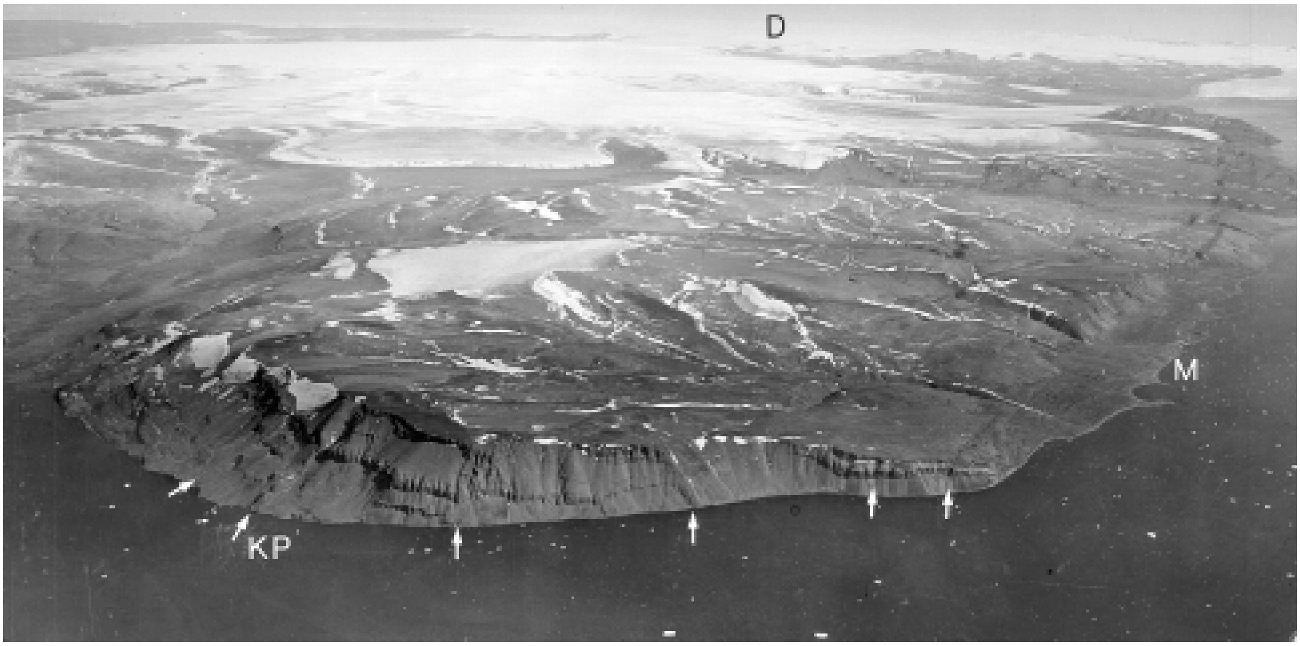


Fig. 106. Typical exposures of the Dundas Group (Steensby Land Formation) punctuated by resistant basic sills and later dykes. The Steensby Land sill complex, composed of a dozen or so Hadrynian sills, is cut by WNW-trending late Hadrynian dykes (arrowed) that represent the latest event of the Franklin magmatic episode. View is east over Granville Fjord and Moriussaq settlement (M) with Dryasbjerg (D) in the background. Kap Peary (KP) is about 650 m high. Photo: 543 I-Ø 4585, July 1950; Kort- og Matrikelstyrelsen, Denmark.

Dundas Group

The Dundas Group representing thick basinal strata is widespread in Greenland (Figs 2, 4, 120). Three units have been mapped as formations: the Steensby Land, Kap Powell and Olrik Fjord Formations. However, formal nomenclatorial definition at formational level is not made in this bulletin.

Dundas Group

new group

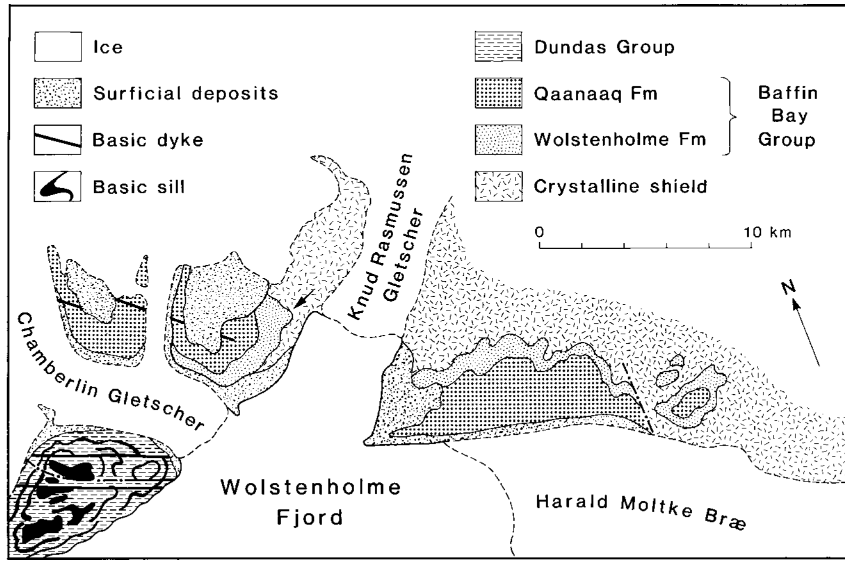
Composition. The group corresponds broadly to the 'dark shales and sandstones' of Chamberlin (1895) that were recognised subsequently by all workers to constitute a major rock series (Figs 6, 95). However, the group does not include the dolomites of Koch (1926, 1929a) thought to underlie the dark clastic rocks and mapped together with them (see Koch, 1926; Dawes & Haller, 1979, plate 1). All strata of the Danish Village formation of Kurtz & Wales (1951), as well as the lowermost beds of their Narssarssuk formation, outcropping north of Sioraq, are included in the group. The Dundas Group represents an elevation in status of the Dundas Formation of Davies *et al.* (1963) as defined in the North Star Bugt area, and as used regionally by Dawes (1976a) and Dawes *et al.* (1982a).

Name. After Dundas Fjeld, North Star Bugt, the characteristic mesa-like landmark of the Thule district (Fig. 105).

Distribution. Wide distribution in Greenland from Sonntag Bugt in the north to central Olrik Fjord in the east to Wolstenholme Ø in the south (Fig. 2).

Geomorphic expression and colour. Dark grey to brownish-weathering sediments punctuated in many areas, e.g. Steensby Land, by darker, more resistant basic sills that dominate the landscape (Figs 106, 107). Variable resistance of the well-bedded arenaceous and argillaceous beds produces stepped to terraced geomorphic expression. In southern exposures, sediments are generally poorly exposed except where protected by igneous rock; in northern Prudhoe Land the group forms some steep coastal sections with good exposures (Figs 5B, 112), but moderate slopes are prone to scree cover.

Fig. 107. Geological map of the head of Wolstenholme Fjord, Greenland. The Baffin Bay Group is composed of relatively thin outliers on the crystalline shield; the down-faulted Dundas Group is characterised by prominent basic sills and dykes. The arrow locates the view of the unconformity seen in Fig. 97. For location, see Fig. 2.



Type area. North Star Bugt area including Dundas Fjeld, Dundas peninsula and inland area. Thus defined the type area includes the 'type locality' of the forerunner to the group (Dundas Formation) referred to by Davies *et al.* (1963) as two sections, namely on Nordfjeld and Dundas Fjeld (Fig. 105). A stratigraphic log of Dundas Fjeld is given in Fig. 108.

Thickness. An unknown but very substantial thickness. The Dundas Group is estimated to be at least 2 km, possibly 3 km, thick. In view of the grossly monotonous lithology without regional markers and the separation of sections by block faulting (Figs 5B, 109), regional correlation is not obvious. True sedimentary thickness is frequently obscured by basic sills and the thickest intrusion-free sedimentary section is in northern Prudhoe Land, at least 700 m thick. The upper limit of the group is unknown since all sections are cut by the present erosion surface.

Dominant lithology. Regularly interbedded, dominantly thin- to medium-bedded, variously laminated quartz arenites, siltstones and shales, with lesser amounts of dolomite and dolomitic limestone, chert and evaporitic rocks (Figs 108, 110). Interlayering of fine-grained sandstones, siltstone and shale occurs on all scales from interlamination to thin beds. Regionally the Dundas Group shows wide lateral variation in the ratio of sandstone to siltstone-shale. In southern exposures (Northumberland Ø, Herbert Ø, southern Steensby Land, Wolstenholme Fjord and North Star Bugt) the strata are intruded by numerous basaltic sills (Figs 106, 107). In association with these, the sediments may be baked, slaty and often rusty weathered with pyrite increasing towards the intrusion.

In the type area (Steensby Land Formation; section 46, Figs 105, 108) quartz arenites are very fine grained to medium grained with gradation to siltstone, and thin laminated to medium bedded. As well as fine interbedding of shale and siltstone, coarsening-upwards cycles from shales to fine sands occur (Fig. 110A, B). Sedimentary structures include current ripples and ripple-drift bedding with transition to flaser lamination; mudcracks are common in some units, and small-scale cross lamination and bedding and small channels were noted occasionally. Shales are black to dark grey, variously laminated, fissile and micaceous with some calcareous types and in places with pyrite (Fig. 110D). Typical black paper shales are common. In the upper part siltstones may be siliceous, some thin green cherts occur and evaporite appears as bedding plane coatings, occasional nodules and as secondary veins (Fig. 110). Some laminated shale beds are dissected by a network of subconcordant veins of fibrous gypsum (Fig. 110B, C). Dolomite, in places stromatolitic (Fig. 110H), occurs as occasional thin beds showing gradations to calcareous sandstone and siltstone in which pyritic concentrations occur parallel to bedding. The carbonate rocks increase in abundance upwards.

In southern Steensby Land grey to bluish grey dolomite and dolomitic limestone form units up to several metres thick varying from massive thick-bedded rock to thin-bedded, platy dolomites (Fig. 110G). Some of these rocks are rusty weathering indicative of concentrations of iron sulphides in thin veins and small lodes. At Barden Bugt discrete beds of dolomitic limestone

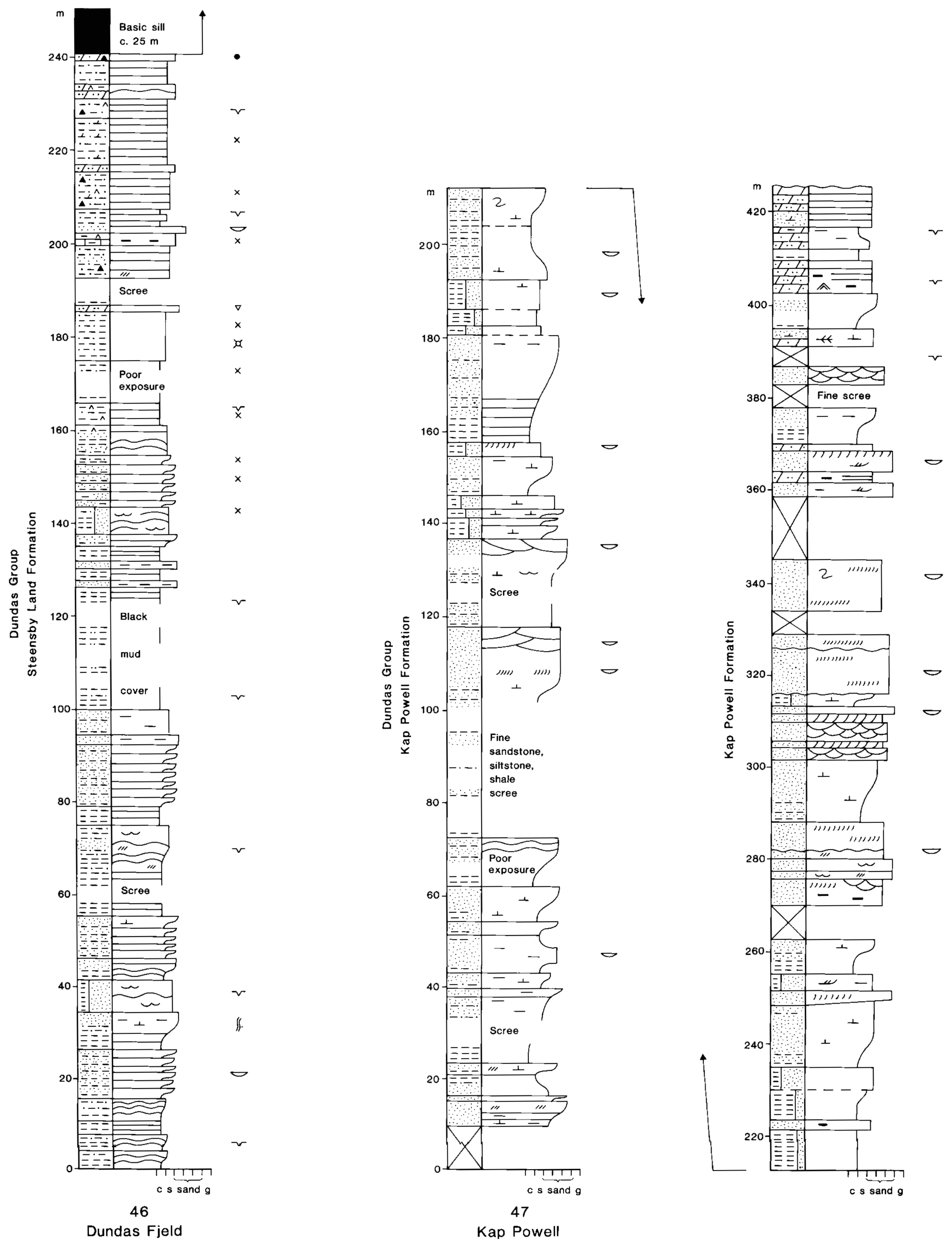


Fig. 108. Stratigraphic logs of the Dundas Group from Dundas Fjeld, North Star Bugt and Kap Powell, Prudhoe Land. The sections are compiled from the following sources: section 46, own data; section 47, mainly from O'Connor (1980). Sections are located in Fig. 105, and Figs 111, 112, respectively.

Fig. 109. The Olrik Fjord graben juxtaposing Dundas Group (D, Olrik Fjord Formation) against Precambrian shield (Ps). NS = Nares Strait Group, BB = Baffin Bay Group (Qaanaaq Formation). The view is to the west; the islands are Herbert Ø (H) and Northumberland Ø (N) with Ellesmere Island in the distance. The Barden Bugt Fault (f) is also shown (see Fig. 70). Photo: 543 L-V 1349, July 1949; Kort- og Matrikelstyrelsen, Denmark.

in black shales show small reef build-ups, commonly stromatolitic with columnar and cone-in-cone structures that may be variously brecciated (Fig. 110E, F).

Several parts of the group are dominated by thick shale sequences. One such sequence is in the Olrik Fjord graben (Olrik Fjord Formation, Fig. 109) where multicoloured shales dominate a 400 m succession. Black, grey, maroon, green, buff and brown weathering shales are variably intercalated with laminated silts and fine arenaceous beds, some of which can be calcareous. Fine-grained sandstones forming distinct geomorphic ribs occur in lower and upper parts of the succession.

In northern exposures in Prudhoe Land (Kap Powell Formation; section 47, Figs 108, 111), the succession contains more sandstone than in the type area. Quartz arenites may be coarse grained and cross-bedding is much more common; both planar and festoon types occur. Ripple marks and channels are common. The succession is characterised by prominent cliff-forming units of sandstone separated by intervals of darker sandstone-siltstone-shale (Fig. 112). The cliffed sandstones are either the tops of coarsening and thickening upwards cycles, or discrete planar sand bodies that are commonly cross-bedded and may have erosive bases. A typical cycle is: at the base, black shales with millimetre-thick sandstone beds passing upwards into laminated thinly-bedded fine-grained sandstone and siltstone containing millimetre-thick shale layers with, at the top, thin to medium bedded, medium- to coarse-grained sandstone. A few fining-upwards cycles also occur. Some shale units have a distinct green colour and sandstone-siltstones may weather olive green. Towards the top, sandstones are calcareous and yellow-weathering dolostone and arenaceous dolostone may display rip-up clasts.

Depositional environment. The Dundas Group marks a change from the continental and littoral sedimentation of the Baffin Bay Group to more basinal deposition. The general setting is suggested to be intertidal to subtidal; the many upward-coarsening units may be indicative of an overall deltaic environment. The thick coarsening-up cycles in the north (Kap Powell Formation), characterised by channels and thicker bedded, cross-bedded tops, might represent progradation delta front sequences; the thinner, lower energy cycles of the type area with some pyrite development (Steensby Land Formation) may indicate delta plain deposition. The thick shale packages are interpreted as prodelta muds. Some non-cyclic sand bodies may represent tidal channel sands and Jackson (1986) suggests that some quartz arenites in the North Star Bugt area may have been deposited by turbidity currents during storms or periods of flood. The incoming of calcareous rocks in the uppermost part of the group, both as carbonates

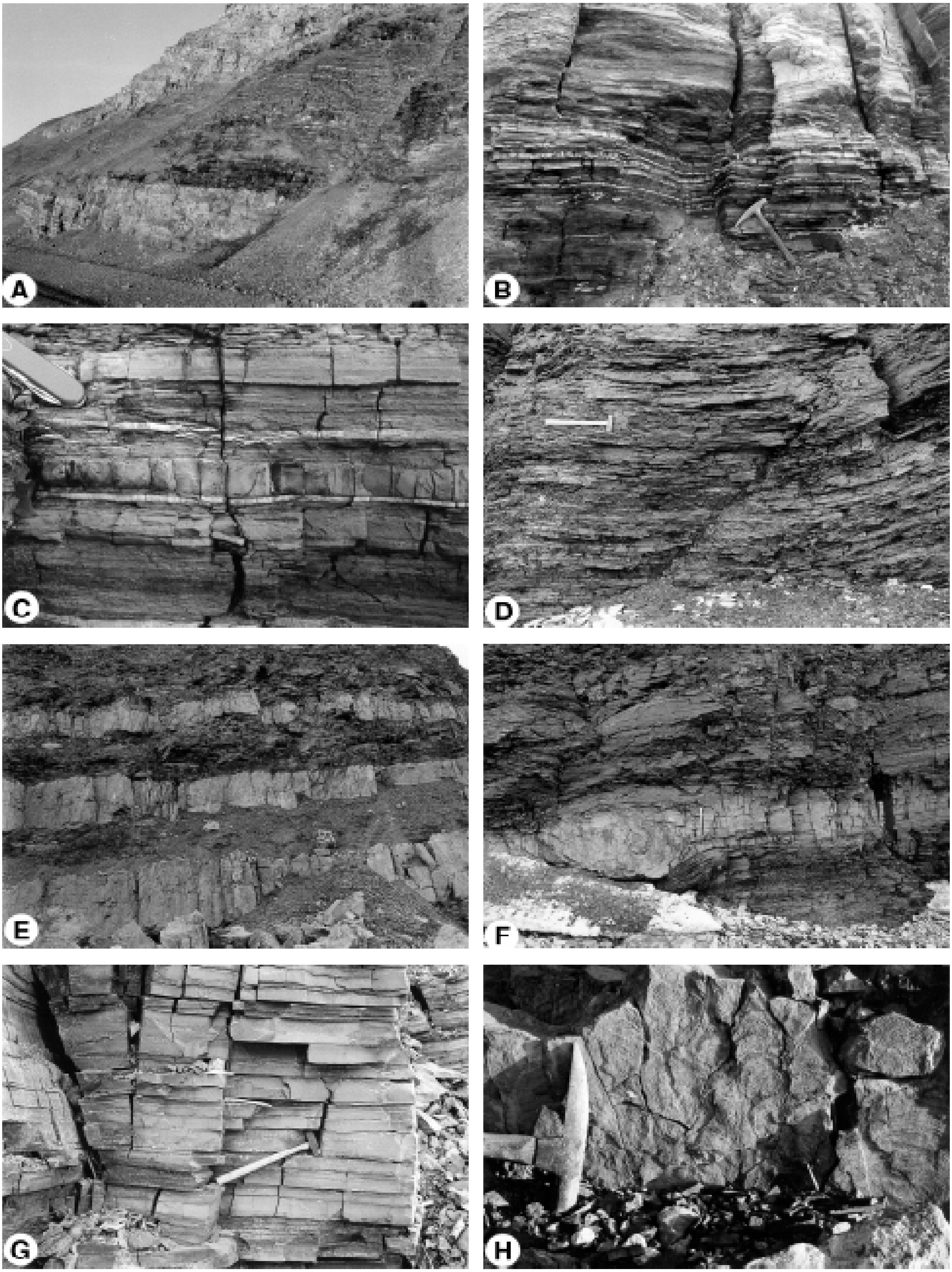
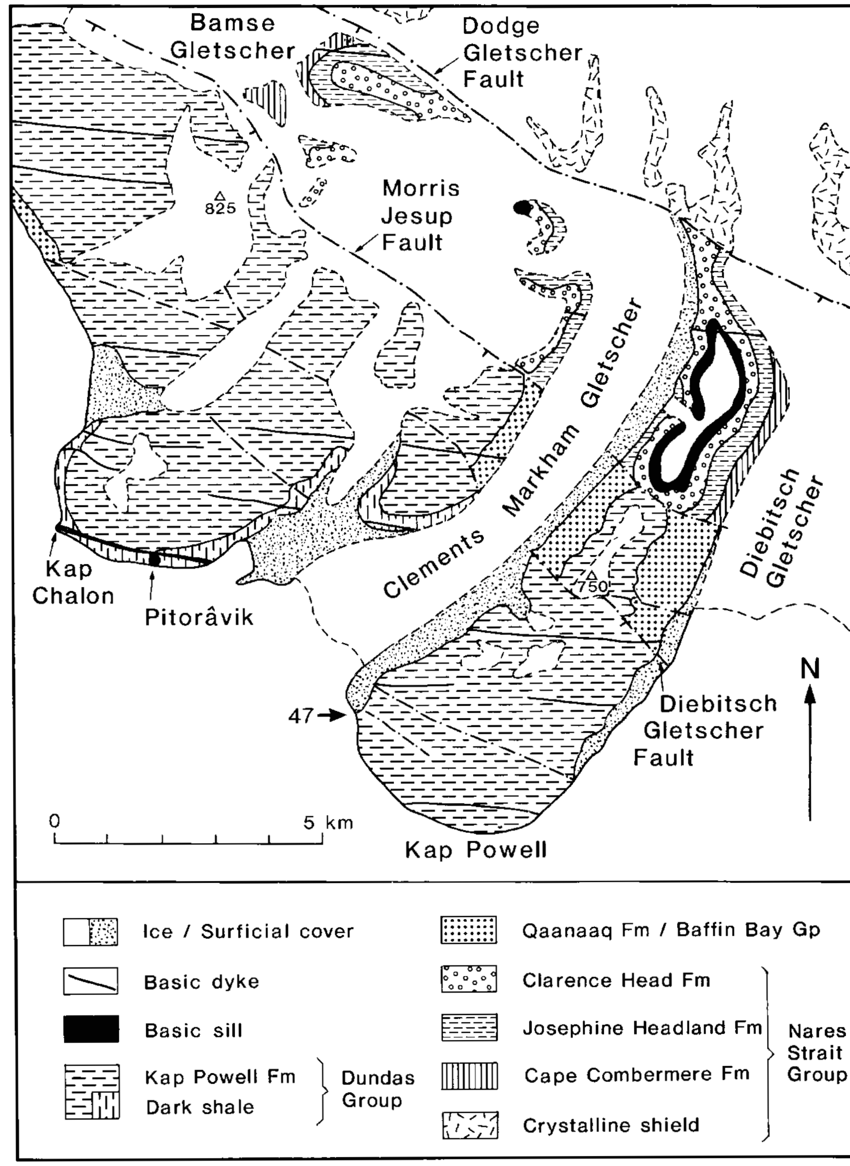

A
B
C
D
E
F
G
H

Fig. 111. Geological map of northernmost Prudhoe Land, Greenland, showing main faults with downthrow to the south-west and the location of section 47 (cf. Fig. 5B). Heights are in metres. For location, see Fig. 2.



and sulphates, together with reefs and stromatolites, are interpreted as marking a change to intertidal and supratidal environments and, as has been suggested earlier (Dawes, 1979a), progradation of the coastline and the passage to the restricted peritidal environment of the Narssârssuk Group. However, the occurrence of carbonates and evaporites with black shales invites comparison with an evaporite-euxinic shale association; the possibility that some calcareous rocks are basinal rather than littoral deposits cannot be excluded.

Fossils. Stromatolites: columns; low relief, laterally-linked domes; conical forms of *Conophyton*-type (Grey, 1995), and organic-walled microfossils (acritarchs and filamentous forms). The acritarch assemblage includes typical Late Riphean taxa known from elsewhere in

Fig. 110. Characteristic lithologies of the Dundas Group. **A:** buff-weathering shales and siltstones (5–6 m thick above beach) overlain by black shales that pass upwards into pale sandstones. White evaporite veins are conspicuous, **B:** part of coarsening-upwards unit with black shales and siltstones (ribbed by evaporite veins) passing upwards into paler fine-grained sandstones; **C:** detail of B showing fine-grained sandstone beds in shales with fibrous gypsum veins and stringers. **D:** Black shales and laminated siltstones showing lenticular bedding. **E:** Discrete pale limestone beds within black shales; **F:** small reef about 80 cm thick showing internal brecciated structure within calcareous siltstone bed; **G:** grey, thin-bedded laminated limestones with wavy bedding surfaces; **H:** stromatolites of *Collenia* type in grey arenaceous dolomite. Locations: **A**, east side of North Star Bugt; **B**,**C**, Dundas Fjeld, section 46; **D**,**E**,**F**, south coast of Barden Bugt; **G**, Nûgdlît, Steensby Land; **H**, south of Uvdle, Wolstenholme Fjord.

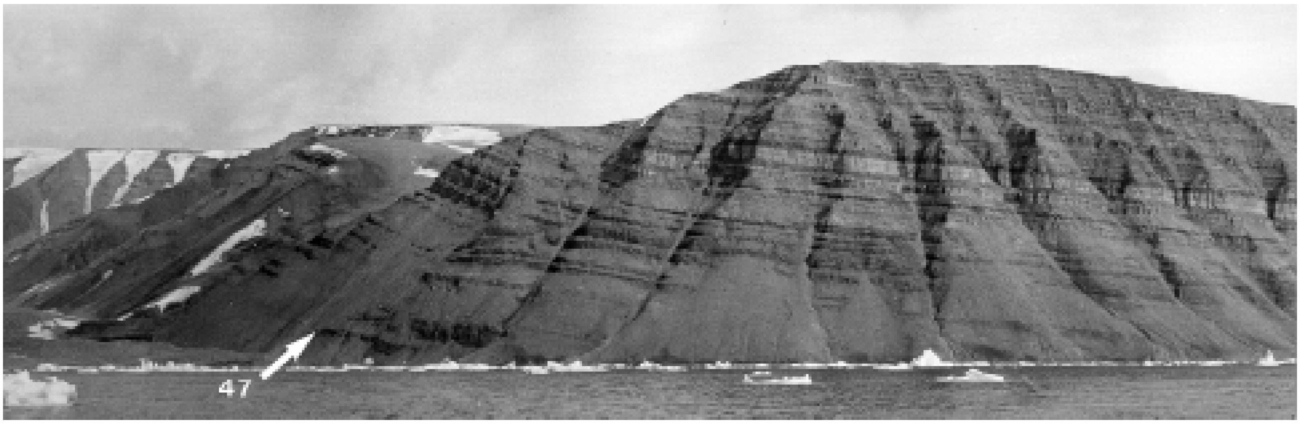


Fig. 112. Kap Powell Formation of the Dundas Group at Kap Powell, Prudhoe Land, showing the location of section 47 that is given in Fig. 108. The summit of the cape is around 500 m. Faults affect the succession on the left (see geological map, Fig. 111).

the North Atlantic (Vidal & Dawes, 1980; Dawes & Vidal, 1985), the stratigraphically most important taxa being: *Kildinosphaera*, *Lophostriata*, *K. chaginata*, *Tasmanites rifejicus* and *Vandalosphaeridium varangeri* (see under *Geological age* below).

Boundaries and correlation. The Dundas Group conformably overlies the Baffin Bay Group along a gradational contact that has been described earlier (Fig. 102); the only strata demonstrably overlying the group are Quaternary deposits. Local, apparently non-conformable relationships between the Dundas Group and the Baffin Bay Group (Qaanaaq Formation) are seen as local overlapping of the Dundas strata onto fault blocks.

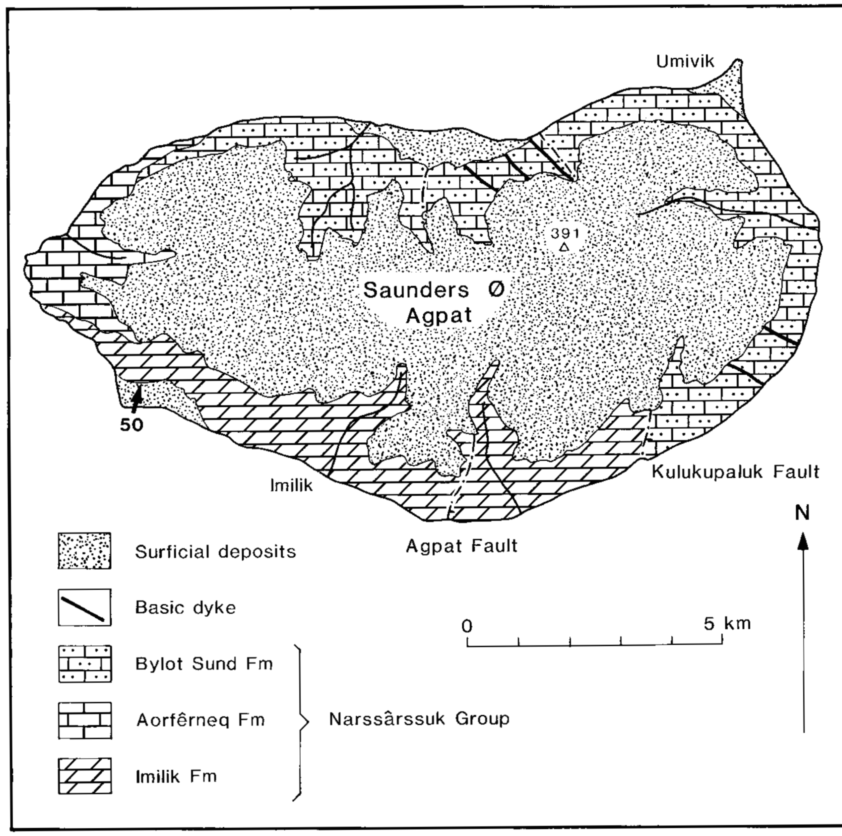
The group is in near contact with the Narssârssuk Group, the boundary being situated under the wide Quaternary-filled valley supporting the air base Pituffik. This valley is parallel to regional faults and is likely to be tectonically controlled. The Narssârssuk Group is preserved in a graben or half-graben (see later under that group). Dundas strata on the north side of Sioraq, and the isolated outcrops protruding through the surficial cover of the valley floor, form the south-eastern extension of a 20 km wide belt of southerly-dipping rocks that form southern Steensby Land (Figs 2, 105). If no major structural complications exist, the Dundas Group can be projected to underlie the Narssârssuk Group.

One can only speculate as to the nature of the lower boundary of the Narssârssuk Group. It may be conformable with the Dundas Group, a disconformity of varying significance, or the groups may, in part, have an intertonguing relationship. Inconclusive evidence suggests that the two groups are lithologically linked. The uppermost part of the Dundas Group shows some variation to Narssârssuk lithologies, i.e. the incoming of carbonate with stromatolites, chert and evaporitic rocks. This fits a model of inherent transition between the two groups rather than a major hiatus.

Geological age. Neohelikian–Hadrynian, possibly reaching late Hadrynian (Sturtian–Vendian); an age range based on microfossils and radiometric dating of intrusive rocks. The most recent and reliable whole-rock K-Ar ages on dolerite from the Steensby Land sill complex, including sills from Dundas Fjeld that cut the uppermost strata of the group, are in the range from 705 to 660 Ma (Dawes & Rex, 1986). Acritarch assemblages indicate a Late Riphean (Karatauian and Kudashian) age for the main part of the Dundas Group (Vidal & Dawes, 1980; Dawes & Vidal, 1985). However, the presence of *Vandalosphaeridium varangeri* in downfaulted strata in Olrik Fjord (Olrik Fjord Formation, Fig. 109) suggests that the group might pass into the Vendian. This typical Scandinavian species is inferred to have a stratigraphical range restricted to the Kudashian – Lower Vendian (G. Vidal, personal communication, 1991) and it is also present in the Narssârssuk Group.

Subdivisions. The Dundas Group is not formally subdivided in this bulletin, but three units have been mapped as formations: the Steensby Land, Olrik Fjord and Kap Powell Formations. These are essentially geographically defined formations based on lithological lateral facies of the group, but the Olrik Fjord Formation may represent the youngest stratigraphic package. On the most recent map (Dawes, 1991a), the Olrik Fjord Formation is named; the other two formations constitute the ‘undivided’ strata.

Fig. 113. Geological map of Saunders Ø, Greenland, showing the location of section 50. The tripartite division of the Narssârssuk Group has been established in the type area on the mainland (see Fig. 105); assignment of formational names on Saunders Ø is provisional. The height of 391 is in metres. For location, see Fig. 2.



Narssârssuk Group

The occurrence of the Narssârssuk Group is restricted to a graben structure on the south-eastern margin of the Thule Basin (Figs 2, 4, 120). Three formations are provisionally recognised: the Imilik, Aorfêrneq and Bylot Sund Formations, but these are not formally defined in this bulletin.

Narssârssuk Group

new group

Composition. Strata assigned to this group are part of four different units of the Thule Formation of Koch (1929a; see Dawes & Haller, 1979, plate 1). The strata were first recognised as a distinct rock division by

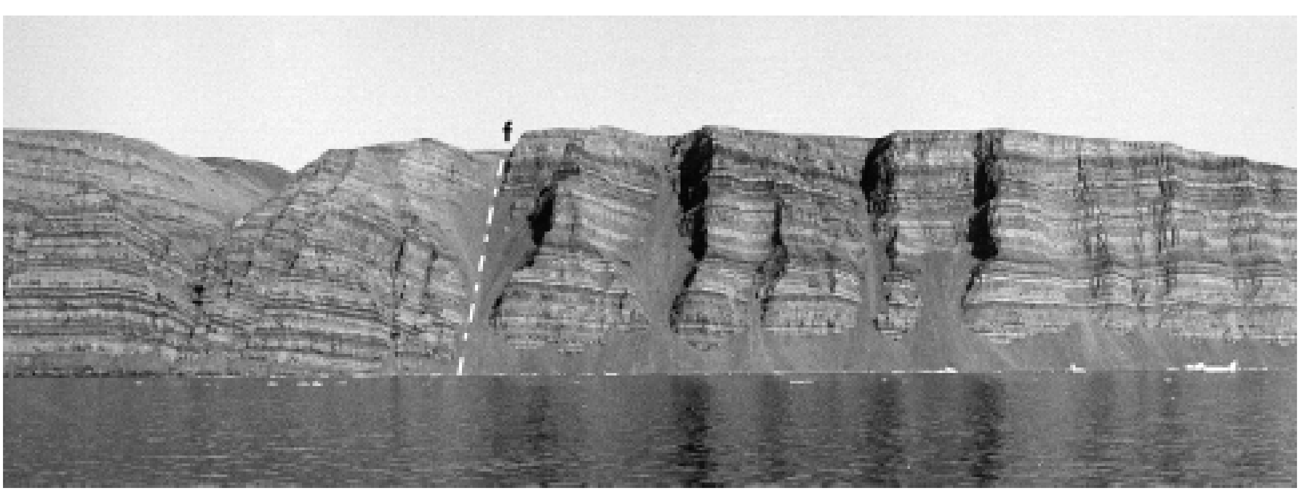
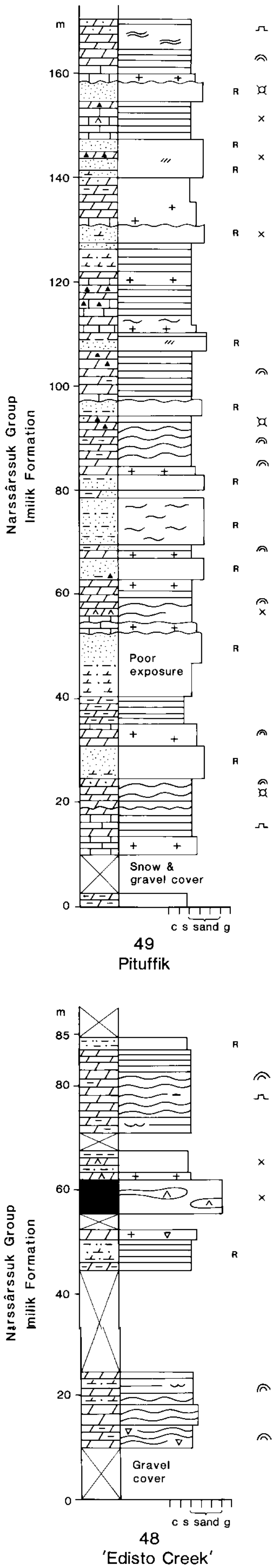
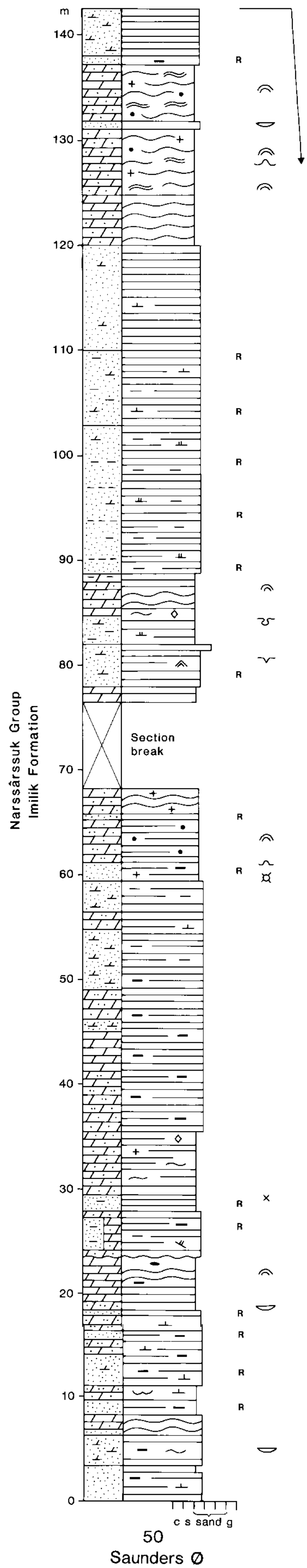


Fig 114. The Narssârssuk Group in the sea-cliffs of southern Saunders Ø, showing characteristic banding formed essentially by cyclic arrangement of siliciclastic (mainly red) and paler carbonate units. Displacement on the Agpat Fault (see Fig. 113) is greater than the cliff height, which exceeds 300 m.

Fig. 115. See facing page





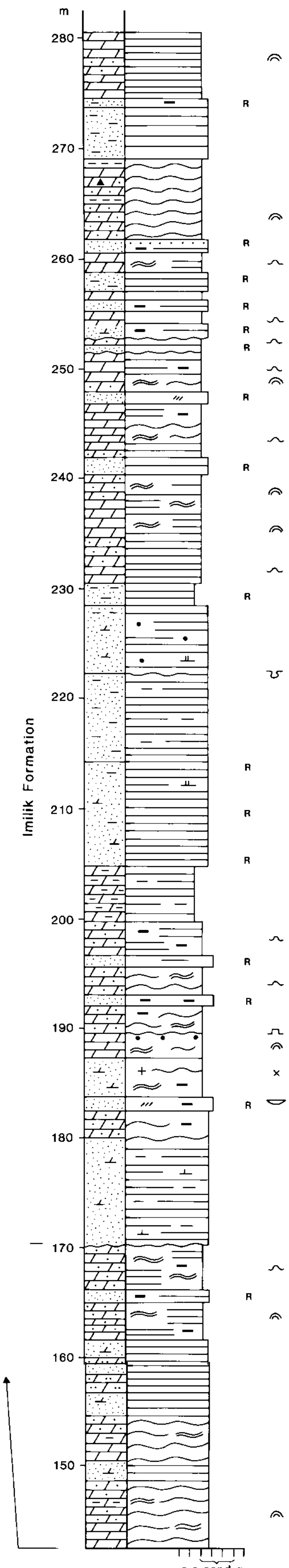


Fig. 115. See facing page

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Fig. 115. Stratigraphic logs of the Narssârssuk Group through lower, middle and upper parts of the succession (Imilik, Aorfêrneq and Bylot Sund Formations). The sections are compiled from the following sources: sections 48, 49 and 51, own data; section 50 logged by the author and B. O'Connor; section 52 mainly from O'Connor (1980). R = red beds. Map locations: sections 48, 49, 51 and 52, Fig. 105; section 50, Fig. 113.

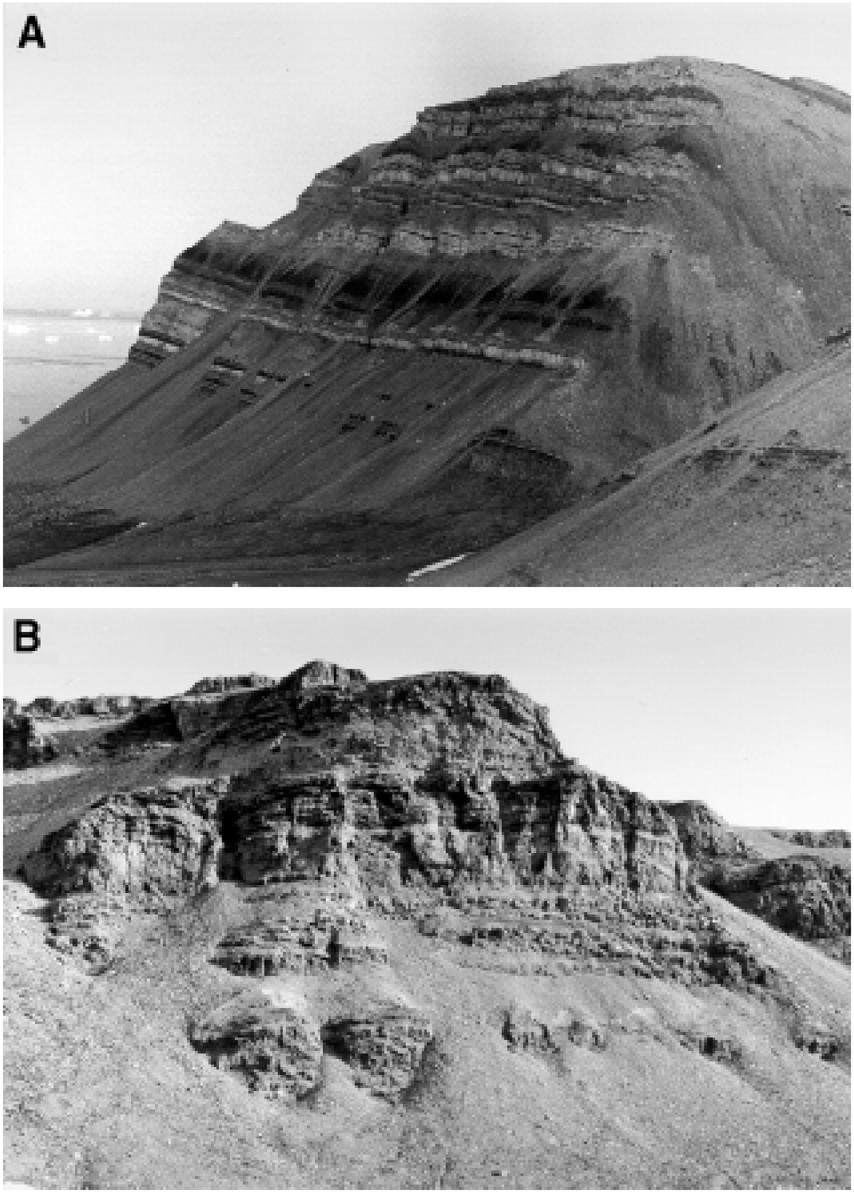


Fig. 116. Views of sections 50 and 51 in the Narssârssuk Group; stratigraphic logs are given in Fig. 115.
A: section 50, south-western Saunders Ø, with conspicuous dark siliciclastic units and pale dolomites; the dark unit in the middle of the section is 33 m thick;
B: section 51, south side of Aorfêrneq Dal, is dominated by grey dolomites of which about 135 m are exposed in foreground hill.

Munch (1941); her 'Sandstone-dolomite series' (Fig. 6). The group correlates essentially with the Narssarssuk formation of Kurtz & Wales (1951), although it excludes the uppermost beds of that formation north of Sioraq; it constitutes a direct raise in status of the Narssârssuk Formation of Davies *et al.* (1963; fig. 7) and Dawes (1976a, fig. 232).

Name. After Narssârssuk, the valley and traditional Eskimo dwelling place on the east side of Bylot Sund (settlement now abandoned) (Figs 2, 105).

Distribution. The most restricted of the five groups of the Thule Supergroup, occurring only in the Bylot Sund area as a south-east trending belt from Saunders Ø across the mainland to the Inland Ice (Figs 2, 105, 113).

Geomorphic expression and colour. A picturesque multicoloured group, very conspicuously banded in reddish, greenish and grey colours. It forms spectacular, in places precipitous, coastal sections as on Saunders Ø (Fig. 114); inland sections are heavily drift covered.

Type area. Coast between Sioraq and Narssârssuk (Fig. 105). Stratigraphic logs through parts of the lower, middle and upper strata in the type area (sections 48, 49, 51, 52), and one section from the lower part of the group from Saunders Ø (section 50), are given in Fig.

115; views of sections are in Figs 116 (sections 50, 51) and 117A (section 49).

Thickness. The group has an estimated thickness of between 1.5 and 2.5 km. In the type area four sections with a composite thickness of 670 m through parts of the lower, middle and upper reaches of the group have been logged. Extrapolations between these sections suggest a thickness on the mainland exceeding 1 km. On south-western Saunders Ø a 600 m section through the lower part of the group has been logged. Strata outcropping to the north and south-east, stratigraphically above and below the log, are estimated to be as much as 1.5 km thick.

Saunders Ø is cut by major faults, several of which have throws of several hundred metres (Fig. 114). The consistent interbedded nature of the group with some lateral facies changes are not conducive to regional correlation between fault blocks or between the type area and Saunders Ø. Carbonates in the middle part of the group appear to thicken westwards, and there may well be strata in eastern Saunders Ø that are stratigraphically higher than the top of the section on the mainland.

Dominant lithology. A well-layered, dominantly fine-grained carbonate-siliciclastic sequence, with evaporites and red beds, which is characterised by lithological cyclicity (Figs 114, 115). Lithologies are gradational both vertically and laterally.

Carbonates are grey, buff and pink dolomite and dolomitic limestone with some pure limestone; siliciclastic strata are red, grey, green and buff sandstone and siltstone with lesser amounts of shale. Thin- to medium-bedded strata dominate but both carbonates and sandstones show variation from thick beds down to very thin laminae. Generally, dolostones and limestones are fine to very fine grained but coarser, blocky recrystallised rocks occur, as well as porous and vuggy types. Sandstones are fine-grained quartz arenites with some subarkoses and arkoses. Some thin beds reach medium grain size; coarser grained pockets are rare. There is widespread compositional gradation between carbonates and siliciclastic rocks. Thus, dolostones are variously arenaceous and sandstones commonly have matrix carbonate; argillaceous dolomites and calcsiltites are common. Many rocks are laminated, often finely planar to wavy lamination, with locally well-developed wave-ripple lamination and wavy algal laminites (Figs 117B, F; 118A, B, H). Carbonates and siliciclastic rocks are variously interlayered from bed down to lamina scale; vertical passage between arenaceous dolomites and sandstones is often seen as a colour interlamination (Fig. 117D, E).

Disturbance of bedding and lamination is common in some intervals. This ranges from flaser bedding and irregular laminations, to flakes and flat clasts occurring in discrete pockets, to rip-up breccia beds (Fig. 118C). Other sedimentary structures are desiccation and diastasis cracks, small-scale channels, symmetrical and asymmetrical ripple marks, ripple-drift bedding and cross-bedding, the latter particularly in red siliciclastics. Cracks take on a variety of forms from mudcracks to dewatering structures and small tepees (Figs 117E, 118G). Cracks can be deeply penetrative and are often filled by detritus, in places forming thin dykes that are conspicuous in the axial regions of tepees and also occur in the troughs between algal mounds. Carbonates show stylolites (Fig. 118E), and a variety of diagenetic compaction structures and many intervals are richly stromatolitic. Flat to wavy cryptalgal laminites and low-relief dome and mounds are common forms; the broadest mounds seen approach 2 m in diameter (Figs 117B, F; 118B). Columnar and spheroidal stromatolites are less common.

The dolomites can be variously silicified and chert is present in minor amounts particularly in the middle part of the group. It is mostly dark grey to black and occurs as seams and thin beds. Strother *et al.* (1983) regard all chert as early diagenetic in origin, with some chert as thin horizons replacing algal mats.

Evaporite, mainly gypsum, has been noted in all sections examined varying in abundance and form of occurrence. It occurs as seams, nodules, stringers, veins and thin beds, as well as the matrix of breccia beds in which dolomite or shale is broken up and variously gypsiferous (Figs 117C, 118D). Breccia units, up to several metres thick, are commonly very porous with rotten-stone character. The thickest breccia noted, some 14 m thick, is composed of lenticular bedded dolomite in various stages of replacement by evaporite (Fig. 118F). An 8 m thick bed of gypsum is reported in a well log by Davies *et al.* (1963), an occurrence regarded as a bedded evaporite (W. E. Davies, personal communication, 1980).

The Narssârssuk Group is dominated by interbedded cyclic sequences of widely varying lithology and thickness. End members are carbonates and red siliciclastics. Such cycles range from less than 5 to over 20 m; many are between 10 and 15 m thick. Abortive cycles, conspicuous by the absence of red beds or by one or more other lithologies, occur singly or more

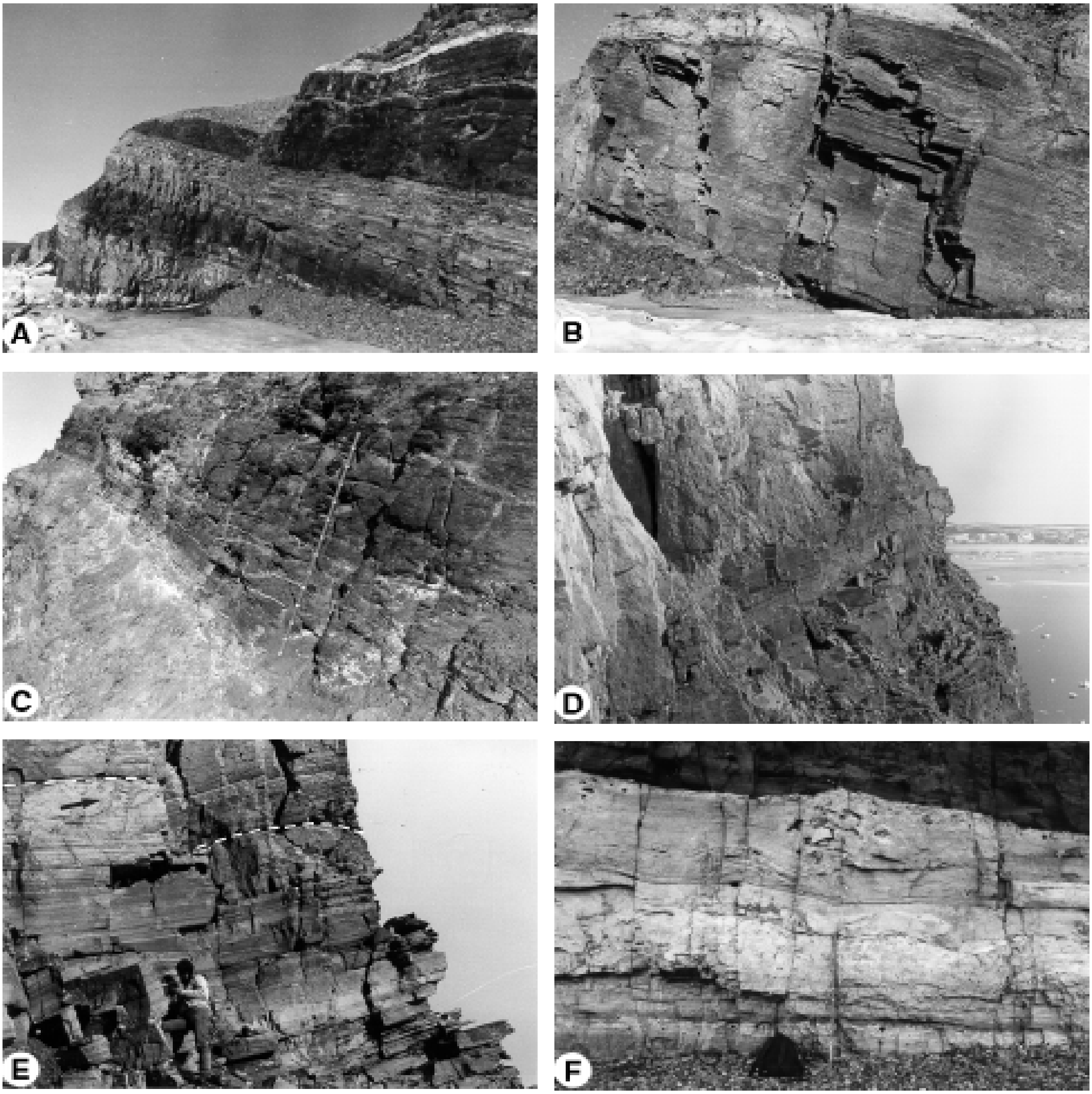


Fig. 117. Cyclic lithologies of the Narssârssuk Group. **A:** progradational cycles capped by red siliciclastic beds. Lowest red bed is 4 m thick; **B:** lower part of progradational cycle showing porous dolomitic limestone passing up into wavy laminated stromatolitic dolomite overlain by pale, variously arenaceous dolomite that contains chert and evaporite. Base of red bed is visible at top left (arrowed). Strata are about 10 m thick; **C:** top of progradational cycle showing laminated dolomites passing up into pale thin bedded siltstone and green calcarenite capped by red sandstone. Evaporite forms white coatings, seams and veins. Staff has 10 cm grid; **D:** part of a regradational cycle with red sandstone below passing upwards into pink and grey interlaminated arenaceous dolomite and at the top grey stromatolitic dolomite. Strata are about 10 m thick; **E:** intergradational siliciclastics and carbonates: red calcareous sandstone at the base passes upwards by interlamination into pink arenaceous and algal dolomites, and finally into red and grey laminated dolomites at the top of which is an eroded algal dolomite bed with tepee structures (arrowed); **F:** algal dolomite sequence with sharp contact with overlying red bed. Planar laminated arenaceous dolomite with some irregular algal beds pass up into paler stromatolitic dolomite with dark algal mat layers, followed by a unit of finely laminated dolomites with algal mounds and a vuggy dolomite top. Wave-ripple lamination is present in the uppermost part (see Fig. 118H). Staff has 10 cm grid. Locations: **A**, **B** and **C**, Pituffik, section 49; **D** and **E**, Saunders Ø, section 50; **F**, Narssârssuk, section 52.

often in multicycle packages. Prominent, particularly in the lower part, are progradational cycles in which basal carbonates grade into mixed carbonate-siliciclastic lithologies and finally into siltstone-sandstone which is commonly red (Fig. 117A). Typical cycles have at their base coarse, porous, thick-bedded dolomite or limestone that pass upwards into thinner, often wavy-bedded, well laminated dolomite, with wavy laminated, low-relief stromatolites (Fig. 117B). The 'ideal' cycle continues upwards into variously shaly dolomite and calc-siltstone, in places with chert and evaporite and capped by fine-grained, rarely medium-grained, siliciclastics (Fig. 117C). Evaporite, where present, generally increases upwards with incoming of siliciclastic material. An erosional surface, limonitic in places, commonly truncates the upper siliciclastic beds but red beds may also have sharp and locally erosional contacts with lower lithologies. Common in some cycles are units of arenaceous dolomites and algal laminites that may grade or have sharp contact with siliciclastics (Fig. 117F). Some other cyclic variations within the basic shallowing-upwards sequences are mentioned by Jackson (1986).

On Saunders Ø transgressive cycles occur in which red, pink and green siliciclastic rocks grade upwards into pink arenaceous dolomite or buff-grey dolomite and algal dolomite (Fig. 117D, E). Both carbonate and siliciclastic rocks can occur in single units bounded by sharp contacts, although gradation between these rock types is more common. Interbedding between carbonates or carbonate-dominated units and siliciclastic rocks occurs on all scales. The thickest siliciclastic units are more than 30 m thick. The two conspicuous dark-weathering units in south-western Saunders Ø (Fig. 116A) are composed of red-purple, with lesser amounts of green, finely laminated, fine-grained micaceous or silty sandstone with ripples indicating currents from the east.

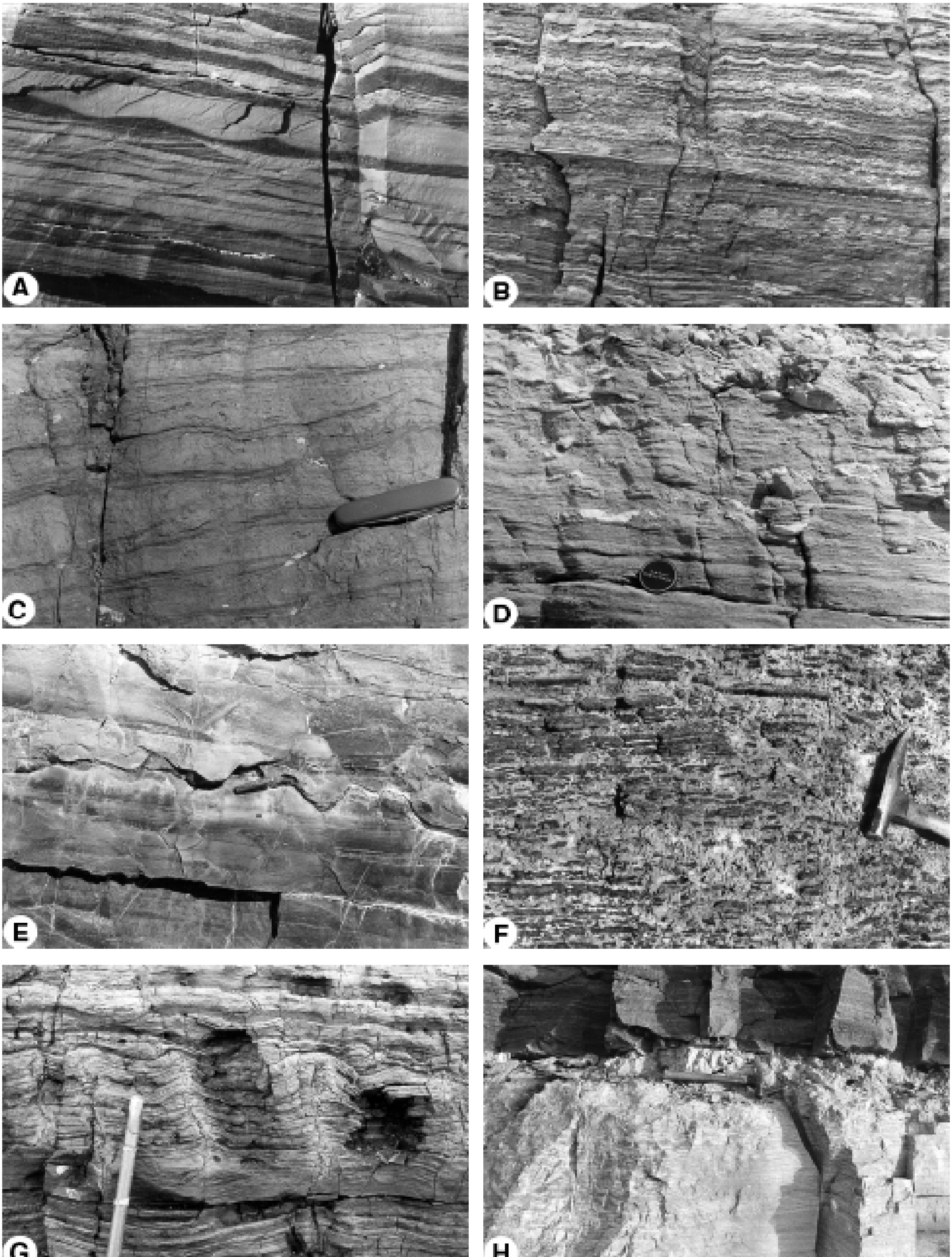
In the type area the group can be divided into three parts: lower and upper successions (Imilik and Bylot Sund Formations), characterised by cycles involving red siliciclastic strata, are separated by a carbonate-dominated, generally thicker bedded unit (Aorfêrneq Formation) in which dolomites are generally clean, and siliciclastic rocks are restricted to sporadic thin red beds. The Aorfêrneq Formation contains considerably more evaporite than the sequences below and above. The strata on Saunders Ø in gross terms reflect this tripartite subdivision (Fig. 113), although the rather massive pale dolomite units that characterise the western end of the island – overlain and underlain by cyclic red bed sequences – show clear differences from the Aorfêrneq Formation; for example, important clastic intervals occur. The lateral facies and thickness variations seen locally are expected to be reflected regionally in differences between the type area and more basinal strata to the west.

Depositional environment. Previous studies of the Narssârssuk lithologies conclude that the very shallow water strata represent subtidal to supratidal deposition in an arid or semi-arid environment (Dawes, 1979a; Strother *et al.*, 1983; Jackson 1986).

A low-energy environment sheltered from the open influence of the sea is suggested, such as a large protected embayment with lagoonal conditions. The cyclic sedimentation indicates regular fluctuations of the shallow, quiet water in which for the most part only rip-up clasts indicate sedimentary reworking. Deposition must have been on a wide carbonate shelf with very gentle bottom slopes. Stromatolites and evaporites occur at all levels of the group indicating persistence of warm hypersaline conditions. Evaporite is conspicuous as a diagenetic phase (disrupting and replacing other lithologies and as fracture infillings) but primary nodules, seams and thin beds point to arid or semi-arid evaporitic environments. The overall depositional environment is perhaps analogous to modern coastal sabkhas.

The lower and upper parts of the Narssârssuk Group characterised by red beds in regressive cycles, indicate repeated progradation from intertidal carbonates to supratidal siliciclastics. The transgressive cycles noted in the west may reflect coeval allocyclic sedimentation. Cross-bedding and ripple marks in clastic lithologies (particularly in the upper part in the east) evince periods of stronger current action and a consistent transport of clastic material from the east. The middle part of the group, characterised by cleaner and thicker carbonate units and appreciably more evaporite, is taken to represent a protracted stable period in which broad carbonate tidal flats persisted and in which algal growth was rife. Some subtidal carbonates are suggested by Jackson (1986) to be represented in the group, a view supported by the micro-organism habitats studied by Strother *et al.* (1983).

The role of faulting – penecontemporaneous faults were recorded initially by Kurtz & Wales (1951) – in the generation of the cyclic sequences is uncertain, but the gross lithological character suggests that deposition was in a shallowly subsiding basin with complimentary migration of the shoreline, rather than a tectonically controlled shelf sea.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Fossils. Algal associations including algal mats and stromatolites of varying types (domes, columns, oolites, low-relief algal laminites) and microbiota – both acritarchs and cyanobacteria. Shales have yielded filamentous microfossils and an acritarch assemblage of five taxa, the most stratigraphically significant being *Vandalosphaeridium varangeri* (Vidal & Dawes, 1980; Dawes & Vidal, 1985; see below under *Geological age*). Twenty entities of planktonic micro-organisms from carbonaceous cherts have been described by Strother *et al.* (1983), including five new taxa. The microfossils represent four distinct microbial associations and one allochthonous assemblage.

Boundaries and correlation. Lack of exposure and erosion determine that the stratal limits of the Narssârssuk Group are unknown. The only observed boundary is the fault contact with the crystalline shield that bounds the group to the south (Fig. 105). The northern boundary is concealed below the valley of Sioraq and the group is preserved in a WNW-trending half graben or graben. The group is limited upwards by the present erosion surface. The nearest strata (both geographically and stratigraphically) are those of the Dundas Group exposed in the valley of Sioraq. As described under that group, these strata dip south and most likely underlie the Narssârssuk Group.

Geological age. Late Hadrynian – Vendian, an age based on microfossils and on the whole-rock isotopic dating of basic intrusions. The K-Ar age of dolerite from a dyke that cuts the uppermost strata (Bylot Sund Formation) is 645 ± 26 Ma. This dyke is part of the regional WNW-trending swarm that has a K-Ar age range of 675–630 Ma (Dawes, 1991a). An acritarch assemblage from the Narssârssuk Group contains Late Riphean – Vendian species which also occur in the Baffin Bay and Dundas Groups. Only one species, *Vandalosphaeridium varangeri*, is stratigraphically significant within the limits discussed here, and it has been found elsewhere in the Thule Supergroup only in the Olrik Fjord Formation of the Dundas Group. This species is only known from one sample from the lowermost strata (Imilik Formation) and it is considered indicative of an early Vendian age (Vidal & Dawes, 1980). The microbes described by Strother *et al.* (1983) are consistent with this early Vendian age, viz. around 700 Ma. The K-Ar age of the WNW-trending and cross-cutting basic dyke swarm suggests that substantially younger strata are probably not present.

Subdivision. The three subdivisions established in the type area and mentioned under *Lithology* have been mapped as formations and their distribution tentatively extended to Saunders Ø (Figs 105, 113). From base upwards these are: Imilik Formation, Aorfêrneq Formation and Bylot Sund Formation. Precise correlation between the type area and Saunders Ø is problematic (see earlier, under *Thickness*). In any case there are distinct lithological packages in many parts of the group that warrant formal recognition. Pending further field work, formal definition at formation level is not made in this bulletin.

Fig. 118. Characteristic lithologies and structures of the Narssârssuk Group. **A:** interlaminated arenaceous dolomite and darker sandy material showing wave ripples and ripple-bedded sand lenses. Distance between central ripples is about 15 cm; **B:** wavy algal laminite. Penknife, upper centre, is 7 cm long; **C:** pink arenaceous dolomite with fine algal laminae and rip-up flake/clast layers. Penknife is 9 cm long; **D:** gypsum nodules and stringers in a red bed at top of shallowing-up cycle showing increased concentration upwards; **E:** stylolite in fine-grained dolomitic limestone; dark shale is present in the plane. Penknife is 9 cm long; **F:** carbonate-evaporite breccia showing invasion and replacement of dolomite; **G:** tepee structures in dolomite showing central deeply penetrative cracks cutting darker arenaceous dolomite layers, photo: B. O'Connor; **H:** detail of algal dolomite and overlying laminated red sandstone shown in Fig. 117F. Wave-ripple laminated dolomite showing lateral passage to planar lamination capped by coarser vuggy dolomite that contains red chert and evaporite clots. Locations: **A**, **B** and **C**, Saunders Ø, section 50; **D** and **E**, south of Pituffik; **F**, Aorfêrneq Dal, section 51; **G** and **H**, Narssârssuk, section 52.