# Proterozoic age of the Thule Group: new evidence from microfossils

**Peter R. Dawes and Gonzalo Vidal**

This report deals with recent results of a micropalaeontological programme aimed at a biostratigraphic dating of the Thule Group. Earlier results are reported on by Vidal & Dawes (1980).

The Thule Group is a several kilometre thick, sedimentary and volcanic sequence that forms large areas of North-West Greenland where it overlies the Archaean–Proterozoic crystalline basement with profound unconformity (fig. 7). The strata are unmetamorphosed and they form flat-lying to shallow-dipping outcrops; faulting, crushing, minor folding, and contact 'metamorphic' effects due to basic igneous intrusion, are the only post-depositional disturbances to have affected the sequence. Acritarchs are generally well preserved and, with the exception of rocks affected by contact metamorphism in connection with emplacement of basic rocks, indicate a low index of thermal alteration.

## *General geology*

The Thule Group is presently divided into three formations (Davies *et al.*, 1963). The *Wolstenholme Formation* at the base is composed of a variable sequence of red beds (mainly sandstone, conglomerate and shale), volcanic rocks, and pale sandstones, with minor shale and siltstone; this passes upwards without stratigraphic break into the *Dundas Formation* which is a dark weathering, generally thin-bedded sequence of shale, siltstone and fine sandstone, with some dolomites. The upper unit, the *Narssârssuk Formation* which only outcrops in the southern part of the Thule Basin south of Thule Air Base and on Saunders Ø (fig. 7), is composed mainly of pale dolomites, arenaceous sandstones and red beds (siltstone and shale), with some chert and evaporite.

Within the Thule Basin, this tripartite succession is overlain by Quaternary deposits; to the north of Kap Alexander, the Dundas and Narssârssuk Formations are absent and the Rensselaer Bay Formation (a much thinner stratigraphical equivalent of the Wolstenholme Formation) is disconformably overlain by basal Cambrian clastics (Dallas Bugt Formation; Peel *et al.*, 1982) (fig. 7).

Parts of the Thule succession are characterised by widespread basic igneous material in the form of sills; in the lower part of the Wolstenholme Formation these are intimately associated with extrusive units. K/Ar whole-rock dates on sill rock suggest that the basal strata of the group could be as old as 1200 m.y. A regional swarm of WNW-trending dykes post-dates the deposition of the Thule Group, and four samples from individual and geographically widely separated dykes have given K/Ar whole-rock ages ranging from 727 ± 30 to 627 ± 25 m.y. (Dawes *et al.*, 1973, 1982a; D.C. Rex, personal communication).

Life-forms occurring throughout the Thule Group include stromatolites from carbonate lithologies, and the acritarch assemblages reported on earlier by Vidal & Dawes (1980). Silicified carbonates in the middle part of the Narssârssuk Formation have yielded benthic cyanobacteria that have been described by Strother *et al.* (1983).

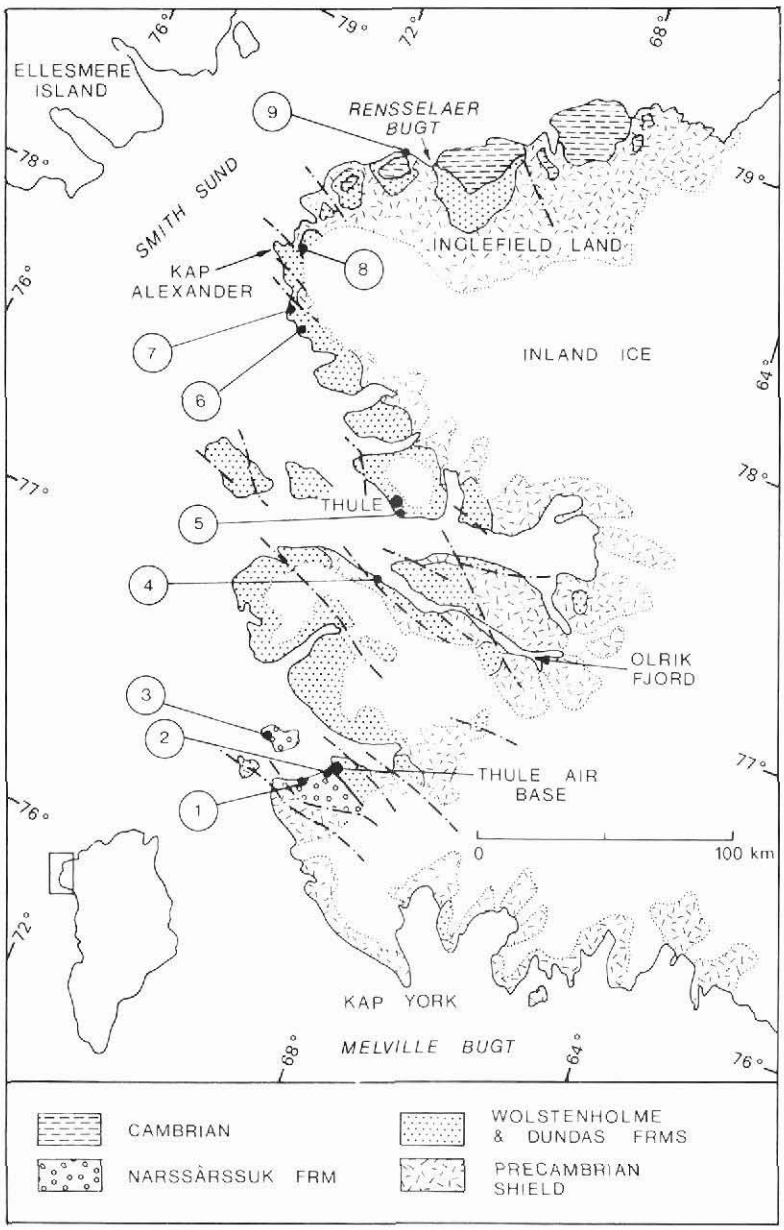


Fig. 7. Simplified geological map of the Thule district, North-West Greenland, showing the locations of the nine sites from which microfossil samples were collected. 1 GGU 272358; 2 GGU 243201, 243202; 3 GGU 272002, 272003, 272006, 272011, 272016, 272017; 4 GGU 272334–272341; 5 272251–272258; 6 GGU 272302, 272305, 272307, 272308, 272311, 272318, 272319; 7 GGU 272321–272323, 272325; 8 GGU 272041; 9 GGU 272018.

Preliminary stratigraphic accounts of the Thule Group can be found in Dawes (1976) and Dawes *et al.* (1982b).

## *The material*

The material reported on here comprises 38 samples from nine localities that were collected specifically for microfossil analysis during regional mapping studies in 1980 and 1982. The lithology of the material is quite homogeneous and the majority is of grey to dark grey shale. Ten samples come from the lower part of the Thule Group the Wolstenholme Formation and its equivalent strata in the north, the Rensselaer Bay Formation; three samples come from a sequence at the passage between the Wolstenholme and Dundas Formations; sixteen samples are from the Dundas Formation and nine are from the Narssârssuk Formation. The majority of the samples are located in the central part of the Thule Basin. Only two samples are from the areas north of Kap Alexander in south-western Inglefield Land (fig. 7).

Small chips weighing up to about 50 g were chemically processed in hydrofluoric acid in the manner described by Vidal (1976a). Permanent microscopic slides were prepared of the acid-resistant residues.

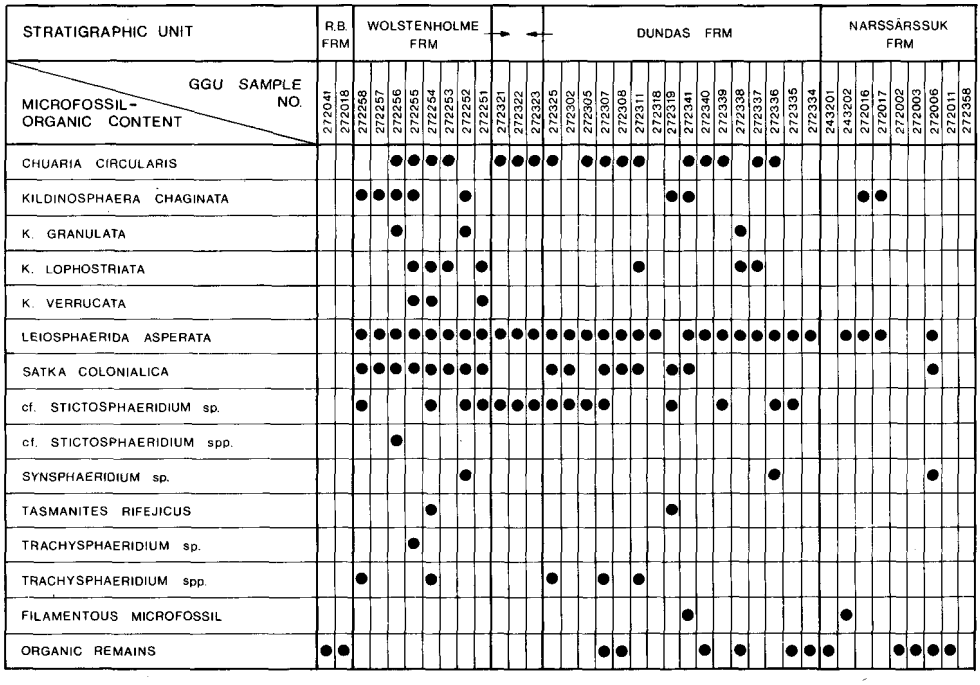


Fig. 8. Stratigraphic distribution of the microfossil taxa from the Thule Group. The samples are arranged from left to right in general ascending stratigraphic order. R.B. = Rensselaer Bay Formation.

### *The results*

Of the 38 samples, only one (GGU 272358) from the uppermost part of the Narssârssuk Formation proved to be completely devoid of organic traces, while the two samples from the Rensselaer Bay Formation (GGU 272018, 272041) only yielded scattered fragments of degraded organic matter. Brown-coloured organic debris only was recovered from several of the samples from the Narssârssuk Formation (GGU 243201, 272002, 272003, 272011); this formation in general contained relatively few, scattered acritarchs. In contrast, the Wolstenholme and Dundas Formations, which contain dark shale lithologies, have yielded well preserved, and in some samples extremely abundant, acritarchs.

The distribution of the acritarch taxa identified are shown in fig. 8 where the samples are arranged, as far as possible, in stratigraphic order. However, due to the geographically widely separated localities it is not possible in all cases to place the different collections in precise stratigraphic order. Thus, for the Dundas Formation, the samples within each series, 272302–272319 and 272334–272341, are arranged in stratigraphical order, although the younger age inferred in fig. 8 for the latter series is based on an uncertain correlation of sequences about 100 km apart.

The colour and preservation of the organic matter shows an index of alteration (AMC) on the scale of Rovnina (1981) from 4 to 6. This suggests a thermal alteration from about 125° to 200°C. The induced ultra-violet and blue light fluorescence of the organic residues is low for the AMC-4 samples (125°–150°C) and non-existent for the AMC-5 and higher samples (150°–200°C).

### *Discussion on taxa*

The taxonomic composition of acritarch assemblages from the Wolstenholme and Dundas Formations shows no essential difference; only one genus, *Kildinosphaera verrucata* (previously *Kildinella* sp. *B* of Vidal, 1981a, erected in Vidal & Siedlecka, 1983) is peculiar to one formation – the Wolstenholme Formation. This similarity in the acritarch assemblages is taken as indicative of a similar age for both formations.

The taxa reported here in the Wolstenholme and Dundas Formations are normal constituents of Upper 'Riphean' assemblages elsewhere in the North Atlantic, e.g. Visingsö Beds in Sweden (Vidal, 1974, 1976a, 1979a), Eleonore Bay Group in East Greenland (Vidal, 1976b, 1979b), Vadsø Group and Barents Sea Group in eastern Finmark, northern Norway (Vidal, 1981a) and in the Realdtoppen Group of Svalbard (Knoll, 1984). The most common taxa in the collection are *Leiosphaeridia asperata* (previously *Kildinella hyperboreica*, cf. Lindgren, 1982; also Vidal & Siedlecka, 1983), *Chuaria circularis*, cf. *Stictosphaeridium* sp. and *Satka colonialica* (*Symplassosphaeridium* sp. of Vidal & Dawes, 1980, a non-valid name; erected by Timofeev, 1959); all these are known to have a wide stratigraphical range from Upper Riphean through the Vendian.

The stratigraphically most important species in the assemblages are perhaps *Kildinosphaera lophostriata* (previously *Kildinella lophostriata*, erected by Jankauskas, 1978), *K. verrucata* and *Tasmanites rifejicus*. In other North Atlantic sequences, *K. lophostriata* and *T. rifejicus* are restricted to the Upper 'Riphean'; *K. verrucata* reaches into the lowermost Vendian.

These results are consistent with the acritarch assemblages previously recorded from the Wolstenholme and Dundas Formations that included, in addition, other Upper 'Riphean' forms (Vidal & Dawes, 1980). However, one sample from a fault block of the Dundas Formation in Olrik Fjord (of uncertain stratigraphic position but considered to be from the uppermost part of that formation) contains *Vandalosphaeridium varangeri* (previously reported in Vidal & Dawes, 1980, as *'Peteinosphaeridium'* sp.), a species described by Vidal (1981a) from the Ekkerøy Formation of the Vadsø Group and the Dakkovarre and Grasdal Formations of the Tanafjord Group of northern Norway. This species is inferred to have a stratigraphical range restricted to the Lower Vendian.

This diagnostic species has also been reported from the base of the Narssârssuk Formation (as the only acritarch hitherto known from that formation) and on this evidence it was suggested that the entire formation was of Vendian age (Vidal & Dawes, 1980). Unfortunately, no significant acritarchs have been found in the present collection from the Narssârssuk Formation, and the four species identified also occur in the Wolstenholme and Dundas Formations. Of these, perhaps *Synsphaeridium* sp. is the most noteworthy, having only been recorded in the Upper 'Riphean' – Lower-Middle Vendian (Varangerian) strata elsewhere in the North Atlantic (Vidal, 1981a, 1981b; Vidal & Knoll, 1983). *Kildinosphaera chaginata* (previously *Kildinella sinica,* cf. Vidal & Siedlecka, 1983), and *S. colonialica* have general 'Riphean'–Vendian age ranges, while *L. asperata* is thought to range into the Lower Cambrian (Vidal, 1981a).

### *Age of the Thule Group*

The presence of typical Riphean acritarch assemblages in the Wolstenholme and Dundas Formations suggests that the main part of these formations is of Late 'Riphean' age (*c.* 900–750 m.y.). The stratigraphically lowest acritarch sample known from the Thule Group (GGU 423477, Vidal & Dawes, 1980) is from the middle part of the Wolstenholme Formation and several hundred metres of strata underlie this. The two samples in the present collection from the lower part of the Thule Group (GGU 272018, 272041) failed to yield acritarchs. The basal part of the Wolstenholme Formation might range down into the Middle or Lower Riphean. This would be consistent with the radiometric data that suggest that the basal part of the group may be as old as 1200 m.y.

The presence in the Thule Group of the diagnostic species *V. varangeri* suggests Lower Vendian strata in the uppermost part of the Dundas Formation and in the lowermost Narssârssuk Formation. The age of the main part of the latter formation remains uncertain, although perhaps the presence of *Synsphaeridium* sp. suggests that the succession does not reach the Upper Vendian (Valdaian). The only sample in the present collection from the uppermost part of the Narssârssuk Formation (Upper Red Member, GGU 272358) did not yield microfossils or even organic matter. A Lower to Middle Vendian age for the Narssârssuk Formation is also consistent with the radiometric age dates on basic dykes. The oldest K/Ar age from a dyke cutting the Narssârssuk Formation, south of Thule Air Base, is 727 ± 30. m.y.

The stratigraphical relationship between the Dundas and Narssârssuk Formations is uncertain. The boundary between the two formations is situated in the wide, Quaternary-filled valley in which Thule Air Base is located (fig. 7). Regional stratigraphical and structural

considerations suggest that the Narssârssuk Formation is all, or in part, younger than the Dundas Formation. There is some variation in the uppermost part of the Dundas Formation towards the lithologies of the Narssârssuk Formation, and there may well be a transition between the two formations rather than a major disconformity. This also gains support from the microfossil assemblages. The presence of an early Vendian acritarch in both the uppermost part of the Dundas Formation and the lower part of the Narssârssuk Formation suggests that there may well be continuous late Riphean to Vendian sequence represented in the Thule Group. This would be in contrast to Scandinavia and East Greenland where major disconformity can be demonstrated between the Upper 'Riphean' and Lower Vendian sequences.

*Acknowledgements.* Bernard O'Connor (Marathon Oil, Denver) is thanked for assistance in the collection of samples in 1980.

## *References*

Davies, W. E., Krinsley, D. B. & Nicol, A. H. 1963: Geology of the North Star Bugt area, Northwest Greenland. *Meddr Grønland* **162**(12), 68 pp.

Dawes, P. R. 1976: Precambrian to Tertiary of northern Greenland. *In* Escher, A. & Watt, W. S. (edit.) *Geology of Greenland,* 248–303. Copenhagen: Geol. Surv. Greenland.

Dawes, P. R., Peel, J. S. & Rex, D. C. 1982a: The Kap Leiper basic dyke and the age of dolerites of Inglefield Land, North-West Greenland. *Rapp. Grønlands geol. Unders.* **110,** 14–19.

Dawes, P. R., Frisch, T. & Christie, R. L. 1982b: The Proterozoic Thule Basin of Greenland and Ellesmere Island: importance to the Nares Strait debate. *In* Dawes, P. R. & Kerr, J. W. (edit.) *Nares Strait and the drift of Greenland: a conflict in plate tectonics. Meddr Grønland, Geosci.* **8,** 89–104.

Dawes, P. R., Rex, D. C. & Jepsen, H. F. 1973: K/Ar whole rock ages of dolerites from the Thule district, western North Greenland. *Rapp. Grønlands geol. Unders.* **55,** 61–66.

Jankauskas, T. V. 1978: Plant-microfossils from the Riphean of the southern Urals. *Dokl. Acad. Sci. USSR, Earth Sci. Sect.* **242,** 913–915. (In Russian).

Knoll, A. H. 1984: Microbiotas of the late Precambrian Hunneberg Formation, Nordaustlandet, Svalbard. *J. Paleontol.* **58**, 131–162.

Lindgren, S. 1982: Algal coenobia and Leiospheres from the Upper Riphean of the Turukhansk region, eastern Siberia. *Stockholm Contrib. Geol.* **38,** 35–45.

Peel, J. S., Dawes, P. R., Collinson, J. D. & Christie, R. L. 1982: Proterozoic basal Cambrian stratigraphy across Nares Strait: correlation between Inglefield Land and Bache Peninsula. *In* Dawes, P. R. & Kerr, J. W. (edit.) *Nares Strait and the drift of Greenland: a conflict in plate tectonics. Meddr Grønland, Geosci.* **8,** 105–115.

Rovnina, L. V. 1981: Palynological method to determine the level of katagenesis of organic matter by using Jurassic deposits of western Siberia. *In* Brooks, J. (edit.) *Organic maturation studies and fossil fuel exploration,* 427–432. New York: Academic Press.

Strother, P. K., Knoll, A. H. & Barghoorn, E. S. 1983: Micro-organisms from the Late Precambrian Narssârssuk Formation, North-Western Greenland. *Palaeontology,* **26,** 1–32.

Timofeev, B. V. 1959: Ancient flora of the Baltic area and its stratigraphic significance. *Trudy vses. nauchno-issled. geol.-razv. Inst.* **129**. 320 pp. (In Russian).

Vidal, G. 1974: Late Precambrian microfossils from the basal sandstone unit of the Visingsö Beds in southern Sweden. *Geol. Palaeont.* **8,** 1–14.

Vidal, G. 1976a: Late Precambrian microfossils from the Visingsö Beds in southern Sweden. *Fossils & Strata* **9**, 57 pp.

Vidal, G. 1976b: Late Precambrian acritarchs from the Eleonore Bay Group and Tillite Group in East Greenland. *Rapp. Grønlands geol. Unders.* **78,** 19 pp.

Vidal, G. 1979a: Acritarchs and the correlation of the Upper Proterozoic. *Publ. Inst. Mineral. Palaeont. Quat. Geol. Univ. Lund* **219,** 22 pp.

Vidal, G. 1979b: Acritarchs from the Upper Proterozoic and Lower Cambrian of East Greenland. *Bull. Grønlands geol. Unders.* **134,** 40 pp.

Vidal, G. 1981a: Micropalaeontology and biostratigraphy of the Upper Proterozoic and Lower Cambrian sequence in East Finnmark, northern Norway. *Bull. Nor. geol. Unders.* **362,** 53 pp.

Vidal, G. 1981b: Aspects of problematic acid-resistant, organic-walled microfossils (acritarchs) in the Upper Proterozoic of the North Atlantic region. *Precambrian Res.* **15,** 9–23.

Vidal, G. & Dawes, P. R. 1980: Acritarchs from the Proterozoic Thule Group, North-West Greenland. *Rapp. Grønlands geol. Unders.* **100,** 24–29.

Vidal, G. & Knoll, A. H. 1983: Proterozoic plankton. *Mem. Geol. Soc. Amer.* **161,** 265–277.

Vidal, G. & Siedlecka, A. 1983: Planktonic, acid-resistant microfossils from the Upper Proterozoic strata of the Barents Sea region of Varanger Peninsula, East Finnmark, Northern Norway. *Bull. Nor. geol. Unders.* **382,** 45–79.

*G.V.,*
*Dept. of Historical Geology and Palaeontology,*
*Lunds Universitet,*
*Box 740,*
*Micropalaeontological Laboratory,*
*Kemicentrum,*
*S-220 07 Lund,*
*Sweden.*

# Fission track dating of lower Tertiary rhyolitic glass rocks from Disko

**Kirsten Hansen and Asger Ken Pedersen**

## *Geology and stratigraphy*

The Tertiary igneous activity in West Greenland has not been dated in detail. Sediments contemporaneous with, or slightly older than, the early volcanic rocks are assigned a middle Paleocene age from palaeontological evidence (Henderson *et al.*, 1981), and palaeomagnetic work by Athavale & Sharma (1975) indicates that the Vaigat Formation picrites and the lower 500 m or so of the overlying Maligât Formation (Hald & Pedersen, 1975) were erupted in the time span represented by geomagnetic anomaly 25 together with the long reversal period between anomalies 25 and 24. The age estimated for this period is 56 to 52 Ma (Butler & Coney, 1981). The late Stage lamprophyre magmatism on Ubekendt Ejland appears to be much younger, about 30 to 40 Ma (Parrott & Reynolds, 1975). No reliable radiometric age determinations have been published from the Disko–Nûgssuaq area.

In order to date the younger part of the basalt succession on Disko, zircons were separated from three blocks of garnet-bearing peraluminous rhyolite glass from a conglomerate