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THE PORTFJELD FORMATION (? EARLY CAMBRIAN) OF EASTERN NORTH GREENLAND

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The Portfjeld Formation (Jepsen, 1971) was mapped (map 1) during the 1978 field season across the so-called Hagen Fjord Arch (Dawes, 1976), through portions of the South Peary Land – Vildtland Basin and the Hagen Fjord – Danmark Fjord Basin (fig. 6). The beds are flat lying or dip gently to the north on the western side of the area, with gentle dips to the east along Danmark Fjord. The Portfjeld Formation is characterized by well bedded, grey or buff coloured dolomites which form prominent cliffs above the Inuiteq Sø Formation, the Moræneso Formation and its lateral equivalents, or the Fyns Sø Formation. A typical Portfjeld Formation succession is summarized in fig. 7 by the section measured to the west of

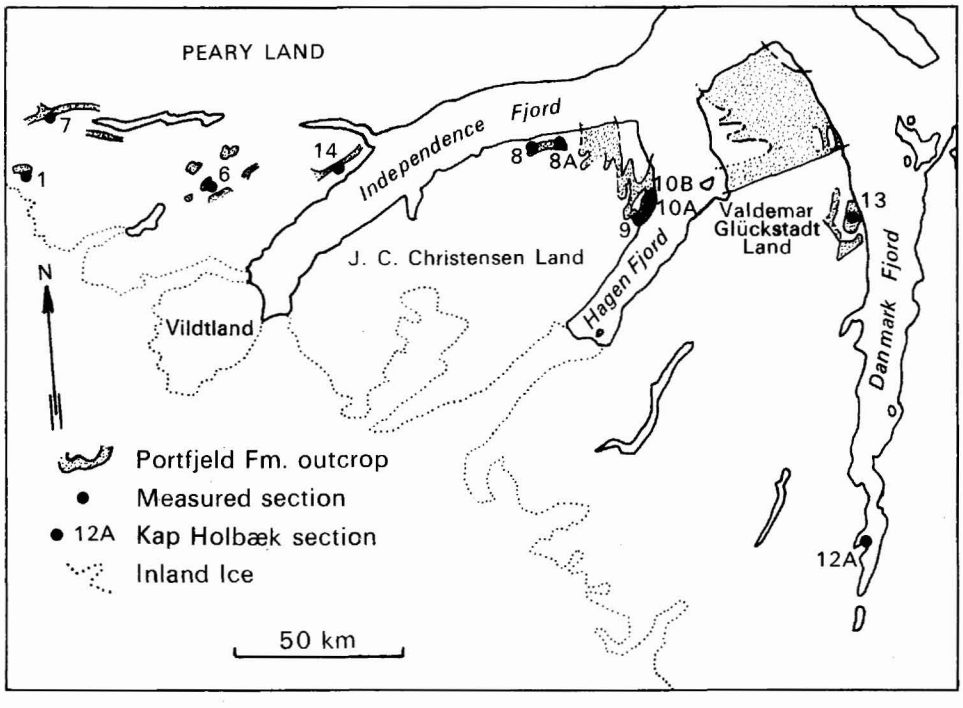

Fig. 6. Outcrop and measured sections within the Portfjeld Formation.

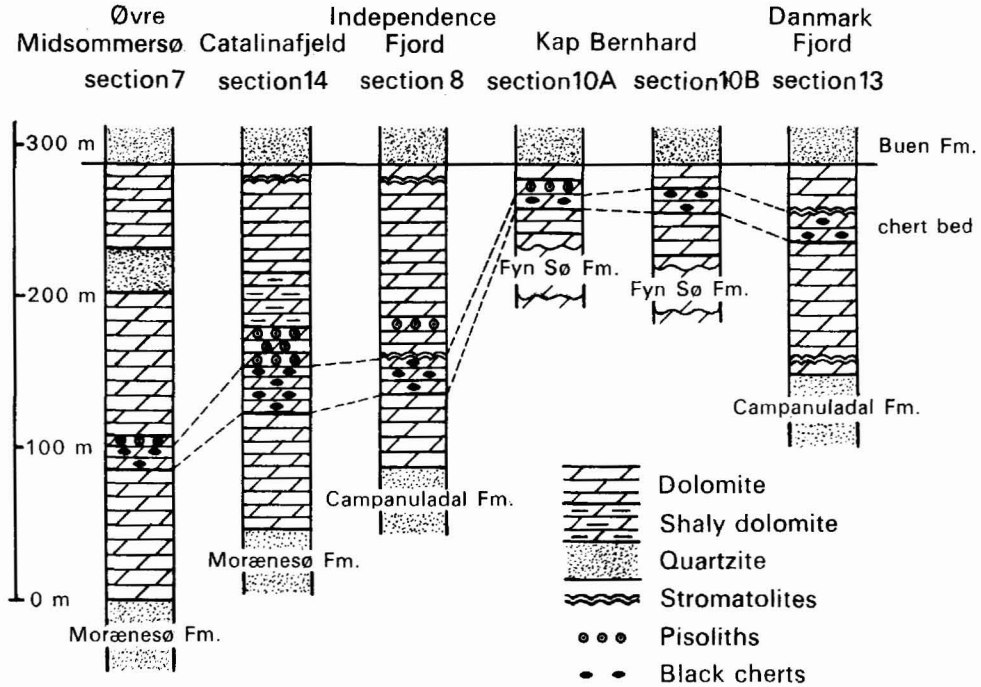

Fig. 7. Sections through the Portfjeld Formation.

Øvre Midsommersø (section 7, fig. 6). This section includes several good marker horizons which have been noted previously by several authors (Jepsen, 1971; Haller, 1971; Troelsen, 1949, 1956). These marker beds and the horizons in between are described briefly here.

The basal portion of the Portfjeld Formation varies from 85 m to 15 m in thickness (fig. 7) and typically comprises a hard, grey, flinty, recrystallized dolomite which may contain small white chert nodules, a few centimetres across. This sub-unit is well bedded and may show channels, intra-formational conglomerates, asymmetrical ripple marks and planar cross-bedding including herring-bone structures. *Collenia* type stromatolite horizons are developed in some sections although they never exceed 1.5 m total thickness.

Above these basal beds lies the most widespread and most useful marker horizon within the Portfjeld Formation, the 'Chert-Bed'. This horizon was seen at all Portfjeld Formation localities from Øvre Midsommersø in the west to Danmark Fjord in the east, including the type section of Jepsen (1971). This bedded, dark grey, bituminous dolomite horizon contains both lenses and discontinuous beds of black chert, although white and grey cherts may occur, usually above and below the black chert. These lenses are flattened in form and may measure 0.5 m across. Sedimentary structures include large scale cross-bedding, channels, intraformational conglomerates and possible mud cracks. The thickness of the Chert Bed is remarkably constant, usually being between 10 m and 15 m, although the total thickness of the Portfjeld Formation varies markedly (fig. 7).

Immediately above the Chert Bed lies a second marker horizon, a buff coloured pisolitic and oolitic dolomite. This pisolite horizon was observed at eight localities within the Portfjeld Formation and often occurs as a low cliff about 3 m high. Its thickness varies from zero to 15 m, being thickest to the west. This sub-unit is typically either cross-bedded on a large scale or shows horizontal lamination. Occasional channels and slumps are also seen.

The beds above the pisolite marker horizon show a variety of dolomitic lithologies although they are still dominated by the normal grey or buff coloured dolomites of the Portfjeld Formation. This sub-unit shows grey dolomites with minor chert concretions interbedded with oolitic dolomites towards the base. At Øvre Midsommersø these lithologies pass up into fine-grained, thinly bedded, flinty dolomites with distinctive purple, green or grey colouring. At section 1 in west Heilprin Land (fig. 6) this purple and green horizon is limestone rather than dolomite and shows sedimentary breccias, fine mud cracks, small scale bounce marks and current ripples. In general the upper beds of this unit are composed of thinly bedded dolomites interleaved with millimetre thick shaley dolomites. The beds show mud cracks, planar cross-bedding and possible slump horizons. The thickness of this sub-unit varies from 100 m to 30 m between the different sections.

The next marker horizon within the Portfjeld Formation is a quartz sandstone which shows a maximum thickness of 30 m in section 7. However, this thins rapidly to about 10 m at Nedre Midsommersø to the east (P. D. Lane, A. T. Thomas, J. Ineson and R. L. Christie, personal communication) and to a few centimetres in an incomplete section in west Heilprin Land (section 1). Peel (this report) notes a thickness of at least 20 m at Adams Gletscher in the extreme west, but the sandstone was not found at Catalinafjeld (section 14) or at any of the localities to the south-east.

The upper beds of the Portfjeld Formation, i.e. those above the sandstone marker north-west of Catalinafjeld or above the purple, green or grey flinty dolomites south-east of Catalinafjeld, have a maximum observed total thickness of 45 m and show coarse intraclasts, oolites and quartz granules set in a well-bedded grey dolomite. However, Peel (this report) measured 80 m of dolomite between the quartz sandstone and the overlying Buen Formation. Tabular cross-bedding within these dolomites is increasingly common towards the top of the formation and is associated with minor channels. South-east of Catalinafjeld beds above the fine-grained, flinty dolomites again show major cross-bedding as well as possible slump horizons, sedimentary breccias, mud cracks and *Collenia* type stromatolite horizons.

Sedimentary environment

The overall sedimentary environment is undoubtedly a shallow water, near shore environment with herring-bone structures indicating tidal influence and mud cracks showing intermittant sub-aerial exposure. Slumps, channels and intraformational breccias indicate high energy conditions. Current direction indicators measured within the Portfjeld Formation show a dominance of currents flowing from the south-east although reversals can be seen from the orientation of planar cross-beds, especially herring-bone structures, with some currents flowing from the north-west.

Base and top relationships

The actual contacts of the Portfjeld Formation with the units above and below were observed at only three localities. In two places (localities 6 and 7) the base of the Portfjeld Formation shows clastics derived from the Morænesø Formation beneath, included within the basal dolomite beds as sand grade quartz and mica flakes. These clastic grains may be found as high as 35 m above the base of the Portfjeld Formation. The top of the Portfjeld Formation where it lies beneath the sandstones of the Buen Formation was seen at section 13 on the eastern side of Valdemar Glückstadt Land. Here, blocks derived from the upper dolomite beds of the Portfjeld Formation have been eroded and are incorporated within the basal 1.5 m of the Buen Formation as an irregularly developed intraformational conglomerate. At none of these three exposures of the boundary of the Portfjeld Formation is there any evidence for unconformity, rather the incorporation of clasts of underlying lithologies within overlying beds appears to be a result of sedimentation onto an unconsolidated or poorly consolidated substrate.

Thickness variations

The measured thickness (fig. 7) of the Portfjeld Formation varies from 290 m in the west near Øvre Midsommersø (section 7) to 30 m at Hagen Fjord (section 13). In spite of these changes in the thickness af the Formation, the Chert Bed is found in all measured sections and retains its thickness at between 10m and 15m. This thinning of the Portfjeld Formation at Hagen Fjord presumably reflects the influence of the Hagen Fjord Arch (Dawes, 1976). In addition to the marked thinning of the Portfjeld Formation across the Hagen Fjord Arch, other lithological changes include the incoming of the yellow coloured Fyns Sø Formation (Clemmensen, this report) beneath the Portfjeld Formation in north-eastern J. C. Christensen Land. The Fyns Sø Formation is absent beneath the Portfjeld Formation at section 13 on Danmark Fjord, although it is found beneath the Portfjeld Formation in northern Valdemar Glückstadt Land and in faulted outcrops on the west side of southern Danmark Fjord. The outcrop of the Fyns Sø Formation appears to follow a NNW trend and may trace the line of the Hagen Fjord Arch from southern Danmark Fjord to J. C. Christensen Land.

Correlation

Two sections seen at Kap Holbæk (section 12A) and Kap Bernhard (section 9) have important implications concerning the age of the Portfjeld Formation and associated beds and also for correlation with the succession to the south-east towards Centrum Sø.

The Fyns Sø Formation is usually overlain by the Portfjeld Formation in J. C. Christensen Land but at Kap Bernhard it is overlain by the 'Clastic Interval' (fig. 8) on the southern part of the Kap and by the Portfjeld Formation to the north. The relationship between the Portfjeld Formation and the 'Clastic Interval' is not certain although the Portfjeld Formation most probably lies above the clastics occupying the higher moraine covered ground behind the cliff top. The 'Clastic Inverval' comprises 45 m of well sorted, clean, quartz sand inter-

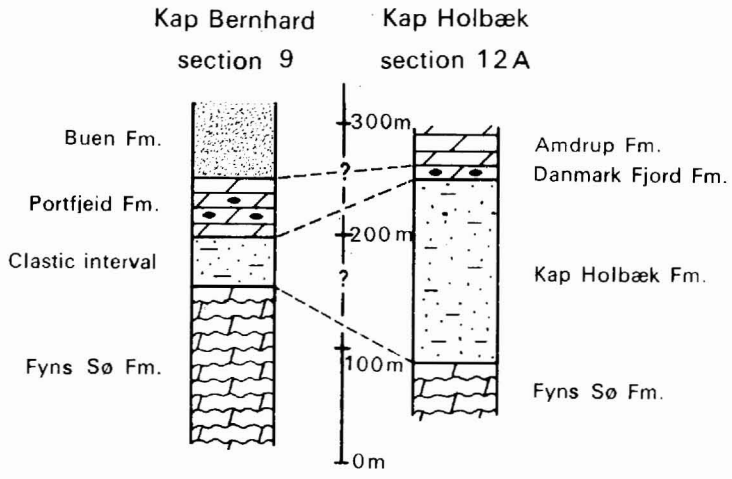

Fig. 8. Tentative correlation between sections 9 and 12A.

bedded with black shales. Sedimentary structures include channels, large scale cross-bedding and possible slump structures. In addition, upward thickening cycles are defined by the sandstones. At Kap Holbæk the Fyns Sø Formation is overlain by 150 m of the Kap Holbæk Formation which is in turn overlain by the Danmarks Fjord Formation (Adams & Cowie, 1953; Cowie, 1971). The Kap Holbæk Formation consists in part of fine to medium grade quartz sandstone, commonly showing large scale cross bedding with interbedded shales. The proportion and thickness of the sandstones increases upwards until clean quartz sandstone beds 3.5 m thick are separated by millimetre thick pale green silts about the centre of the sandstones. These silts also infill *Skolithos* burrows within the thicker sandstones. The top of the Kap Holbæk Formation is composed of sub-greywacke sandstones interbedded with shales and showing flaser bedding, asymmetrical ripple marks, large scale cross-bedding and mud cracks. Upward thickening cycles defined by the sandstone beds are also found within the Kap Holbæk Formation. The overlying Danmarks Fjord Formation bears a striking resemblance to the Chert Bed marker horizon of the Portfjeld Formation in that it is composed of 8 m of hard, dark grey, bituminous dolomite with black chert lenses. The tentative correlation presented in fig. 8 between the Kap Bernard and Kap Holbæk sections is entirely lithological. Nevertheless, the resemblance between the two sections is striking. It should be noted that the Danmarks Fjord Formation has generally (Cowie, 1971) been correlated with dolomites of the Brønlund Fjord Formation (now a part of the Brønlund Fjord Group; see Peel, this report), although Poulsen (1978) recently correlated the Danmarks Fjord Formation with the Portfjeld Formation and the lower part of the Buen Formation. The relationship between the early Ordovician Amdrup Formation (Cowie, 1971) and the Buen Formation (fig. 8) now appears problematical, but the possibility of regional overstep by the early Ordovician is discussed in this report by Peel. These problems of correlation will be solved only by further mapping to the south-east towards the localities of Adams & Cowie (1953) nearer Centrum Sø.

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