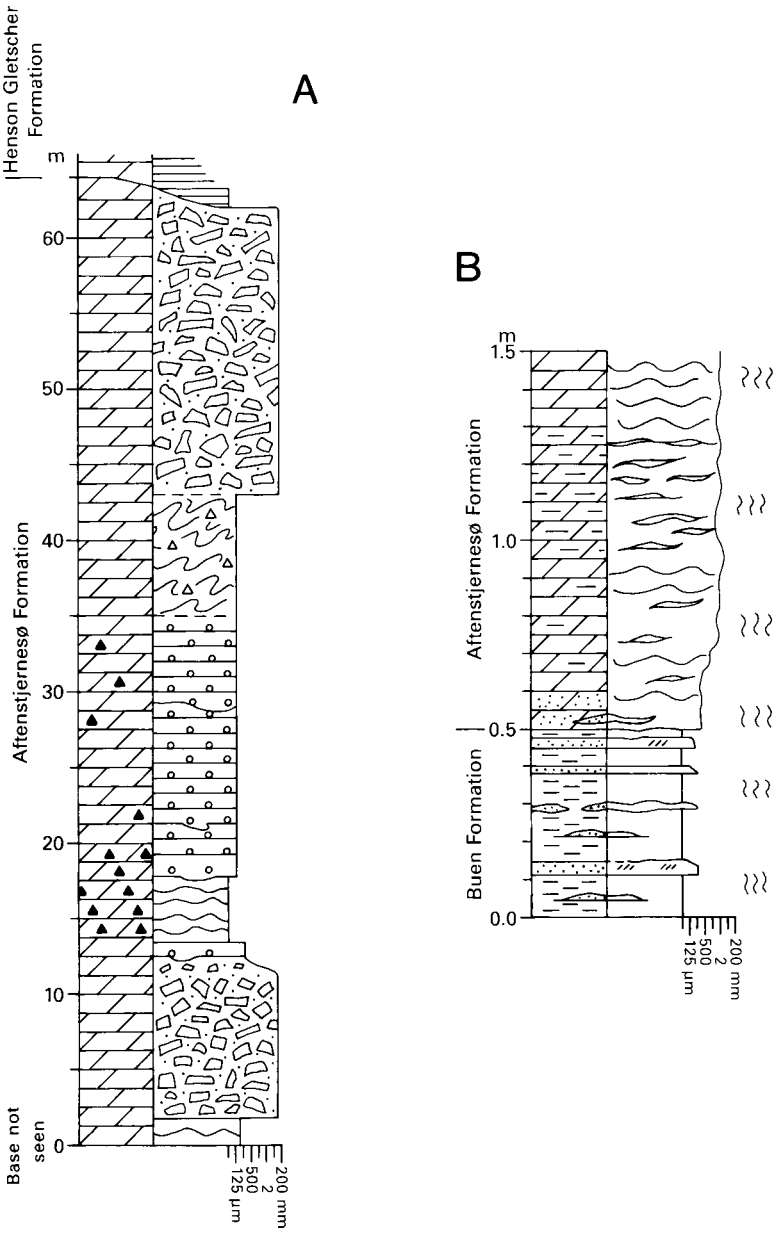

Fig. 24. **A**. Type section of the Aftenstjernesø Formation, Lauge Koch Land (Fig. 23). **B**. Detailed section of the base of the Aftenstjernesø Formation at the western end of Buen, eastern Peary Land (see Fig. 68). See Fig. 14 for legend; sigmoidal signature indicates silty mudstone flasers.

& Peel, 1980). In south-east Peary Land the formation is equivalent to Members A, B and C of the Brønlund Fjord Formation of Christie & Peel (1977). In south-western 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. 2).

Type section. Fig. 24; 3 km to the south of the snout of Ekspedition Bræ, along the east side of the gully (Figs 23, 25).

Thickness. About 62 m at the type locality. The base is not exposed at the type section, but is estimated to be within 1 m of the base of the measured section (Fig. 24). The formation thickens to the south from the type locality to *c.* 75 m at Henson Gletscher and over 70 m at Jungersen Gletscher, Freuchen Land. It thins eastward from Henson Gletscher to a minimum of 30 m in the Sæterdal area (Fig. 26). Farther east again, the formation thickens to about 130 m in the Børglum Elv valley. In its northern outcrop, between northern Nyeboe Land and north-west Peary Land (Fig. 16), the Aftenstjernesø Formation is typically 25–50 m thick.

Lithology. The Aftenstjernesø Formation characteristi-

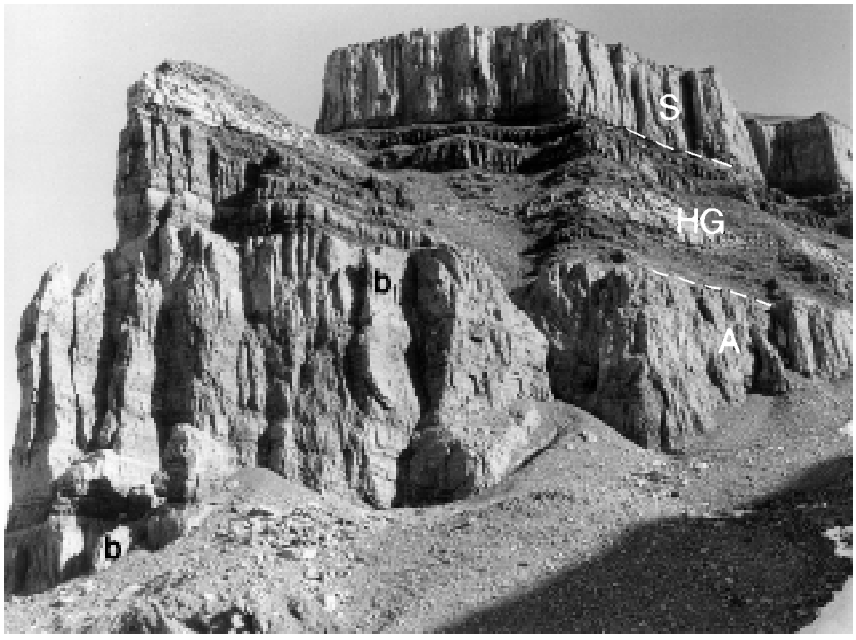

Fig. 25. Type locality of the Aftenstjernesø (A), Henson Gletscher (HG) and Sydpasset (S) Formations, Lauge Koch Land. The type section of the Aftenstjernesø Formation was measured along the base of the cliff from left to right; note the poorly stratified carbonate breccia beds (b) at the base and top of the formation, sandwiching a well-bedded carbonate turbidite interval (see Fig. 24A). The type section of the overlying Henson Gletscher Formation traverses the slopes shown centrally in this photograph; the sandstones in the middle of this formation (see Fig. 31) are clearly visible as a pale-coloured stripe. The type section of the cliff-forming Sydpasset is located in a narrow gully to the right of this photograph (see Fig. 42).

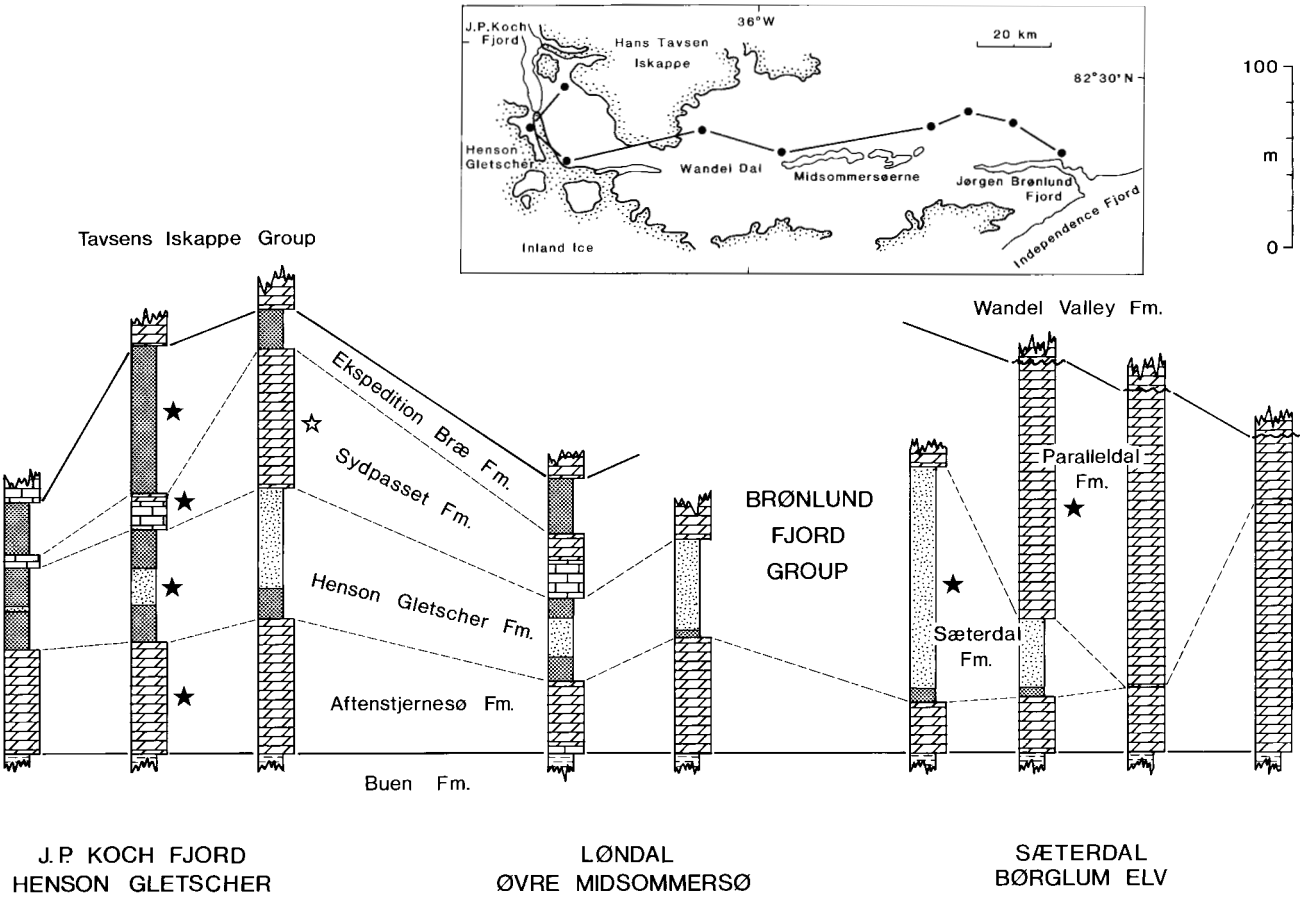

Fig. 26. Generalised stratigraphic logs of the Brønlund Fjord Group in the southern outcrop belt illustrating the stratigraphic relationships and lateral thickness variations from the Henson Gletscher region in the west to Jørgen Brønlund Fjord in the east (see inset map). Type sections are marked by solid stars, reference sections by open stars. Dense stipple denotes argillaceous lime mudstone/dolomite, commonly interbedded with siliciclastic mudstone; see Fig. 14 for remaining symbols.

Fig. 27. Nodular dolomites at the base of the Aftenstjernesø Formation in the type section, overlain abruptly by a dolomitised mass-flow breccia bed. Note the abundant black phosphorite in these basal beds occurring as intraclasts, nodules and discrete hardground surfaces. From Higgins *et al.* (1991a).

cally forms pale, yellow-brown weathering cliffs above the recessive slopes of the underlying Buen Formation (Fig. 22A). It is composed almost entirely of dolomite in the southern outcrop belt although limestones and dolomitic limestones are preserved in the lower 10 m of the formation in Løndal on the east side of Hans Tavsen Iskappe (Fig. 2).

In the type section (Figs 24, 25), the Aftenstjernesø 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.* 2 m) are iron-grey weathering dolomites, in thin to medium beds, with thin, mudstone interbeds and flasers in the lower metre. Brown-black phosphorite seams up to 2 cm thick are common (Fig. 27) and are associated with dolomite rich in glauconite, phosphatic bioclasts and phosphorite shell moulds. This distinctive basal unit is a characteristic feature of the Aftenstjernesø Formation and is recognised in all outcrop areas, from northern Nyeboe Land to south Peary Land; it is equivalent to Member A of Christie & Peel (1977; see also Frykman, 1980) and is laterally equivalent to the Kap Troedsson Formation in the Nordenskiöld Fjord – Warming Land area. In Løndal, this interval is undolomitised or only partially dolomitised, and comprises bioturbated, glauconitic, skeletal wackestones, packstones and grainstones.

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

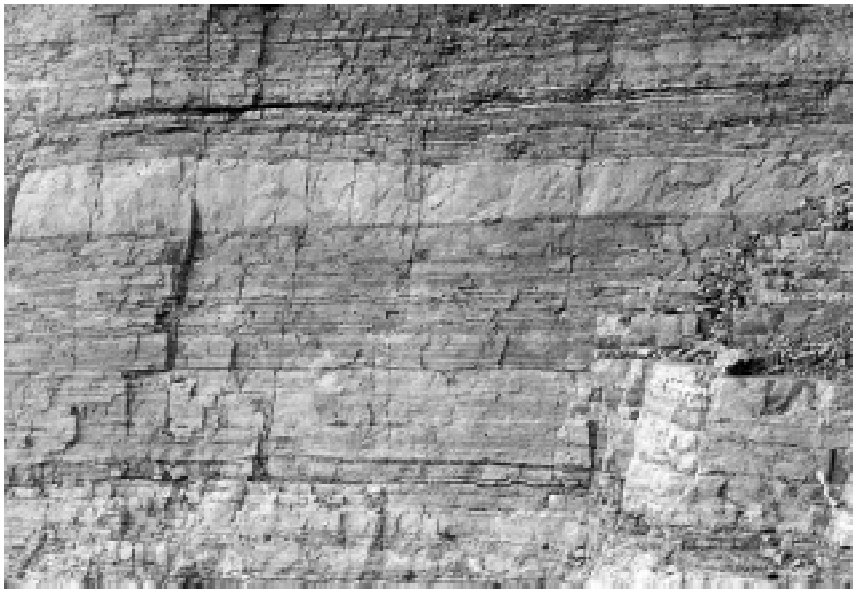

Fig. 28. Thin-bedded dolomites (carbonate turbidites) forming the middle well-bedded portion of the Aftenstjernesø Formation in the type section (see Figs 24, 25). Note that the solitary thick bed (*c.* 0.5 m thick) has a flat base and an irregular top.

the formation (Figs 24, 25). These mass-flow breccia beds range between 0.5 and 20 m in thickness and are composed of pale grey dolomite clasts, typically elongate with average dimensions of 15 × 5 cm in a matrix of smaller pale fragments and dark bitumunous 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. 28); in some beds relict grain-size grading and the Bouma sequence of sedimentary structures are preserved.

The Aftenstjernesø Formation is composed of comparable lithofacies to the south and east of the type locality, although the graded carbonate beds are less common in southerly exposures, and nodular, platy or wavy-bedded, bioturbated, mid-dark grey dolomites predominate. Pull-aparts, slump folds and thin, discontinuous, brecciated horizons are common features of the formation throughout its outcrop, as are dolomite spar-filled vugs and sheet cracks. At the head of Nordenskiöld Fjord, west of the type section, large pale olistoliths up to 50 m across (Figs 12A, 21) are prominent in the upper levels of the formation. In its northern outcrop, in northern Nyeboe Land, Freuchen Land and north-west Peary Land, the Aftenstjernesø Formation consists largely of dark wavy, nodular thin-bedded lime mudstones and dolomites; phosphoritic, pyritic carbonates mark the base and a single 5–10 m thick breccia bed caps the formation.

Boundaries. The lower boundary of the Aftenstjernesø Formation is taken at the first carbonate bed, conformably overlying the sandstones, siltstones and mudstones of the Buen Formation. Troelsen (1949) proposed the existence of a 'simple erosional disconformity' at the base of his Brønlund Fjord Dolomite, but commonly the boundary is gradational, and only at Troelsen's original type section could an erosive contact be demonstrated (Figs 3, 11B; Frykman, 1980).

West of Øvre Midsommersø (Fig. 26), the Aftenstjernesø Formation is conformably overlain by dark, recessive weathering limestones, dolomites and pale sandstones of the Henson Gletscher Formation (Figs 25, 29). The contact is sharp; black, platy carbonates overlie or drape the planar or hummocky upper surface of the breccia bed capping the Aftenstjernesø Formation.

In central Peary Land, from the eastern end of Øvre Midsommersø to Sæterdal (Fig. 26), the upper boundary is similarly sharp, but the Aftenstjernesø Formation is conformably overlain by the dominantly siliciclastic Sæterdal Formation (Fig. 30). The Sæterdal Formation

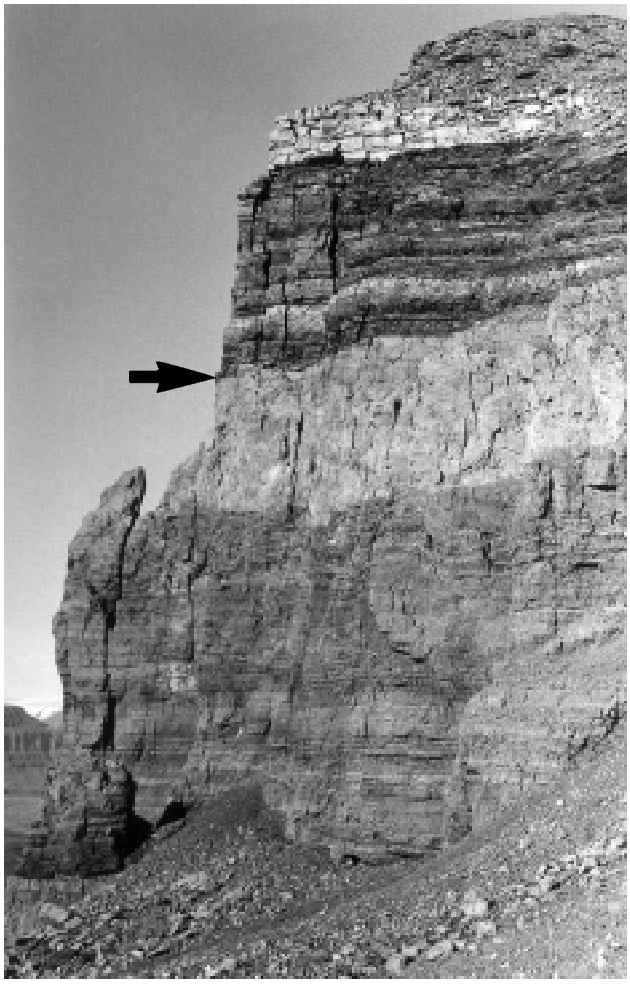

Fig. 29. The massive pale breccia bed capping the Aftenstjernesø Formation is draped (arrow) by the dark dolomites of the Henson Gletscher Formation. Light-coloured sandstones in the middle of the Henson Gletscher Formation cap the exposure; the thin pale bands in the lower Henson Gletscher Formation are bioturbated intervals (see Fig. 31).

pinches out to the south and east from Sæterdal, so that in Paralleldal and on the north side of Frysefjeld, the Aftenstjernesø Formation is conformably overlain by pale weathering carbonates of the Paralleldal Formation (Figs 5, 20). In the cliffs along Børglum Elv, the upper boundary of the Aftenstjernesø Formation is less obvious than elsewhere, but is taken at the change from massive, slumped dolomites into pale cross-stratified dolomites of the Paralleldal Formation (Fig. 17).

Distribution. The formation crops out from the east side of Nordenskiöld Fjord, Freuchen Land, across Lauge Koch Land and southern Peary Land to Independence Fjord (Figs 2, 20), forming conspicuous cliffs to the north of Aftenstjernsø and along the northern

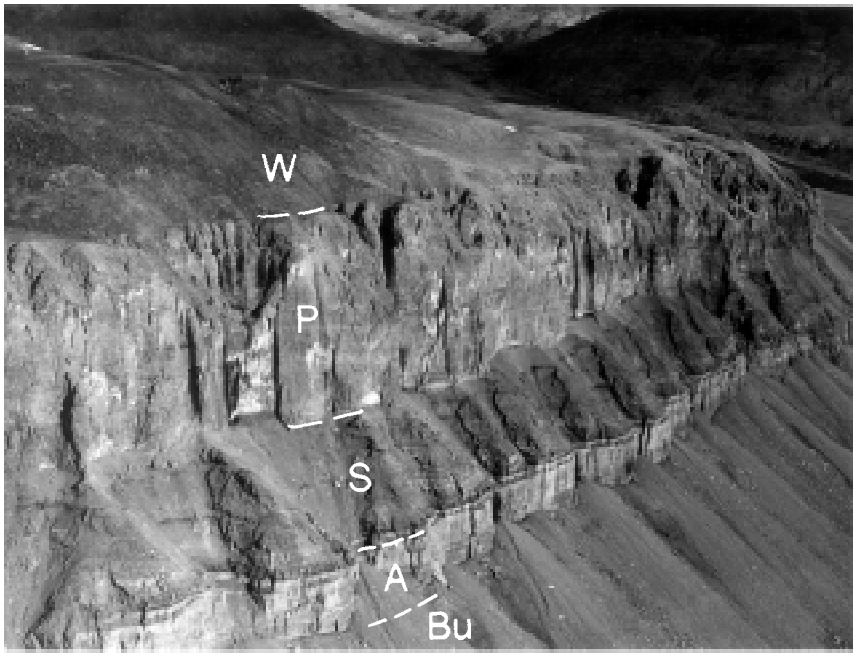

Fig. 30. Brønlund Fjord Group on the north side of Sæterdal, Peary Land (see Fig. 68), conformably overlying the largely scree-covered Buen Formation (Bu) and unconformably overlain by the Wandel Valley Formation (W; Lower – Middle Ordovician, Ryder Gletscher Group). A, Aftenstjernesø Formation; S, Sæterdal Formation; P, Paralleldal Formation.

side of Wandel Dal. It is exposed in folded inliers near the north coast of central North Greenland from Nyeboe Land to north-west Peary Land (Fig. 16). The Aftenstjernesø Formation is correlated with the Kap Troedsson and Bistrup Land Formations of the Nordenskiöld Fjord – Warming Land area (Fig. 8).

Fauna and age. In most outcrops, 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; Bendix-Almgreen & Peel, 1988), including molluscs, *Chancelloria*, inarticulate brachiopods, trilobites *Bonnia*, *Calodiscus* and *Wanneria*, and the small shelly fossil *Hadimopanella apicata* Wrona, 1982, indicative of the *Bonnia–Olenellus* Zone (late Early Cambrian).

The Henson Gletscher, Sæterdal and Paralleldal Formations, which overlie the Aftenstjernesø Formation, also yield Early Cambrian faunas and the unfossiliferous dolomites of the upper Aftenstjernesø Formation are thus assigned a late Early Cambrian age.

In north-eastern Nyeboe Land an unusually thick development of the Aftenstjernesø Formation is more uniformly fossiliferous. Blaker (1991) has described *Olenellus* associated with *Serrodiscus daedalus*, *S. speciosus* and *S. latus*?. Other fossils include *Hadimopanella apicata* and *Latouchella* (Peel, 1974; Dawes & Peel, 1984; Peel & Larsen, 1984; Bendix-Almgreen & Peel, 1988).

Henson Gletscher Formation

new 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). A detailed study of the distribution of this formation and its lateral variation was given by Christiansen *et al.* (1985, 1987).

Name. After Henson Gletscher, the glacier at the head of J. P. Koch Fjord (Fig. 23).

Type section. Fig. 31; 3 km to the south of the snout of Ekspedition Bræ, Lauge Koch Land, along the east side of the gully (Figs 23, 25).

Reference section. Fig. 32; adjacent to Jungersen Gletscher, southern Freuchen Land (Figs 2, 21, 33, 78).

Thickness. 62 m at the type locality, thickening to the south and west to 73 m at Henson Gletscher (Fig. 26) and 112 m at Jungersen Gletscher. In its northern outcrop, near the north coast of North Greenland, the Henson Gletscher Formation is typically 20–60 m thick but it attains a thickness of 90 m in northern Nyeboe Land.

Lithology. The Henson Gletscher Formation forms dark grey or black weathering, recessive slopes between

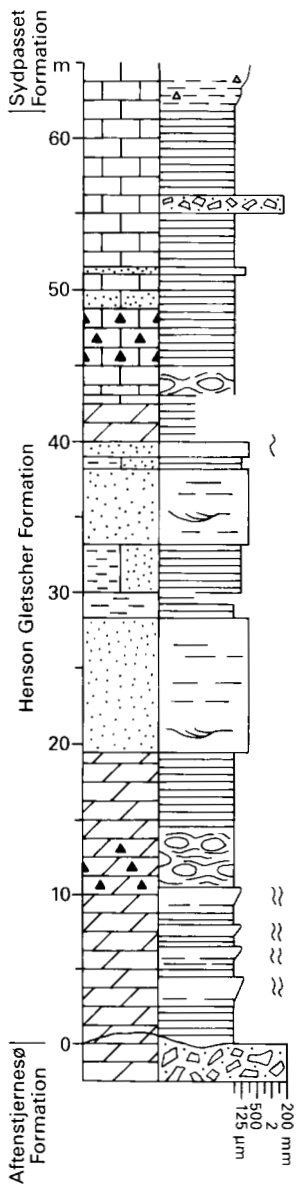

Fig. 31. Type section of the Henson Gletscher Formation, Lauge Koch Land (Figs 23, 25). See Fig. 14 for legend.

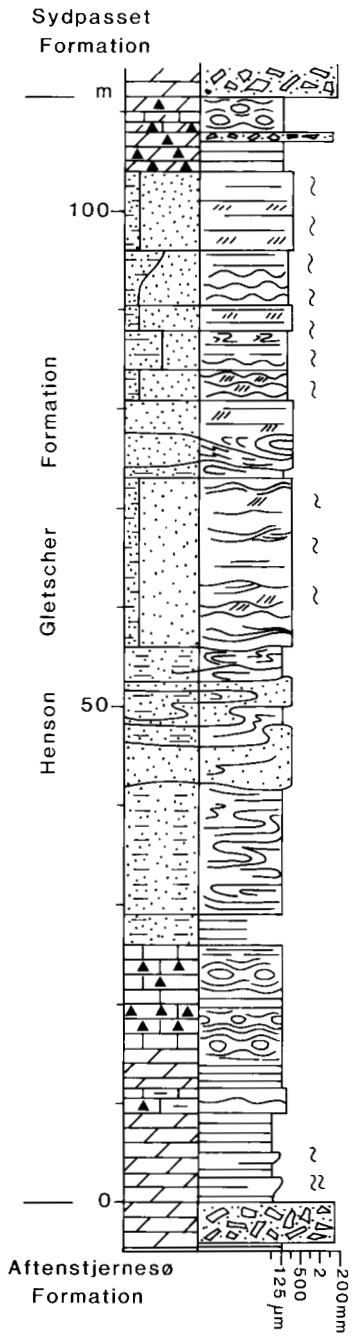

Fig. 32. Reference section of the Henson Gletscher Formation, south Freuchen Land (Figs 21, 33, 78). See Fig. 14 for legend.

the cliff-forming Aftenstjernesø Formation below and the Sydpasset Formation above (Figs 18, 25). It is composed of sooty, shaly weathering, bituminous, thin-bedded and finely laminated dolomites, limestones, calcareous and dolomitic mudstones and pale cream weathering, fine-grained sandstones and siltstones. In more northerly localities, sandstones are subordinate to argillaceous carbonates which characteristically show parallel lamination, well-developed concretions (Figs 34, 35) and contain lenses, stringers and continuous beds of black chert (Fig. 36).

In the type section (Fig. 31), bituminous fissile cherty dolomites and shaly dolomitic mudstones dominate the lower third of the formation, interbedded with pale weathering horizons of bioturbated dolomite (Fig. 29). The carbonates of the upper third of the formation at the type section are largely undolomitised and comprise parallel-laminated, spicular lime mudstones, shelly wackestones, graded beds of peloidal and bioclastic packstone and grainstone, and a prominant limestone breccia bed, approximately 1 m thick.

Dolomitic sandstones and siltstones form a pale

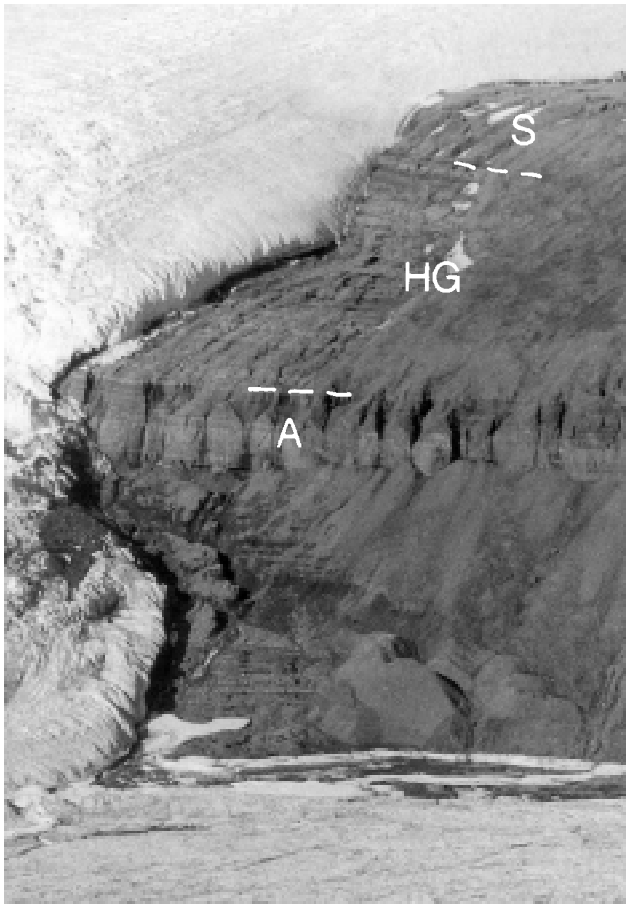

Fig. 33. Reference section of the Henson Gletscher Formation (HG), south Freuchen Land. A, Aftenstjernesø Formation, S, Sydpasset Formation. See Figs 21, 78 for location.

cream weathering unit in the middle of the formation (Figs 25, 29); this unit thickens markedly south of the type section and dominates the formation at Koch Væg (Fig. 10) and at Jungersen Gletscher (Fig. 32). The well-sorted, fine-grained sandstones form 0.1–4 m thick sheets with sharp boundaries (Fig. 13F). They are generally structureless or faintly laminated but locally show hummocky cross-stratification and dish structures. Interbedded with the sand sheets are parallel-laminated and bioturbated silty sandstones and siltstones, which exhibit ripple cross-lamination in southern exposures. Slump sheets of siltstone and silty sandstone are prominent in the formation at Jungersen Gletscher (Fig. 32).

In Løndal, east of Hans Tavsen Iskappe, medium-bedded, coarse skeletal glauconitic packstones and grainstones form pale weathering ledges near the base of the formation. Similar beds can be identified at this stratigraphic level farther to the east, but are represented by pale weathering, glauconitic, medium-coarse crystalline dolomites showing ghosted skeletal grains. At the same locality and in other southern exposures, small-scale trough cross-bedding occurs in mid-grey weathering skeletal dolomites in the upper levels of the formation.

Boundaries. The Henson Gletscher Formation overlies the Aftenstjernesø Formation with apparent conformity. The boundary is sharp and often irregular where dark recessive-weathering carbonates of the Henson Gletscher Formation drape the uppermost

Fig. 34. Laminated bituminous cherty dolomites of the lower Henson Gletscher Formation in the type section (*c.* 12 m above base, Fig. 31). From Higgins *et al.* (1991a).

Fig. 35. Carbonate concretion within laminated argillaceous dolomites; note the evidence of early diagenetic pre- and syn-compactional growth of the concretion. Henson Gletscher Formation, type section.

hummocky breccia bed of the Aftenstjernesø Formation (Fig. 29).

The upper boundary is gradational in detail, although the overlying Sydpasset Formation commonly forms a pale weathering vertical cliff and the boundary is readily defined at the break of slope for mapping purposes (Fig. 18). At the type locality, the boundary is placed where dark weathering, shaly carbonates are overlain by more resistant platy, nodular carbonates of the Sydpasset Formation (Fig. 25). In southernmost exposures (e.g. at Jungersen Gletscher, Figs 32, 33), the upper boundary is placed where recessive sandstones or lime mudstones are sharply overlain by cliff-forming dolomites of varied lithology which are assigned to the Sydpasset Formation. In the northern outcrop belt, the upper boundary is placed where varied nodular platy lime mudstones and breccia beds overlie black, cherty, spicular lime mudstones; the former are assigned to the Kap Stanton Formation of the Tavsens Iskappe Group (see Fig. 5; Ineson *et al*., 1994).

Distribution. In its southern outcrop belt, the Henson Gletscher Formation crops out from Nordenskiöld Fjord in southern Freuchen Land eastward across Lauge Koch

Fig. 36. Laminated bituminous dolomite with black chert lenses and bands. Henson Gletscher Formation, type section.

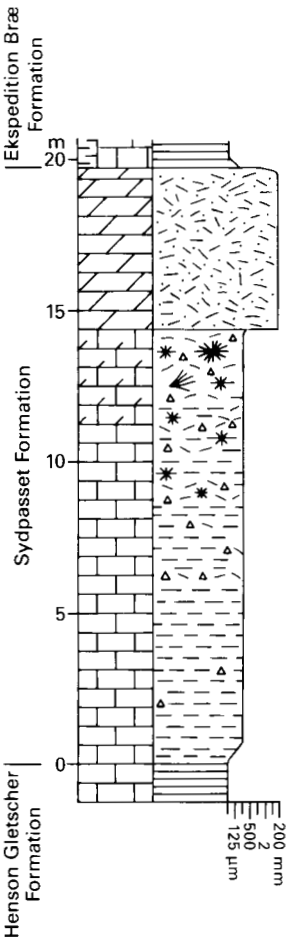

Fig. 37 Type section of the Sydpasset Formation, Lauge Koch Land (Figs 23, 25, 42). See Fig. 14 for legend.

Land and southern Peary Land to Øvre Midsommersø (Figs 2, 20, 26). The formation is not recognised east of an arbitrary north–south line at the eastern end of Øvre Midsommersø. In Sæterdal, east of this line, the Aftenstjernsø Formation is conformably overlain by a thick siliciclastic-dominated formation (Sæterdal Formation; see Fig. 20) which is the lateral equivalent, in part at least, of the Henson Gletscher Formation. In the northern outcrop belt, the Henson Gletscher Formation crops out in anticlinal inliers from northern Nyeboe Land east to north-west Peary Land (Fig. 16).

Fauna and age. The strata of the Henson Gletscher Formation are often richly fossiliferous and have yielded faunas of late Early to late Middle Cambrian age (Palmer & Peel, 1979; Blaker, 1986, 1991; Peel, 1994a). The type section in southern Lauge Koch Land is generally poorly fossiliferous, but Blaker (1991) described Early Cambrian trilobites about 45 m above the base and above the conspicuous pale weathering sandstone unit. Middle Cambrian trilobites of the *Ptychagnostus gibbus* Zone occur only in the uppermost beds in this section and in outcrops in Løndal (Palmer & Peel, 1979; Robison, 1984; Blaker, 1991). The reference section in southern Freuchen Land has yielded abundant fossils indicative of an Early Cambrian (*Bonnia–Olenellus* Zone) age (Blaker, 1991; Peel & Blaker, 1988; Peel, 1989) but Middle Cambrian faunas are absent. Olenellids, *Kootenia* spp., *Bonnia brennus*, *Ogygopsis typicalis*, *O. batis*, *O. virgata*, *Pagetides elegans*, *Arthricocephalus* sp. and *Peronopsis roddyi* are conspicuous (Blaker, 1991).

Early Cambrian faunas have not been located in the northern outcrop belt of the Henson Gletscher Formation although the lower levels of the formation are inferred to be of this age (Ineson *et al.*, 1994; Figs 16, 86). In more eastern outcrops within this northern belt, in outer J. P. Koch Fjord (see Fig. 10), the presence of latest Middle Cambrian faunas (*Lejopyge laevigata* Zone) in the lowest beds of the overlying Kap Stanton Formation suggests that the poorly fossiliferous Henson Gletscher Formation in this region may also extend into the latest Middle Cambrian (Ineson *et al.*, 1994; Babcock, 1994a; Robison, 1994). In northern Nyeboe Land, the Henson Gletscher Formation has yielded rich faunas of early Middle to medial Middle Cambrian age (*Glossopleura* Zone to *Ptychagnostus atavus* Zone) described by Babcock, 1994a; Robison, 1994; Peel, 1994b; see also Poulsen, 1969), suggesting that the top of the formation is diachronous in the northern outcrop belt, younging towards the east. This pronounced diachroneity is also evident when comparing the age of the top of the formation in the northern and southern outcrops. At the reference section, in southern Freuchen Land, the formation is entirely of Early Cambrian age. This diachroneity is attributed by Ineson *et al.* (1994) to the northward pinchout of carbonate slope apron wedges and the resultant amalgamation in northern sections of condensed mud-dominated outer shelf successions which are collectively assigned to the Henson Gletscher Formation (Fig. 10).

Sydpasset Formation

new formation

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

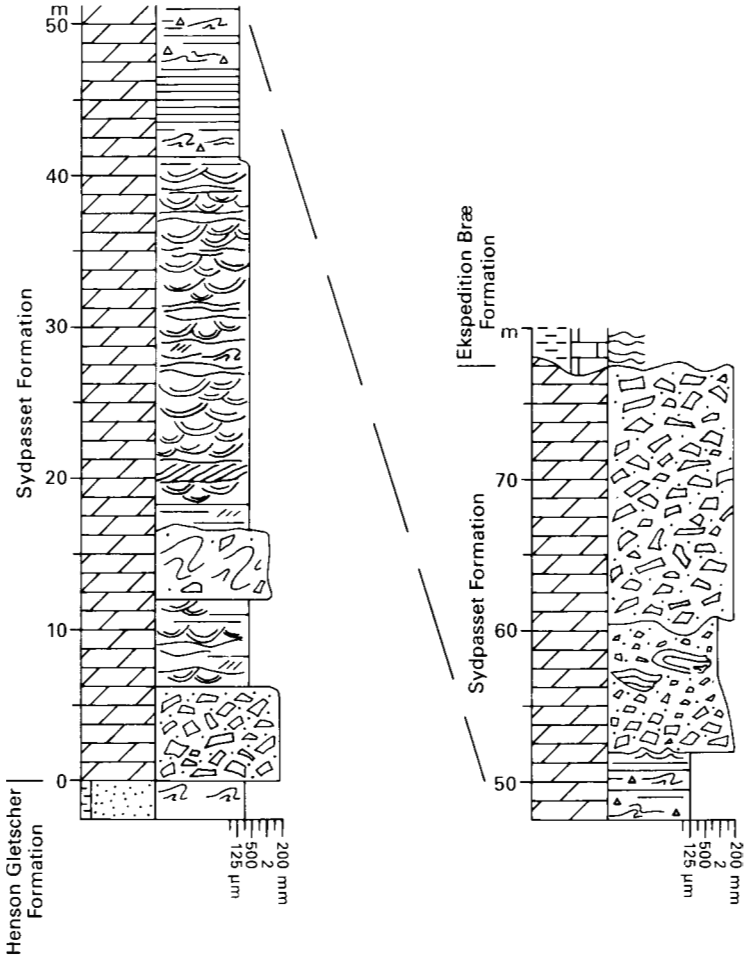

Fig. 38. Reference section of the Sydpasset Formation at the southern end of Koch Væg, south-west Peary Land (Fig. 23). See Fig. 14 for legend.

Name. After Sydpasset at the western end of Øvre Midsommersø, southern Peary Land (Fig. 2).

Type section. Fig. 37; 3 km to the south of the snout of Ekspedition Bræ (Fig. 23), along the eastern side of the gully (Fig. 25).

Reference section. Fig. 38; south Koch Væg, western Peary Land (Fig. 23).

Thickness. 20 m at the type locality, thinning northwards (Fig. 26). The formation is generally thicker in southern exposures, and in western Peary Land the formation thickens markedly south of Troelsen's Fault (Figs 10, 23), reaching a maximum measured thickness of 77 m at the south end of Koch Væg (Fig. 38).

Lithology. Pale weathering, cliff-forming carbonates of the Sydpasset Formation form a distinctive mapping unit separating the recessive formations above and below (Figs 18, 39). In exposures around the head of J. P. Koch Fjord (Fig. 23), distinctive platy, nodular limestones (microsparites) and dolomites dominate the formation. The nodular component weathers pale grey and forms platy sheets (5–10 mm thick), lenses and spheres interbanded with, and enclosed by, dark grey laminated carbonate (Fig. 40A). These platy nodular carbonates commonly exhibit pull-aparts, interstratal breccia lenses and buckle folds attributed to slope creep of differentally cemented lime mudstones (see Fig. 13B; Ineson & Surlyk, 1995, Fig. 9.5a). 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 20 cm across (Fig. 40B).

The Sydpasset Formation is characteristically capped by one or more carbonate breccia beds. In the type section (Fig. 37) and other sections around the head of J. P. Koch Fjord, the breccia bed is thin (*c.* 5 m), commonly dolomitised, and is composed of flat, platy clasts, lithologically similar to the underlying *in situ* nodular carbonates.

The formation changes character in southern locali-

Fig. 39. Cliff-forming carbonates of the Sydpasset Formation (S) at the type locality; note the gradational base with the Henson Gletscher Formation (HG) beneath and the sharp top, overlain by the largely scree-covered argillaceous carbonates of the Ekspedition Bræ Formation (EB). Viewed westwards across J. P Koch Fjord to Fimbuldal.

ties, thickening considerably (Figs 10, 38) and variably composed of mid-grey, trough cross-bedded skeletal dolomites, dark grey, laminated dolomites and wavy bedded, nodular bioturbated dolomites. The capping breccia beds are thick, sometimes composite and locally contain pale, cross-bedded dolomite clasts up to tens of metres across. Indeed, at Jungersen Gletscher, huge olistoliths of pale dolomite, up to 100 m across, protrude from the top of the Sydpasset Formation.

Boundaries. The lower boundary of the formation is marked by a distinct break in slope where the cliff-forming carbonates of the Sydpasset Formation conformably overlie the recessive carbonates and clastics of the Henson Gletscher Formation (Fig. 18). At the type locality (Figs 25, 39) the boundary is placed where bituminous shaly limestones of the Henson Gletscher Formation are overlain by more prominent-weathering, platy, nodular or thin wavy-bedded dark carbonates. At Koch Væg 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. 38). At Jungersen Gletscher, the base of the formation is placed where dark cherty, laminated lime mudstones and dolomites are overlain by a resistant dolomite breccia bed (Fig. 32).

West of the western end of Øvre Midsommersø (Figs 2, 20), the Sydpasset Formation is conformably overlain by the uppermost formation of the Brønlund Fjord Group, the Ekspedition Bræ Formation. East of this point, which is defined by the western limit of the Lønelv Formation (Figs 5, 20), the Sydpasset Formation forms the uppermost unit 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 (see Fig. 63). 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 argillaceous lime mudstones (Fig. 39).

Distribution. The Sydpasset Formation crops out from Jungersen Gletscher in southern Freuchen Land eastward to the eastern end of Øvre Midsommersø (Figs 2, 20), where an arbitrary north–south line forms the limit of the formation. 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 Tavsen Iskappe (Figs 2, 20, 23). 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 the phosphatic tube *Hyolithellus* have been recorded from bioclastic dolomites in the reference section at the south end of Koch Væg (Figs 23, 38; Palmer & Peel, 1979; Peel, 1979). This fauna was also collected by Dawes (1976a) and thought to indicate an Early Cambrian age, by comparison with Early Cambrian faunas from basal beds of

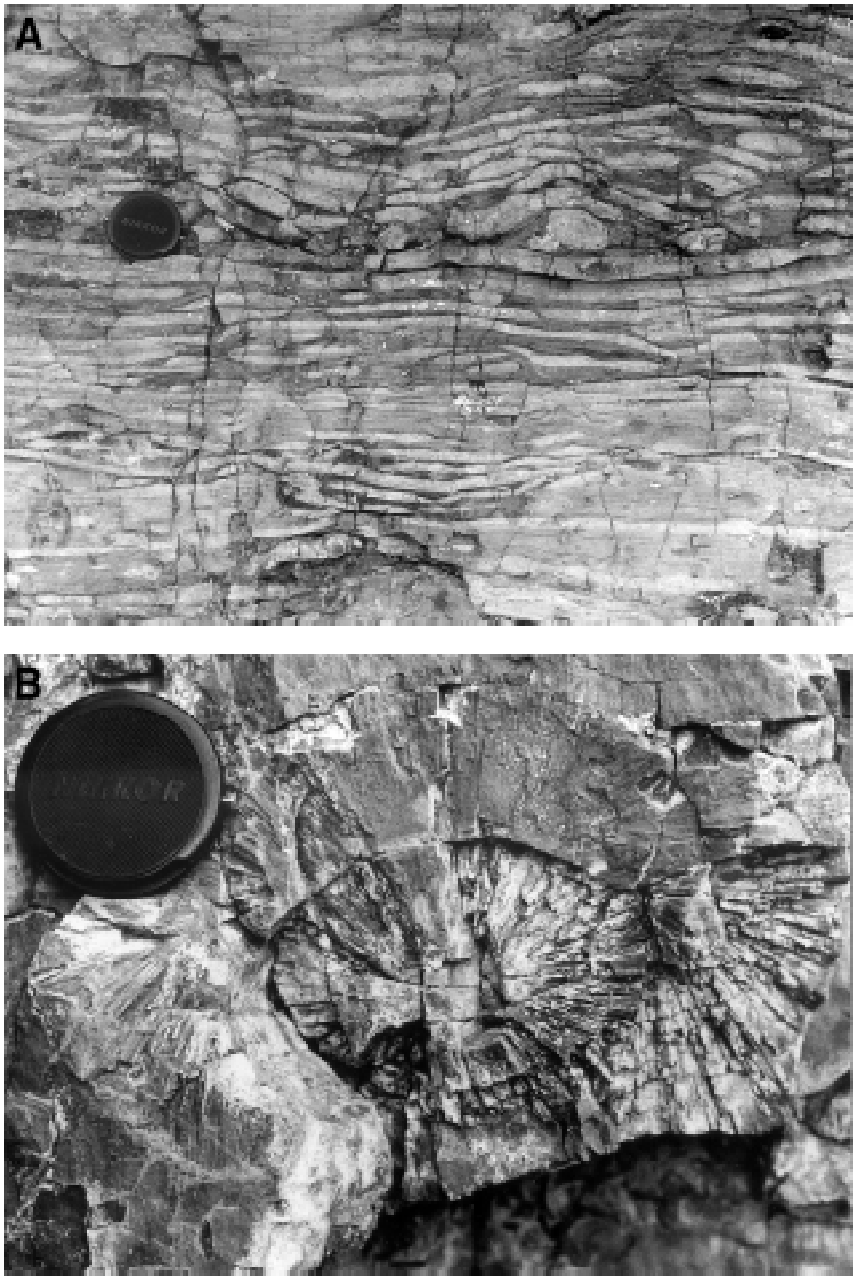

Fig. 40. **A**. Nodular dolomitic lime mudstones of the Sydpasset Formation at the type section showing the characteristic platy, lenticular and ovoid nodular forms. **B**. Fibrous neomorphic calcite showing two distinct phases of development. Sydpasset Formation, type section.

the Aftenstjernesø Formation. However, fieldwork in 1978 demonstated the presence of Middle Cambrian faunas in the subjacent Henson Gletscher Formation in its type section and adjacent localities and the Sydpasset Formation was assigned a Middle Cambrian age on account of its stratigraphic position. In these localities the formation is of undoubted medial Middle Cambrian age on account of faunas obtained from the underlying and overlying formations. However, at the reference section (Fig. 38), where the meagre fauna was obtained, the Sydpasset Formation is much thickened with respect to northerly outcrops and the underlying Henson Gletscher Formation yields only Early Cambrian faunas; the first unambiguous Middle Cambrian faunas occur in the overlying Ekspedition Bræ Formation at this locality (Palmer & Peel, 1979). It is likely, therefore, that the lowest carbonates assigned to the Sydpasset Formation at this and other southern localities are of Early Cambrian age.

At Jungersen Gletscher, southern Freuchen Land, dark weathering, resistant dolomites assigned to the lower Sydpasset Formation yielded fragments of polymeroid trilobites, inarticulate brachiopods and *Latouchella*, probably of Middle Cambrian age. Immediately

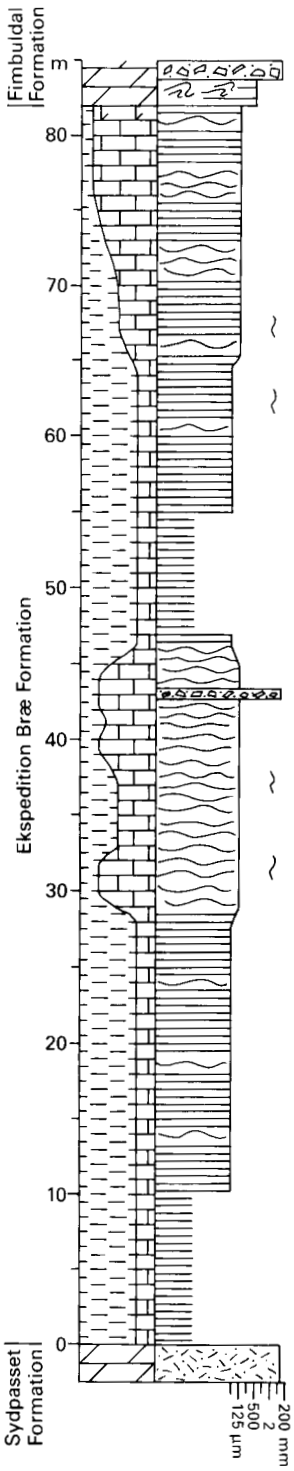

Fig. 41. Type section of the Ekspedition Bræ Formation, Lauge Koch Land (Figs 23, 42). See Fig. 14 for legend.

underlying beds of the Henson Gletscher Formation have yielded olenellid and other trilobites of late Early Cambrian age (Blaker, 1986, 1991).

Ekspedition Bræ Formation

new formation

History. The formation has been previously referred to as formation 4 of the Brønlund Fjord Group (Peel, 1979; Ineson & Peel, 1980) and is equivalent in part to Unit F of Dawes (1976b).

Name. After Ekspedition Bræ, the small glacier flowing east into the head of J. P. Koch Fjord, east Freuchen Land (Fig. 23).

Type section. Fig. 41; 3 km to the south of the snout of Ekspedition Bræ (Figs 23, 42) up the east side of the gully and south along the crest of the ridge.

Thickness. At the type locality the formation is 82 m thick, thinning to about 30 m at Koch Væg, to the south, and at the mouth of Gustav Holm Dal, to the north-east (Figs 10, 23, 26). The Ekspedition Bræ Formation thins westward across southern Freuchen Land, finally wedging out at the junction of Jungersen Gletscher and Nordenskiöld Fjord.

Lithology. The Ekspedition Bræ Formation forms recessive, grey weathering slopes between cliff-forming formations above and below (Figs 18, 39, 42). At the type section, dominant strata are pale weathering, thin-bedded, dark grey lime mudstones and skeletal wackestones, interbedded with grey-green shaly, calcareous mudstones (Fig. 43, see also Fig. 13E). Bedding is parallel or slightly wavy and the lime mudstones commonly show 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, scoured bases. A prominent limestone breccia bed occurs in a carbonate-dominated interval roughly halfway up the section (Fig. 41). It is composed of tabular lime mudstone clasts (average dimensions 0.03 × 0.1 m) in a dark, dolomitic lime mudstone matrix. A distinctive multiple phosphorite hardground occurs at 68.5 m above the base of the type section.

Although the formation thins north-eastward across J. P. Koch Fjord, it is lithologically identical to the type

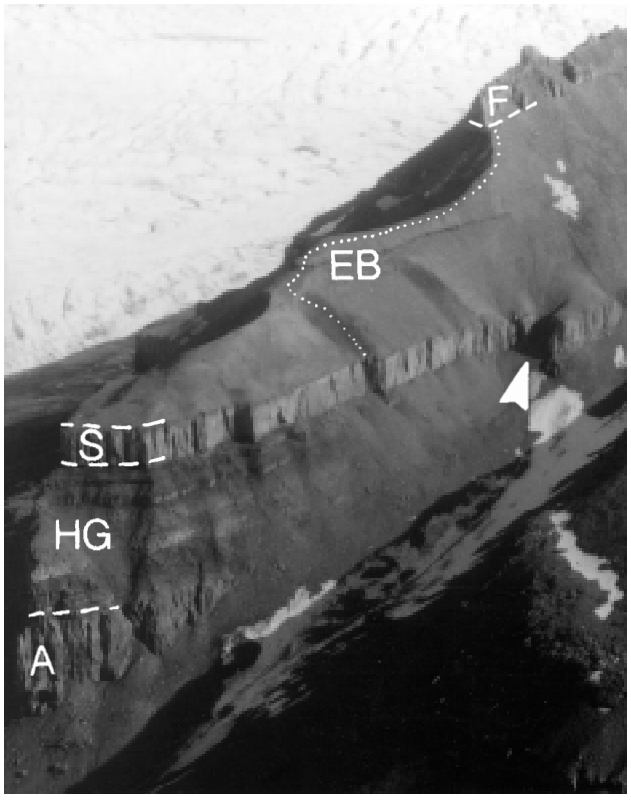

Fig. 42. The type locality of the Aftenstjernesø (A), Henson Gletscher (HG), Sydpasset (S) and Ekspedition Bræ (EB) Formations, Lauge Koch Land. The type section of the Sydpasset Formation is located in the narrow gully (arrow); the Ekspedition Bræ type section (dotted line) is constructed by traversing the lower slopes and ascending the ridge to the base of the Fimbuldal Formation (F, Tavsens Iskappe Group).

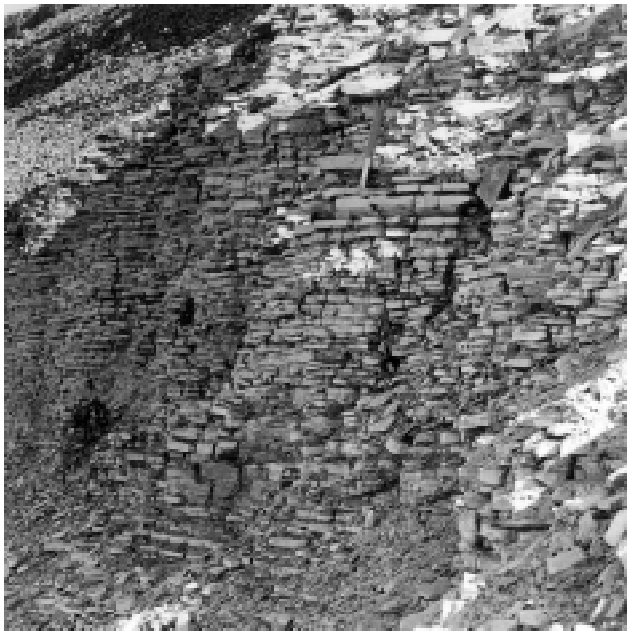

Fig. 43. Thinly interbedded lime mudstones and calcareous siliciclastic mudstones of the Ekspedition Bræ Formation in the type section.

section. To the south at Koch Væg (Fig. 23), the argillite content decreases, occurring only as thin interbeds and partings between irregular, wavy beds of bioturbated lime mudstone, wackestone, cross-laminated skeletal grainstone and packstone. Slumped intervals and limestone breccia beds occur more frequently in such southern sections. Grey-green siliciclastic mudstones are dominant near Jungersen Gletscher in the west, however, with limestones being most conspicuous in the basal few metres.

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 18, 38, 39).

The formation is conformably overlain by the basal beds of the Tavsens Iskappe Group: the Fimbuldal Formation to the west of Hans Tavsen Iskappe and the Lønelv Formation to the east of the ice cap (Fig. 5). At the type section, the boundary is sharp (Figs 41, 42) 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, the Ekspedition Bræ Formation is overlain by cliff-forming, argillaceous, platy, nodular limestones assigned to the Fimbuldal Formation with the boundary taken at the incoming of the nodular limestones, which approximately coincides with the break of slope. At Koch Væg, the upper boundary is placed where argillaceous limestones and dolomitic limestones are overlain by pale cream weathering, laminated and slumped dolomites, assigned here to the Fimbuldal Formation.

East of Hans Tavsen Iskappe, in Løndal, argillaceous limestones of the Ekspedition Bræ Formation are overlain abruptly by cliff-forming, pale yellow-weathering dolomites of the Lønelv Formation.

Distribution. The Ekspedition Bræ Formation crops out in southern Freuchen Land, Lauge Koch Land and western Peary Land; Jungersen Gletscher forms the western limit of the formation. The formation is not recognised east of a point to the north of Sydpasset (Figs 2, 20). Here, the overlying Lønelv Formation pinches out (Figs 5, 20), and 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 to the Erlandsen Land Formation.

The Ekspedition Bræ Formation generally weathers recessively and is only consistently exposed in steep cliffs, for example along J. P. Koch Fjord, in Fimbuldal and at Koch Væg (Figs 22A, 23).

Fauna and age. The Ekspedition Bræ Formation is richly fossiliferous; it has yielded well-preserved faunas of agnostoid and ptychoparioid trilobites, helcionelloids and inarticulate brachiopods, indicative of the medial Middle Cambrian (Palmer & Peel, 1979). The trilobite genera include *Peronopsis*, *Ptychagnostus*, *Syspacephalus* and *Elrathia*, an assemblage that is thought to indicate a maximum age range from high *Ptychagnostus gibbus* Zone to high *Ptychagnostus atavus* Zone (R. A. Robison, written communication, 1981).

Tavsens Iskappe Group

The Henson Gletscher region is the type area of the Tavsens Iskappe Group and includes the type localities of the Fimbuldal, Holm Dal and Perssuaq Gletscher Formations; the group ranges from 400 m to 700 m in thickness in this region.

Fimbuldal Formation

new formation

History. This formation is equivalent to the informal formation T1 of Ineson & Peel (1980) and approximately equivalent to formation 1 of Peel (1979). At Koch Væg, south-western Peary Land, 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 linking the head of J. P. Koch Fjord to Wandel Dal, west Peary Land (Figs 2, 23).

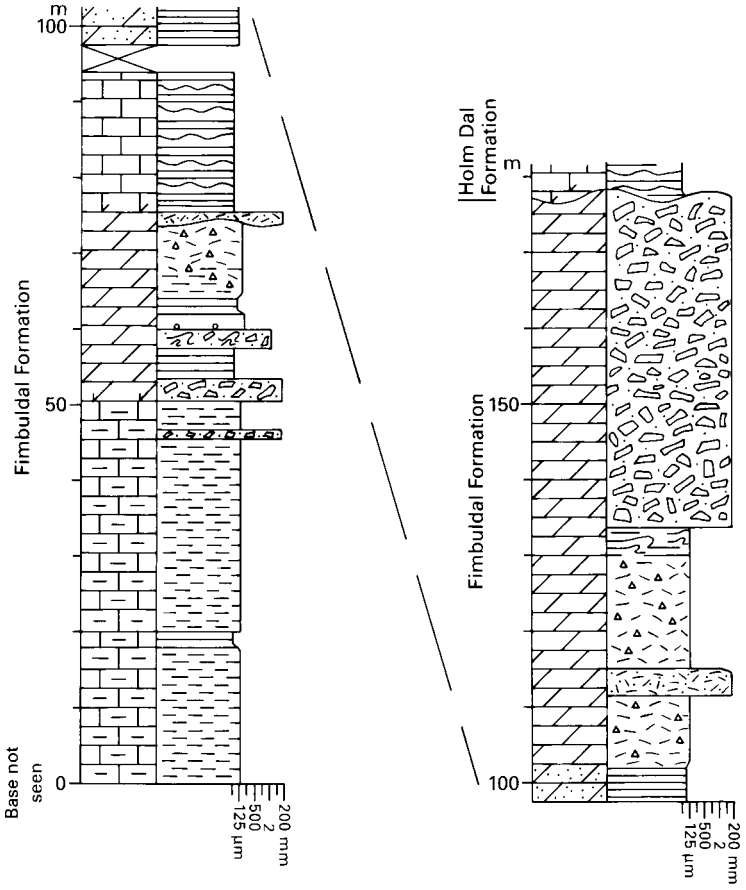

Fig. 44. Type section of the Fimbuldal Formation, west Peary Land (Figs 23, 45). See Fig. 14 for legend.

Type section. Fig. 44; gully on the west side of Gustav Holm Dal, south-west Peary Land (Figs 23, 45).

Thickness. Approximately 180 m at the type locality, thinning south to about 80 m at Koch Væg (Figs 10, 46).

Lithology. The Fimbuldal Formation is composed of alternating units of dark weathering, recessive and pale weathering, cliff-forming carbonates, producing characteristic terraced exposures (Fig. 45) above the recessive, argillaceous carbonates of the Ekspedition Bræ Formation.

In northern exposures around the head of J. P. Koch Fjord, the formation comprises a varied sequence of platy, nodular limestones (microsparites) and dolomites, skeletal wackestones, bituminous parallel-laminated lime mudstones, and thin, graded beds of intraclastic peloidal lime grainstone, interbedded with pale weathering carbonate breccia beds. Platy, nodular carbonates dominate the lower half of the type section and exhibit undulatory bedding, pull-aparts and discontinuous brecciated horizons (Fig. 47). The clast-supported breccia beds range from less than a metre to 40 m in thickness and are commonly dolomitised together with adjacent, thin-bedded carbonates. Clasts are mostly tabular (average dimensions of 2 cm × 10 cm) and, where undolomitised, are composed of lime mudstone, wackestone and peloidal packstone in a lime mudstone matrix. Pale weathering blocks of ooidal grainstone occur sporadically in the breccia beds (Fig. 48) 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, the formation is 80 m thick and comprises a lower pale weathering interval (*c.* 30 m) of laminated, locally slumped dolomite, interbedded with dolomite breccia beds (0.5–2 m thick), overlain by about 50 m of thin wavy-bedded, dark grey dolomites (Fig. 10).

Boundaries. The Fimbuldal Formation conformably overlies the Ekspedition Bræ Formation. The boundary is not exposed at the type locality, but on the east side of Gustav Holm Dal (Fig. 23) 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 (Fig. 22A). At the southern end of the Koch Væg cliffline, the boundary is placed where pale yellow weathering dolomites overlie recessive argillaceous carbonates assigned to the Ekspedition Bræ Formation.

Fig. 45. Type locality of the Fimbuldal Formation (F) on the west side of Gustav Holm Dal, west Peary Land (Fig. 23). The boundary with the underlying Ekspedition Bræ Formation (EB, Brønlund Fjord Group) is not exposed; the top of the Fimbuldal Formation is highly irregular and draped by argillaceous carbonates of the Holm Dal Formation (H). The terraced nature of this locality is typical of the formation in all but the steepest of exposures.

In the Henson Gletscher area, the formation is conformably overlain by cliff-forming ooidal dolomites assigned to the Perssuaq Gletscher Formation (Fig. 46). The boundary is placed at the base of the first cream weathering, ooidal dolomite bed. The Perssuaq Gletscher Formation is strongly diachronous from south to north (Figs 10, 46) and consequently, to the north of the head of J. P. Koch Fjord, the Fimbuldal Formation is conformably overlain by the Holm Dal Formation which, in turn, is overlain by the Perssuaq Gletscher Formation (Figs 22A, 46). In this area the boundary is

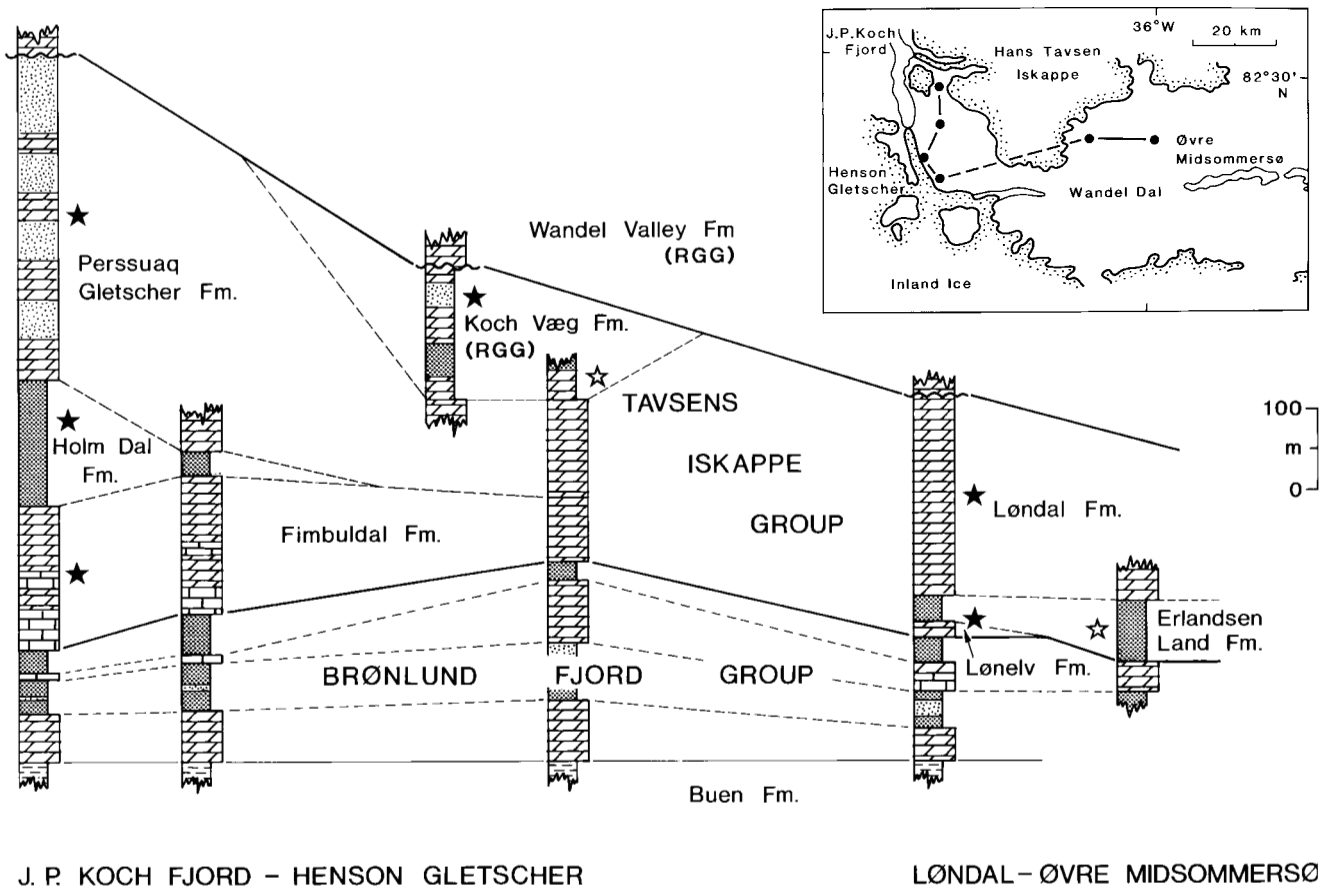

Fig. 46. Generalised stratigraphic logs of the Tavsens Iskappe Group showing the stratigraphic relationships and lateral thickness variations in the Henson Gletscher and Løndal regions of west Peary Land (see inset map). The formations of the Brønlund Fjord Group are shown on Fig. 26. Type sections are indicated by solid stars, reference sections by open stars. Note that the upper levels of the Tavsens Iskappe Group are typically poorly exposed, where accessible, and the generalised logs are constructed in part from float and inference from adjacent cliff sections. See Figs 14, 26 for explanation of symbols.

sharp and is placed where dark recessive, thin-bedded carbonates rest on the uppermost cliff-forming carbonate breccia bed of the Fimbuldal Formation (Figs 22A, 44, 45). The boundary may be planar or hummocky and locally has a relief of up to 5 m.

Distribution. The formation is recognised from the western margin of Hans Tavsen Iskappe, south-west Peary Land, westwards to Jungersen Gletscher, southern Freuchen Land (Fig. 2). In south-western Peary Land it is well exposed in Gustav Holm Dal and along northern Fimbuldal (Fig. 22A) and in the vertical cliffs flanking J. P. Koch Fjord and Henson Gletscher (Fig. 19). Additional accessible sections are located at the south end of Koch Væg and on the south side of Fimbuldal, but the type section is the most complete.

Fauna and age. At the type section as well as on the south side of Fimbuldal, dark bituminous limestones (80–90 m above the base) yield a diverse fauna of agnostoid and ptychoparioid 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 (Peel, 1982a; Robison, 1984). The remainder of the formation is unfossiliferous, but the lower beds of the overlying Holm Dal Formation yield faunas indicative of the latest Middle Cambrian (Palmer & Peel, 1979; Peel, 1982a, 1988b, c; Robison, 1984, 1988) and consequently the upper beds of the Fimbuldal Formation are of probable late Middle Cambrian age.

In southern exposures, around Henson Gletscher, the Fimbuldal Formation is unfossiliferous, but a medial Middle Cambrian age is suggested by its stratigraphic position.

Holm Dal Formation

History. The formation has been described informally as formations 2 and T2 of the Tavsens Iskappe Group (Peel, 1979; Ineson & Peel, 1980). It was formally described by Ineson (1988).

Name. After Gustav Holm Dal, the north–south valley linking Fimbuldal with Perssuaq Gletscher, south-west Peary Land (Figs 2, 23).

Type Section. Fig. 49; north of the prominent gully on the east side of Gustav Holm Dal, at the junction with Fimbuldal (Figs 22A, 23).

Thickness. 155 m at the type locality, thinning south to about 30 m on the south side of Fimbuldal and pinching out altogether a few kilometres south of this locality (Fig. 46). The formation appears to thicken northwards from the type section.

Lithology. The Holm Dal Formation forms recessive, dark weathering slopes between the terraced Fimbuldal Formation below and the pale weathering cliff-forming Perssuaq Gletscher Formation above (Fig. 22A). At the type section, it is dominated by thin, parallel-bedded and wavy-bedded, dark grey dolomites and lime mudstones with grey-green weathering, silty, calcareous mudstone partings and interbeds (Fig. 50). Parallel lamination is the dominant sedimentary structure and is defined locally by thin lenses and laminae (maximum thickness of 10 mm) of skeletal lime

Fig. 47. Platy nodular dolomites of the Fimbuldal Formation at the type section. Note the undulating bedding and local disruption of the nodular fabric.

Fig. 48. A limestone mass-flow breccia bed in the Fimbuldal Formation composed of dark lime mudstone clasts and large blocks of white ooid grainstone in a lime mudstone matrix. Hammer, centre left, for scale; south side of Fimbuldal, west Peary Land.

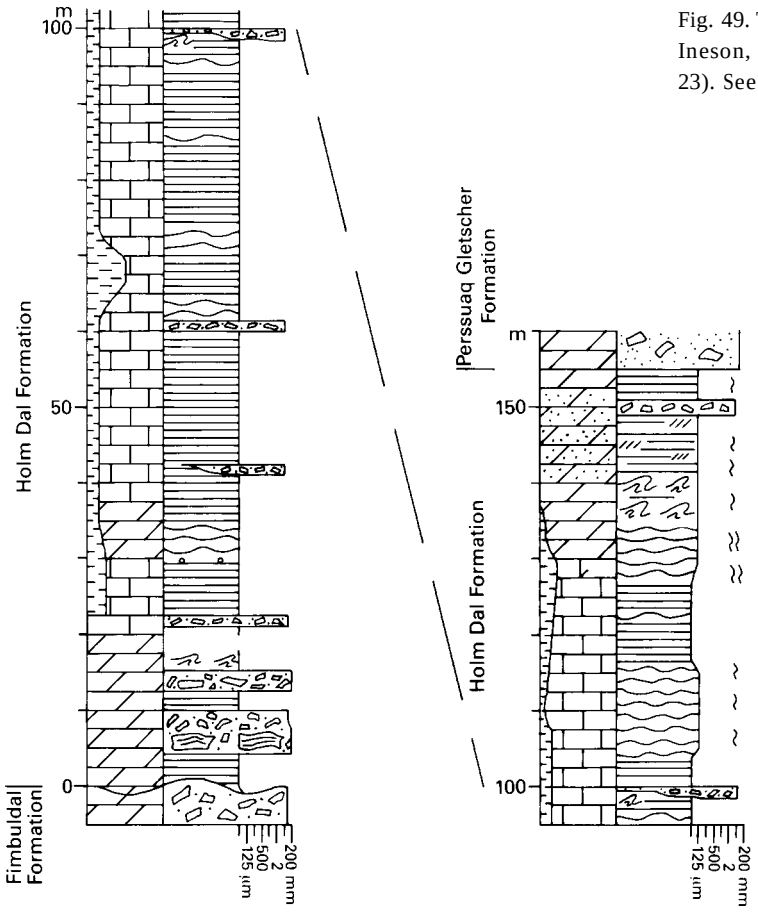

Fig. 49. Type section of the Holm Dal Formation (redrawn from Ineson, 1988), Gustav Holm Dal, west Peary Land (Figs 22A, 23). See Fig 14 for legend.

packstone and grainstone. About 1 km 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; they form a prominent bench approximately 110 m above the base of the formation (Fig. 49). The upper beds are dolomitised in the type section and include an interval of parallel-laminated and bioturbated, fine-grained, dolomitic sandstones which locally show small-scale cross-stratification and current-rippled bedding planes. Slumped, brecciated horizons and carbonate breccia beds up to 5 m thick occur frequently near the base and top of the formation. A detailed description of the sedimentology of the Holm Dal Formation was given by Ineson (1988).

Boundaries. The Holm Dal Formation overlies the Fimbuldal Formation with a sharp, but apparently conformable boundary (Figs 22A, 49). Along Gustav Holm Dal, this boundary undulates markedly with a relief of up to 5 m, but elsewhere it is planar.

The Holm Dal Formation is conformably overlain by the Perssuaq Gletscher Formation (Fig. 22A). At the type locality the boundary is placed where recessive laminated, dark sandy carbonates are abruptly overlain by a massive cliff-forming dolomite breccia bed (see Fig. 55). The boundary between these formations is, however, clearly diachronous on the scale of a fjord wall (see Fig. 19). Pale wedge-shaped units of dolomites and sandstones, assigned to the Perssuaq Gletscher Formation, thin northwards, interdigitating with dark thin-bedded carbonates (Fig. 19) and eventually pinch out into the underlying Holm Dal Formation. For mapping purposes, the zone of interdigitation is included in the Perssuaq Gletscher Formation.

Distribution. The formation crops out around the head of J. P. Koch Fjord in south-west Peary Land and westward across Freuchen Land to the glacier at the head of Navarana Fjord. It pinches out approximately 5 km south of the type section, and is not recognised south of the head of J. P. Koch Fjord (Figs 23, 46). The Holm Dal Formation is well exposed in the cliffs along J. P. Koch Fjord, Navarana Fjord and around the junction

Fig. 50. Thin-bedded argillaceous lime mudstones of the Holm Dal Formation in the type section; from Ineson (1988). Additional facies of this formation were illustrated by Ineson (1988).

of Fimbuldal and Gustav Holm Dal (Figs 19, 22A), but accessible exposures are rare, the type section being the most complete.

Fauna and age. Apart from the uppermost 30 m, this formation is richly fossiliferous, yielding a diverse fauna of agnostoid and other trilobites, molluscs and brachiopods (Robison, 1988; Hood & Robison, 1988; Peel, 1988c; Zell & Rowell, 1988; see also Bergström & Ineson, 1988). The trilobite fauna is dominated by polymeroids that are most characteristic of the lower and middle *Cedaria* Zone (early Dresbachian) as widely applied in North America. Agnostoid species are characteristic of the upper part of the *Lejopyge laevigata* Zone (Robison, 1988).

Perssuaq Gletscher Formation

new 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.

Name. After Perssuaq Gletscher, a distributary of Hans Tavsen Iskappe, which flows west into J. P. Koch Fjord in south-west Peary Land (Figs 1, 23).

Type area and type section. East side of Gustav Holm Dal, south-west Peary Land (Figs 23, 51). The formation is poorly exposed in accessible terrain and lateral facies variation is great. Therefore, the formation is defined herein from a composite section made up of three sections along the east side of Gustav Holm Dal. Together, these sections illustrate the main features of the formation in the type area, but following Hedberg (1976), the most complete section (Fig. 51, section B) is designated the type section (holostratotype); the adjacent sections (Fig. 51, sections A and C) are thus reference sections (parastratotypes).

Thickness. Approximately 400 m at the type section (Fig. 51). The formation 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 120–150 m thick (Fig. 46); comparable thicknesses are observed south of Navarana Fjord.

Lithology. The cliff-forming, yellow-brown weathering formation is composed of cross-bedded dolomites, dolomitic sandstones and silica-cemented sandstones (quartz arenites), interbedded with slumped intervals and breccia beds. At the type section, the lower half of the formation comprises fine- to medium-grained sandstones interbedded with breccia beds which range from 0.5 to 40 m in thickness. In the lower 100 m of the formation, the breccias are composed predominantly of dolomite, but quartz sand forms an increasing proportion of both matrix and clasts up-section (Fig. 52).

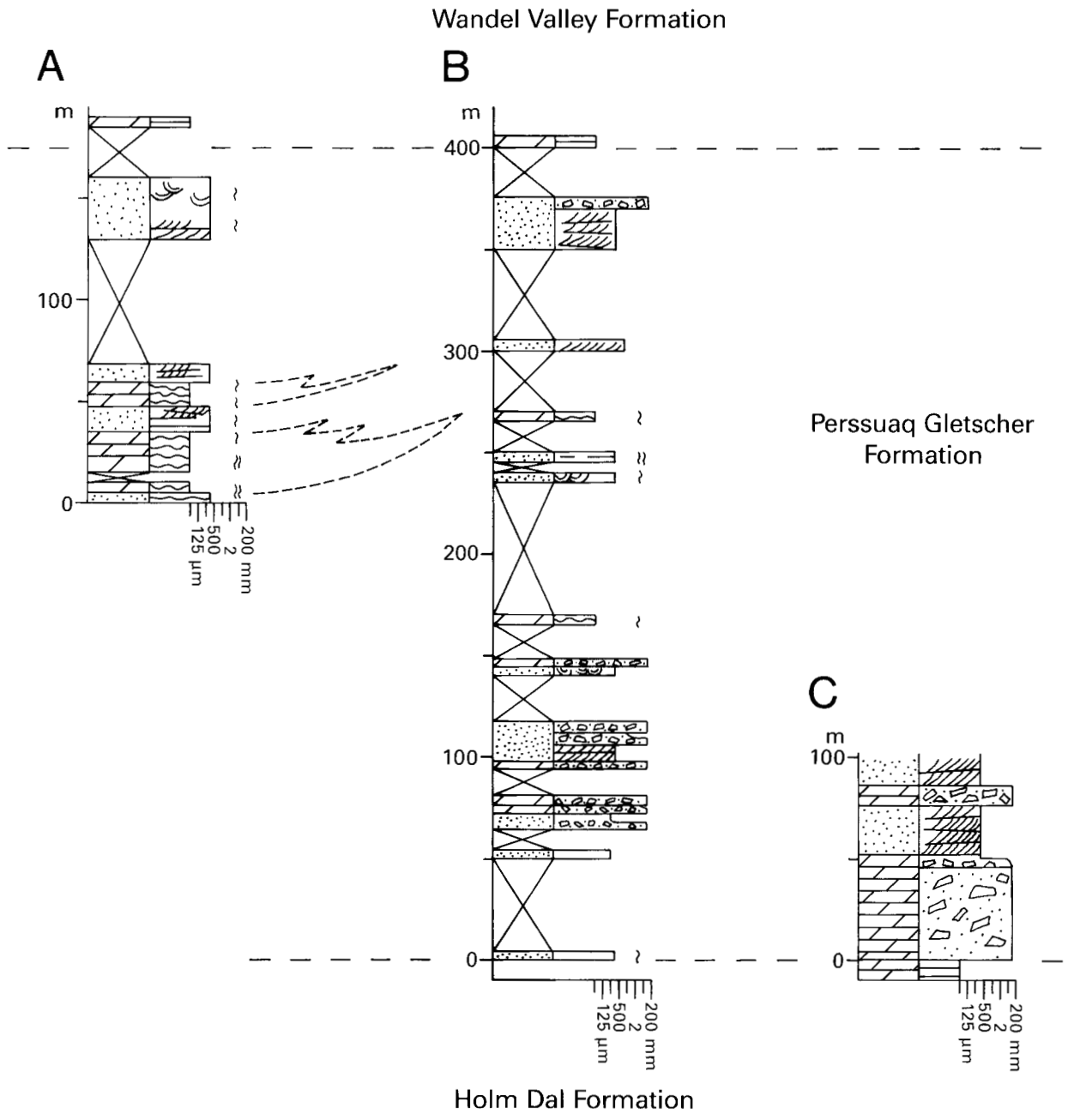

Fig. 51. Type (B) and reference (A, C) sections of the Perssuaq Gletscher Formation, Gustav Holm Dal, west Peary Land (Fig. 23). See Fig. 14 for legend.

The sandstones commonly show tabular and trough cross-bedding (0.1–1 m sets), convolute bedding and parallel lamination. Parallel-laminated and small-scale cross-bedded sandstones (Fig. 53), bioturbated dolomitic sandstones and burrow-mottled pale dolomites make up the upper half of the formation at the type locality. At the northern end of Gustav Holm Dal (Fig. 51), dark grey-brown weathering, wedge-shaped units of dark grey, thin, wavy-bedded silty dolomites are intercalated with the pale siliciclastic sediments that characterise the formation in the type area. The dark recessive units pinch out southwards so that they 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 northward dipping clinoforms. This interdigitation and northward progradational pattern is well illustrated in the cliffs along J. P. Koch Fjord (Fig. 19).

South of the type area, the formation is composed

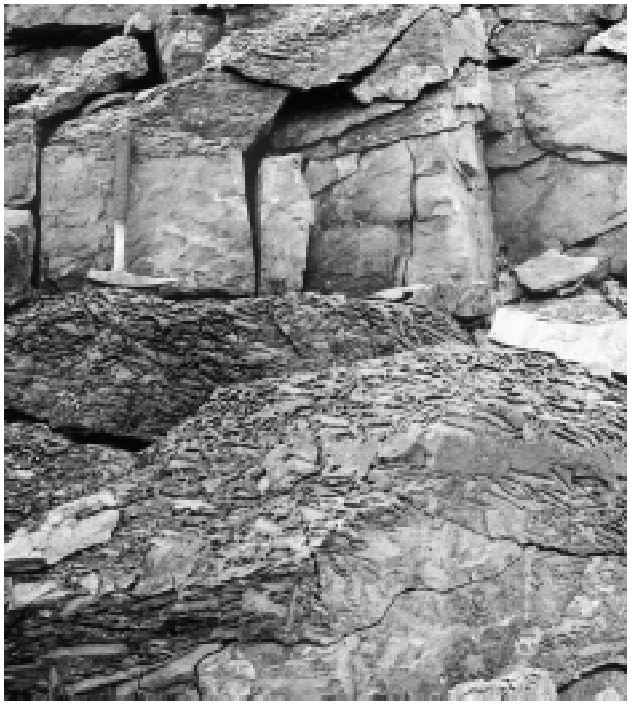

Fig. 52. Sandy dolomite mass-flow breccia beds in the type section of the Perssuaq Gletscher Formation. Note the abrupt grading into a structureless sandstone cap, succeeded above the hammer by the next coarse breccia bed.

of pale yellow, structureless or cross-bedded, medium to thick-bedded, medium-coarse crystalline dolomite, in which ooids and bioclasts are locally recognisable. Along Koch Væg, lenticular bodies of ooidal dolomite, intercalated with darker weathering dolomites, describe sigmoidal clinoforms dipping northwards at up to 30 degrees (Figs 10, 54, 100A).

Along the glacier flowing into the head of Navarana Fjord, the formation comprises an alternation of siliciclastic and carbonate units showing northward-dipping clinoform bedding (Fig. 22B); these accessible sections are analagous to the vertical cliff sections along J. P. Koch Fjord (Fig. 19). The carbonate units (2–10 m thick) comprise light-coloured, bioturbated dolomites and thrombolitic mounds. Siliciclastic units, dominated by well-sorted, fine-grained sandstones (quartz arenites), are up to 40 m thick and consist of matrix-rich conglomerates, trough cross-bedded, laminated and bioturbated sandstones (Surlyk & Ineson, 1987).

Boundaries. North of the head of J. P. Koch Fjord, the formation conformably overlies the Holm Dal Formation (Figs 22A, 46). The boundary is poorly exposed at the type section and is defined in the reference section at the south-east corner of Gustav Holm Dal (Fig. 51C), where cliff-forming dolomite breccias rest with a sharp planar contact on dark recessive laminated dolomites of the underlying Holm Dal Formation (Fig. 55). The Perssuaq Gletscher Formation interfingers with the Holm Dal Formation as described previously and, for mapping purposes, the zone of interdigitation is included in the Perssuaq Gletscher Formation (Fig. 19).

South of the head of J. P. Koch Fjord, the Holm Dal Formation is not recognised and the Perssuaq Gletscher Formation conformably overlies the Fimbuldal Formation (Fig. 46). At the southern end of Koch Væg, dark thin-bedded dolomites assigned to the Fimbuldal Formation are overlain by pale ooidal dolomite of the Perssuaq Gletscher Formation. The change is gradational, the two rock types being interbedded over a 10 m interval. The boundary is placed at the base of the first discrete pale bed of ooidal dolomite.

To the north of Troelsen's Fault (Fig. 23), the formation is unconformably overlain by Lower – Middle Ordovician dolomites of the Wandel Valley Formation. The contact is rarely exposed in accessible sections, and even in cliff sections, the unconformity is commonly delineated by a recessive, scree-covered ledge (Fig. 19). The boundary is apparently sharp and planar and, although bedding is commonly sub-parallel, an angular discordance of up to 15 degrees can be observed locally where the underlying Perssuaq Gletscher sediments exhibit depositional dips (Fig. 19).

Fig. 53. Medium-grained sandstones of the Perssuaq Gletscher Formation showing tabular cross-bedding in sets 5–10 cm thick. Gustav Holm Dal, west Peary Land.

Fig. 54. Northward prograding platform margin carbonates of the Perssuaq Gletscher Formation (PG) along Koch Væg on the east side of Henson Gletscher. The Perssuaq Gletscher Formation is abruptly overlain by platform interior carbonates of the Koch Væg Formation (KV) which in turn is overlain unconformably by the Wandel Valley Formation (W; both Ryder Gletscher Group). Cliff height *c.* 600 m. From Higgins *et al.* (1991a).

To the south of Troelsen's Fault, the cliff-forming thick-bedded dolomites of the Perssuaq Gletscher Formation are overlain conformably by recessive pale weathering dolomites, argillaceous dolomites and sandstones of the Koch Væg Formation (Figs 46, 54). The boundary is readily defined in cliff section (see Fig. 54), but where accessible at the south end of Koch Væg, the boundary is poorly exposed, being placed broadly where cross-stratified ooidal and sandy dolomites give way to faintly laminated and burrow-mottled dolomites. At the type section of the Koch Væg Formation (Fig. 23; see Ryder Gletscher Group), the boundary is placed at the change from pale to dark weathering dolomites which approximately corresponds to the break in slope.

Distribution. The Perssuaq Gletscher Formation is restricted to south-west Peary Land and Freuchen Land, west of Hans Tavsen Iskappe. It crops out along Navarana Fjord, south J. P. Koch Fjord and Henson Gletscher (Figs 2, 23) and extends east to the western margin of Hans Tavsen Iskappe. The Perssuaq Gletscher Formation is exposed in excellent cliff sections along the fjords and along Henson Gletscher, but accessible sections with adequate exposure are scarce. It is best examined in Gustav Holm Dal, along the southern edge of Koch Væg and on the western side of the glacier flowing north into Navarana Fjord.

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

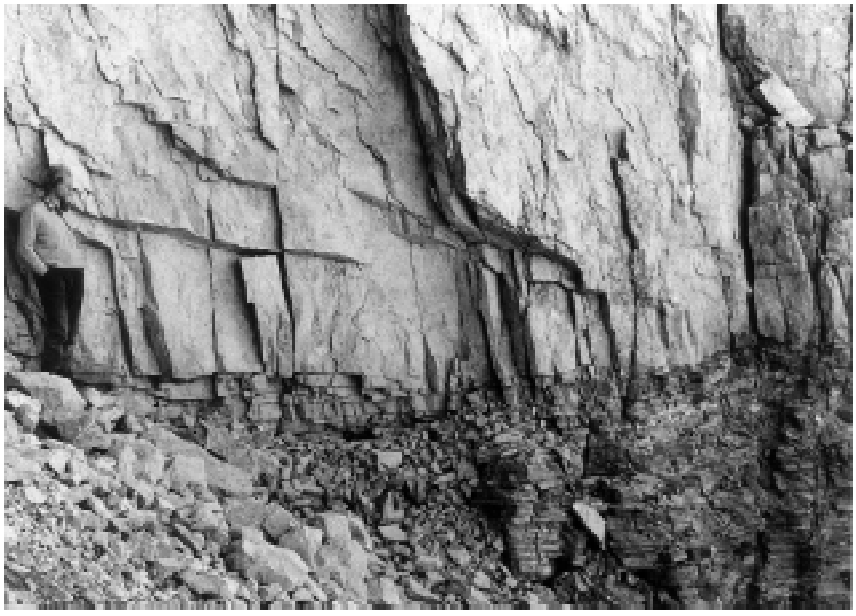

Fig. 55. Abrupt boundary between thin-bedded dark dolomites of the uppermost Holm Dal Formation in its type section and massive pale dolomites of the overlying Perssuaq Gletscher Formation (reference section A, Fig. 51). From Ineson (1988).

the north end of Gustav Holm Dal, indicating a latest Cambrian or earliest Ordovician age (Miller *in* Peel, 1982a; Smith & Bjerreskov, 1994). The strongly progradational pattern of sedimentation exhibited by this formation in this area (see Fig. 19) indicates that the uppermost strata of the formation north of Gustav Holm Dal are most likely of Early Ordovician age.

The age of the formation south of Troelsen's Fault is less certain. At the south end of Koch Væg, the youngest Cambrian faunas obtained are of medial Middle Cambrian age from the Ekspedition Bræ Formation of the Brønlund Fjord Group (Palmer & Peel, 1979). It can be demonstrated in northern exposures that the base of the Perssuaq Gletscher Formation is strongly diachronous from south to north (Figs 8, 10) and thus, although the formation is largely of Late Cambrian age in the type area, it may be wholly of Middle Cambrian age in southern exposures.

Løndal region

The Løndal region, as employed here, extends east from Hans Tavsen Iskappe across Løndal and western Erlandsen Land to the major valley north of the eastern end of Øvre Midsommersø (Figs 2, 16, 56–58). Within this region, the Brønlund Fjord Group conformably overlies the Buen Formation and is represented by the Aftenstjernesø, Henson Gletscher, Sydpasset and Ekspedition Bræ Formations, as defined above from the Henson Gletscher region. The succeeding Tavsens Iskappe Group comprises three new formations: the Lønelv, Erlandsen Land and Løndal Formations. The Tavsens Iskappe Group is unconform-ably overlain by the Wandel Valley Formation (late Early – Middle Ordovician). Two formations, the Ekspedition Bræ Formation of the Brønlund Fjord Group and the Lønelv Formation of the Tavsens Iskappe Group, are only recognised in the western part of the area, in Løndal itself (Figs 26, 46, 57).

Brønlund Fjord Group

This group in the Løndal region is closely comparable to that of the reference area (Henson Gletscher region) and the constituent formations are readily recognised (Figs 26, 58). The total thickness of the group is 152 m, measured on the west side of Løndal.

Aftenstjernesø Formation

The formation is about 40 m thick in this area. It comprises a fawn to grey-brown weathering succession of dolomitised carbonate turbidites and nodular dolomites, capped by a distinctive 5 m thick mass-flow breccia bed that is locally composite (see Ineson, 1985). Of particular note in this area is the local preservation of about 2 m of only partially dolomitised or undolomitised glauconitic skeletal lime grainstones, packstones and bioturbated wackestones at the base of the formation (Frykman, 1980).

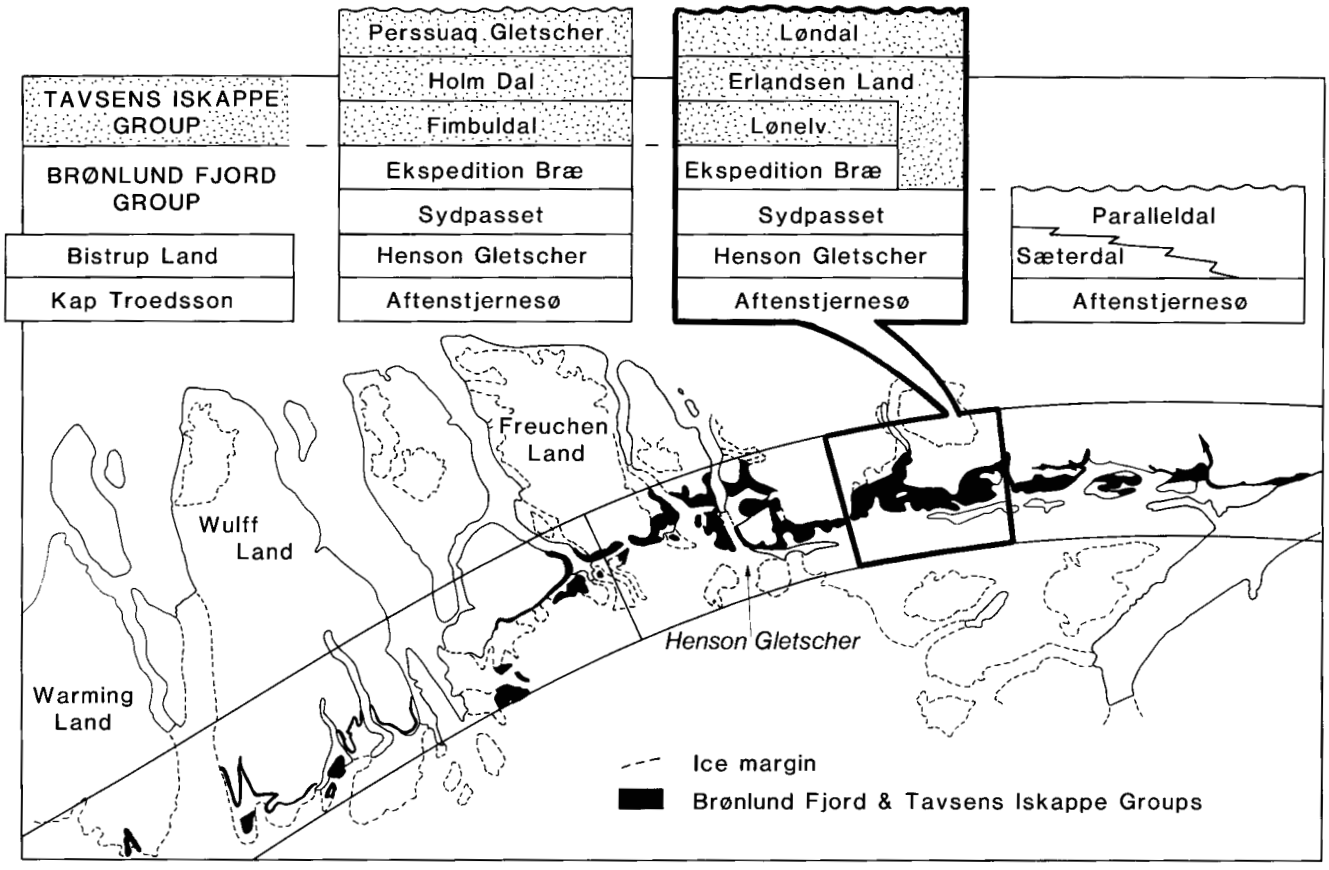

Fig. 56. Map showing the location and stratigraphy of the Løndal region in relation to the remainder of the southern outcrop belt of the Tavsens Iskappe and Brønlund Fjord Groups.

Henson Gletscher Formation

The Henson Gletscher Formation is 45.5 m thick on the western bank of Lønelv and it shows a comparable tripartite division to that seen in the type section. Argillaceous carbonates at the top and base of the formation are separated by a pale weathering siliciclastic sand-rich interval, 22 m thick. The lower carbonate interval includes two highly fossiliferous coarsening-upwards cycles, 2–2.5 m thick, that grade up from laminated, black lime mudstones through bioturbated wavy-bedded lime mudstones and wackestones to coarse, glauconitic, skeletal grainstones and packstones containing abundant trilobites of Early Cambrian age. Blaker (1991) has described 11 species of trilobites from these beds, including *Bonnia brennus, Kootenia marcoui, Lancastria plana, Ogygopsis batis, O. typicalis, Olenellus* cf. *O. truemani, Pagetides elegans* and *Peronopsis roddyi*.

Phosphatised wackestones at the top of the formation, immediately below the Sydpasset Formation, yield agnostoid and molluscan faunas of Middle Cambrian age, with abundant stenothecoids and helcionelloids such as *Latouchella* and *Protowenella*.

Sydpasset Formation

The Sydpasset Formation is about 35 m thick in Løndal. The lower half is composed of dolomitic limestones showing spectacular platy and fibrous nodular forms; these are particularly well displayed along the western banks of Lønelv. Two thick dolomitised breccia beds make up the upper 17 m of the formation.

Ekspedition Bræ Formation

The Ekspedition Bræ Formation is 30 m thick in Løndal and comprises wavy and parallel-bedded argillaceous, fossiliferous lime mudstones that are locally slumped and partially disaggregated; clast-rich limestone breccia

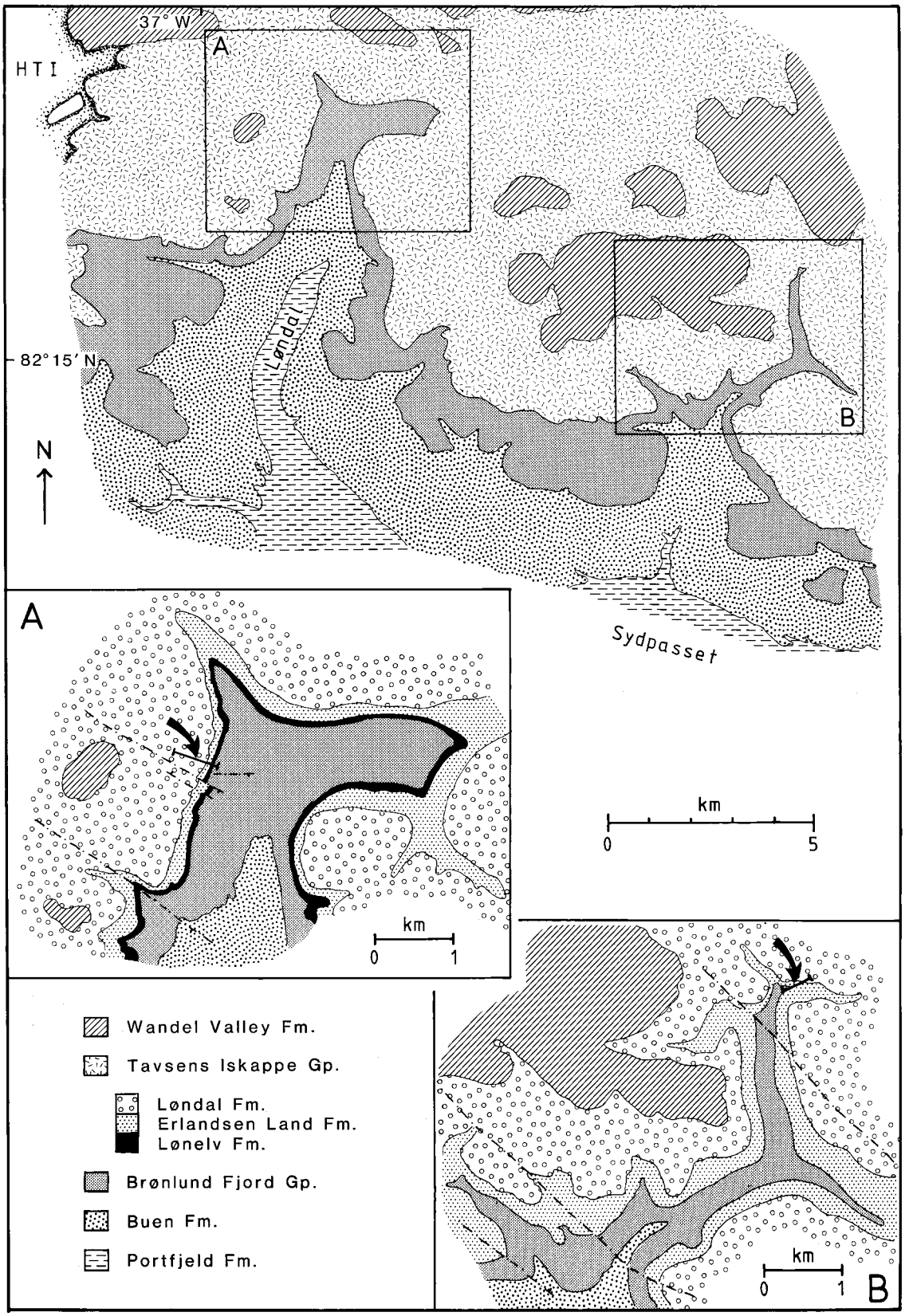

Fig. 57. Geological sketch map of the Løndal region, southern Peary Land showing the distribution of the Brønlund Fjord and Tavsens Iskappe Groups. Inset A shows the location of the type sections of the Lønelv, Erlandsen Land and Løndal Formations on the west side of Løndal; the reference section of the Erlandsen Land Formation is shown on inset B. HTI, Hans Tavsen Iskappe.

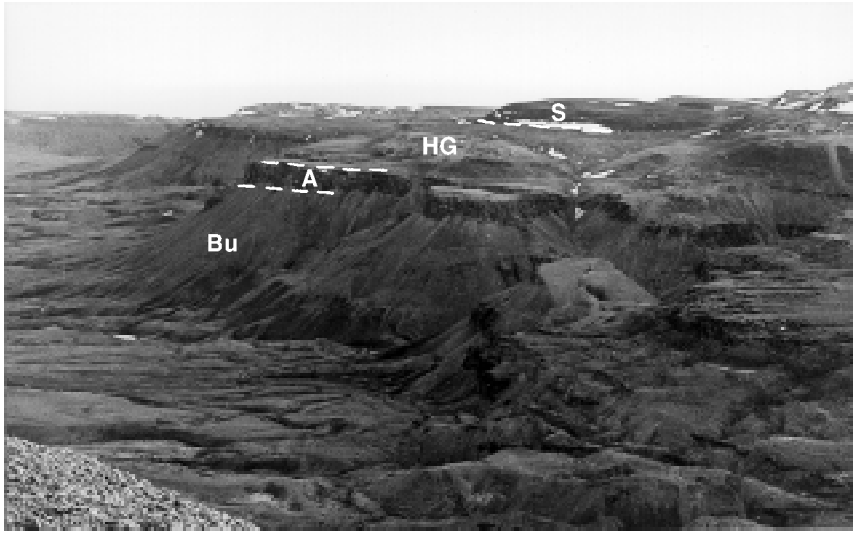

Fig. 58. Cambrian strata on the west side of Løndal, south-west Peary Land, viewed towards the south-west. The largely scree-covered Buen Formation (Bu) is succeeded by the distinctive terraces of the Brønlund Fjord Group (A, Aftenstjernesø Formation; HG, Henson Gletscher Formation; S, Sydpasset Formation).

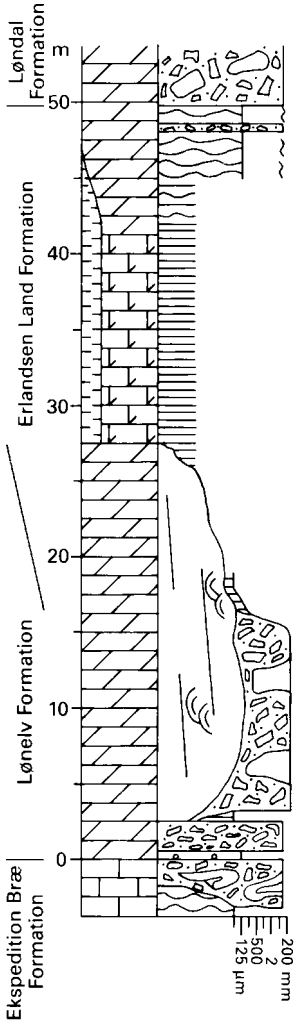

Fig. 59. Type sections of the Lønelv and Erlandsen Land Formations, north-west Løndal, southern Peary Land (Figs 56, 57, 60). Note that the top of the Lønelv Formation is highly irregular; large protruding blocks often display bedding at high angles to the regional dip. See Fig. 14 for legend.

beds occur at several levels in the formation. The Ekspedition Bræ Formation is not recognised east of the point in western Erlandsen Land where the Lønelv Formation of the Tavsens Iskappe Group pinches out (see Figs 46, 56 and definition of Ekspedition Bræ Formation).

Tavsens Iskappe Group

The Tavsens Iskappe Group in the Løndal region has a total thickness of about 300 m. Although biostratigraphic data are few, the Lønelv and Erlandsen Land Formations are thought to be roughly equivalent to the upper Ekspedition Bræ Formation (Brønlund Fjord Group) in the Henson Gletscher region (Figs 5, 8) whereas the Løndal Formation probably equates to the Fimbuldal and Holm Dal Formations.

Lønelv Formation

new 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 Tavsen Iskappe, south-west Peary Land (Figs 2, 57).

Type section. Fig. 59; west side of Løndal, south-west Peary Land (Figs 2, 57, 60).

Thickness. 15–30 m at the type locality. The top of the

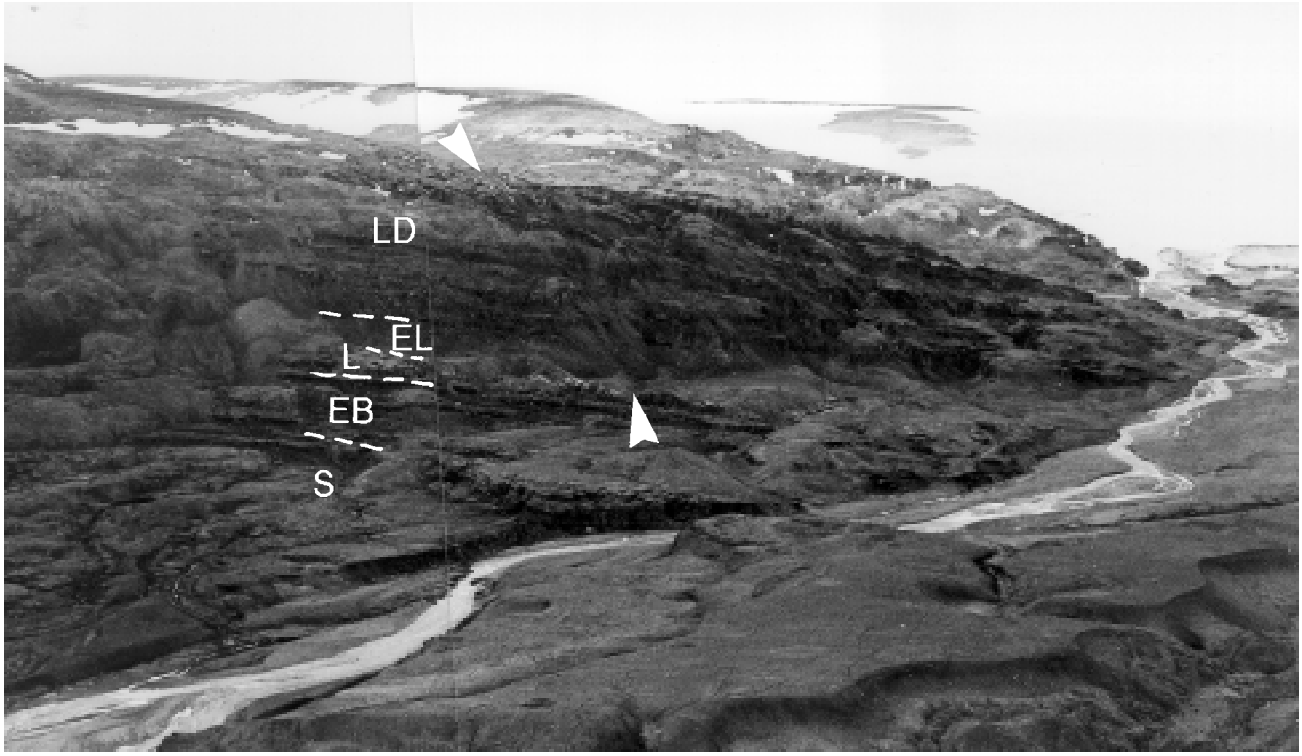

Fig. 60. Cambrian strata on the west side of the western tributary of Lønelv, looking northwards to the south-eastern margin of Hans Tavsen Iskappe. The Sydpasset (S) and Ekspedition Bræ (EB) Formations of the Brønlund Fjord Group are overlain by the Lønelv (L), Erlandsen Land (EL) and Løndal Formations (LD) of the Tavsens Iskappe Group. The type sections of the latter three formations were measured up the central gully (arrows).

formation is locally highly irregular, but the formation is estimated to have an average thickness of 15–20 m. It thins and pinches out completely about 9 km south-east of the type locality (Figs 46, 57).

Lithology. The pale yellow or cream weathering dolomites of the Lønelv Formation form prominent crags between the recessive Ekspedition Bræ and Erlandsen Land Formations (Fig. 60). At the type section, the formation is apparently composed of two separate breccia beds, sandwiching a thin interval (0.1–2 m) of thin-bedded, parallel-laminated, dark grey, medium crystalline dolomite, which is commonly distorted and locally absent (Figs 59, 61). Lateral exposure is limited, however, and the bedded interval may equally represent a rafted slab within a single thick debris bed. A thin interval (*c.* 0.5 m) 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 or 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 (Fig. 59). Elongate, folded, dark grey dolomite slabs form a minor proportion of the clasts. The pale clasts range from a few centimetres in diameter to huge blocks, 30 m across, which locally protrude up to 12 m from the top of the upper breccia bed, producing the irregular top of the Lønelv Formation (Figs 59, 60).

Boundaries. The Lønelv 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 limestone breccia bed of the Ekspedition Bræ Formation (Fig. 59).

The Lønelv Formation is overlain, apparently conformably, by the Erlandsen Land Formation. The boundary is sharp and locally irregular, with a relief of 12 m 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 recognised on the east side of Hans Tavsen Iskappe in the vicinity of Løndal (Figs 46, 57). It crops out from the margin of the icecap, east into Løndal and pinches out approxi-

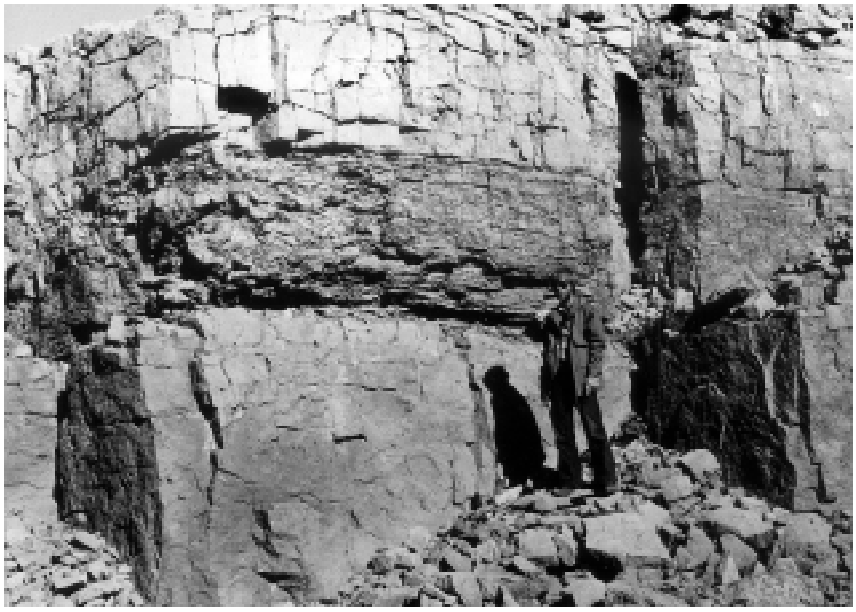

Fig. 61. Lønelv Formation in the type section showing disrupted thin-bedded dolomites (a clast?) sandwiched between pale structureless mass-flow carbonate breccia.

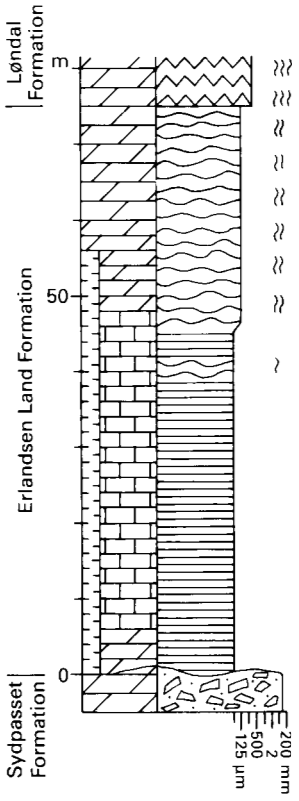

Fig. 62. Reference section of the Erlandsen Land Formation, east of Løndal, southern Peary land (Figs 56, 57, 63). See Fig. 14 for legend.

mately 9 km south-east of the type section. It is best exposed along the west side of Løndal.

Fauna and geological age. Fossils have not been found in the Lønelv Formation, but the formation 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.

Erlandsen Land Formation

new formation

History. This 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. 2).

Type section. Fig. 59; west side of Løndal, south-west Peary Land (Figs 57, 60).

Reference section. Fig. 62; east side of narrow valley, 13 km east of type section (Figs 57, 63).

Thickness. The formation varies from 22–33 m 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 25 m in Løndal. At the reference section,

the Lønelv Formation is not recognised and beds assigned to the Erlandsen Land Formation conformably overlie the Sydpasset Formation and attain a thickness of 75 m (Figs 46, 62, 63).

Lithology. The Erlandsen Land Formation is characterised by dark grey to yellow-brown weathering, thin-bedded carbonates forming recessive slopes between the cliff-forming formations above and below (Figs 60, 63). At the type locality, the basal beds are parallel-laminated and bioturbated, dark grey, fine to medium crystalline, calcareous dolomites with argillaceous partings. These pass up into thin, parallel-bedded, argillaceous lime mudstones that show faint parallel lamination, locally defined by skeletal packstone and grainstone laminae. The middle part 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. 59) and a discontinuous wispy lamination and faint mottling attributable to bioturbation. A thin (0.5 m), clast-supported breccia bed near the top of the formation in the type section is composed of tabular, dark grey dolomite clasts (average dimensions 3 × 10 cm) in an argillaceous dolomite matrix.

The Erlandsen Land Formation is lithologically uniform east of the type locality. In the ravine north of Øvre Midsommersø it comprises a thick succession of thin, parallel-bedded, argillaceous lime mudstones (Fig. 64) and platy or wavy bedded, bioturbated dark grey dolomites.

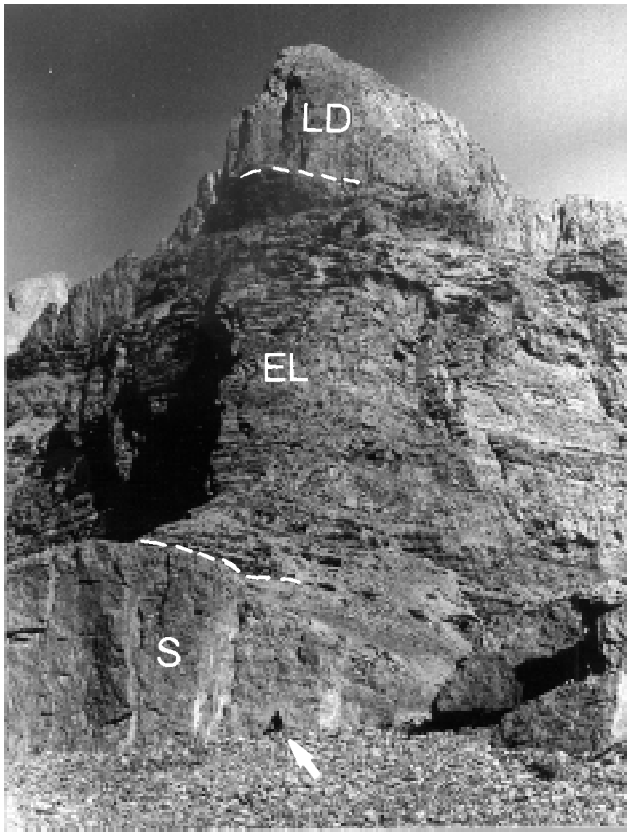

Fig. 63. The Erlandsen Land Formation (EL) in the reference section (Fig. 62), comprising thin-bedded argillaceous carbonates sandwiched between pale cliff-forming dolomites of the Sydpasset (S; Brønlund Fjord Group) and Løndal (LD) Formations. Figure (arrowed) for scale.

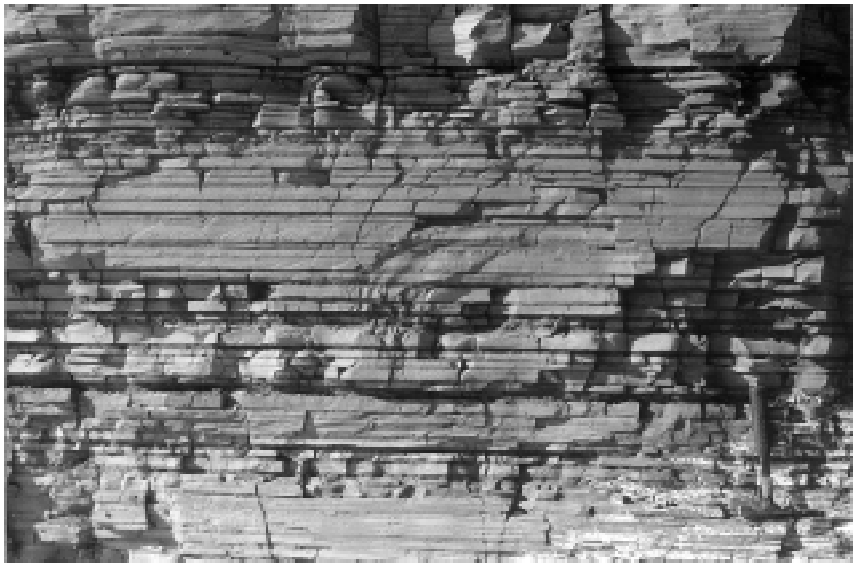

Fig. 64. Thin, parallel-bedded lime mudstones with calcareous mudstone partings; Erlandsen Land Formation, reference section.

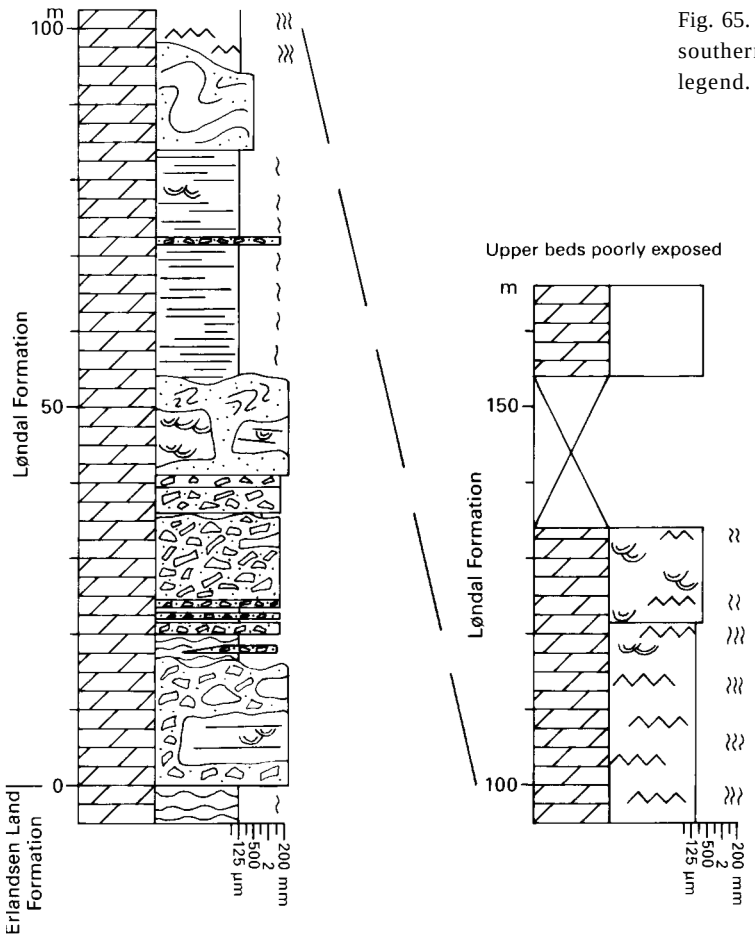

Fig. 65. Type section of the Løndal Formation, Løndal, southern Peary Land (Figs 56, 57, 60). See Fig. 14 for legend.

Boundaries. At the type section, the base of the formation is sharp but highly irregular; it 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 9 km south-east of the type section (Fig. 46), and the carbonates of the Ekspedition Bræ and Erlandsen Land Formations coalesce into one indivisible succession of dark weathering, recessive, thin-bedded carbonates which conformably overlies the Sydpasset Formation. These strata are assigned to the Erlandsen Land Formation, and consequently the Ekspedition Bræ Formation is not recognised 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 5, 46, 56). The boundary is sharp and often hummocky and is placed where platy, dark grey, recessive weathering dolomites overlie pale cream weathering, cliff-forming dolomites of the upper Sydpasset Formation (Fig. 63).

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 (Fig. 59). At the reference section, 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 62, 63).

Distribution. The formation is recognised east of Hans Tavsen Iskappe and it crops out from the eastern margin of the ice cap, east across Erlandsen Land to the limit of outcrop of the Tavsens Iskappe Group, about 8 km north of the eastern end of Øvre Midsommersø (Fig. 56).

Exposure is poor in central Erlandsen Land with the best exposed areas being around Løndal; accessible sections with reasonable exposure are obtainable at the type and reference localities (Fig. 57).

Fig. 66. Large-scale lenticular packaging of strata within the Løndal Formation, north of the type section. Viewed towards the south, this represents a strike section through northward-prograding platform foreslope deposits and illustrates the lenticular nature of individual prograding lobes. Section illustrated is about 200 m thick.

Fauna and age. Fossils are locally abundant and these include brachiopods, molluscs and trilobites, indicative of a medial Middle Cambrian age (Palmer & Peel, 1979; R. A. Robison, written communication, 1981).

Løndal Formation

new 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 Tavsen Iskappe, south-west Peary Land (Figs 2, 57).

Type section. Fig. 65; on the west side of Løndal, south-west Peary Land (Figs 57, 60).

Thickness. Approximately 250 m 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 (Fig. 65), the lower 50 m of the formation is dominated by dolomite breccia beds interbedded with dark grey, bituminous, thin-bedded and parallel-laminated dolomites. The breccia beds range from 0.5 m to 30 m in thickness and are composed of a mixture of tabular, dark, laminated clasts and boulders and slabs of pale yellow weathering ooidal and coarse crystalline dolomite in a darker dolomite matrix. The basal breccia bed is variable in thickness laterally and locally contains huge pale dolomite slabs up to 100 m across.

The breccia-dominated basal unit is overlain by a succession of thin-bedded, yellow-brown weathering, medium to fine crystalline dolomites; pale laminae and thin graded beds (5–20 cm 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-bedded to thick-bedded dolomites in which lamination is commonly absent or discontinuous.

Pale cream weathering, medium to coarse crystalline dolomites are common near the middle, and they 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-bedding are recognisable locally.

Lateral facies variation in the Løndal Formation is clearly evident in Løndal. To the north of the type section, the pale dolomites (above 70 m in the type section) interdigitate with dark, grey-brown weathering, bioturbated dolomites which form a progressively larger proportion of the formation in northern Løndal. Figure 66 illustrates the 3-dimensional complexity of this transition. This south-to-north facies variation is recognisable throughout the outcrop area, the more southerly exposures showing a dominance of pale weathering ooidal dolomites whereas, in northern exposures, the Løndal Formation is dominated by darker weathering dolomites which include bioturbated do-

lomites, parallel-laminated, graded dolomites and dolomite breccia beds.

Boundaries. The cliff-forming Løndal Formation conformably overlies the recessive and 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 (Fig. 65). To the east, at the reference locality of the Erlandsen Land Formation, the base of the Løndal Formation is defined at the change in weathering colour and break of slope, where yellow-brown weathering, medium-bedded, burrow-mottled dolomites overlie thin, wavy-bedded dark grey dolomites (Figs 62, 63).

The Løndal Formation is overlain unconformably by the Wandel Valley Formation. The upper beds of the formation are poorly exposed throughout Erlandsen Land, however, and the unconformity has not been observed in detail. 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. The unconformable nature of the boundary is thus not demonstrable but is assumed by correlation with adjacent areas (Figs 5, 46).

Distribution. The formation crops out from the eastern margin of Hans Tavsen Iskappe, east across Erlandsen Land to the eastern limit of the Tavsens Iskappe Group, north of the eastern end of Øvre Midsommersø (Figs 2, 56). It is best exposed and accessible along the west side of Løndal and in the ravine at the reference section of the Erlandsen Land Formation (Fig. 57).

Fauna and age. The Løndal Formation is generally unfossiliferous, but dark dolomites near its base yield phosphatic brachiopods which resemble the Middle Cambrian acrotretid *Prototreta* (A. R. Palmer, written communication 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.

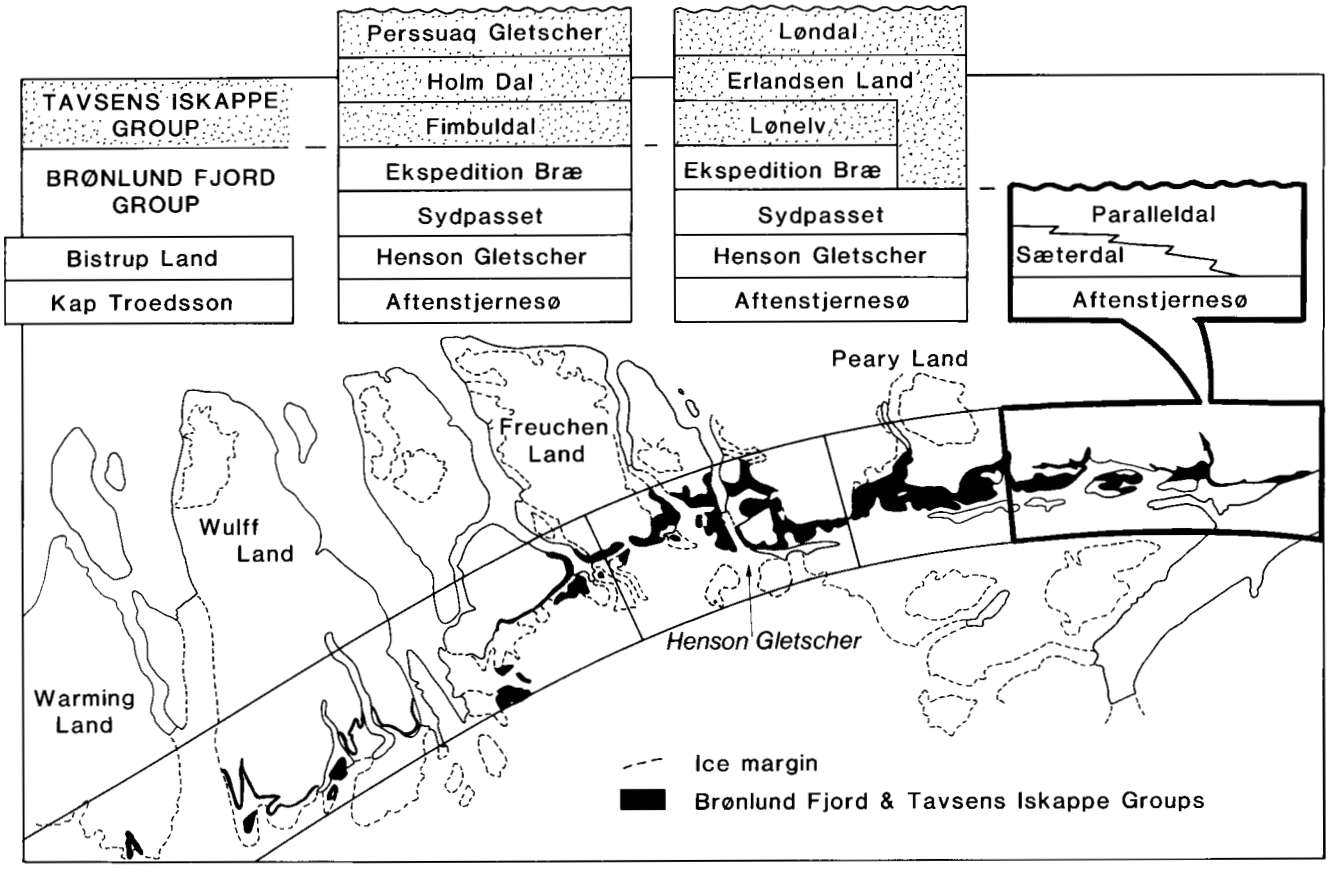

Fig. 67. Map showing the location and stratigraphy of the Paralleldal region in relation to the remainder of the southern outcrop of the Brønlund Fjord Group.

Paralleldal region

This region extends from the eastern end of Øvre Midsommersø to the shores of Independence Fjord (Figs 2, 67). In this area, the Brønlund Fjord Group conformably overlies the Buen Formation (Early Cambrian) and is overlain unconformably by the Wandel Valley Formation (late Early – Middle Ordovician) of the Ryder Gletscher Group; the Tavsens Iskappe Group is not represented. The Brønlund Fjord Group in this region consists of the Aftenstjernesø, Sæterdal and Paralleldal Formations; the Sæterdal Formation is recognised only in the western part of the Paralleldal region (Figs 5, 26, 67, 68).

Brønlund Fjord Group

On the north side of Paralleldal, at the type section of the Paralleldal Formation, the Brønlund Fjord Formation is 215 m thick; the group thins both southwards and eastwards to the mouth of Børglum Elv, the type area, where the group is about 175 m thick.

Aftenstjernesø Formation

The formation thickens eastward from 27–40 m in Sæterdal and western Paralleldal to *c.* 130 m at Børglum Elv (Figs 26, 68). In western Paralleldal, north of Frysefjeld, the formation has a distinctive banded appearance, made up of a thin, basal, yellow-brown stripe, a middle, dark grey-brown weathering dolomite interval and an upper pale cream weathering unit. The basal pale weathering unit (*c.* 2 m thick) consists of nodular, argillaceous skeletal dolomites, typically containing detrital glauconite and phosphorite, and black phosphorite seams (Member A of Christie & Peel, 1977; fossils from this interval were noted by Peel *et al.*, 1974; Palmer & Peel, 1979; Bendix-Almgren & Peel, 1988). The succeeding beds are thin, parallel-bedded, mid to dark grey dolomites, locally displaying grading, interbedded with nodular dolomites showing irregular, amoeboid and burrow-shaped nodule forms. A clast-supported breccia bed (1–12 m thick) occurs at the top of the formation in many sections.

Similar facies form the thickened Aftenstjernesø Formation in the Børglum Elv valley, where the formation is dominated by a highly distinctive, thick breccia bed that immediately overlies the phosphoritic nodular dolomites ('Member A') at the base of the formation. This breccia bed is thickest at the mouth of Børglum Elv (30–40 m) and it thins north and west, wedging out between the western end of Buen and Frysefjeld (Fig. 68). The breccia is typically clast-supported, composed of tabular and irregular, nodular clasts of coarse pebble to cobble grade (see Christie & Peel, 1977, Fig. 8). It also includes large, pale dolomite blocks several tens of metres across which commonly protrude from the top of the breccia bed; they are draped by darker, thin-bedded dolomite, producing the hummocky, billowing surface that is so conspicuous in the cliffs around the mouth of Børglum Elv and north of Jørgen Brønlund Fjord (Figs 3, 17).

Sæterdal Formation

new 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 southern Peary Land, the north-east to south-west trending valley that meets Wandel Dal at the eastern end of Nedre Midsommersø (Figs 2, 68).

Type section. Fig. 69; the type section is on the east side of a steep stream valley (Fig. 70) entering the north-western side of Sæterdal (Fig. 68).

Thickness. Approximately 130 m at the type section (Fig. 69), thinning west along the north side of Wandel Dal to the western limit of the formation, north of the eastern end of Øvre Midsommersø (Fig. 67). The Sæterdal Formation thins rapidly east and south of the type section, eventually pinching out about 18 km east of the type locality (Figs 26, 68).

Lithology. The siliciclastic-dominated Sæterdal Formation forms banded recessive slopes between the cliff-forming carbonate formations above and below (Fig. 30). At the type section (Fig. 69), units dominated by cream weathering, thin-bedded to thick-bedded, fine-grained sandstones alternate with dark, recessive units dominated by parallel-laminated, ripple cross-laminated and bioturbated siltstones and silty sandstones. The pale sandstones are well-sorted, although locally containing shell fragments and outsize siltstone clasts. They form laterally persistent beds, 0.1–1 m thick (Fig. 71); erosive contacts and bed amalgamation are

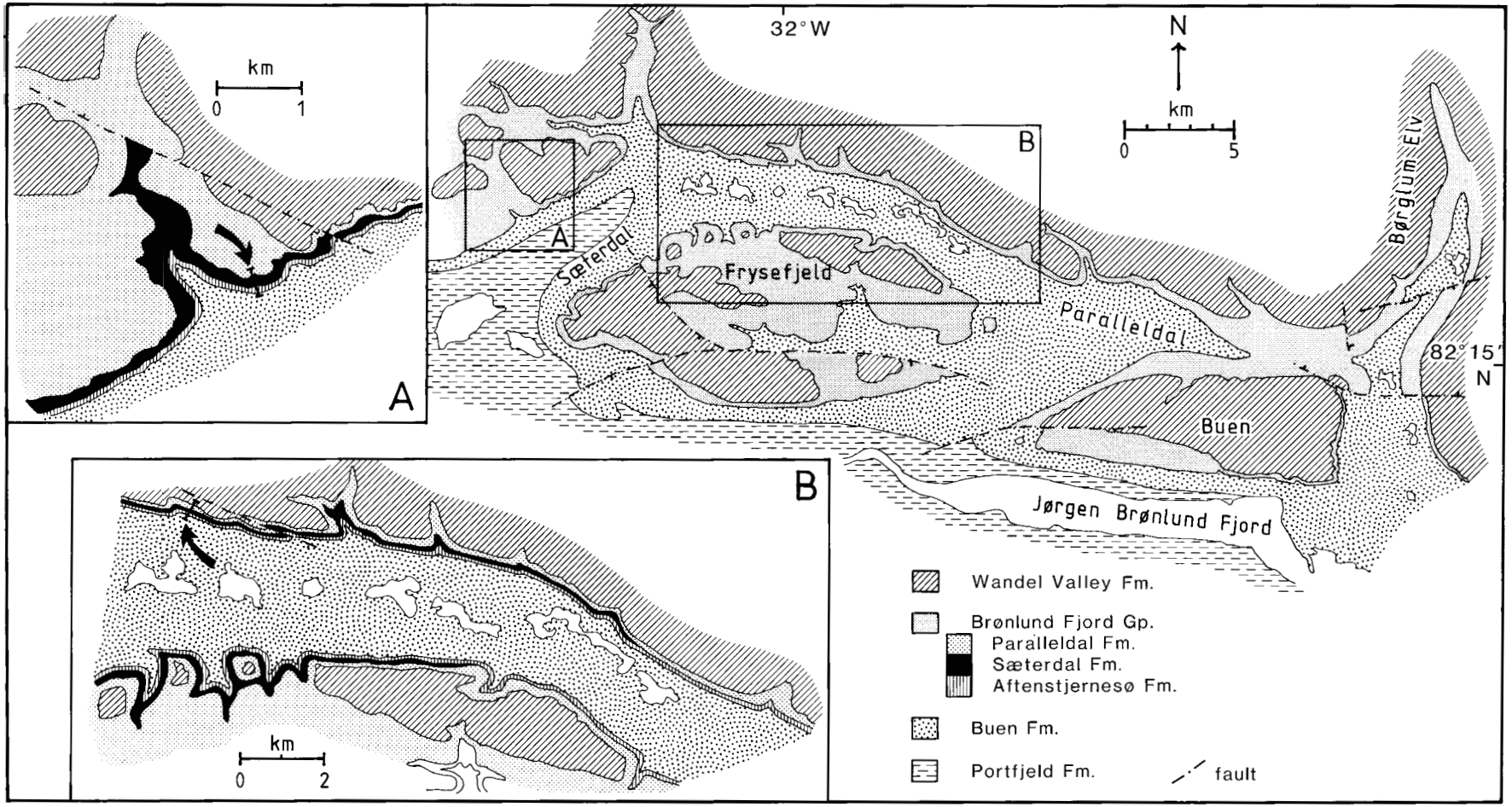

Fig. 68. Geological sketch map of the Paralleldal region showing the distribution of the Brønlund Fjord Group from the eastern end of Nedre Midsommersø to the type area of the group at Jørgen Brønlund Fjord (see Fig. 17). Inset maps A and B show the locations of the type sections of the Sæterdal and Paralleldal Formations respectively; note that the Sæterdal Formation pinches out eastwards (inset B).

observed locally. Internally, the beds are commonly structureless or show diffuse parallel lamination, but locally they exhibit normal grading, hummocky cross-stratification, internal erosion surfaces and convolute lamination. Slump folds are common at the type section. Dark, laminated, bioturbated and glauconitic skeletal dolomites occur at the base of the formation.

The sand-dominated intervals thin east and west of the type section, concomitant with the thinning of the formation, 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 30, 69, 70).

The upper boundary is defined at the abrupt change from recessive weathering siliciclastic sediments to the overlying cliff-forming carbonates (Fig. 69). At the type section, it is somewhat obscured by mottling, fracturing, brecciation and geopetal cavity fills, features which are interpreted as the result of karstic processes at the sub-Wandel Valley Formation unconformity (Ineson, 1985). Elsewhere, the boundary is planar and sharp where cliff-forming carbonate mass-flow breccia overlies recessive dolomitic sandstones and dolomites (see Figs 72, 73).

Distribution. The Sæterdal Formation crops out from the western arbitrarily defined limit, north of the eastern end of Øvre Midsommersø, eastwards along the northern side of Wandel Dal, on both sides of Sæterdal and the western end of Paralleldal (Figs 2, 67, 68). 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 central Paralleldal (Figs 26, 68).

The formation is poorly exposed along the north side of Wandel Dal and over much of Frysefjeld. It is well exposed on the north side of Sæterdal, but commonly inaccessible.

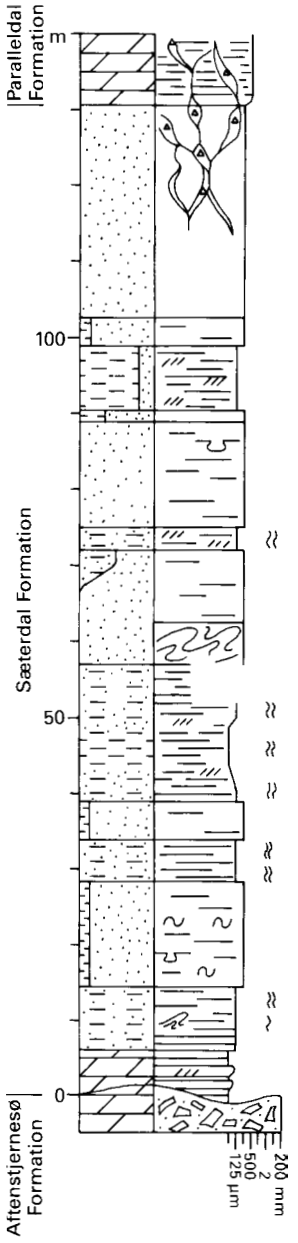

Fig. 69. Type section of the Sæterdal Formation, north-west side of Sæterdal, southern Peary Land (Figs 68, 70). See Fig. 14 for legend.

Fauna and age. The formation is poorly fossiliferous in general, but sandstone beds locally yield a diverse fauna including moulds of articulate and inarticulate brachiopods (*Kutorgina* and *Nisusia*) and trilobites indicative of a late Early Cambrian age (Palmer & Peel, 1979). Blaker (1991) described *Bonnia brennus, Kootenia marcoui* (both of which also occur in the Henson Gletscher Formation, to the west), *Olenellus* cf. *O. gilberti* and undetermined ptychoparioids. The fossils occur at various stratigraphic levels with the highest being about 20 m from the top of the formation. Thus it seems likely that the whole formation is of late Early Cambrian age.

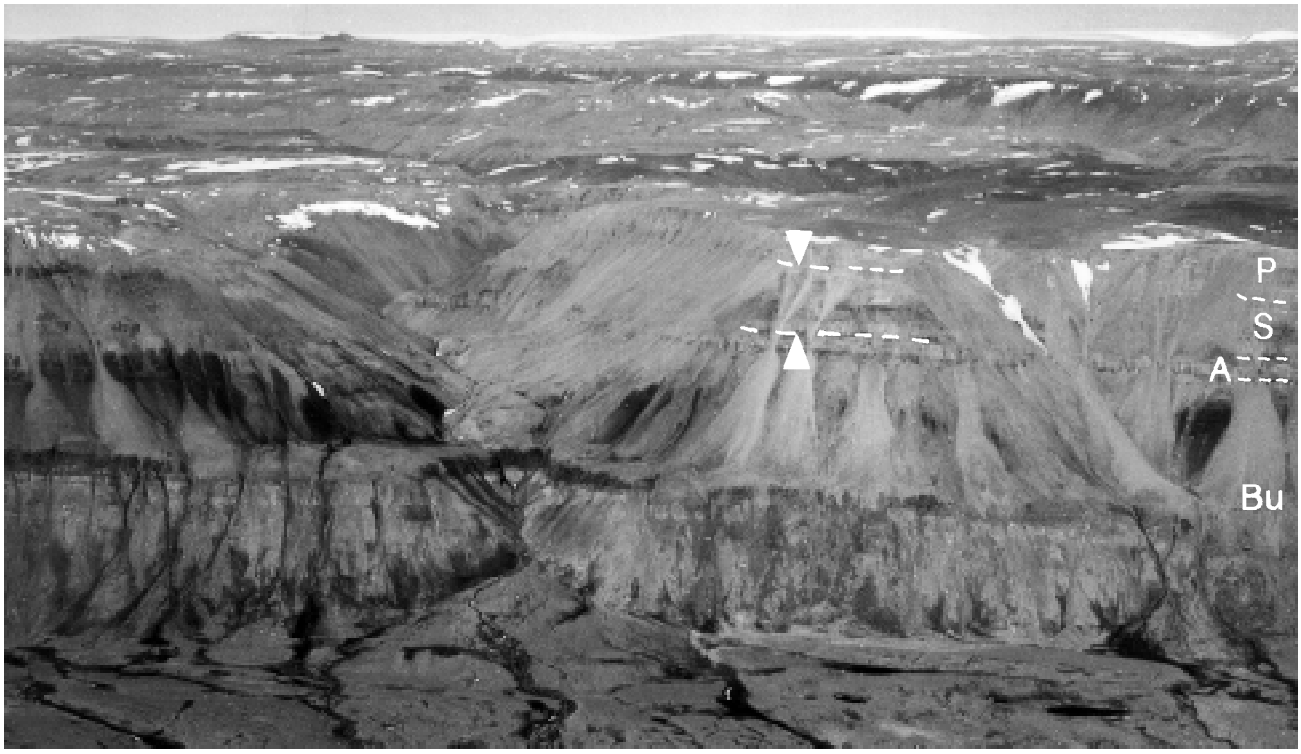

Fig. 70. Cambrian succession on the north-west side of Sæterdal: the largely scree-covered upper Buen Formation (Bu) is succeeded by cliff-forming dolomites of the Aftenstjernesø Formation (A), banded siliciclastics and subordinate carbonates of the Sæterdal Formation (S; type section arrowed) and poorly exposed carbonates of the Paralleldal Formation (P).

Paralleldal Formation

new 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 (Figs 5, 17, 67). At Børglum Elv, it 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 (Figs 2, 68).

Type section. Fig. 72; the type section was measured up a steep gully on the north side of Paralleldal (Figs 68, 73), approximately 2 km east of Sæterdal.

Thickness. The formation attains a thickness of 141 m at the type locality, thinning westward along Sæterdal. The formation thickens eastwards from the type section, as the underlying Sæterdal Formation thins, reaching a maximum measured thickness of 165 m on the north side of Paralleldal (Fig. 68). In the valley of Børglum Elv, the formation is approximately 40 m thick (Fig. 26).

Lithology. The dolomites of the Paralleldal Formation commonly form steep cliffs above the recessive Sæterdal Formation and below the pale thin-bedded dolomites of the Pyramideplateau Member of the Wandel Valley Formation (Fig. 73). At the type section (Figs 72, 73), the lower third of the formation shows grey-brown weathering and is composed of dark grey, laminated, nodular and graded dolomites (Fig. 74), interbedded with thick breccia beds which locally contain rafts of thin-bedded dolomite up to 5 m thick. The remainder of the strata at the type section weathers orange-brown or pale yellow and is composed largely of oolitic, bioclastic, intraclastic and peloidal dolomites showing medium-scale to small-scale trough and tabular cross-bedding. Parallel-laminated dolomites and dolomite breccia beds occur in places. The upper 30 m of the formation at the type section comprise pale medium-coarse crystalline dolomite which is predominantly structureless but large tilted angular blocks of pale, medium- to thick-bedded, cross-bedded dolomite can be identified locally (Fig. 72).

Fig. 71. Fine-grained structureless sheet sandstones with thin siltstone interbeds and partings; *c.* 1.5 m of section illustrated. Sæterdal Formation, north Paralleldal.

East and south of the type section, the lower darker weathering interval comprises dark grey-black, silty, laminated, bioturbated and burrow-mottled dolomites; thin silicified bioclastic horizons near the base of the formation yield a diverse fauna of trilobites, molluscs, brachiopods and archaeocyathans. The dark dolomites are overlain by, and to the south interdigitate with, massive cream weathering, fine to coarsely crystalline dolomites (Fig. 75). Locally, granular cross-bedded varieties can be differentiated from the fine crystalline mottled, shelly dolomites (wackestone texture) containing archaeocyathans (Fig. 76), but more commonly these dolomites are structureless, vuggy and highly recrystallised. In the Børglum Elv region, the formation is characterised by pale yellow weathering, sugary dolomites locally showing trough cross-bedding in sets up to 0.3 m thick (see Fig. 12B).

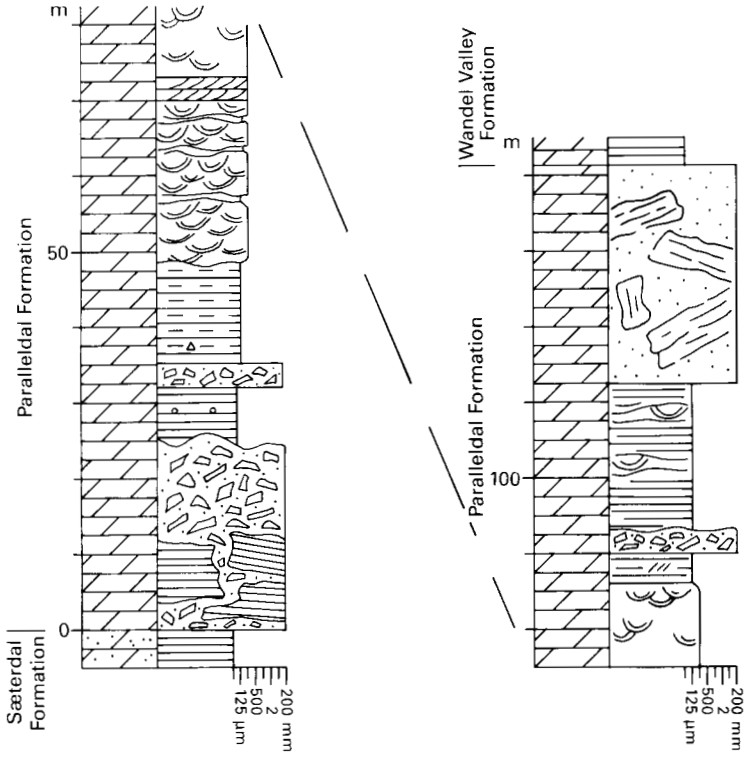

Fig. 72. Type section of the Paralleldal Formation at the western end of Paralleldal, southern Peary Land (Figs 68, 73). See Fig. 14 for legend.

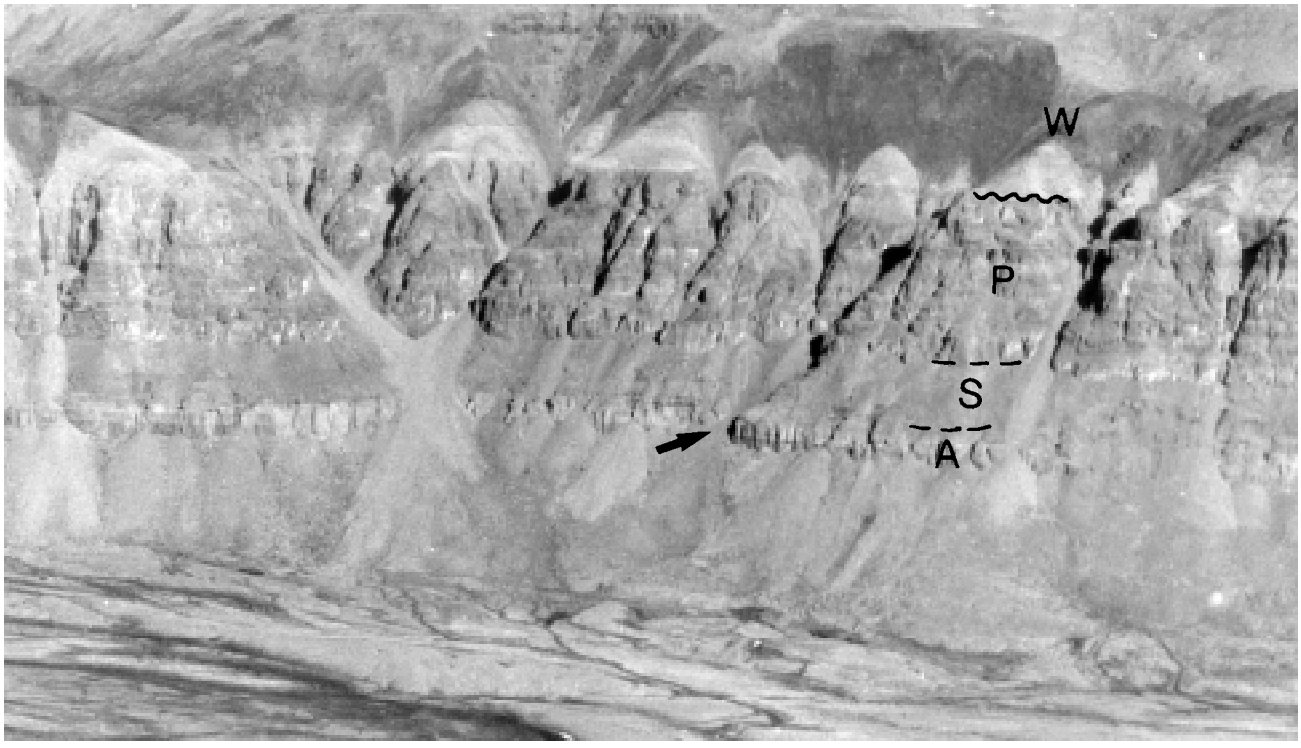

Fig. 73. Type section (arrowed gully) of the Paralleldal Formation (P) on the north side of Paralleldal. A, Aftenstjernesø Formation; S, Sæterdal Formation; W, Wandel Valley Formation.

Fig. 74. Parallel-laminated dark dolomites in the type section of the Paralleldal Formation (*c.* 25-30 m above the base, see Fig. 72), with occasional lenticular skeletal grainstone beds (at upper centre).

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 (Figs 30, 72, 73). In eastern Paralleldal, on the southern side of Frysefjeld and around Børglum Elv (Fig. 68), the Paralleldal Formation conformably overlies the Aftenstjernesø Formation. 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. 75). In the Børglum Elv valley the lower boundary is less distinct and, for mapping purposes, is taken at the change in weathering colour, from brownish-grey to pale yellow (Fig. 17). At outcrop, the boundary is defined at the first recognisable cross-bedded dolomite bed overlying structureless or slumped dolomites, assigned here to the Aftenstjernesø Formation.

The Paralleldal Formation is unconformably overlain by the Wandel Valley Formation (late Early – Middle Ordovician) with a sharp and planar contact, marked by a change from pale yellow weathering, coarsely crystalline, cliff-forming dolomites into recessive, pale grey, fine crystalline dolomites (Figs 17, 73, 75).

Fig. 75. Paralleldal Formation (P) on the north side of Paralleldal showing the interdigitation of dark laminated fossiliferous dolomites and pale archaeocyathan-bearing dolomites reflecting northward (left) progradation of shallow-water facies. A, Aftenstjernesø Formation; W, Wandel Valley Formation.

Distribution. The western limit of the Paralleldal Formation is arbitrarily defined at a line running north from the eastern end of Øvre Midsommersø (Fig. 67). East of this line the Paralleldal Formation crops out along the north side of Wandel Dal, along Sæterdal, Paralleldal and the Børglum Elv valley to the shores of Independence Fjord (Figs 67, 68). The formation is poorly exposed west of Sæterdal but well exposed in Paralleldal and the valley of Børglum Elv.

Fauna and age. At most localities, fossils are scarce; the type section has yielded only indeterminate, poorly-preserved trilobites and inarticulate brachiopods. A diverse fauna has been collected from the lower half of the formation in central Paralleldal (see Figs 75, 76), including regular archaeocyathans, trilobites (including *Kootenia* and olenellids), *Salterella*, brachiopods (*Kutorgina* and orthides) and various molluscs (including *Yochelcionella*, *Latouchella* and *Cambridium*). The archaeocyathan assemblage is typical of the middle – late Toyonian Stage of the late Early Cambrian (Debrenne & Peel, 1986). The upper beds of the formation may therefore extend into the Middle Cambrian.

Fig. 76. Silicified archaeocyathans in the Paralleldal Formation on the north side of Paralleldal (locality shown in Fig. 75).

Nordenskiöld Fjord – Warming Land region

The Brønlund Fjord and Tavsens Iskappe Groups as recognised in the Henson Gletscher – J. P. Koch Fjord region extend westwards, essentially unchanged, to

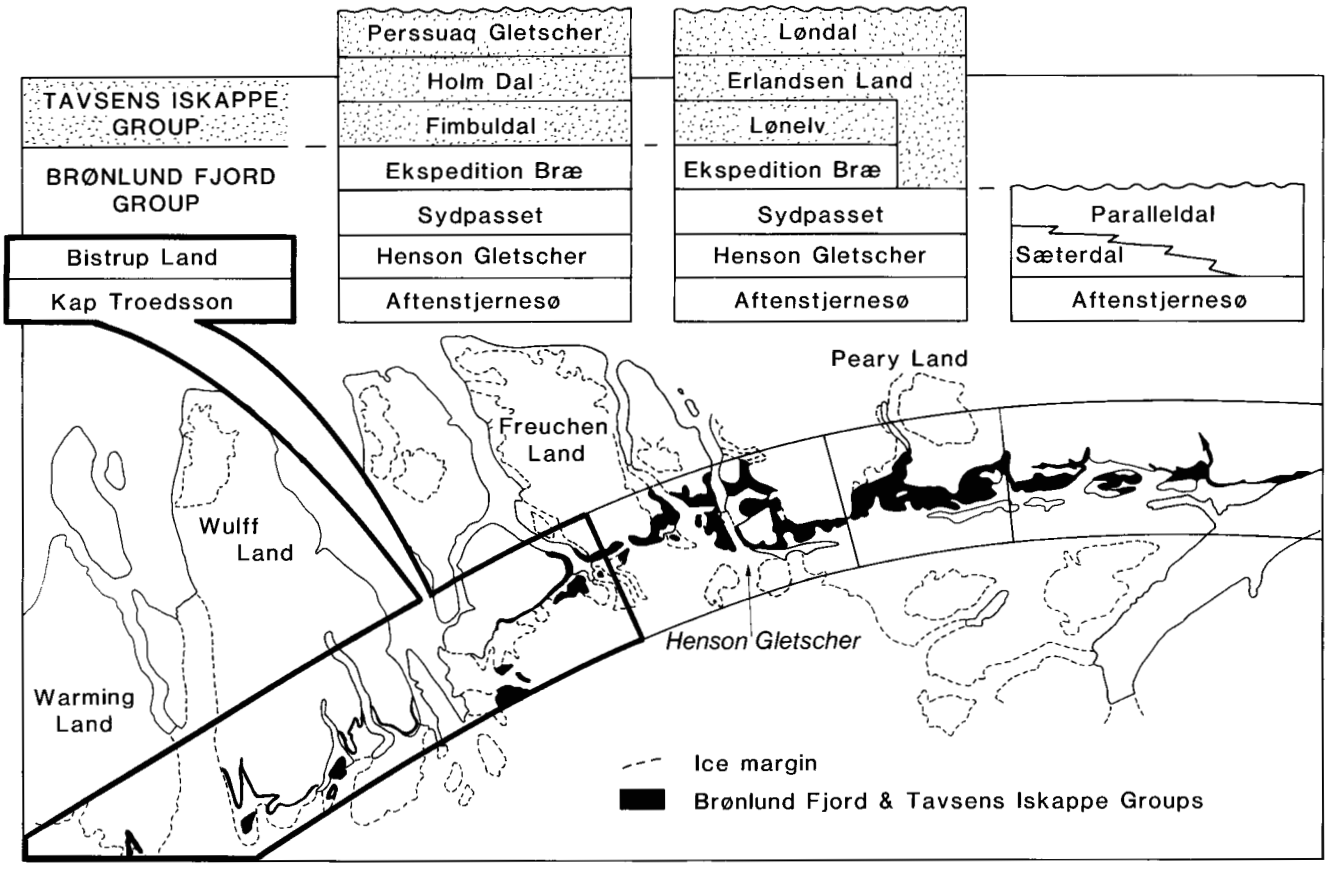

Fig. 77. Map showing the location and stratigraphy of the Nordenskiöld Fjord – Warming Land region in relation to the remainder of the southern outcrop belt.

the head of Nordenskiöld Fjord in south-west Freuchen Land. A complex facies transition occurs in this key area between the off-platform dominated strata of the Brønlund Fjord and Tavsens Iskappe Groups to the east and north-east and the western succession from Nordenskiöld Fjord to Warming Land which is dominated by platform interior strata of the Ryder Gletscher Group (see Fig. 105; Peel & Wright, 1985; Ineson & Peel, 1987). In this western area, ramp, slope apron and platform margin strata assigned to the Brønlund Fjord Group form only the lower 100 m of a thick succession (*c.* 500 m) of Cambrian carbonates.

Brønlund Fjord Group

The Brønlund Fjord Formation in the Nordenskiöld Fjord – Warming Land area is represented by the Kap Troedsson Formation and the Bistrup Land Formation (Fig. 77). These overlie the Buen Formation and are themselves overlain by strata assigned to the Ryder Gletscher Group (Ineson & Peel, 1987). Through much of the area, the Brønlund Fjord Group is about 100 m thick but thickens dramatically to about 350 m in the immediate vicinity of Nordenskiöld Fjord (see Fig. 105).

Kap Troedsson Formation

new formation

History. This formation was described informally as formation RG 1 of the Ryder Gletscher Group (Peel & Wright, 1985), but was subsequently reassigned to the Brønlund Fjord Group (Ineson & Peel, 1987). It is equivalent to the basal part of the 'undifferentiated Cambrian carbonate unit' of Peel (1980).

Name. After Kap Troedsson, a promontory into the Inland Ice in south-west Wulff Land (Fig. 78)

Type section. Fig. 79; on the eastern side of the major north–south, un-named, valley in south-west Wulff Land (Fig. 78).

Thickness. 25 m at the type section, thickening to a

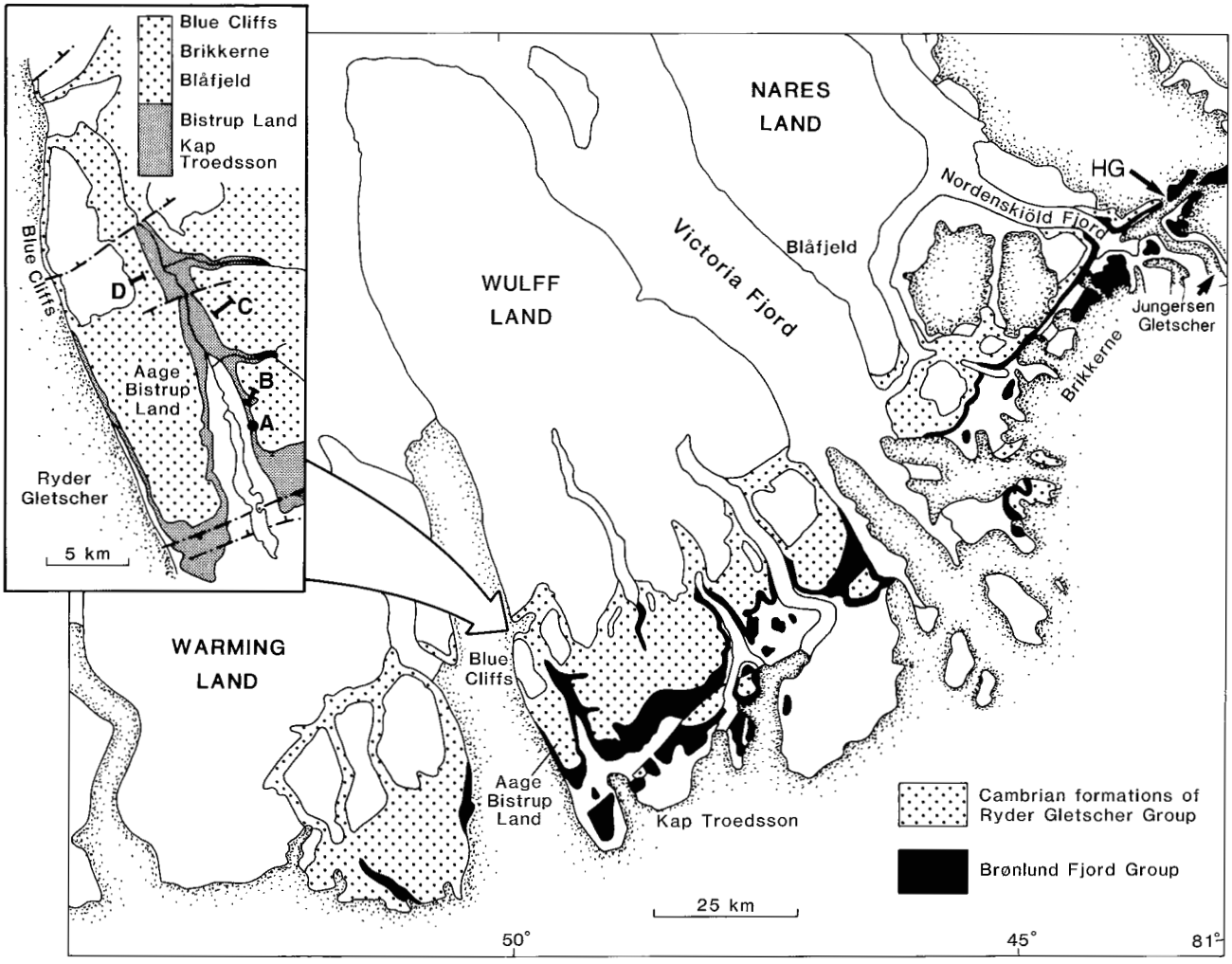

Fig. 78. Map showing the distribution of the Brønlund Fjord Group and the Cambrian formations of the Ryder Gletscher Group between Nordenskiöld Fjord in the east and south-east Warming Land in the west; HG, reference section of the Henson Gletscher Formation (see Figs 21, 32, 33). Section A (inset map) is the type section of the Kap Troedsson Formation (Brønlund Fjord Group), B is the type section of the Bistrup Land Formation (Brønlund Fjord Group), C includes the type sections of the Blåfjeld, Brikkerne and Blue Cliffs Formations (Ryder Gletscher Group) and D is the reference section of the Blue Cliffs Formation.

maximum of 65 m immediately east of C. H. Ostenfeldt Gletscher at the head of Victoria Fjord (Fig. 78). The formation thins eastwards from this locality and is much reduced in thickness (*c.* 10 m) at Nordenskiöld Fjord which forms the eastern limit of the formation (Fig. 78).

Lithology. The Kap Troedsson Formation forms a distinctive iron grey or dark grey limestone unit between recessive black shales of the Buen Formation beneath and golden-brown crags of the overlying Bistrup Land Formation (Fig. 80). Thin-bedded pale grey dolomites occur at the top of the formation but it mainly comprises a thin-bedded succession of silty, skeletal intraclastic grainstones and packstones with minor lime mudstones, intercalated with bioturbated green-grey silty mudstones (Fig. 81). The medium-grained to very coarse-grained skeletal limestone beds are 5–20 cm thick and typically have sharp, gently erosional bases and burrowed tops; U-shaped burrows (*Arenicolites*) are common. Some beds contain intraformational clasts up to cobble size; current ripple cross-lamination and hummocky cross-stratification are commonly observed. Siliciclastic siltstone interbeds are glauconitic in places while phosphoritic hardgrounds were recorded from limestones in the middle of the formation (Peel & Wright, 1985). On the east side of C. H. Ostenfeldt Gletscher, coarse skeletal limestones are rare and the formation is composed largely of parallel-bedded lime mudstones with silty mudstone interbeds and partings.

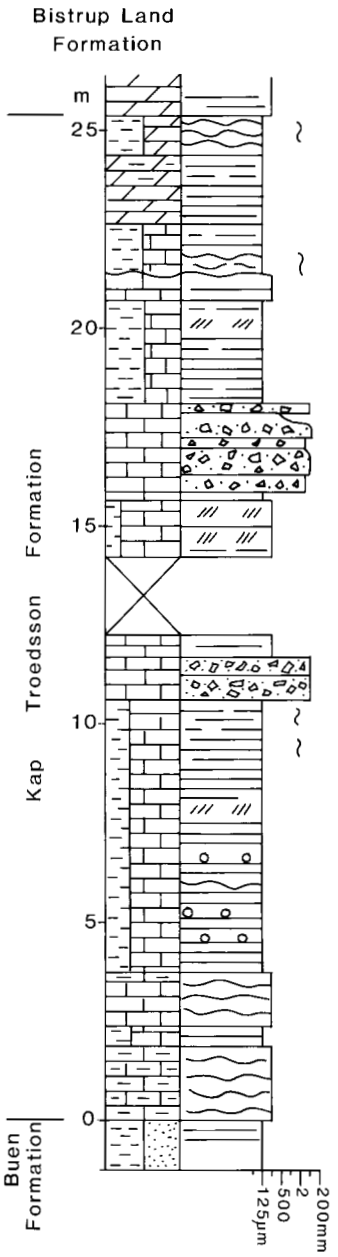

Fig. 79. Type section of the Kap Troedsson Formation, south-west Wulff Land (Figs 78, 80). See Fig. 14 for legend.

Boundaries. The carbonate-dominated Kap Troedsson Formation conformably overlies the siliciclastic Buen Formation. Rare thin skeletal limestones have been recorded from the upper levels of the Buen Formation in the Wulff Land area; the boundary is thus defined at the point where argillaceous limestones become the dominant lithology. At outcrop this boundary is abrupt and rarely ambiguous, although often poorly exposed. The formation is conformably overlain by the Bistrup Land Formation with the boundary being placed at the transition from grey, thin-bedded argillaceous limestones and dolomites into cliff-forming yellow-brown dolomites (Figs 79, 80).

Distribution. The Kap Troedsson Formation crops out from southern Warming Land westwards across southern Wulff Land to Nordenskiöld Fjord (Fig. 78); this forms the eastern limit of the formation. Farther east, across the fjord, the Kap Troedsson Formation correlates with a thin, but distinctive interval of glauconitic, phosphoritic carbonates that form the basal unit of the Aftenstjernesø Formation (Member A of the Brønlund Fjord Formation of Christie & Peel, 1977; see also Frykman, 1980).

Fauna and age. The skeletal intraclastic limestones of the Kap Troedsson Formation contain a rich, but often fragmented, fauna of trilobites and inarticulate brachiopods of late Early Cambrian age. Reports of *Olenellus*, *Callavia*, *Wimanella* and *Botsfordia* by geologists of Greenarctic Consortium, reported by Dawes from Wulff Land (1976, p. 268), are probably based on material collected from this formation, as are also the fossiliferous limestones noted by Peel (1980) from the upper Buen Formation. Blaker (1991) described the trilobites *Calodiscus lobatus*, *Ekwipagetia marginata*, *Kootenia*, *Labradoria misera*? and *Olenellus* cf. *O. truemani*, of which the latter also occurs in the Henson Gletscher Formation in Løndal and in southern Freuchen Land.

Bistrup Land Formation

new formation

History. The formation has been referred to informally as RG2 (Peel & Wright, 1985). Initially assigned to the Ryder Gletscher Group but subsequently reassigned to the Brønlund Fjord Group (Ineson & Peel, 1987), it forms part of the 'undifferentiated Cambrian carbonate unit' of Peel (1980).

Name. After Aage Bistrup Land (Fig. 78).

Type section. Fig. 82; on the eastern side of the major north–south, un-named, valley in south-west Wulff Land (Fig. 78).

Thickness. 73 m at the type section. The formation has a constant thickness across Warming Land and Wulff Land (Fig. 78) but thickens rapidly immediately southwest of Nordenskiöld Fjord where the formation is in excess of 350 m thick.

Lithology. The Bistrup Land Formation consists wholly of dolomite and typically forms yellow-brown or rusty

Fig. 80. Thin-bedded argillaceous limestones of the Kap Troedsson Formation (KT) in the type section overlain by cliff-forming dolomites of the Bistrup Land Formation (BL).

red weathering crags (Fig. 80). At the type section it is composed of two distinct portions. The lower portion (*c.* 55 m thick) consists of medium-bedded to thick-bedded graded or structureless dolomites interbedded with breccia beds up to 15 m thick (Figs 82, 83). The breccias are of coarse pebble grade, matrix-supported and show flat or rarely erosional contacts; some beds show a weak coarse-tail grading in their uppermost levels. The upper portion (18 m thick) shows pale cream or yellow weathering colours and consists of coarse intraclastic dolomites in beds 10–40 cm thick, typically showing hummocky cross-stratification (Fig. 84); trough cross-bedding and flat or low-angle parallel lamination are present in places.

At the head of Nordenskiöld Fjord, where the formation is vastly thicker than at the type locality, a similar subdivision is possible. The lower, darker weathering portion (*c.* 150 m) consists largely of platy, nodular dolomites showing varying degrees of disruption from minor pull-aparts and buckles to chaotically brecciated dolomite. Large exotic blocks of pale dolomite occur in places and large-scale wavy undulating bedding (wavelengths of tens of metres) is characteristic of this interval on the south-east side of Nordenskiöld Fjord. The upper, pale weathering portion is at least 200 m thick in this area and it forms vertical cliffs on either side of the fjord (Fig. 85). This upper part consists largely of structureless, coarsely recrystallised pale

Fig. 81. Thin-bedded skeletal lime grainstones and packstones interbedded with burrowed siltstones; a minor normal fault cuts the succession. Kap Troedsson Formation, south-west Wulff Land (locality B, Fig. 78).

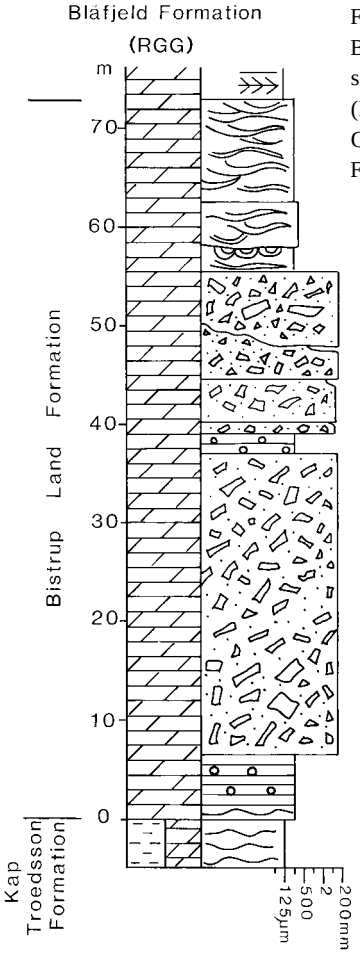

Fig. 82. Type section of the Bistrup Land Formation, south-west Wulff Land (Fig. 78). RGG, Ryder Gletscher Group. See Fig. 14 for legend.

dolomite, locally showing clinoforms dipping to the north. Recognisable primary facies include cross-bedded ooid, intraclast and pisoid grainstones with thin intervals of columnar stromatolites and microbial laminites. West of Nordenskiöld Fjord, this interval includes a vaguely banded dolomite succession of microbial boundstones with subordinate grainstones. These stromatolitic dolomites show flat, crinkly and domal lamination, and in detail exhibit clotted textures and arborescent, plumose and columnar growth forms (Ineson & Peel, 1987); archaeocyathids occur locally. Syndepositional internal cavities contain stalactitic, pendant microbial structures and are lined with early fibrous cement fringes, locally interspersed with internal sediment (see Fig. 12C).

Boundaries. The Bistrup Land Formation conformably overlies the Kap Troedsson Formation over most of its outcrop; the boundary is placed where cliff-forming yellow-brown dolomites overlie dark grey, argillaceous dolomites and limestones (Fig. 80). On the north-east side of Nordenskiöld Fiord, in Freuchen Land, cliff-forming pale dolomites assigned to the Bistrup Land Formation overlie recessive dark carbonates and siliciclastics of the Henson Gletscher Formation (Fig.85); the boundary is inaccessible but appears sharp and planar.

Fig. 83. Bistrup Land Formation at the type section showing the basal unit of parallel-bedded dolomites (carbonate turbidites) capped by a structureless mass-flow breccia bed. About 5 m of section illustrated.

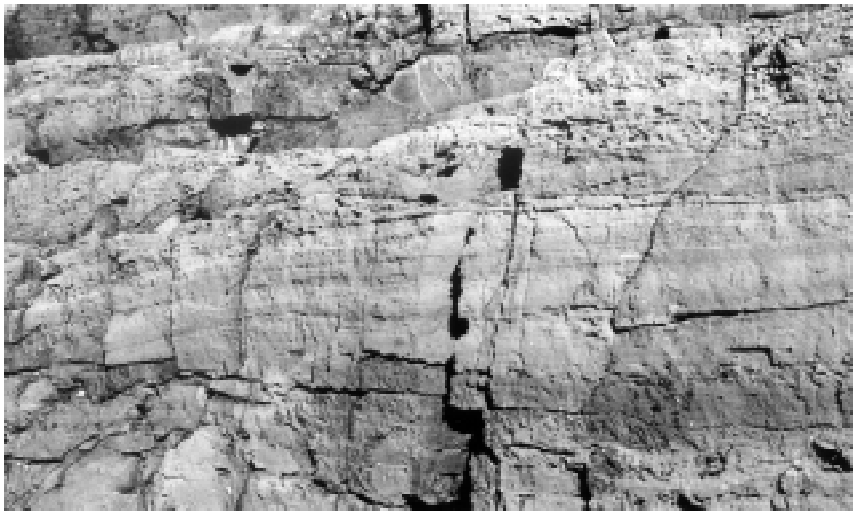

Fig. 84. Dolomites (intraclastic grainstones) near the top of the Bistrup Land Formation (locality C, Fig. 78) showing hummocky cross-stratification; section illustrated *c.* 0.6 m thick.

In the type area, the Bistrup Land Formation is overlain by dark grey-brown oncolitic and stromatolitic dolomites of the Blåfjeld Formation of the Ryder Gletscher Group (RG3 of Peel & Wright, 1985). The junction is sharp and is marked by an abrupt facies change from pale cross-bedded dolomitised grainstones to dark, burrow-mottled, oncoidal dolomites (Fig. 82). Around Nordenskiöld Fjord, the top of the formation is either poorly exposed or in inaccessible cliffs; it is overlain, apparently conformably, by thin-bedded to medium-bedded pale dolomites and sandstones assigned to the Blue Cliffs Formation of the Ryder Gletscher Group (Fig. 85; see Fig 105)).

Distribution. The Bistrup Land Formation is recognised from south Warming Land in the west to south-west Freuchen Land in the east (Fig. 78). North-east of Nordenskiöld Fjord, along the north side of Jungersen Gletscher, the massive, pale, platform margin carbonates of the Bistrup Land Formation grade laterally towards the north-east into the slope facies of the Sydpasset Formation of the Brønlund Fjord Group. Consequently this forms the eastern limit of the Bistrup Land Formation.

Fauna and age. The only fossils known from this formation are poorly preserved archaeocyathans which occur in the greatly thickened development of the formation on the western side of Nordenskiöld Fjord, where the formation is overlain by beds assigned to the Blue Cliffs Formation of the Ryder Gletscher Group (Ineson & Peel, 1987). Elsewhere in North Greenland, archaeocyathans are only recorded from the Paralleldal Formation in Peary Land (Debrenne & Peel, 1986) where they occur in rocks interpreted to represent a comparable environmental setting. The Paralleldal Formation fauna indicates a middle – late Toyonian (latest Early Cambrian) age. In the absence of more precise determination, the fauna from the Bistrup Land Formation can only be ascribed a general late Early Cambrian age.

The Blåfjeld and Brikkerne Formations, which overlie the Bistrup Land Formation in Warming Land, Wulff Land and most of the land area south of Nares Land, have not yielded fossils. The succeeding Blue Cliffs Formation has yielded Middle Cambrian trilobites from near the base of formation in south-western Wulff Land. The Bistrup Land Formation is overlain directly by this formation at Nordenskiöld Fjord.

The Bistrup Land Formation is laterally equivalent, to the east and north-east, to the Sydpasset Formation; this relationship can be observed along the cliffs on the north side of Jungersen Gletscher and Nordenskiöld Fjord (Figs 8, 105). As discussed earlier, the Sydpasset Formation is of late Early – Middle Cambrian age in its more southern exposures. The Ekspedition Bræ Formation, of medial Middle Cambrian age, overlies the Sydpasset Formation at Jungersen Gletscher and it apparently wedges out above the easternmost portion of the Bistrup Land Formation. It is possible, therefore, that the Bistrup Land Formation extends up into the Middle Cambrian in this area.

In summary, the Bistrup Land Formation is probably of late Early Cambrian age throughout its western outcrop (Wulff Land, Warming Land) but may extend up into the Middle Cambrian in its easternmost outcrop adjacent to Nordenskiöld Fjord.

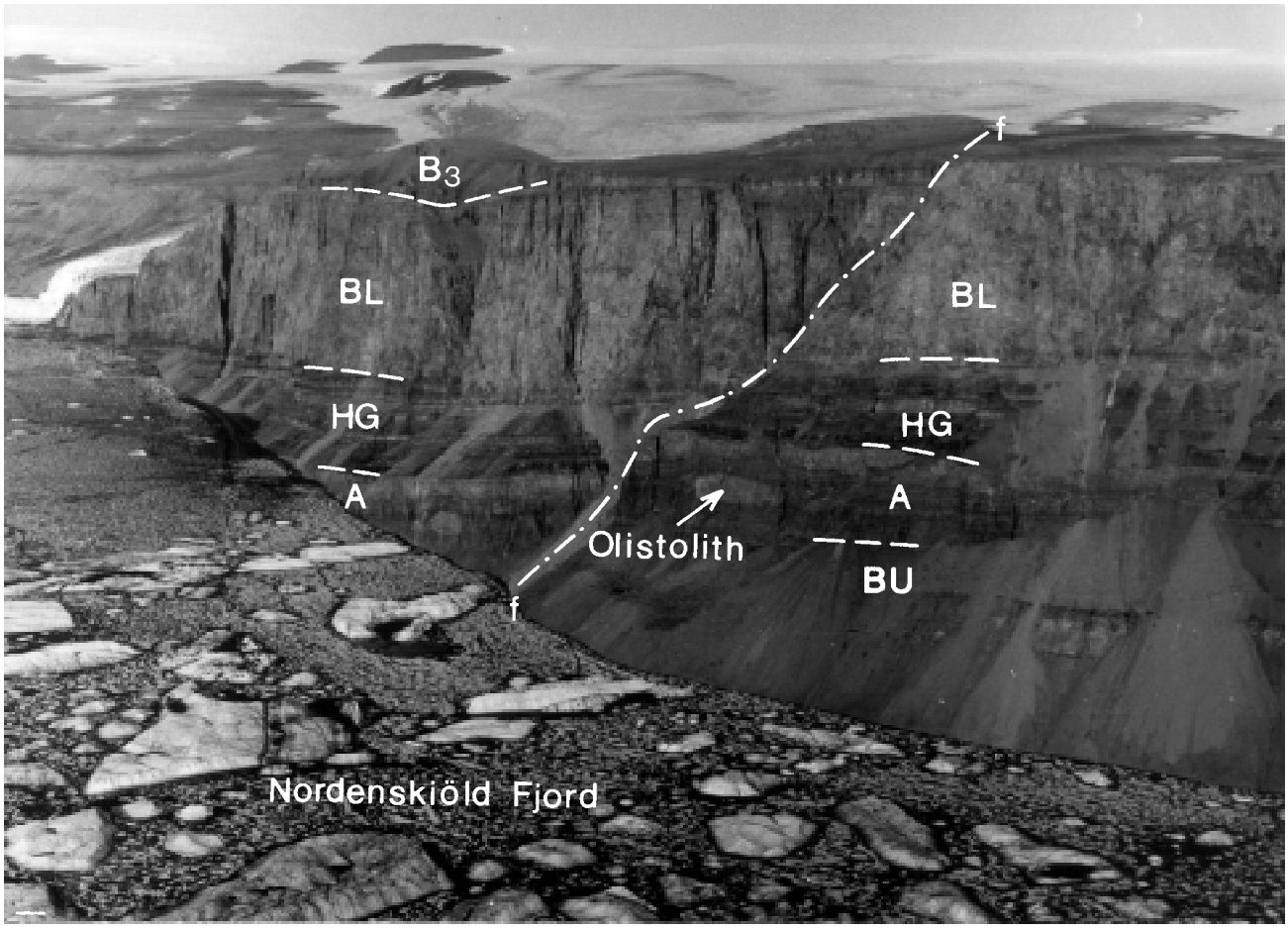

Fig. 85. Cambrian succession at the head of Nordenskiöld Fjord showing the markedly thickened Bistrup Land Formation (BL; 150–180 m thick in this section) overlying the banded slopes of the Henson Gletscher Formation (HG). Note the pale olistolith blocks in the megabreccia bed that caps the Aftenstjernesø Formation (A). BU, Buen Formation; B3, Blue Cliffs Formation; f–f, fault. From Higgins *et al.* (1991a).

Brønlund Fjord and Tavsens Iskappe Groups: northern outcrop belt

The Brønlund Fjord and Tavsens Iskappe Groups crop out in a series of anticlinal inliers and thrust slices within the southern part of the North Greenland fold belt from Nyeboe Land eastward to western Peary Land (Fig. 86). Three formations are recognised, corresponding to the lower three units of the four-part Cambrian – Lower Silurian 'starved basin' sequence described by Higgins & Soper (1985). The lower two of these formations are assigned to the Aftenstjernesø and Henson Gletscher Formations of the Brønlund Fjord Group, as defined from the southern outcrop belt around Henson Gletscher. The Kap Stanton Formation, representing the third unit of Higgins & Soper (1985), was defined by Ineson *et al.* (1994; Peel, 1994a) and assigned to the Tavsens Iskappe Group. The fourth unit, composed of cherty black graptolitic mudstones, has been referred to the Amundsen Land Group as defined from the trough succession (Friderichsen *et al.*, 1982; Higgins *et al.*, 1991a, b).

Correlation between the northern and southern outcrop belts (Figs 10, 87) was discussed by Ineson *et al.* (1994). The boundaries of the Aftenstjernesø Forma-