COCCOLITHS FROM VOLCANIC SEDIMENTS (DANIAN) IN NÛGSSUAQ, WEST GREENLAND

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Coccoliths found in a conglomeratic layer within a volcanic subaquatic pillow breccia and in a tuff layer just below the main volcanic sequence on Nûgssuaq, West Greenland, make it possible to correlate the two coccolith assemblages and to compare these with a coccolith assemblage previously known from the Nûgssuaq peninsula. On the basis of the coccoliths alone the onset of the Tertiary volcanism in the Nûgssuaq area must be revised to be not older than Upper Danian.

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Coccoliths were found in samples collected during field work with the Geological Survey of Greenland in the Nûgssuaq area, West Greenland (1971–1973). The samples were collected in Danian deposits at Marrait kitdlît on the south-west coast of Nûgssuaq and at Kangilia on the north coast (pl. 1. figs. 1–2). Previously, coccoliths had been found in Danian deposits in the interior of Nûgssuaq (Perch-Nielsen, 1973) and a relative correlation between these coccolith assemblages is now possible.

A fossiliferous deposit had been found in the Marrait kitdlît area (Rosenkrantz 1970, Hansen 1970). North-east of this outcrop a new coccolith-bearing deposit was found in 1971. This outcrop consists of a conglomeratic layer 1 m thick containing rounded basalt fragments with a diameter of up to 8 cm and very few macrofossils. The layer overlies an unfossiliferous conglomerate 6 m thick and is overlain by 3.5 m of calcareous, unfossiliferous conglomerate composed of more angular basalt fragments. These layers are interbedded within a volcanic subaquatic pillow breccia, in the lower part of the volcanic sequence as found in the Nûgssuaq area. The boundary between the pillow breccia and the underlying sediments is not exposed in the Marrait kitdlît area and the area is strongly faulted. Therefore the exact position of the coccolith-bearing conglomerate is problematic. Nevertheless, as seen e.g. in the great sections along the south coast of Nûgssauq, the pillow breccia forms foresets several hundred metres high. The foresets generally dip eastward and it is possible that the Marrait kit-

dlît deposits, which are situated more than 20 km west of these sections, belong to the oldest known volcanic deposits on Nûgssuaq. The marine deposits at Marrait kitdlît have previously been considered as of Upper Danian age with some degree of uncertainty (Rosenkrantz, 1970 and Hansen, 1970).

The coccoliths at Kangilia occur in a tuff bed (Tuff II of Floris, 1972) which according to Rosenkrantz (1970) belongs to the Thyasira Member of the Kangilia Formation (table 1). The Thyasira Member is defined as a 35 m thick sequence initiated and terminated by a 7 m thick tuff layer with shale and sandstone between (Rosenkrantz, 1970). During the visits in 1971 and 1973 to the locality, the lower tuff (Tuff I of Floris, 1972) was not observed whereas the upper tuff (Tuff II of Floris, 1972) was well exposed. The tuffs of the Thyasira Member are considered to be the oldest known volcanic rocks in the Nûgssauq area and have been dated to Lower Danian (e.g. Rosenkrantz, 1970, Rosenkrantz & Pulvertaft, 1969, Hansen, 1970, Bendix-Almgreen, 1969 and Floris, 1972).

The study was supplemented by some material from the Sonja Lens of the Sonja Member kindly provided by A. Rosenkrantz and H. J.Hansen. The Sonja Member forms part of the Agatdal Formation and consists mainly of dark shales with arkosic sandstone lenses (e.g. Sonja Lens). As mentioned above, Perch-Nielsen (1973) previously found coccoliths in the Sonja Lens. The coccolith assemblage demonstrated that the reworked sediment of the Sonja Lens is not older than lower Upper Danian (Perch-Nielsen, 1973), an age corresponding to that found by Rosenkrantz (1970) and Hansen (1970).

Calcareous nannofossils

The following genera and species of calcareous nannofossils were found in the two outcrops at Marrait kitdlît and Kangilia, and are compared below with those from the Sonja Lens of the Agatdal Formation (Perch-Nielsen, 1973).

List 1

Species	Marrait kitdlît	Kangilia Tuff II	Sonja Lens
Braarudosphaera bigelowi (Gran & Braarud) Deflandre	+	+	+
Biscutum sp.		+	
Chiasmolithus danicus (Brotzen) Hay & Mohler	+	+	+
Chiasmolithus cf. *C. bidens* (Bramlette & Sullivan) Hay & Mohler	+		
?Crepidolithus sp.			+
Cruciplacolithus cf. *C. inseadus* Perch-Nielsen	+	+	
Cruciplacolithus tenuis (Stradner) Hay & Mohler	+	+	+
Ericsonia cava (Hay & Mohler) Perch-Nielsen	+	+	+
Ericsonia cf. *E. subpertusa* Hay & Mohler	+	+	
Markalius inversus (Deflandre) Bramlette & Martini		+	
Micrantholithus sp.	+	+	+
Neochiastozygus modestus Perch-Nielsen			+
Neochiastozygus digitosus Perch-Nielsen	+	+	
Neochiastozygus cf. *N. saepes* Perch-Nielsen		+	
Prinsius cf. *P. martinii* (Perch-Nielsen) Haq	+	+	+
Thoracosphaera operculata Bramlette & Martini	+	+	+
Thoracosphaera sp.	+	+	+
Zygodiscus sigmoides Bramlette & Sullivan	+	+	+
Reworked species			
Arkhangelskiella cymbiformis Vekshina			+
Eiffellithus turriseiffeli (Deflandre) Reinhardt	+	+	+
Glaukolithus sp.	?	+	
Micula staurophora (Gardet) Stradner			+
Prediscosphaera cretacea (Arkhangel'skiy) Gartner			+
Watznaueria barnesae (Black) Perch-Nielsen	+		+

Coccoliths are rare and poorly preserved, making the species identification difficult. The coccolith assemblages at Marrait kitdlît and Kangilia as well as in the Sonja Lens (Perch-Nielsen, 1973) are dominated by small specimens of the genus *Prinsius* and the genus *Thoracosphaera*, whereas the frequency of other species is low.

The present study of the coccoliths in the Marrait kitdlît and Kangilia deposits shows that the coccolith assemblages from both localities belong to the *Chiasmolithus danicus* zone (= NP 3 zone) of the "Standard Tertiary Calcareous Nannoplankton Zonation" of Martini (1971). Athavale and Sharma (in press) have suggested from palaeomagnetic studies an age of about 63 m.y. for the earliest Tertiary lavas on Disko, south of Nûgssuaq (Pl. 1. fig. 2).

In Denmark *Cruciplacolithus inseadus* appears in the uppermost Danian

and Selandian (Perch-Nielsen, 1969) and the genus *Neochiastozygus* also makes its first Tertiary appearance in the Late Danian in the upper part of NP 3 zone (Perch-Nielsen, 1969, 1971). According to Perch-Nielsen (1973) the occurrence of *Neochiastozygus modestus* as found in the reworked Sonja Lens material is referred to lower Upper Danian. As *Neochiastozygus digitosus* and *Neochiastozygus saepes* in Europe appear later than *Neochiastozygus modestus* (Perch-Nielsen, 1971, 1973) the coccolith assemblage from Marrait kitdlît and Kangilia is younger than the coccolith assemblage in the Sonja Lens.

Therefore, on the basis of the coccoliths alone the onset of Tertiary volcanism in the Nûgssuaq area must be considered to be not older than Upper Danian. This contrasts with the Lower Danian age indicated by macrofossil studies.

There is thus a discrepancy in ages arrived at by nannofossil as opposed to macrofaunas. Further work in several fields will be necessary before it can be ascertained where the source of this discrepancy lies.

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Dansk sammendrag

På Nûgssuaq, Vestgrønland er der i danien aflejringer, der anses for at være tilknyttet den vulkanske aktivitets begyndelse, gjort nye fund af kokkolitter. Ved Marrait kitdlît (pl. 1, fig. 2) er kokkolitterne fundet i et konglomerat, der er indeholdt i en vulkansk, subaquatisk pillow breccie, som indgår i den nedre vulkanske serie. Ved Kangilia er kokkolitterne fundet i et tufsediment, der anses for at markere den vulkanske aktivitets begyndelse på Nûgssuaq. Det antages at de to kokkolitselskaber er omtrent samtidige og formodentlig noget yngre end kokkolitselskabet beskrevet af Perch-Nielsen (1973) i Sonja linsen fra Agatdal Formationen (centrale Nûgssuaq (pl. 1, fig. 2). Alle tre kokkolit selskaber er af Øvre danien alder. Ud fra dette antydes det, at den vulkanske aktivitet på Nûgssuaq næppe kan være startet tidligere end øvrige danien.

PREVIOUS WORK					THIS PAPER
DANIAN	UPPER	Abraham Member Andreas Member Turritellakløft/Sonja Member	AGATDAL FORMATION	? Marrait Kitdlît	Marrait Kitdlît (Conglomerate) _ Tuff II of Kangilia (Thyasira Member) Sonja Lens (reworked) (Agatdal – Sonja Member)
	LOWER	Propeamussium Member Thyasira Member Fossil Wood Member Conglomerate Member	KANGILIA FORMATION		

Table 1. The general relationship between the Agatdal and Kangilia Formations and their members on Nûgssuaq (Rosenkrantz, 1970 and Hansen, 1970), compared with the stratigraphic positions of the coccolith-bearing deposits as dated by the coccoliths (this paper and Perch-Nielsen, 1973).

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Plate 1

Fig. 1. Index Map, the hatched area showing the geographical position of Nûgssuaq.

Fig. 2. Map showing the geology of Nûgssuaq (from Rosenkrantz & Pulvertaft) with the localities where coccoliths were found.

Figs. 3–12. Nannofossils illustrated by scanning electron micrographs (SEM) and light micrographs (LM). The specimens on figs. 3, 4, 11 & 12 are from sample number 157120 (Marrait kitdlît) of the Greenland Geological Survey, figs. 5, 6, 7, 8, 9 & 10 from sample number 157126 (Kangilia). The illustrated specimens are deposited in the Mineralogical Museum of Copenhagen (MMH prefix).

Fig. 3. *Neochiastozygus* sp. ca. 9000 × (SEM). MMH 13031.

Fig. 4. *Chiasmolithus danicus* ca. 9000 × (SEM). MMH 13032.

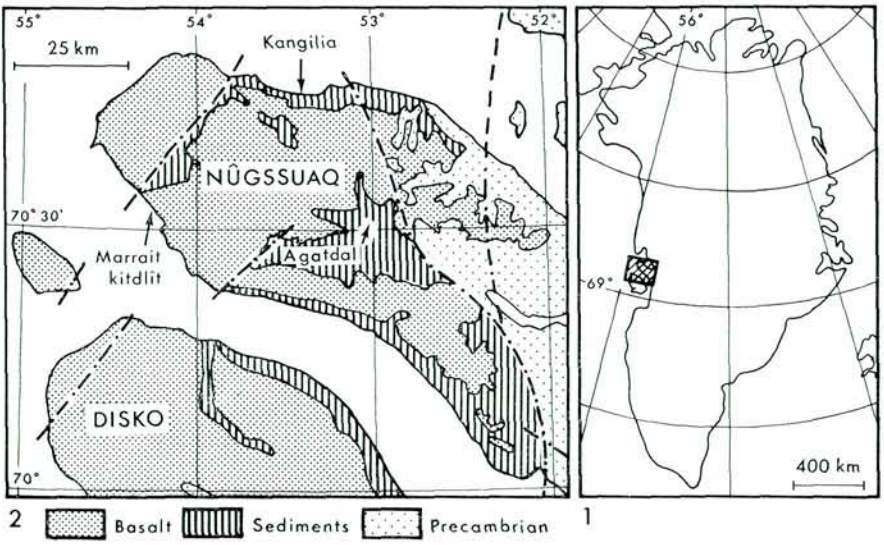
Fig. 5. *Thoracosphaera sp.* ca. 2000 × (LM, crossed nicols). MMH 13033.

Fig. 6. *Neochiastozygus* cf. *N. saepes* ca. 2000 × (LM). MMH 13034.

Fig. 7 & 8. *Neochiastozygus digitosus* ca. 2000 × (fig. 7 crossed nicols, LM). MMH 13035.

Fig. 9 & 10. *Chiasmolithus tenuis* ca. 2000 ×. (fig. 9 crossed nicols, LM). MMH 13036.

Fig. 11 & 12. *Chiasmolithus* cf. *C. bidens* ca. 2000 ×. (fig. 11 crossed nicols). MMH 13037.


55°
54°
53°
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25 km
Kangilia
NÛGSSUAQ
70° 30'
Marrait kitdlit
Agatdal
DISKO
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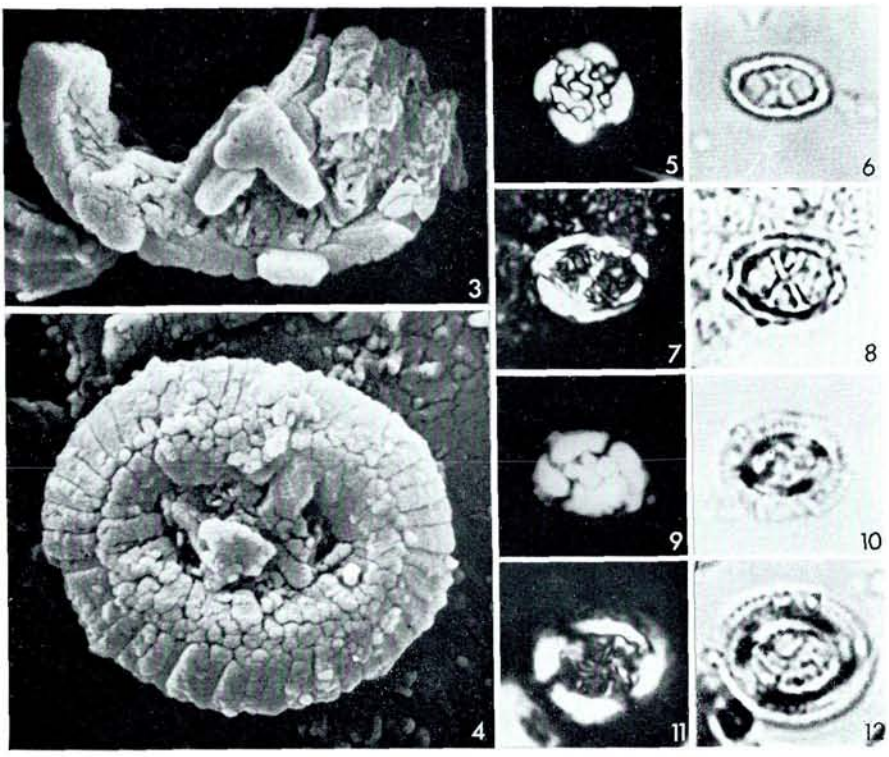
69°
400 km
2
Basalt
Sediments
Precambrian
1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