Upper Cretaceous dinoflagellate cyst stratigraphy, onshore West Greenland

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Stratigraphical ranges and geographical distribution of dinoflagellate cysts and selected pollen species are described based on the analysis of 250 samples from 29 surface and 12 subsurface sections of Late Cretaceous age from Svartenhuk Halvø and Nuussuaq peninsula, West Greenland. The sections make up an approximately 1500 m thick black mudstone succession, previously dated as late Turonian to Maastrichtian on the basis of scattered ammonite occurrences.

The dinoflagellate cysts and pollen indicate that the majority of the studied samples are Coniacian/Santonian to Maastrichtian. A few samples have been dated as early Paleocene. It is possible to divide the Upper Cretaceous strata into 10 intervals based on the palynomorph assemblages.

Diversity of dinoflagellate cysts is relatively high in the Coniacian to early Santonian deposits at Svartenhuk Halvø, whereas it decreases in the younger Campanian and Maastrichtian strata of Nuussuaq. The Coniacian to early Santonian assemblages are dominated by the genera *Chatangiella* and *Isabelidinium*, which in several samples constitute 20 to 50 percent of the dinoflagellate content.

New finds of ammonites and study of the palynomorphs indicate that the Cretaceous–Tertiary boundary should be moved from the base of what was previously called the 'basal Danian conglomerate' at Annertuneq to approximately 118 m above the top of this conglomerate.

Systematic and stratigraphic notes are included on selected *Arvalidinium*, *Cerodinium*, *Chatangiella* and *Isabelidinium* species. Three new species, *Alterbidinium*? *ulloriaq* *Chatangiella mcintyrei* and *Isabelidinium svartenhukense*, are described.

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Cover picture

Turritellakløft viewed from the west with Agatdalen in the background, central Nuussuaq, West Greenland. The Kangilia Formation represented in the lower part of the picture is a marine shale of late Santonian to Campanian/?Paleocene age. This is overlain by the Agatdal Formation represented by shallow marine sandstone of Paleocene age, covered by Paleocene volcanics of the Vaigat Formation.

Contents

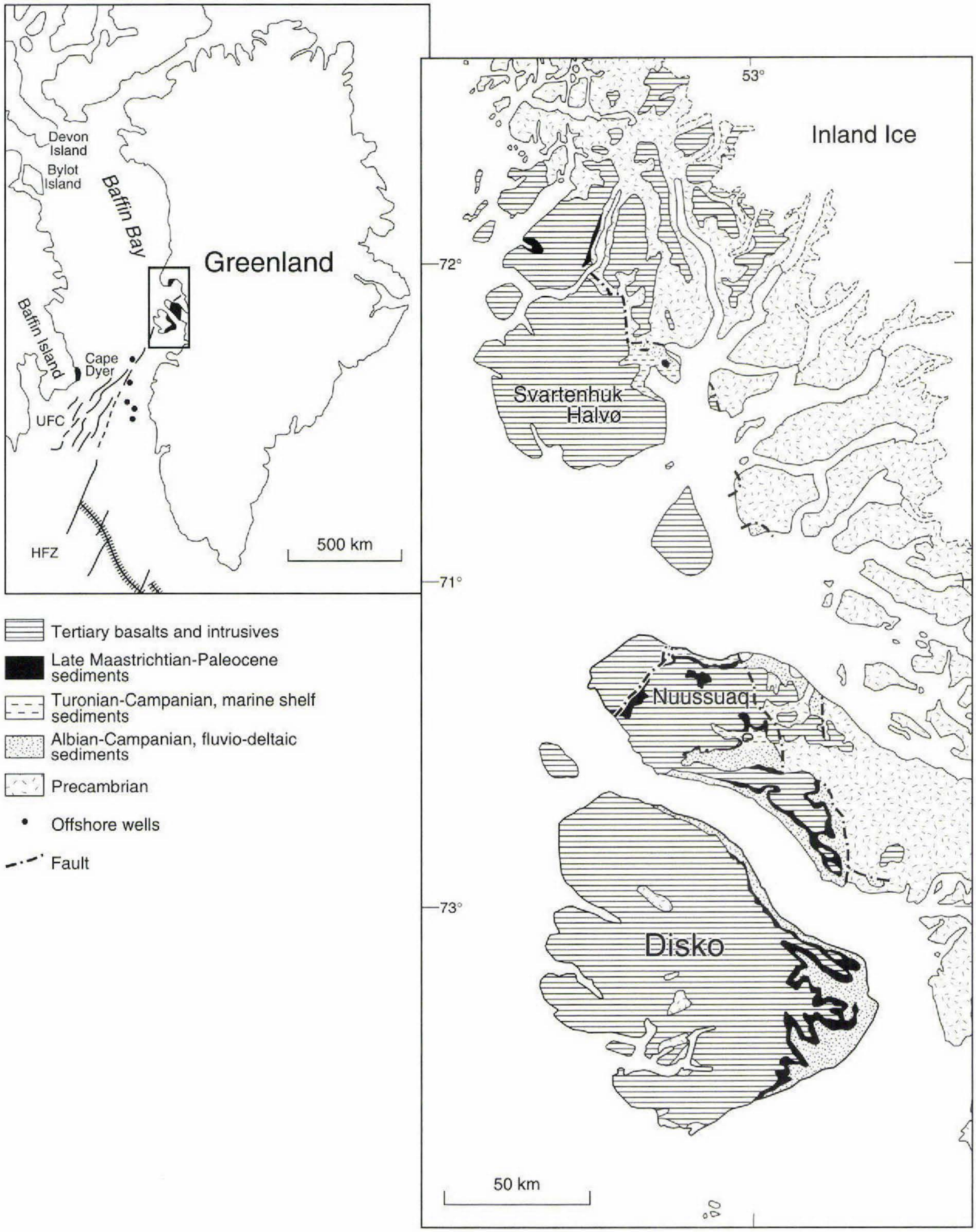


Fig. 1. Geological map of central West Greenland, showing the location of the Cretaceous outcrops in the studied area. Based on maps from the Geological Survey of Greenland. *HFZ*=Hudson Land Fracture Zone, *UFC*= Ungava Fault Complex.

Introduction and geological setting

This study is part of the Geological Survey of Greenland (GGU) project 'Sequence stratigraphic analysis of the Cretaceous sediments in West Greenland', and aims to establish a palynostratigraphy for the Disko–Nuussuaq–Svartenhuk Halvø area in West Greenland (Christiansen *et al.*, 1992; Christiansen, 1993; Nøhr-Hansen, 1993, 1994a, b, c).

The West Greenland continental margin is a rifted margin developed during the opening of the Labrador Sea in late Mesozoic – early Cenozoic time (Fig. 1). A number of rift basins developed along the continental break-up zone which stretches from the Labrador Sea to northern Baffin Bay (Rolle, 1985; Chalmers, 1991; Chalmers & Pulvertaft, 1993; Chalmers *et al.*, 1993). In this region onshore exposures of Mesozoic – Lower Tertiary sediments occur only at Cape Dyer on Baffin Island, Canada (Burden & Langille, 1990; 1991) and in central West Greenland on a number of islands and peninsulas between 69° and 72° (Rosenkrantz, 1970). Farther north in Canada Cretaceous and Tertiary sediments of marine origin are exposed on Bylot and Devon Islands (Ioannides, 1986; Benham & Burden, 1990). While the deposits on Baffin Island have a limited distribution and consist mainly of fluviatile sediment (Burden & Langille, 1990), the deposits in West Greenland cover a larger area and include both marine and terrestrial strata (Henderson *et al.*, 1976; Pedersen & Pulvertaft, 1992; Dam & Sønderholm, 1994). Studies of the deposits from West Greenland are therefore essential for a detailed interpretation of not only onshore but also offshore geology in the region.

In West Greenland the onshore basin of the rifted continental margin, which developed in late Mesozoic – early Cenozoic time, has a preserved sedimentary succession more than 2.5 km thick (Henderson *et al.*, 1981; Pulvertaft, 1987). The sediments, which range from early Cretaceous (Albian) to early Tertiary (Paleocene), are overlain by volcanic rocks of Paleocene age (Pedersen, 1985; Piasecki *et al.*, 1992; Larsen *et al.*, 1992). The Cretaceous to Tertiary outcrops are bounded to the east by Precambrian basement rocks against which the Cretaceous sediments have a faulted contact (Rosenkrantz & Pulvertaft, 1969; Pedersen & Pulvertaft, 1992). Towards the west, south and north the basin passes into offshore areas and the margins, however connected, are still not mapped.

Shelf mudstones of Coniacian to Santonian age are exposed on Svartenhuk Halvø. The Campanian shelf mudstones on the north coast of Nuussuaq are unconformably overlain by Maastrichtian shelf deposits (Dam & Sønderholm, 1994).

Biostratigraphic correlation of the sediments in the region is difficult due to the interdigitation of Cretaceous fluviatile, deltaic and brackish to fully marine deposits which have been dated using different fossil groups (Birkelund, 1965; Schiener, 1975; Pulvertaft, 1979, 1987; Pedersen & Pulvertaft, 1992). The Upper Cretaceous succession yields no microplankton (Hansen, 1970). The Maastrichtian to Lower Paleocene succession has been divided into two sequence stratigraphic units by Dam & Sønderholm (1994).

Field work on the marine succession in the summers of 1990 to 1992 was concentrated on detailed sedimentological studies, sampling for palynological and organic geochemical studies, and mapping and structural analysis (Christiansen *et al.*, 1992).

Previous palynological studies in the Upper Cretaceous of West Greenland

Previous studies of Upper Cretaceous dinoflagellate cysts from West Greenland are by Croxton (1976, 1978a, b, 1980), Ehman *et al.* (1976), Lentin & Williams (1980). Lentin & Williams mentioned (1980, p. 20) that the Campanian assemblage from West Greenland contains elements of both the offshore eastern Canadian assemblages (the Williams suite) and the Mackenzie Delta assemblages from arctic Canada (the McIntyre suite) described by McIntyre (1974, 1975). The present study confirms this observation. Paleocene dinoflagellate cyst assemblages from West Greenland have been described by Hansen (1980) and Piasecki *et al.* (1992).

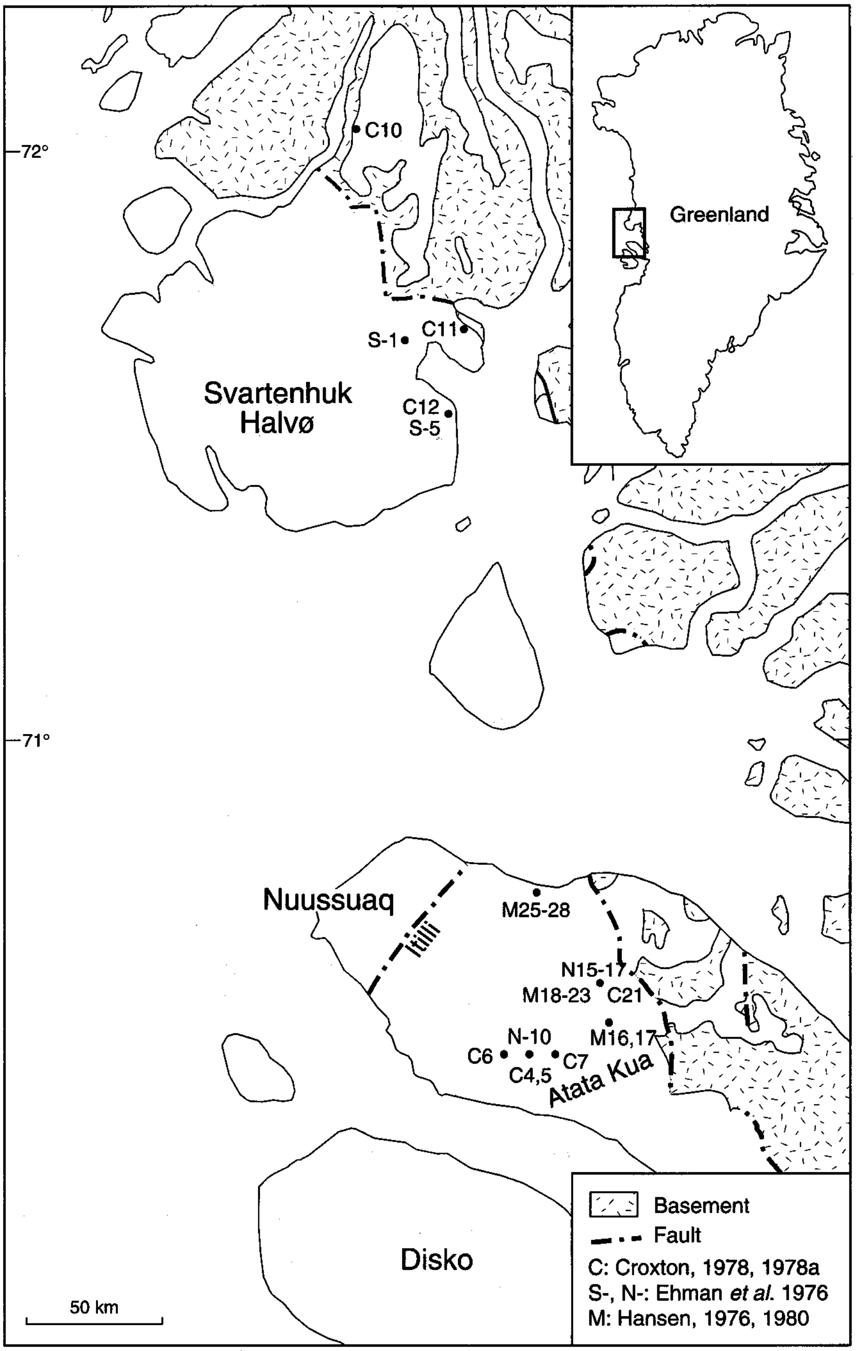


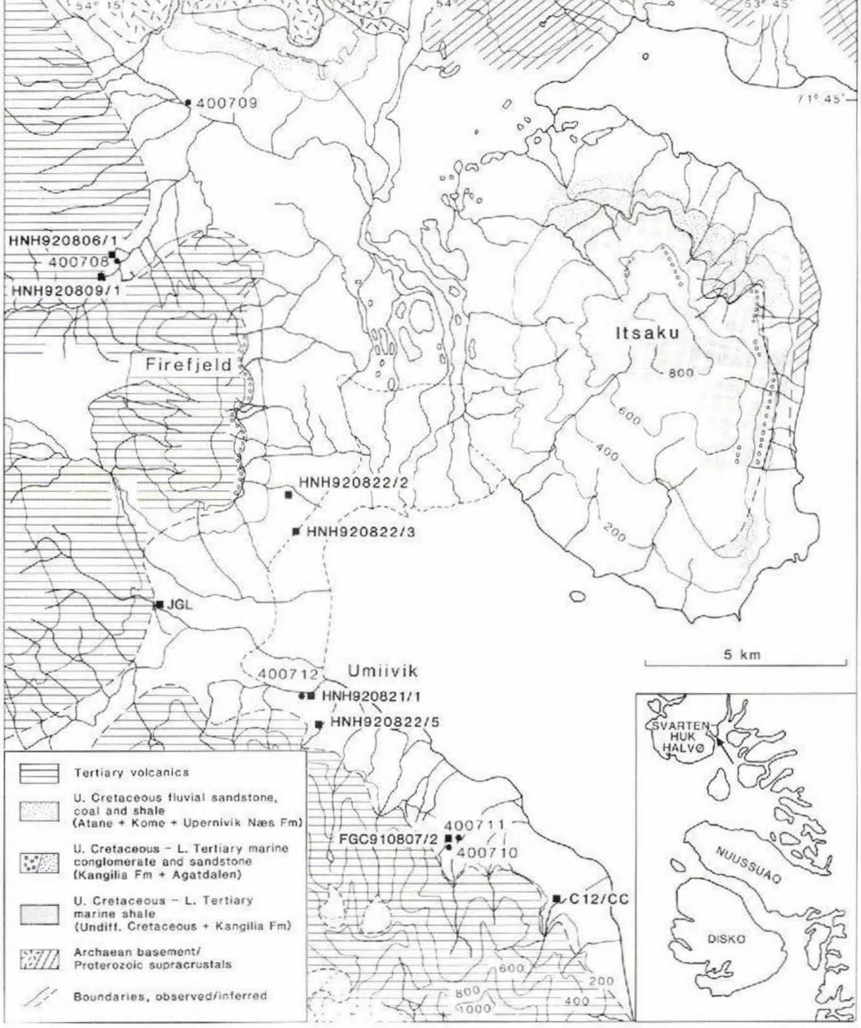
Fig. 2. Map showing location of previously measured and palynologically analysed Upper Cretaceous sections on Svartenhuk Halvø and Nuussuaq.

Svartenhuk Halvø

Croxton (1978a) briefly described the palynomorph content from three localities at Svartenhuk Halvø and Itsaku (C10, C11, C12; Fig. 2). Pollen from the C10 locality was determined as Paleocene, while pollen and dinoflagellate cysts suggested a Coniacian to Campanian age for C12. Croxton (1978a, p. 65) mentioned that the thermally altered palynomorphs from the Itsaku section C11 caused problems; however, she dated the lower part of the section as late Albian – early Cenomanian, and noted that pollen from the top of the section may indicate a Paleocene age.

Pulvertaft (1987, table 1) noted that the Cenomanian age for localities S5 and S1 in the Umiivik (Umîvik)

Fig. 3. Location of the outcrop and subsurface sections on Svartenhuk Halvø that yielded dinoflagellate cysts.



(Fig. 3) area given by Ehman *et al.* (1976), are not consistent between text and logs.

Hansen (1980, p. 92) recorded early Paleocene dinoflagellate cysts from an unspecified locality in the Svartenhuk area.

Nøhr-Hansen (1994a) described the palynomorph content from 9 surface and 5 subsurface sections on Svartenhuk Halvø (Fig. 3), and dated the approximately 300 m marine succession as Coniacian/early Santonian to ?early Campanian (Fig. 9).

Central Nuussuaq

Croxton (1978a, b) briefly described the palynomorph assemblages from five localities in central Nuussuaq (C4–C7, C21, M19, M22; Fig. 2). The palynomorphs from the localities at Qilakitsoq (C4), Qaatunnat Ilorliit (C5), Ilugisssoq (C6) and Nallurarissat (C7) indicate a late Cenomanian to early Campanian age. A possible reworked Maastrichtian assemblage is recorded from the top of section C5, and dinoflagellate cysts from the topmost shale at C6 indicate a possible 'middle' Paleocene age (Croxton, 1978a). Sections C21 and M19 represent the 'Oyster-ammonite conglomerate' from Agatdalen; according to Croxton (1978b) palynomorphs from these section may indicate reworked Maastrichtian floras. Eight sections from central Nuussuaq (M16-M23; Fig. 2) were sampled by Hansen (1976); data on the palynological content from the two sections M16 and M17 from Tunoqqu have not been published. A few dinoflagellate cysts, probably indicating a late Campanian age, were recorded by Croxton (1978a) from Scaphitesnæsen (M22).

Hansen (1980) described the Paleocene dinoflagellate cysts from the Sonja section (M18), Turritellakløft section (M20), Qaarsutjægerdal section (M21) and Ättestupet section (M23). According to Hansen (1980)

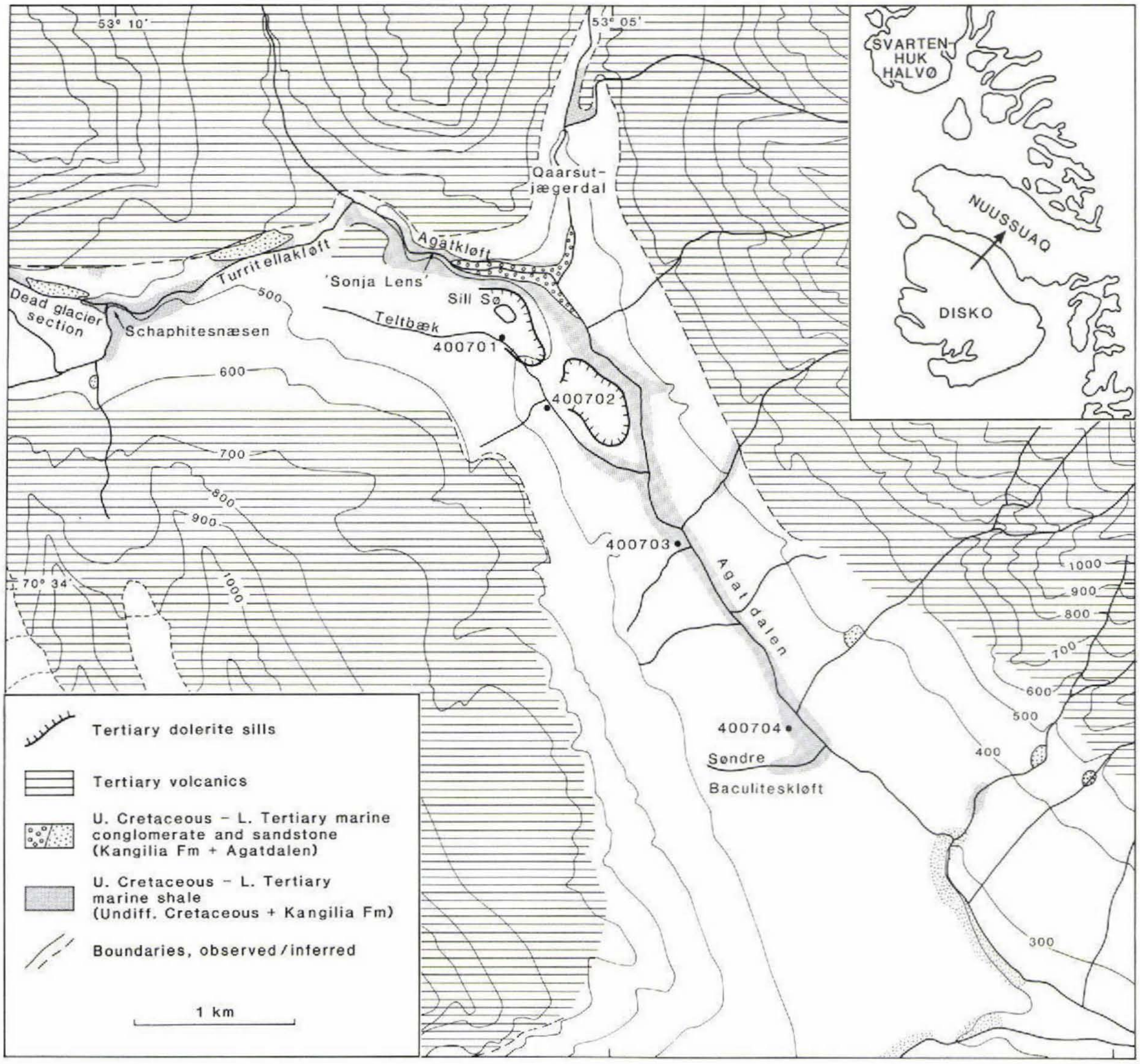


Fig. 4. Location of the outcrop and subsurface sections in the Agatdalen area that yielded dinoflagellate cysts.

the 'middle' Campanian to early Maastrichtian species *Isabelidinium microarmum* is recorded as reworked specimens in the sections M18-M21.

Ehman *et al.* (1976) studied the four sections (Fig. 2) Qilakitsoq (N10), Turritellakløft (N15), Qaarsutjægerdal (N16) and Nassaat (N17) in central Nuussuaq. The ages given by Ehman *et al.* (1976) are middle Cenomanian and early Danian for N10, Campanian or Maastrichtian to Paleocene for N15, Paleocene for N16 and N17. It should be noted that the ages given in the text by Ehman *et al.* (1976) are not always consistent with the ages given in their logs (Pulvertaft, 1987, table 1).

Nøhr-Hansen (1994b) described the palynomorph assemblages from 15 surface and 4 subsurface sections around Agatdalan and from the valleys Kangersooq and Aaffarsuaq south of Agatdalen (Figs 4, 5), and dated the 1100 m thick marine succession as late Santonian to 'middle' Campanian (Fig. 10). One sample is dated as Paleocene.

D. J. McIntyre (personal communication, 1995) described the Upper Cretaceous spore and pollen assemblages from the Ataata Kuua section in south-west Nuussuaq (Fig. 2).

Northern Nuussuaq

Croxton (1978a, b, 1980) briefly described palynomorph assemblages from three localities between Niaqornat and Ikorfat on the north coast of Nuussuaq (M25, M27-28; Fig. 2). The palynomorphs from these three localities in the Kangilia and Annertuneq area indicate a late Campanian to Maastrichtian age.

Hansen (1980) described the Paleocene dinoflagellate cysts and proposed a zonation for the mudstone deposited above the so-called 'basal Danian conglomerate' at the Kangilia/Annertuneq section (M25; Fig. 2, Enclosure 38).

Piasecki *et al.* (1992) described 'mid'-Paleocene dinoflagellate cyst assemblages from sediments interbedded in the Tertiary volcanic rocks on Disko and Nuussuaq and dated the sediments as NP 4 to NP 8.

Nøhr-Hansen (1993) described a low diversity dinoflagellate assemblage of late Maastrichtian? to early Paleocene age from the uppermost part of the more than two kilometre thick turbidite succession exposed immediately below the Tertiary pillow breccia on the south-east side of the Itilli valley in Nuussuaq (Fig. 2), and compared the results with preliminary palynological studies of the Kangilia section (Figs 6, 7). Nøhr-Hansen (1994c) described the palynomorph assemblages from 5 surface and 3 subsurface sections between Niaqornat and Ikorfat on the north coast of Nuussuaq (Figs 6, 7). The sections make up an approximately 500 m thick black mudstone succession. The dinoflagellate cysts and pollen date the majority of the samples as late Campanian and Maastrichtian. A few samples have been dated as Coniacian – late Santonian and early Paleocene.

Previous palynological studies in the Upper Cretaceous elsewhere

Arctic Canada

Santonian to Maastrichtian Upper Cretaceous dinoflagellate cysts have been described from arctic Canada by Manum (1963), Manum & Cookson (1964), Felix & Burbridge (1976), McIntyre (1974, 1975), Doerenkamp *et al.* (1976), Ioannides & McIntyre (1980), Ioannides (1986), Núñez-Betelu & Hills (1992), Núñez-Betelu *et al.* (1994) and Núñez-Betelu (1994). Ioannides (1986) studied the dinoflagellate cyst assemblages from the Santonian to Maastrichtian part of the Kanguk Formation and the Lower Paleocene Eureka Sound Formation on Bylot and Devon Islands. The dinoflagellate cyst assemblages described by Ioannides (1986) are very similar to these from West Greenland. Unfortunately, Ionnanides' stratigraphy is not very detailed due to poor outcrop and absence of macrofossils.

Núñez-Betelu (1994) described the source-rock potential and palynomorphs, and recorded one late Coniacian ammonite from the Turonian to Campanian Kanguk Formation in the area around Eureka Sound (situated between Axel Heiberg Island and Ellesmere Island), arctic Canada. Núñez-Betelu (1994) described four palynozones of which the three youngest partly correlate with the assemblages described from West Greenland.

Western Canada, western U.S.A.

Upper Cretaceous dinoflagellate cyst assemblages from western Canada and western U.S.A. have been described by Stanley (1965), Wall & Singh (1975), Harland (1973, 1977), Sweet & McIntyre (1988), Stone (1973), Harker *et al.* (1990) and Kurita & McIntyre (1994). Nichols & Sweet (1993) described the biostratigraphy of the Upper Cretaceous non-marine palynofloras in a north–south transect of the Western Interior Basin. The stratigraphical ranges given for the genera *Aquilapollenites* and *Wodehouseia* by Nichols & Sweet (1993) are very important for the dating the Upper Cretaceous strata of northern Nuussuaq.

Offshore eastern Canada, eastern U.S.A.

Burden & Langille (1991) described the palynology of the Cretaceous and Tertiary strata at Cape Dyer, eastern Baffin Island. These strata, which contain Aptian to Albian and Paleocene to Eocene terrestrial palynomorphs, are the onshore Cretaceous to Tertiary deposits closest to West Greenland.

The Upper Cretaceous dinoflagellate cyst assemblages from offshore eastern Canada were described by Barss *et al.* (1979), Bujak & Williams (1978), Williams (1975), Williams & Brideaux (1975), Williams & Bujak (1977a, 1977b), Williams *et al.* (1974) and Williams *et al.* (1990).

The stratigraphical distribution of Mesozoic and Cenozoic dinoflagellate cysts has been described by Williams & Bujak (1985) for the world and by Williams *et al.* (1993) for the northern hemisphere.

Upper Cretaceous to Paleocene dinoflagellate cyst assemblages from eastern U.S.A. were described by Benson (1976), May (1980), Tocher (1987), Moshkovitz & Habib (1993), Aurisano & Habib (1977) who established

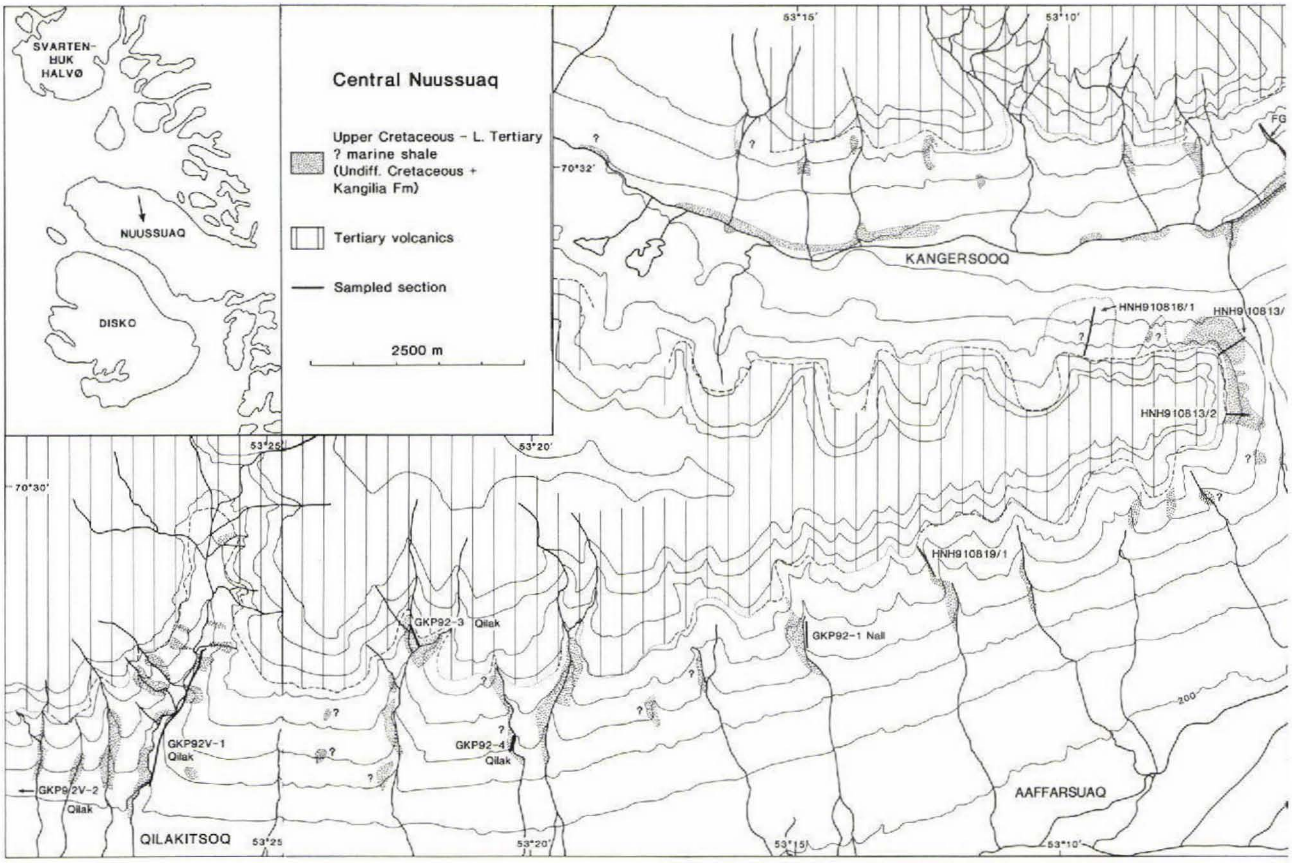


Fig. 5. Location of the outcrop and subsurface sections south of the Agatdalen area that yielded dinoflagellate cysts.

a Campanian to lowermost Tertiary dinoflagellate cyst zonation, and by Aurisano (1989) who proposed a Cenomanian to Maastrichtian dinoflagellate cyst zonation for the Atlantic Coastal Plain of New Jersey and Delaware.

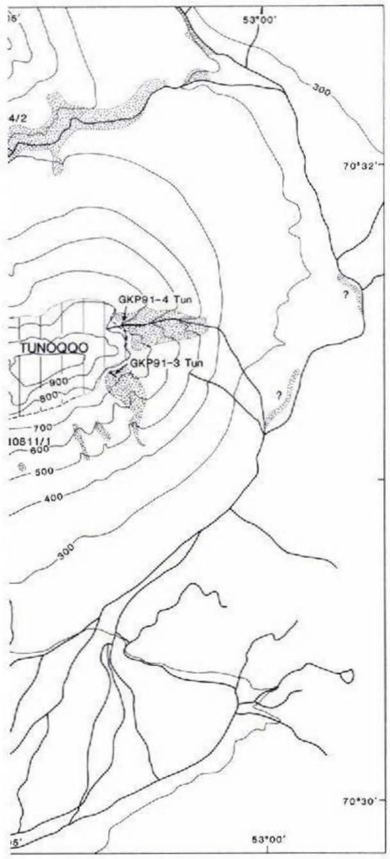
Northern North Sea, clastic deposits

According to Costa & Davey (1992, pp. 105–106) dinoflagellate cyst information has not been published from this region, apart from Costa (1985). However observations by Lucy I. Costa (reported in Costa & Davey, pp. 105–106) indicate assemblage affinities with the Upper Cretaceous arctic assemblages described by Vozzhennikova (1967) from Siberia, Manum & Cookson (1964) and Doerenkamp *et al.* (1976) from arctic Canada, and McIntyre (1974) from the District of Mackenzie, Canada.

North-western Europe

The stratigraphical distribution of Upper Cretaceous dinoflagellate cysts in North-West Europe has been compiled by Foucher (1979) and Costa & Davey (1992). Clarke & Verdier (1967) described the Cenomanian to Campanian on the Isle of Wight and made the first and only attempt to establish a dinoflagellate zonation for the British Upper Cretaceous. The dinoflagellate cyst assemblage from the Turonian type area around Saumur in France has been described by Foucher (1982). Tocher & Jarvis (1987) described Turonian dinoflagellate cysts from Devon, England. Jarvis *et al.* (1987, 1988) described the Albian to Turonian stratigraphy and anoxic events in the Cenomanian–Turonian.

Foucher (1971a,b) and Robaszynski *et al.* (1980) described dinoflagellate cyst assemblages of Coniacian age from France. Schiøler (1992) described a diverse dinoflagellate cyst assemblage from the island of Bornholm, Denmark. Westin (1992) established a dinoflagellate cyst stratigraphy from the Albian to Santonian in southern Sweden. The diverse assemblages described from Bornholm (Schiøler, 1992) and Sweden (Westin, 1992) are dominated by North Sea and North-West European limestone facies species; however the abundance of the northern North Sea genus *Chatangiella*, especially in southern Sweden, is remarkable. Yun (1981) described a



Lower Santonian dinoflagellate cyst assemblage from north-west Germany.

Foucher (1983) and Robaszynski *et al.* (1983) described the palynology of the Campanian to Maastrichtian in Belgium and the Netherlands. Hart *et al.* (1987) listed dinoflagellate cysts together with other microfossils from key Upper Cretaceous sections on the Isle of Wight. Prössl (1990) proposed a dinoflagellate cyst zonation for the late Hauterivian to the late Turonian in Germany. Kirsch (1991) described the dinoflagellate cyst content and proposed a zonation for the Turonian to late Maastrichtian from the Oberbayern in southern Germany. Marheinecke (1992) described the dinoflagellate cyst content and proposed a zonation for the Maastrichtian from Niedersachsen in northern Germany. Schiøler & Wilson (1993) proposed a dinoflagellate cyst zonation for the Dan Field in the Danish part of the North Sea.

Australia, Antarctica

There are numerous papers describing Cretaceous dinoflagellate cysts from Australia. Helby *et al.* (1987) established a palynological zonation covering the entire Mesozoic of Australia.

Askin (1988) described the Campanian to Eocene palynological succession of Seymour Island and adjacent islands, Antarctica.

Mohr & Gee (1992) and Mao & Mohr (1992) described the Cenomanian to Maastrichtian dinoflagellate cyst assemblages from the ODP leg 120 in the southern Indian Ocean.

The interesting point about the Upper Cretaceous palynomorphs recorded from Australia and around Antarctica is that they are very similar at generic level to the material recorded from West Greenland, whereas there are small but distinguishable differences between superficially similar species from the two regions, which makes direct correlation difficult.

Samples and methods

Samples

This study covers samples from Svartenhuk Halvø and Nuussuaq obtained from 29 surface localities and 12 slim cores from shallow slim core holes drilled by GGU's helicopter-transportable drilling equipment in 1992 (Figs 3–7). The sections are 20 to 470 metres thick and represent an approximately 1500 m thick mudstone succession.

Preparation

Palynological preparation and studies were carried out at GGU. Palynomorphs were extracted from 20 g of sample by modified standard preparation techniques. The bulk of the minerals were dissolved by hydrochloric and hydrofluoric acids. A first slide was made after this treatment. A second slide was made of the organic residue after sieving using a 20 micron nylon mesh. A third slide was made after oxidation (3 to 10 minutes) with fuming nitric acid, followed by washing with a weak potassium

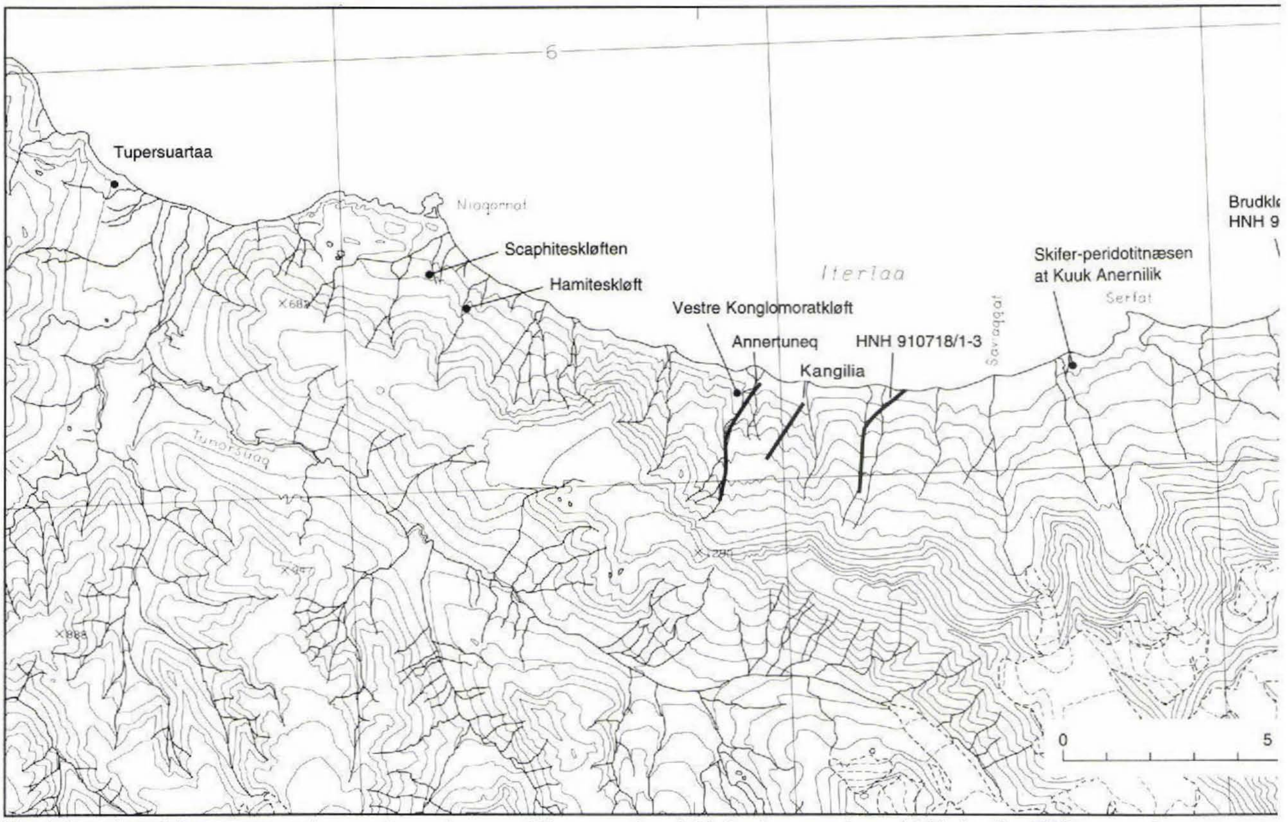


Fig. 6. Location of the outcrop sections on the north coast of Nuussuaq that yielded palynomorphs, and Birkelund's (1965) ammonite localities.

hydroxide solution. The oxidation was carried out in order to clean the sample of minor amorphous kerogen particles and pyrite. Finally, palynomorphs were separated from coal particles and woody material in most samples using the separation method described by Hansen & Gudmundsson (1978).

After each of the steps mentioned above the organic residues were mounted in a permanent medium (Eukitt R; produced by O. Kindler, Germany).

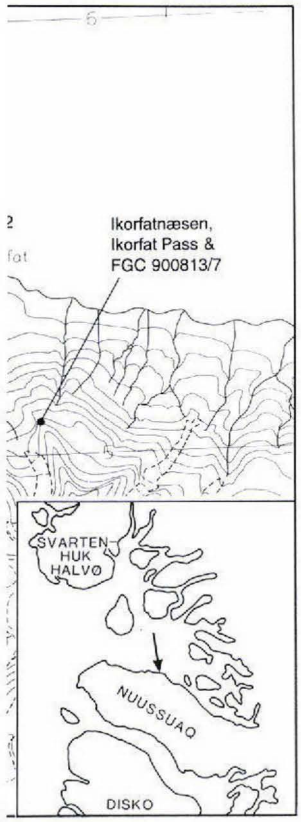
Recording of material and analyses

The palynological slides were studied with transmitted light using a Leitz Dialux 22 microscope (512 742/057691). All the coordinates in the plate captions refer to this microscope. England finder index corners: Z 75 4 = 74.6–92.3; Z 1 3 = 1.9–9220; A 1 1 = 1.9–116.7; A 65 2 = 64.6–116.6, centre: O 38 = 38.1–103.3.

The illustrated dinoflagellate cysts are marked with GGU number (sample number), slide number, microscope coordinates, laser-video-record number (LVR) and database number (MicroImage; MI) for later identification. The illustrated dinoflagellate cysts are also marked with MGUH numbers and are kept in the type collection of the Geological Museum of the University of Copenhagen. The additional palynological preparations from the West Greenland samples are housed at the Geological Survey of Greenland (Copenhagen) where they are accessible for examination.

Dinoflagellate cysts, acritarchs and selected stratigraphically important pollen species were recorded from the sieved, oxidised or gravitation-separated slides. Counting of specimens was only done on the material from the north coast of Nuussuaq, where approximately 100 specimens were counted when possible.

Reworked species are recorded by their different state of preservation and by their ?Jurassic or Lower Cretaceous origin. Reworked species constitute a minor part of the examined material, except from the lowermost Paleocene sample from the Annertuneq section on the north coast of Nuussuaq, where brown specimens of *Cribroperidinium? perforans* constitute 30 % of the assemblage.



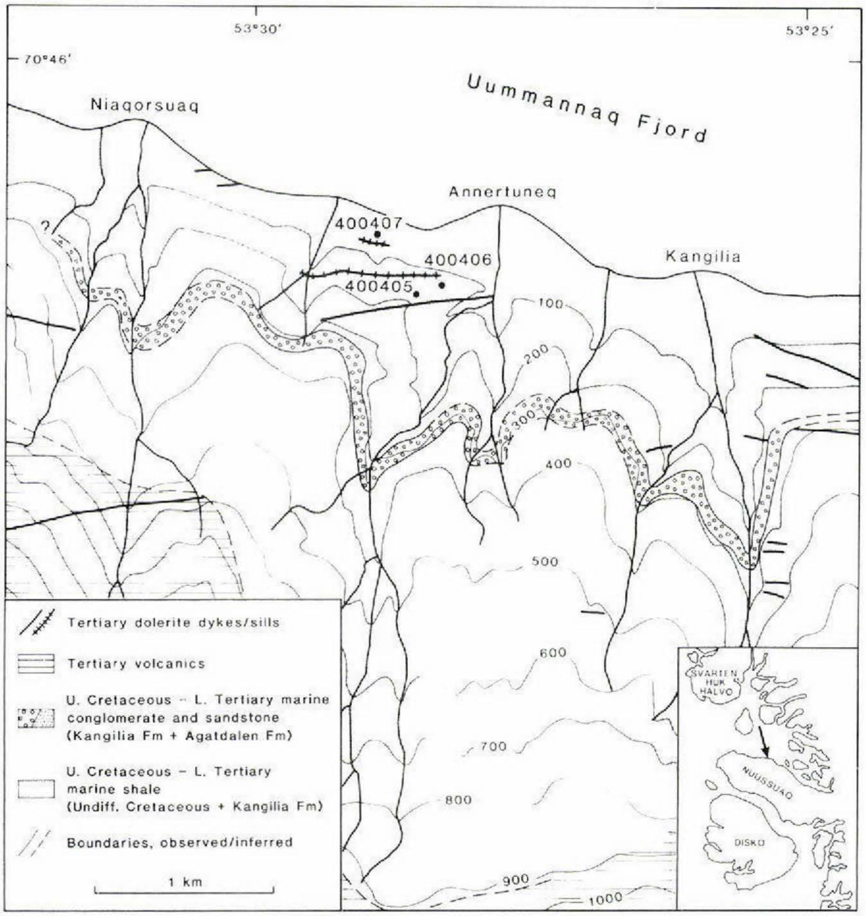


Fig. 7. Location of the outcrop and subsurface sections in the Annertuneq area that yielded palynomorphs.

Composition of the organic material and maturation

The organic material is dominated by terrestrially derived black to brownish woody material and cuticles, whereas amorphous organic material, dinoflagellate cysts, spores and pollen constitute only a minor part, 137 dinoflagellate cysts, acritarchs and selected stratigraphically important pollen species were recorded.

A TAI (Thermal Alteration Index) evaluation was carried out on the unoxidised sieved slide. The study revealed TAI values between –2 and 3, which indicate that the organic material is thermally immature to mature with respect to oil generation. The TAI values agree with the chemical analyses of the organic material which yielded T_{max} values between 404 and 456°C.

Diversity

The diversity of dinoflagellate cyst species as measured by the number of recorded species per sample varies from 1 to 32 (Enclosure 39). The highest diversity (19 to 32) occurs in the lowermost 200 m of strata of Coniacian to early Santonian age, recorded from Svartenhuk Halvø. The two diversity maxima (30, 31) both occur within the range of *Arvalidinium scheii*, whereas the diversity decreases above the last occurrence of *A. scheii* (Enclosure 39). The stratigraphically younger sections studied from Nuussuaq all have a lower diversity (1–20). The species diversity of the upper Santonian to middle Campanian deposits in central Nuussuaq is very low (1–8), except for a level in the lower middle part and in the upper part of the *Aquilapollenites* interval, where the species diversity increases to 13 and 14, respectively. The species diversity of the upper Campanian deposits at the north coast of Nuussuaq is also low (1–9), whereas it increases to 19 at the level dated as late Campanian or early Maastrichtian (just below the basal Danian conglomerate, Enclosure 39). *Odontochitina* species have their last occurrence at the same level. The diversity of the Maastrichtian deposits on the north coast of Nuussuaq, above the basal Danian conglomerate, is moderate (5–15).

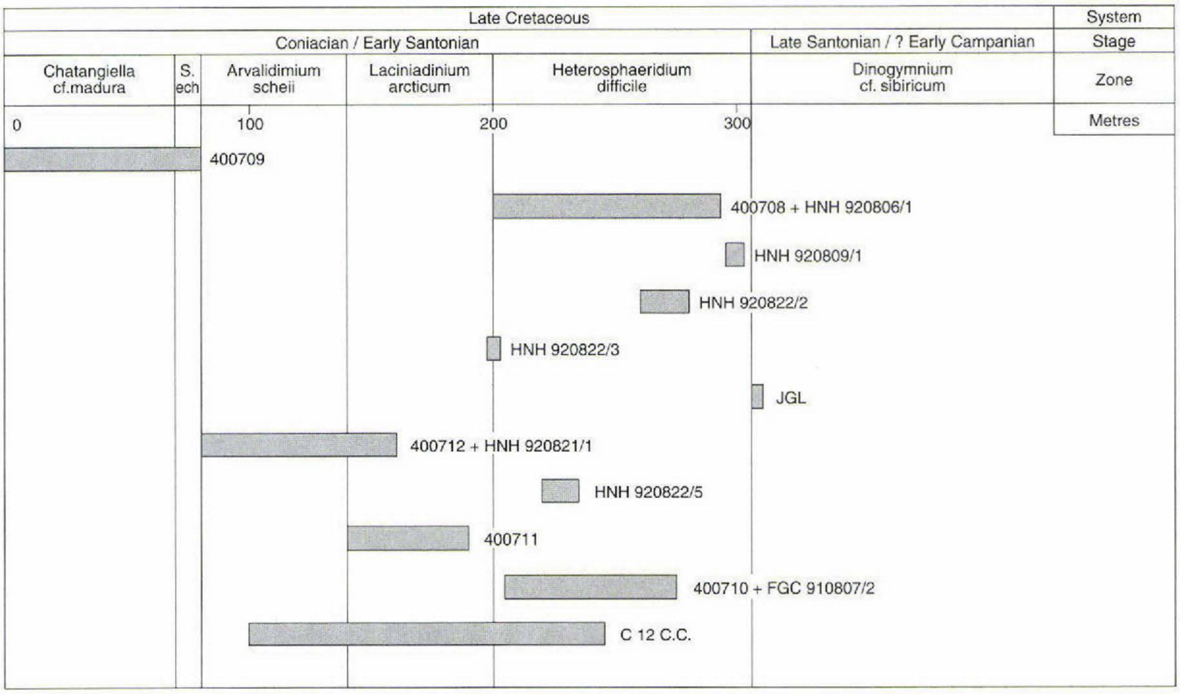


Fig. 8. Stratigraphical correlation of the sections on Svartenhuk Halvø that yielded dinoflagellate cysts.

Palynostratigraphy in West Greenland

The dinoflagellate cyst and pollen stratigraphy that is here proposed for the marine Upper Cretaceous on Svartenhuk Halvø and Nuussuaq is based principally on a detailed study of material from 29 surface sections and 12 slim cores from shallow core holes.

Additional spot samples from ten other surface sections have been studied in order to confirm that the sections include the entire Upper Cretaceous mudstone sequence exposed between Niaqornat and Ikorfat on the northern coast of Nuussuaq (Figs 6, 7).

Due to the very sparse macrofossil content and the rather homogeneous lithology, the stratigraphical correlation of the geographically widely spread sections is based solely on the first and the last occurrences and acme of stratigraphically important dinoflagellate cysts and pollen.

Coniacian to early Santonian

Dinoflagellate cysts of Coniacian to early Santonian ages have been recorded in all (Enclosures 2–6, 8–12) but one (JGL, Enclosure 7) of the sections studied on Svartenhuk Halvø (Figs 3, 8), in four sections in central Nuussuaq (FGC 900804/2 Agat., GKP 92 1 Nall., GKP 92 V 1 Qilak., & GKP 92 V 2 Qilak. Fig. 5; Enclosure 26, Enclosure 28, Enclosures 31 and 32) and one section HNH 920824/2 (Enclosure 37) at Ikorfat on the north coast of Nuussuaq (Fig. 6).

The dinoflagellate cyst assemblages from the Coniacian to early Santonian are characterised by a large number of specimens of *Chatangiella*. According to the literature the genus *Chatangiella* ranges from the late Cenomanian to the late Maastrichtian (Costa & Davey, 1992, and many others). The genus *Chatangiella* is abundant and is often dominant in late Cretaceous assemblages in the western interior of the U.S.A., western Canada, arctic Canada and the northern North Sea. *Chatangiella* is also very abundant in the southern hemisphere (especially in Australia and Antarctica), but it is less common in North-Western Europe and in the Tethyan realm (Lentin & Williams, 1980; Costa & Davey, 1992).

The presence of *Heterosphaeridium difficile* in all but one of the sections on Svartenhuk Halvø, in three sections in central Nuussuaq (GKP 92 1 Nall, GKP 92 V 1 Qilak. & GKP 92 V 2 Qilak. Enclosure 28, Enclosure 31 and Enclosure 32) and one section HNH 920824/2 (Enclosure 37) at Ikorfat on the north coast of Nuussuaq indicates an early/middle Turonian to early (?late) Santonian age (Haq *et al.*, 1987; Costa & Davey, 1992). The presence of *Isabelidinium cooksoniae* indicates a post-early Turonian age (Costa & Davey, 1992).

The absence of the characteristic species *Litosphaeridium siphoniphorum* and *Stephodinium coronatum*, both of which have their last occurrence in the Turonian, the

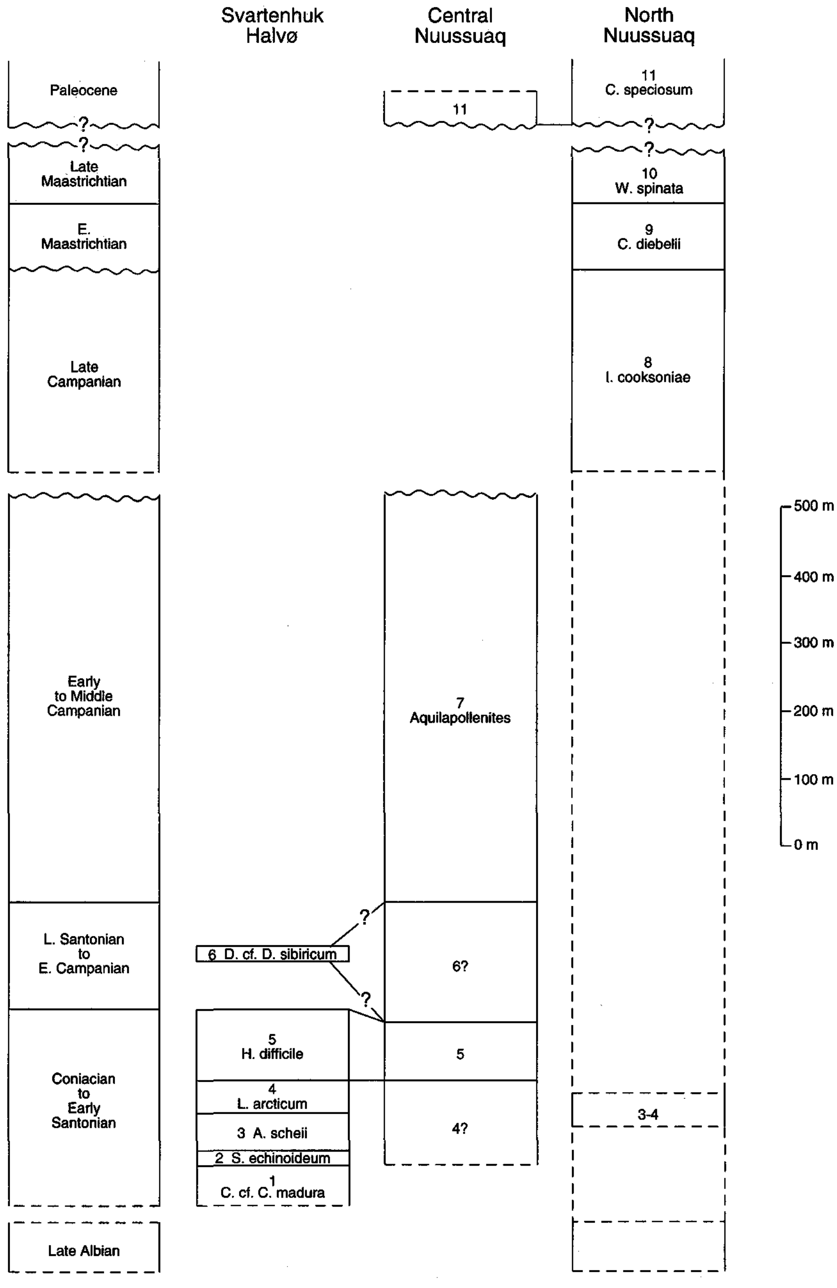


Fig. 9. Cretaceous palyno-intervals, onshore West Greenland.

presence of *Heterosphaeridium difficile* and the abundance of *Chatangiella* specimens indicate a post-Turonian to pre-Campanian age for all the above mentioned sections.

The species list on the composite range chart for Svartenhuk Halvø (Enclosure 1) shows that the assemblage changes only little with time. However, based on the first and last occurrences of a few morphologically characteristic and stratigraphically important species, it has been possible to distinguish six dinoflagellate intervals within the Coniacian to early Santonian strata (Fig. 9).

Late Santonian to middle Campanian

Most of the Upper Cretaceous deposits on central Nuussuaq (Figs 4, 5, 10) are of late Santonian to middle Campanian age. Late Santonian or 'middle'/?late Campanian dinoflagellate cysts have been recorded from one locality on Svartenhuk Halvø (JGL Enclosure 7) and from 15 (Enclosures 14–25, 26, 27, 29 & 30) of the studied localities in central Nuussuaq.

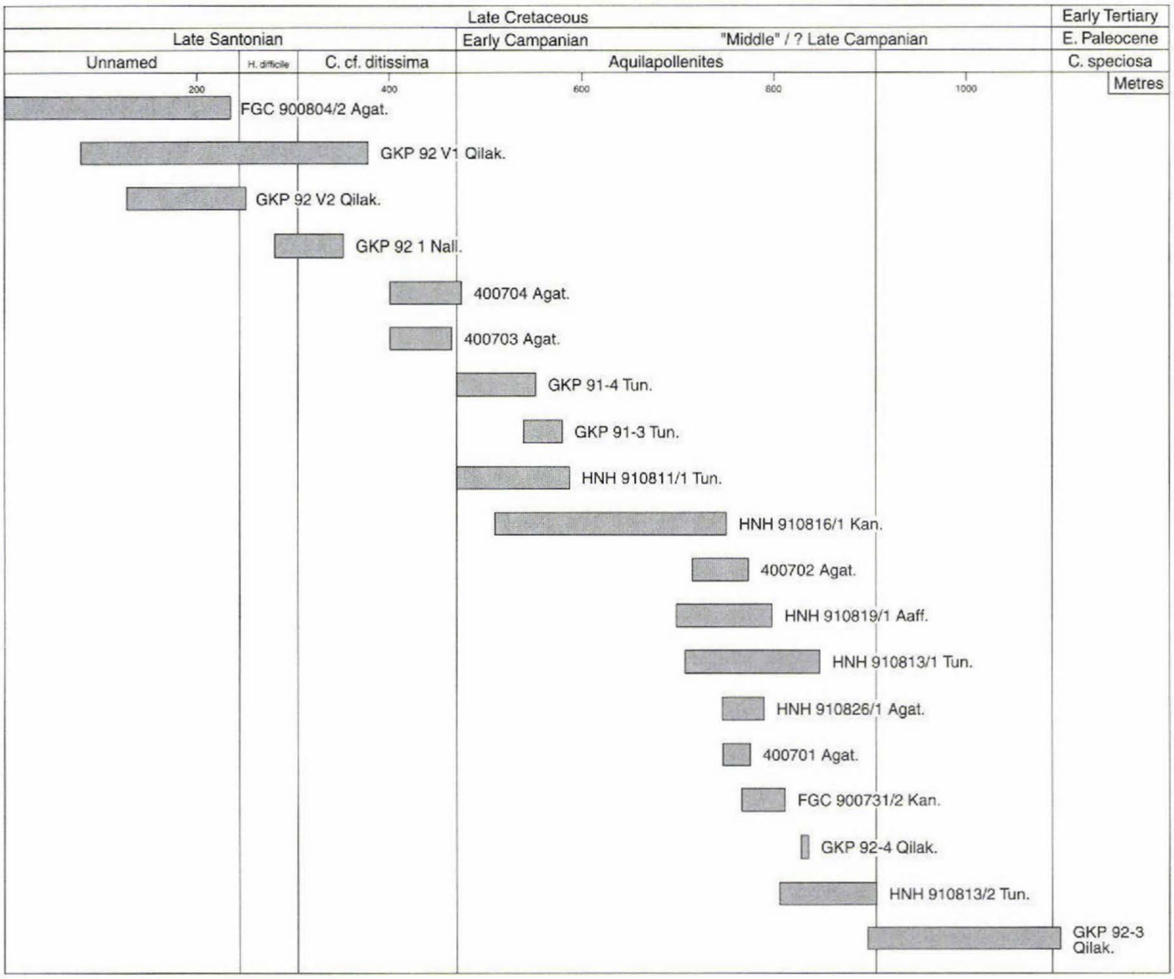


Fig. 10. Stratigraphical correlation of the sections in central Nuussuaq that yeilded dinoflagellate cysts. Kan.=Kangersooq, Agat.=Agatdalen, Qilak.=Qilakitsoq, Nall.=Nalluarissat, Tun.=Tunoqqu, Aaff.=Aaffarsuaq.

The age determination and stratigraphical correlation of this interval is based on limited observations as the dinoflagellate cyst content in the sections is very low; normally a slide contains one to ten specimens. However, terrestrially dominated samples are common. Most of the studied samples with marine palynomorphs contain one or more specimens of the genus *Chatangiella*. The presence of the pollen genus *Aquilapollenites* and the absence of *Heterosphaeridium difficile* suggests a post-?early/late Santonian age for the interval.

Aquilapollenites has been recorded in almost all of the studied sections within the interval. According to Traverse (1988) *Aquilapollenites* occurs sporadically from late Turonian to late Santonian, becomes consistent in the latest Santonian, and occurs through to the early Paleocene. Nichols & Sweet (1993) recorded the first occurrence of the genus *Aquilapollenites* in the 'uppermost' Santonian from Yukon and Northwest Territories of Canada, whereas they first recorded the genus in the 'lower' Campanian in New Mexico, USA. Croxton (1980, p. 16) concluded "Although only a preliminary assessment has to date been made of the earliest occurrence of *Aquilapollenites* in West Greenland it is not thought to occur in strata older than Campanian in age". The fact that Nøhr-Hansen (1994a, this paper) does not record *Aquilapollenites* in Coniacian to upper Santonian sediments on Svartenhuk Halvø and Nuussuaq, suggests that the genus has a post-late Santonian occurrence in West Greenland.

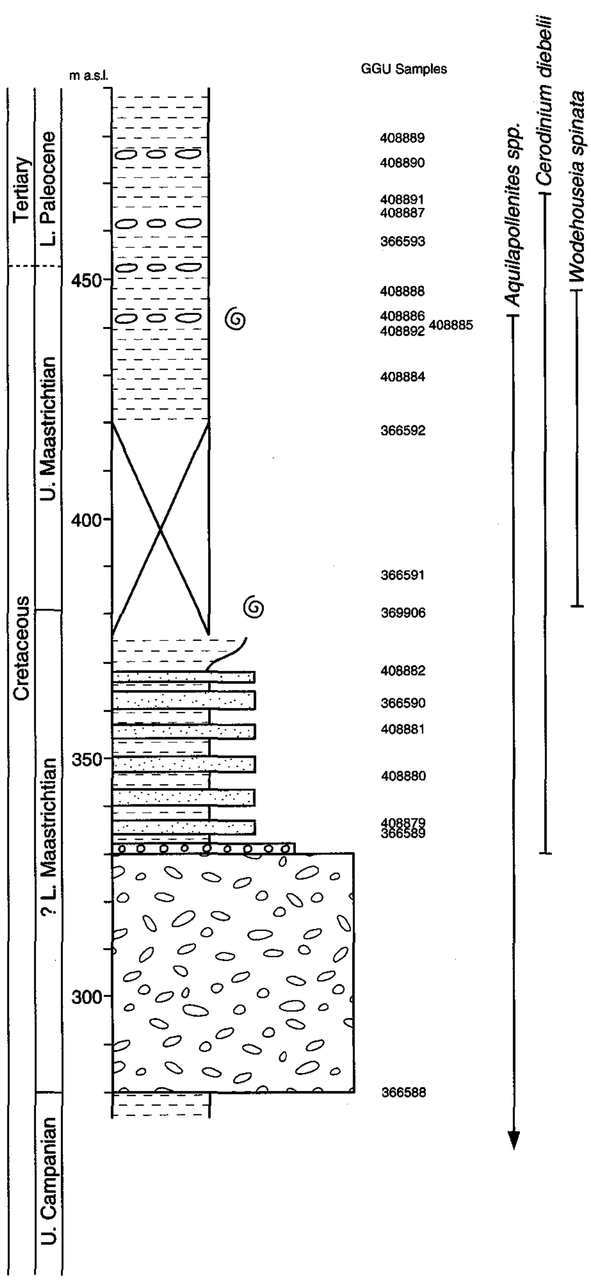
The presence of *Isabelidinium acuminatum* and *I. microarmum* indicates a Campanian age according to McIntyre (1975) and Costa & Davey (1992).

The species list on the composite range chart for central Nuussuaq (Enclosure 13) shows low diversity assemblages for the late Santonian to middle Campanian described by the *Aquilapollenites* interval (Fig. 9).

Late Campanian to late Maastrichtian

Marine palynomorphs of late Campanian to late Maastrichtian age have been recorded from four of the sections between Niaqornat and Ikorfat on the north coast of Nuussuaq (Figs 6, 7).

Age determination and stratigraphical correlation here is based on limited observations as the dinoflagellate cyst diversity in the sections is low and the specimens are not always well preserved. Many samples are dominated by terrestrial material.



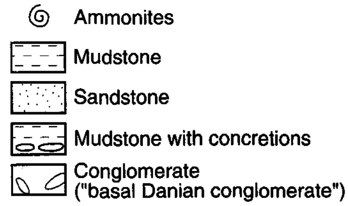


Fig. 11. Stratigraphic log, sample position and range of stratigraphically important palynomorphs from the base of the 'basal Danian conglomerate' to the Cretaceous–Tertiary boundary at the Annertuneq section on northern Nuussuaq.

The outer shelf mudstone succession between sea level and the conspicuous 'basal Danian conglomerate' (approximately 280 m a.s.l.) of Rosenkrantz (1970), is here dated as late Campanian based on the absence of large *Isabelidinium* species and the presence of *Chatangiella* cf. *ditissima*, *Odontochitina striatoperforata* and *Aquilapollenites* (Fig. 11, Enclosure 33). The 'basal Danian conglomerate' has been interpreted as a submarine channel by Dam & Sønderholm (1994).

Aquilapollenites has been recorded in the lower part of four of the sections, indicating a post-late Santonian age (see discussion above).

The absence of large *Isabelidinium* species, such as *I. acuminatum* and *I. microarmum* in sediments between Niaqornat and Ikorfat on the north coast of Nuussuaq suggests that the lowermost exposed strata in the area are younger than the early to middle Campanian strata from central Nuussuaq (Nøhr-Hansen, 1994b, this paper).

McIntyre (1975) recoreded *Chatangiella ditissima* consistently from Santonian to middle Campanian and sporadically from late Campanian to 'middle' Maastrichtian from the Mackenzie District area, N.W.T., Canada. According to Costa & Davey (1992) and Williams *et al.* (1993) *Chatangiella ditissima* last occurs in the late Campanian and *Odontochitina* species last occur in the early Maastrichtian.

The 'basal Danian conglomerate' is approximately 50 m thick at Annertuneq; no palynomorphs have been recorded from this interval (Fig. 11, Enclosures 33, 38)

The Kangilia Formation includes the 'basal Danian conglomerate' and the overlying outer shelf mudstone situated below the Lower Tertiary volcanic rocks at Kangilia, and consists of approximately 500 m of strata (Enclosure 38). The Kangilia Formation represents a transgressive system tract, according to Dam & Sønderholm (1994). Dam & Sønderholm (1994, fig. 14) suggest a sequence boundary at the base of the 'basal Danian conglomerate' mudstone deposits. Their interpretation indicates a hiatus, of late Campanian to late Maastrichtian age, situated between the Cretaceous outer shelf deposits and the conglomerate. The palynomorph content (Enclosure 33) confirms a late Campanian age for the youngest mudstone deposits situated below the 'basal Danian Conglomerate', whereas the first occurrence of the late Maastrichtian pollen *Wodehouseia spinata* at a level approximately 50 m above the top of the conglomerate at Annertuneq, suggests that the lower part of the Kangilia Formation is of early Maastrichtian age (Enclosure 33, Fig. 11).

The Kangilia Formation has previously been dated as early Paleocene to middle Paleocene by Hansen (1980, Enclosure 38) on the dinoflagellate cysts present and the interval correlated with the nannoplankton zones NP3 to NP6.

During field work in 1990–1992 ammonites were found in a loose concretion at 50 m and *in situ* at 112 m above the top of the conglomerate at Annertuneq (Fig 11, Enclosure 33). These new finds and the last records of the pollen genera *Aquilapollenites* and *Wodehouseia* at 112 and at 118 m above the conglomerate (Fig. 11, Enclosure 33) indicate that the Cretaceous–Tertiary boundary is situated at approximately 118 m above the top of the thick conglomerate at Annertuneq, and not at the base of it as stated by Rosenkrantz (1970) who termed it the 'basal Danian conglomerate'.

Hansen (1980, figs 14 & 15, p. 89) mentioned that he had no dinoflagellate cyst recovery from the lowermost 140 m of the Kangilia Formation but that it should not be excluded that these strata might represent the *Spiniferites cryptovesiculatus* Zonule (formerly *Hafniasphaera cryptovesiculata*) equivalent to parts of NP3 and NP4 or older strata.

Hansen (1980) recorded *Aquilapollenites* consistently up to 160 m above the conglomerate (Enclosure 38) and Croxton (1980, fig. 2) recorded *Aquilapollenites* and *Wodehouseia* up to approximately 115 m above the conglomerate. Croxton (1980) wrote that no conclusive statement could be made on the current palynological evidence as to whether this interval (approximately 115 m) of strata above the conglomerate represents: (1) Paleocene strata, (2) Maastrichtian strata, or (3) Paleocene strata enclosing largely reworked palynomorph assemblages from different (? younger) Maastrichtian strata below the conglomerate. Neither Birkelund (1965), Croxton (1980) nor Hansen (1980) knew, as we do today, that ammonites occur *in situ* in the interval in question.

An extract of Hansen's (1980, fig. 15) range chart from the Annertuneq/Kangilia section (M25) is shown in Enclosure 38; this shows Hansen's zonation and the proposed correlation with the nannoplankton zones.

The find of ammonites *in situ* at Annertuneq confirms that the lower part of Hansen's (1980) *Cerodinium striatum* (formerly *Deflandrea striata*) Zonule (samples 210433–210447, Enclosure 38) in profile M25 is of latest Maastrichtian age and that the Cretaceous–Tertiary boundary may be situated in the interval between 118 and 135 m above the conglomerate.

Hansen's (1980, p. 123, fig. 49) correlation between dinoflagellate cyst zonation and nannoplankton zones disagrees with the occurrence of nannoplankton characteristic of NP3 recorded by Jürgensen & Mikkelsen (1974) from samples collected just below the volcanic rocks at Annertuneq. An explanation of this disagreement is beyond the scope of the present study; renewed studies of Hansen's samples may solve the correlation problem or simply end with the conclusion that some stratigraphically important dinoflagellate cyst species have an earlier first occurrence in West Greenland than other places such as the North Sea area.

The species list on the composite range chart (Enclosure 33) shows that the assemblages of late Campanian age are of very low diversity whereas the diversity increases in the Maastrichtian. Based on the first and last occurrence and presence or absence of a few morphologically characteristic and stratigraphically important species, it has been possible to distinguish three intervals (Fig. 9) with characteristic dinoflagellate and pollen content from the composite Annertuneq section (Enclosure 33).

At Ikorfat at section FGC 900813 (Enclosure 36), the two lower samples correlate with the upper Maastrichtian strata of Annertuneq (Enclosure 33); ammonites have been sampled at the level of the uppermost sample (366623). The record of the Tertiary dinoflagellate species *Isabelidinium*? *viborgense* in the lowermost Tertiary sample (366624, Enclosure 36) situated 15 m above the uppermost Maastrichtian sample (366623) indicates a hiatus. *Isabelidinium*? *virborgense* has previously been reported by Hansen (1980) as *Senegalinium*? *dilwynense* from the Annertuneq section (Enclosure 38) where it has its first occurrence at approximately 180 m above the last ammonite.

Palynological intervals

Eleven palynofloral intervals have been distinguished in the Svartenhuk Halvø and Nuussuaq areas. Ten palynofloral intervals have been distinguished for the Coniacian/lower Santonian to upper Maastrichtian succession and one interval represents Paleocene strata.

Chatangiella sp. cf. *C. madura* interval

The dinoflagellate cyst assemblage recorded from the core hole GGU 400709 at Svartenhuk Halvø (Enclosure 2) indicates the presence of the oldest recorded marine deposition in the area.

Age. The age of the interval is most likely Coniacian but a late Turonian or early Santonian age cannot be excluded.

Definition. The interval is characterised by the occurrence of *Chatangiella* sp. cf. *C. madura*, its upper limit being the lowermost occurrence of *Spinidinium echinoideum.*

Thickness and distribution. The interval has only been recorded in the core hole GGU 400709 (Enclosure 2), where it is represented by approximately 75 m of sediments.

Characteristic species. The interval is characterised by a diverse flora. However the abundance is moderate (less than 20). The genera *Chatangiella*, *Isabelidinium* and *Heterosphaeridium* dominate the assemblages. The present stratigraphic important species has been recorded; *Chatangiella* sp. cf. *C. madura*, *C. granulifera*, *C. verrucosa*, *Desmocysta plekta*, *Dinopterygium* sp. aff. *D. cladoides*, *Florentinia* sp. aff. *F. deanei*, *F. mantellii*, *Fromea fragilis*, *Heterosphaeridium difficile*, *Odontochitina striatoperforata*, *Palaeohystrichophora infusorioides*, *Scriniodinium* sp. aff. *S. obscurum*, *Surculosphaeridium? longifurcatum*, *Trigonopyxidia ginella*, and *Xenascus* sp. aff. *X. perforatus.*

Discussion. According to the observations by Costa & Davey (1992) from the North Sea region, the presence of *Heterosphaeridium difficile* and *Surculosphaeridium? longifurcatum* throughout the interval indicates an age no younger than early Santonian. *Florentinia deanei* has its last occurrence in the latest Coniacian in Europe (Foucher, 1979; Costa & Davey, 1992). According to Costa & Davey (1992) and Williams *et al.* (1993) *Florentinia mantellii* last occurs in the late Turonian. Schiøler (1992) presumed *F. mantellii* to be reworked in the Coniacian on Bornholm, Denmark, whereas Yun (1982) considered *F. mantellii* to be *in situ* in Santonian deposits in Germany.

Williams *et al.* (1993) reported that *Chatangiella verrucosa* first occurs in the early Coniacian and ranges to the late Campanian in the northern hemisphere. Williams & Bujak (1985) reported a similar range (early Coniacian to late Campanian) for the morphologically closely related *Chatangiella granulifera*. McIntyre (personal communication, 1994) has recorded *C. granulifera* from Turonian in Alberta and *C. verrucosa* and *C. granulifera* from Turonian in the Mackenzie Delta area, Canada. Costa & Davey (1992) reported an early Turonian to late Campanian range for *C. granulifera.*

Williams & Bujak (1985) also reported an early Coniacian to late Campanian range for *Trigonopyxidia ginella*, which was described from the ?late Albian – Cenomanian from Australia by Cookson & Eisenack (1960). In the present study *Chatangiella* sp. cf. *C. madura* has been recorded only from the core hole GGU 400709 (Enclosure 2). *Chatangiella madura* was described by Cookson & Eisenack (1970) from Senonian of Australia. Ioannides (1986) recorded *C. madura* from the lower part of his Santonian–Campanian palynological interval I on Bylot Island, arctic Canada. Núñez-Betelu (1994) recorded the species from his Zone 2 (late Turonian to late Coniacian) and his Zone 3 (late Coniacian to early Campanian) at Glacier Fiord, arctic Canada. Kirsch (1991) reported *C. madura* from the lower part of his Coniacian/Santonian *Raetiaedinium truncigerum* Zone and from his Campanian *Areoligera coronata* Zone in Oberbayern, Germany, (see also systematic notes on *C.* sp. cf. *C. madura* below). Schiøler (1992) reported the very similar species *C. tripartita* from the early to 'mid'-Coniacian on the Danish island of Bornholm. Costa & Davey (1992) reported the *C. tripartita/victoriensis* complex from late Cenomanian to early Maastrichtian in the North Sea region. Helby *et al.* (1987) reported *C. tripartita* from early Santonian (consistent) to 'middle' and late Santonian (inconsistent).

The absence of species with a last occurrence in the Turonian may suggest that this interval is of Coniacian age.

Spinidinium echinoideum interval

Age. Coniacian.

Definition. Interval from the first occurrence of *Spinidinium echinoideum* to immediately below the first occurrence of *Arvalidinium scheii.*

Thickness and distribution. The interval is only represented by two samples in the upper part of the core hole GGU 400709 on Svartenhuk Halvø (Enclosure 2), where it constitutes approximately 10 m of the section.

Characteristic species. The interval is like the *Chatangiella* sp. cf. *C. madura* interval characterised by a diverse flora. However the abundance is moderate (less than 20). The genus *Chatangiella* dominates the assemblages. The stratigraphically important species recorded are: *Chatangiella* sp. cf. *C. madura*, *C. granulifera*, *C. verrucosa*, *Cribroperidinium* sp. aff. *C. intricatum*, *Florentinia* sp. aff. *F. deanei*, *F. mantellii*, *Fromea fragilis*, *Heterosphaeridium difficile*, *Odontochitina striatoperforata*, *Palaeohystrichophora infusorioides*, *Scriniodinium* sp. aff. *S. obscurum*, *Spinidinium echinoideum* and *Surculosphaeridium? longifurcatum.*

Discussion. The first occurrence of *Spinidinium echinoideum* in the upper part of the core hole GGU 400709 (Enclosure 2) indicates a Coniacian to early Santonian age. The species was described by Cookson & Eisenack (1960) from the Santonian and Campanian in Australia. According to Clarke & Verdier (1967) and Foucher (1979) *Spinidinium echinoideum* ranges from the early Santonian to the earliest Campanian in England and France. However, Foucher (1979) reported in addition a *S.* sp. cf. *S. echinoideum* from the late Turonian in France. Schiøler (1992) recorded *S. echinoideum echinoideum* from Coniacian deposits from the island of Bornholm, Denmark. From Oberbayern in Germany Kirsch (1991) recorded the first occurrence for *S. echinoideum* in his Coniacian to Santonian *Raetiaedinium truncigerum* Zone. Heilmann-Clausen (1985) recorded *S. echinoideum* from the early Paleocene in Denmark. *Spinidinium mariae* is considered here to be almost identical with *S. echinoideum.* According to Aurisano (1984, 1989) *Spinidinium mariae* ranges from early Santonian to early Campanian in the Atlantic coastal plain of New Jersey, U.S.A.

Arvalidinium scheii interval

Age. The age of the interval is most likely early Coniacian, due to its position in the core hole GGU 400712, where it has been recorded below *in situ* ammonites of early Coniacian age (Birkelund, 1965).

Definition. Interval from the first occurrence of *Arvalidinium scheii* to immediately below the first occurrence of *Laciniadinium arcticum.*

Thickness and distribution. The interval is represented by the lower 57 m of the core hole GGU 400712 on Svartenhuk Halvø (Enclosure 8) and perhaps by the two lowermost samples (approximately 40 m) from section C12, Svartenhuk Halvø (Enclosure 12). The interval is possibly also represented by one sample from section HNH 920824/2 Nnuu (Enclosure 37) at Ikorfat on the north coast of Nuussuaq.

Characteristic species. The interval is characterised by the presence of numerous *Arvalidinium* and *Chatangiella* specimens, which constitute between 35 and 53% of the dinoflagellate cyst assemblages, and *Odontochitina striatoperforata*, which constitutes up to 10% of the assemblage. The interval is also characterised by the incoming of the species *Arvalidinium scheii, Chatangiella mcintyrei* sp. nov., *Isabelidinium svartenhukense* sp. nov. and *Palaeotetradinium silicorum.* The following characteristic species continue from the previous *Spinidinium echinoideum* interval: *Chatangiella granulifera, C. verrucosa, Desmocysta plekta, Dorocysta litotes, Florentinia* sp. aff. *F. deanei, F. mantellii, Fromea fragilis, Heterosphaeridium difficile, Odontochitina striatoperforata, Palaeohystrichophora infusorioides, Spinidinium echinoideum, Surculosphaeridium? longifurcatum, Trigonopyxidia ginella, Trithyrodinium suspectum, Wallodinium anglicum* and *Xenascus* sp. aff. *X. perforatus.*

Discussion. The abundance of *Arvalidinium scheii* in the interval is important. Previously *A. scheii* has only been reported by Manum (1963) who described the species (as *Deflandrea scheii*) from a 'Deflandreoid'-dominated assemblage from Graham Island, arctic Canada, where according to Manum (1963) and Manum & Cookson (1964) it is very common. The dinoflagellate cyst assemblage from the sample reported by Manum & Cookson (1964) from the presumed Kanguk Formation at Graham Island is quite similar to the assemblage recorded from the *A. scheii* interval on Svartenhuk Halvø. However *Laciniadinium arcticum* (as *Diconodinium arcticum*) which occurs on Graham Island has not been observed in the *A. scheii* interval on Svartenhuk Halvø. Manum (1963) and Manum & Cookson (1964) indicated that their samples were from the upper Albian – lower Cenomanian Hassel Formation, but Felix & Burbridge (1976) considered that Manum's samples more likely represented the Kanguk Formation of late Cenomanian to early Campanian age. Núñez-Betelu (1994) described some forms resembling *A. scheii*, from the base of his late Coniacian to early Campanian Zone 3; the level was dated late Coniacian by the presence of the ammonite *Scaphites depressus* (Hills *et al.*, 1994).

Laciniadinium arcticum interval

Age. The age of the interval is most likely early Coniacian, due to its position at the core hole GGU 400712 (Enclosure 8) where it has been recorded below *in situ* ammonites of early Coniacian age (Birkelund, 1965).

Definition. Interval from the first occurrence of *Laciniadinium arcticum* to the last occurrence of *Arvalidinium scheii.*

Thickness and distribution. The interval is represented by approximately 50 m in the core hole GGU 400711 (Enclosure 10), approximately 50 m in section C12 Svartenhuk (Enclosure 12), approximately 20 m in the composite section GGU 400712+HNH 920821/1 (Enclosure 8) and possibly by one sample in section HNH920822/3 Svar (Enclosure 6). All sections from Svartenhuk Halvø.

Characteristic species. The interval is, like the underlying interval, characterised by the presence of numerous *Chatangiella* specimens. The interval is also characterised by the incoming of *Laciniadinium arcticum. Microdinium reticulatum, Tanyosphaeridium* sp. cf. *T. variecalamus.* The following species continue from the *Arvalidinium scheii* interval: *Arvalidinium scheii, Chatangiella* sp. aff. *C. spectabilis, C.* sp. cf. *C. ditissima, Spinidinium echinoideum, C. granulifera, C. verrucosa, Desmocysta plekta, Florentinia* sp. aff. *F. deanei, F. mantellii, Fromea fragilis, Heterosphaeridium difficile, Odontochitina striatoperforata, Palaeohystrichophora infusorioides, Surculosphaeridium? longifurcatum, Trigonopyxidia ginella, Trithyrodinium suspectum, Wallodinium anglicum* and *Xenascus* sp. aff. *X. perforatus.* The last occurrence of *Palaeotetradinium silicorum* is in the lower part of the interval.

Discussion. The palynomorph assemblage of the interval is very similar to the 'Deflandreoid'-dominated assemblage from Graham Island, arctic Canada, recorded by Manum (1963) and Manum & Cookson (1964). In addition to the abundance of *Arvalidinium scheii* and the presence of *Laciniadinium arcticum* there are 15 other species from the interval that are also present in the Graham Island samples. The interval correlates with the upper part of Zone 2 (late Turonian to late Coniacian) or the lower part of Zone 3 (late Coniacian to early Campanian) described by Núñez-Betelu (1994) for the Kanguk Formation in the Canadian arctic.

Notes on the *Laciniadinium arcticum/ Heterosphaeridium difficile* interval

Samples from three sections on central Nuussuaq have been very difficult to place in one of the 10 defined Upper Cretaceous intervals due to the presence of very few dinoflagellate cysts. Possibly the entire section FGC900804/2 Kan. (Enclosure 26; 110 m), the lower part of section GKP 92 V 1 Qilak. (Enclosure 31; 120 m) and GKP 92 V 2 Qilak. (Enclosure 32; 96 m) belong in this interval.

The samples from the three sections mentioned above contain almost no dinoflagellate cysts exept for a few specimens of the genera *Chatangiella* and *Isabelidinium.* The presence of *Isabelidinium* and *Chatangiella*, especially *C. granulifera*, indicates an early Coniacian to late Campanian range according to Williams & Bujak (1985), whereas Costa & Davey (1992) reported an early Turonian to late Campanian range for *C. granulifera.*

The fact that the samples from the sections GKP 92 V 1 Qilak. (Enclosure 31) and GKP 92 V 2 Qilak. (Enclosure 32) are situated stratigraphically below samples containing the species *Heterosphaeridium difficile* suggest that the interval may correlate with part of the *Laciniadinium articum* interval or part of the *H. difficile* interval.

Heterosphaeridium difficile interval

Age. Coniacian to early Santonian

Definition. Interval from immediately above the last occurrence of *Arvalidinium scheii* to the last occurrence of *Heterosphaeridium difficile.*

Thickness and distribution. The interval is represented in six outcrop sections and two subsurface sections in the Svartenhuk Halvø area, three sections in the central Nuussuaq area and in one section at Ikorfat at the north coast of Nuussuaq. The interval is represented by 94 m in the composite section GGU 400708+HNH 920806/1 (Enclosure 3), 16 m in section HNH 920809/1 Svar (Enclosure 4), section HNH 920822/2 Svar (Enclosure 5), perhaps from the uppermost sample in section HNH 920822/3 Svar (Enclosure 6), 15 m in section HNH 920822/5 Svar (Enclosure 9), 71 m in the composed section GGU 400710+FGC 910807/2 (Enclosure 11) and by approximately 60 m in section C12 (Enclosure 12) on Svartenhuk Halvø. The interval is represented by one sample in each of the sections GKP 92 V 2 Qilak. (Enclosure 32) and GKP 92 1 Nall. (Enclosure 28) and constitutes approximately 95 m of the section GKP 92 V 1 Qilak. (Enclosure 31) in the central Nuussuaq area. The interval is probably also represented by the uppermost sample from section HNH 920824/2 Nnuu (Enclosure 37) at Ikorfat on the north coast of Nuussuaq.

Characteristic species. The interval is characterised by a poorly preserved low diversity palynomorph assemblage. The frequency of *Chatangiella* specimens is very low compared to the previous zone. Species such as *Chatangiella* sp. cf. *C. ditissima, Heterosphaeridium difficile, Laciniadinium arcticum, Odontochitina striatoperforata, Palaeohystrichophora infusorioides* and *Spinidinium echinoideum* are present throughout the zone, whereas *Isabelidinium svartenhukense* sp. nov., *Surculosphaeridium? longifurcatum, Trigonopyxidia ginella* and *Wallodinium anglicum* are recorded only from the lower part of the interval. The following species have a more sporadic occurrence within the interval: *Chatangiella granulifera, C.* sp. aff. *C. spectabilis, Desmocysta plekta, Florentinia* sp. aff. *F. deanei, F. mantellii* and *Xenascus* sp. aff. *X. perforatus.*

Discussion. The last occurrences of *Heterosphaeridium difficile* and *Surculosphaeridium? longifurcatum* indicate an age no younger than early Santonian, in agreement with the range given by Costa & Davey (1992). Based on the last occurrence of *H. difficile*, the interval may be correlated with the lower part of the late Coniacian to early Campanian Zone 3 described for the Kanguk Formation in arctic Canada by Núñez-Betelu (1994).

Dinogymnium sp. cf. *D. sibiricum* interval

Age. Late Santonian or early Campanian

Definition. Interval from immediately above the last occurrence of *Heterosphaeridium difficile* up to the last occurrence of *Dinogymnium* sp. cf. *D. sibiricum.*

Thickness and distribution. The interval has been recorded only in the three metre thick section JLG on Svartenhuk Halvø (Enclosure 7) situated just below the base of the hyaloclastic basalt.

Characteristic species. The interval is represented by a low diversity palynomorph assemblage, characterised by well preserved specimens of *Isabelidinium* sp. aff. *I. acuminatum*, and very few specimens of *Dinogymnium* sp. cf. *D. sibiricum.* The following stratigraphically important species continue from previous zones: *Chatangiella* sp. cf. *C. ditissima*, *Palaeohystrichophora infusorioides*, *Spinidinium echinoideum*, *Trithyrodinium suspectum* and *Xenascus* sp. aff. *X. perforatus.*

Discussion. The presence of *Chatangiella* sp. cf. *C. ditissima*, *Palaeohystrichophora infusorioides* and *Trithyrodinium suspectum* indicates, according to Costa & Davey (1992), an age no younger than Campanian. The same authors mention that *Isabelidinium acuminatum* first occurs, or first becomes consistent in the early Campanian. *Dinogymnium sibiricum* has a Coniacian to early Santonian range, according to Costa & Davey (1992), whereas McIntyre (1974) reported a late Santonian to late Campanian range for the almost identical species *Dinogymnium* sp. cf. *Dinogymnium sibiricum.*

The discussion above clearly illustrates the difficulties in dating the interval. However the absence of *Heterosphaeridium difficile* and the presence of *Spinidinium echinoideum* indicate a late Santonian/early Campanian age.

Notes on an almost barren interval above the *Heterosphaeridium difficile/ Dinogymnium* sp. cf. *D. sibiricum* interval

Samples from two sections and two core holes in central Nuussuaq are almost barren of dinoflagellate cysts and only characterized by occupying an interval between the last occurrence of *Heterosphaeridium difficile* and below the first occurrence of *Aquilapollenites.* The interval is represented by one sample each in the two sections GKP 92 V 1 Qilak. (Enclosure 31), GKP 92 1 Nall. (Enclosure 28), 59 m of the core hole GGU 400703 Cnuu (Enclosure 17) and by the lower 40 m in the core hole GGU 400704 Cnuu (Enclosure 18).

The samples contain a few specimens of the characteristic species *Chatangiella* sp. cf. *C. ditissima*, *C.* sp. cf. *C. spectabilis*, *Florentinia mantellii*, *Fromea fragilis*, *Isabelidinium* spp., *Laciniadinium* aff. *L. arcticum*, *Odontochitina striatoperfarata* and *Spinidinium* aff. *S. uncinatum.*

The fact that the samples from the core hole GGU 400704 Cnuu (Enclosure 18) are situated stratigraphically below samples containing *Aquilapollenites* suggests that the interval may correlate with part of the *H. difficile* interval or part of the *Dinogymnium sp. D. sibiricum* interval and be of Late Santonian or early Campanian age.

Aquilapollenites interval

Age. Early to middle Campanian

Definition. The interval is defined from the first occurrence of species of *Aquilapollenites* to the last occurrence of *Isabelidinium microarmum.*

Thickness and distribution. The interval is recorded only from central Nuussuaq. The interval is represented in the following 13 sections: FGC900731/2 Agat. (Enclosure 14; 50 m), core hole GGU 400701 Cnuu. (Enclosure 15; 60 m), core hole GGU 400702 Cnuu. (Enclosure 16; 55 m), core hole GGU 400704 Cnuu (Enclosure 18; uppermost sample), HNH910826/1 (Enclosure 19; 35 m), GKP 91 4 Tun. (Enclosure 20; 86 m), GKP 91 3 Tun. (Enclosure 21; 38 m), HNH910811/1 (Enclosure 22; one sample), HNH910813/1 (Enclosure 23; 90 m), HNH910813/2 (Enclosure 24; 95 m), HNH910816/1 (Enclosure 25; 155 m), HNH910819/1 (Enclosure 27; 100 m), GKP 92 3 Qilak. (Enclosure 29; one sample) and from section GKP 92 4 Qilak. (Enclosure 30; one sample) all situated in central Nuussuaq.

Characteristic species. The first occurrence of *Aquilapollenites* is diagnostic for the interval. The diversity is low and the dinoflagellate cyst content is poor in the lower part of the interval, a few specimens of *C. granulifera* and *Laciniadinium arcticum* have been recorded from section GKP 91 4 Tun. (Enclosure 20). *Batioladinium jaegeri* appears to be reworked in section GKP 91 4 Tun. (Enclosure 20). The diversity is higher in the lower middle and upper part of the interval (Enclosure 39). *Chatangiella bondarenkoi* and *Isabelidinium acuminatum* have their first occurrences in the lower middle part of the *Aquilapollenites* interval whereas *I. microarmum* has its first occurrence in the upper part of the interval. Other characteristic species from the middle and upper part of the interval are *Aquilapollenites* spp., *Chatangiella* sp. cf. *C. ditissima*, *C. granulifera*, *Desmocysta plekta*, *Exochosphaeridium bifidum*, *E. striolatum*, *Hystrichosphaeridium pulchrum*, *Laciniadinium arcticum*, *Odontochitina striatoperforata* and a single specimen of *Coronifera oceanica*, *Florentinia mantellii*, *Palaeohystrichophora infusorioides*, *Surculosphaeridium* sp. aff. *S. longifurcatum* and *Tanyosphaeridium* sp. cf. *T. variecalamus*.

Discussion. According to Traverse (1988) *Aquilapollenites* becomes consistent in the 'latest' Santonian and through to the early Paleocene. *Aquilapollenites* species have not been recorded in sediments older than middle to late Campanian at Horton River northern Canada (McIntyre, 1974). Sweet *et al.* (1989) recorded the first occurrence of *Aquilapollenites* species in the early Campanian in the Brackett Basin, N.W.T., Canada, whereas Nichols & Sweet (1993) mentioned that *Aquilapollenites* species have their first occurrence in the 'latest' Santonian in Yukon and N.W.T., Canada. On Svartenhuk Halvø *Aquilapollenites* was not recorded in the Coniacian to late Santonian succession by Nøhr-Hansen (1994a), which suggests that the genus has a post-late Santonian occurrence in West Greenland.

Based on the first occurrence of *Aquillapollenites* spp., the interval may be correlated with the upper part of the late Coniacian to early Campanian Zone 3 described for the Kanguk Formation in arctic Canada by Núñez-Betelu (1994).

According to Costa & Davey (1992) *Batioladinium jaegeri* has its last occurrence in the middle Cenomanian. The presence of possibly reworked specimens of *B. jaegeri* in the Campanian section GKP 91 4 Tun (Enclosure 20) indicates that pre-Turonian marine-influenced sediments have been deposited somewhere in central Nuussuaq.

Isabelidinium acuminatum has an early to 'middle' Campanian range in the Mackenzie Delta area (McIntyre, 1975). Harker *et al.* (1990) recorded *I. acuminatum* from the earliest Campanian in the Western Interior, U.S.A. According to Costa & Davey (1992) *I. acuminatum* first occurs, or first becomes consistent in the early Campanian. Previously *C. bondarenkoi* has been reported from Santonian in Western Siberia and from Santonian to Campanian in arctic Canada (Lentin & Vozzhennikova, 1990).

Isabelidinium microarmum has an early Campanian to 'middle' Maastrichtian range in the Horton River section (McIntyre, 1975). Ioannides (1986) recorded *I. microarmum* from questionable Maastrichtian strata in arctic Canada. According to Costa & Davey (1992) *I. microarmum* does not seem to persist beyond the end of the Campanian in the North Sea region.

Odontochitina striatoperforata was described from the Albian to Cenomanian in Australia by Cookson & Eisenack (1962). Williams & Brideaux (1975) recorded a Cenomanian to 'latest' Campanian range for the species from Grand Banks, offshore eastern Canada. Singh (1971) has been followed concerning the systematic position of *O. striatoperforata*.

The presence of *Palaeohystrichophora infusorioides* and *Chatangiella granulifera* indicates a pre-Maastrichtian age (Costa & Davey, 1992).

The presence of single specimens of *Tanyosphaeridium* sp. cf. *T. variecalamus* and *S.* sp. aff. *S. longifurcatum* suggests a pre-Campanian age. The single specimen occurrences suggest, however, that the species may be reworked or that they have a slightly longer range in West Greenland.

An early to 'middle' Campanian age is proposed for the *Aquilapollenites* interval based on the first occurrences of *Aquilapollenites*, *Isabelidinium acuminatum* and *I. microarmum*.

Isabelidinium cooksoniae interval

The sparse dinoflagellate cyst assemblage recorded from the *I. cooksoniae* interval (Enclosures 33, 34, 35) indicates the presence of the oldest recorded marine deposits between Niaqornat and Ikorfat on the north coast of Nuussuaq.

Age. The age of the interval is most likely late Campanian.

Definition. The interval is defined by the abundance of *Isabelidinium cooksoniae* and *Palaeoperidinium pyrophorum*, the upper limit being immediately below the first occurrence of *Cerodinium diebelii*.

Thickness and distribution. Approximately 280 m of composite strata in the core holes GGU 400705, 400706, 400707 (Fig. 7, Enclosure 33) and sediments below the conspicuous conglomerate at the north coast of Nuussuaq (Enclosures 33, 34, 35) are described as the *I. cooksoniae* interval.

Characteristic species. The interval is characterised by the abundance of *Isabelidinium cooksoniae* and *Palaeoperidinium pyrophorum*, and by the presence of *Chatangiella* sp. cf. *C. ditissima*, *Laciniadinium arcticum*, *Odontochitina striatoperforata*, and *Aquilapollenites*. Only a few specimens of the genera *Hystrichodinium* and *Xenascus* have been recorded. *Fibrocysta? vectensis sensu* Ioannides (1986) has been recorded only from the uppermost part of the interval at Annertuneq (Enclosure 33), and *'Isabelidinium* sp. aff. *I. bujakii'* Marheinecke (1992) first occurs in the same interval.

Discussion. The presence of *Aquilapollenites* indicates an age not older than 'latest' Santonian or 'earliest' Campanian (see discussion above). According to Costa & Davey (1992), Williams *et. al* (1993) and Williams & Brideaux (1975) the presence of *Chatangiella* sp. cf. *C. ditissima* and *Odontochitina striatoperforata* indicates a pre-early Maastrichtian age. The absence of *I. acuminatum* and *I. microarmum* in the interval suggests an assemblage younger than the early to 'middle' Campanian assemblages described above and by Nøhr-Hansen (1994b) from central Nuussuaq.

Cerodinium diebelii interval

Age. Early Maastrichtian.

Definition. The interval is defined as being from the first occurrence of *Cerodinium diebelii* to immediately below the first occurrence of the pollen species *Wodehouseia spinata*.

Thickness and distribution. The interval is represented in the Annertuneq section (Enclosure 33) by approximately 46 m, in the Kangilia HN-H section (Enclosure 34) by one sample, in section FGC 900813/7 Nord (Enclosure 36) by one sample and in section HNH 910718/1 (Enclosure 35) by more than 30 m. All four sections are situated on the north coast of Nuussuaq.

Characteristic species. The interval is characterised by the first occurrence of *Cerodinium diebelii*, *Paleocystodinium golzowense*, *Impagidinium* sp. cf. *I. dispertitum*, the informal subspecies *'Hystrichosphaeridium proprium proprium'* erected by Marheinecke (1992) and by the presence of *'Isabelidinium* sp. aff. *I. bujakii'* Marheinecke (1992) and representatives of the pollen genus *Aquilapollenites*. The lowermost sample (366589), representing the interval at Annertuneq (Enclosure 33), is dominated by *'H. p. proprium'* and *Chatangiella* sp. aff. *C. granulifera* of which the latter may be reworked. The species *Chatangiella* sp. cf. *C. ditissima*, *Isabelidinium cooksoniae*, *Laciniadinium arcticum* and *Odontochitina striatoperforata*, when they occur, are recorded only from the lowermost part of the interval.

Discussion. The first occurrence of *Cerodinium diebelii* (see also discussion in the notes to *C. diebelii*) has previously been reported from early Maastrichtian in arctic Canada (McIntyre, 1975) and from the Atlantic Coastal Plain of U.S.A. (Aurisano, 1989), whereas Williams, *et al.* (1993) reported a late Santonian first occurrence for *C. diebelii* in the Northern Hemisphere, Kirsch (1991) recorded a early to late Maastrichtian age from Oberbayern, Germany and Costa & Davey (1992) reported a late Campanian first occurrence from the North Sea area.

The informal species *'Isabelidinium bujakii'* was described and reported only from the latest early Maastrichtian in Germany by Marheineche (1992). According to Costa & Davey (1992) and Williams *et al.* (1993) *Chatangiella ditissima* has its last occurrence in the 'uppermost' Campanian and *Odontochitina* species last occurs in the 'lowermost' Maastrichtian.

Ioannides (1986) recorded *P. golzowense* from the lowermost part of his Maastrichtian interval III and from his early Paleocene IV and IVa intervals on Bylot Island, arctic Canada.

The first occurrence of *Cerodinium diebelii* and the last occurrence of *Chatangiella* sp. aff. *C. ditissima* and *O. striatoperforata* in the lowermost part of the interval, and the presence of *'I.* sp. aff. *I. bujakii'* throughout the interval, suggest an early Maastrichtian age.

Wodehouseia spinata interval

Age. Late Maastrichtian.

Definition. The interval is defined as being from the first occurrence of the pollen species *Wodehouseia spinata* to its last occurrence.

Thickness and distribution. The interval is recorded only from the north coast of Nuussuaq where it is represented by approximately 80 m in the Annertuneq section (Enclosure 33), by approximately 70 m in the Kangilia HN-H section (Enclosure 34), and by approximately 25 m in section FGC 900813/7 Nord (Enclosure 36) at Ikorfat.

Characteristic species. The interval is characterised by *Wodehouseia spinata*. The following dinoflagellate cyst species first occur in the interval: *Deflandrea galeata*, *'Hystrichosphaeridium proprium brevispinum'* of Marheineche (1992) and *Phelodinium kozlowskii*. The species *Cerodinium diebelii*, *'H. p. proprium'* and *Palaeocystodinium golzowense* are present throughout the interval.

Spinidinium clavus is abundant in the lowermost sample of the interval in the Annertuneq section. The pollen of *Pseudointegricorpus protusum*, *Scollardia* sp., *Wodehouseia* sp. cf. *W. fimbriata* and *W.* sp. cf. *W. quadrispina* are rare but have been recorded only from this interval in this study.

Discussion. According to Nichols & Sweet (1993, fig. 3a, table. 1) *Wodehouseia spinata* has its lowest occurrence in their assemblage 9 (lower part of late Maastrichtian) from the Western Interior, U.S.A. and has a stratigraphical range from the late Maastrichtian to the Cretaceous–Tertiary boundary in the Yukon and Northwest Territories of Canada and in New Mexico, U.S.A. However, the species crosses this boundary in the northern part of the Western Interior Basin (Nichols & Sweet, 1993, p. 551). Srivastava (1994) reported the last occurrence of *W. spinata* less than a metre above the Cretaceous–Tertiary boundary in Alberta, Canada. McIntyre (1974) recorded *W. spinata* in sediments of Maastrichtian age in the Horton River section, arctic Canada.

The presence of a few specimens of *Wodehouseia* sp. cf. *W. quadrispina* in the uppermost part of the *W. spinata* interval indicates, according to the work of Nichols & Sweet (1993), a 'latest' Maastrichtian age.

The occurrence of *Wodehouseia* sp. cf. *W. fimbriata* in the concretion surrounding the ammonite sample 408892 (Enclosure 33) is noteworthy. Sweet *et al.* (1989, p. 98) wrote that the occurrence of *Wodehouseia fimbriata* started at an horizon about 22 m above the Cretaceous–Tertiary boundary at Police Island in the Northwest Territories of Canada, and the same first occurrence for *W. fimbriata* was shown by Nichols & Sweet (1993, fig. 5). Srivastava (1994) recorded *W. fimbriata* as abundant in a sample approximately 3.5 m above the Cretaceous–Tertiary boundary in Alberta. However A. R. Sweet (personal communication, 1994) confirmed that specimens similar to the *Wodehouseia* sp. cf. *W. fimbriata* specimens from West Greenland have been recorded from the 'latest' Maastrichtian in the Western Interior, and the pollen assemblages of the samples 408886 and 408892 suggest a 'latest' Maastrichtian age.

According to Schiøler & Wilson (1993, p. 343) *Deflandra galeata* has a first occurrence in the middle part of the late Maastrichtian *Isabelidinium cooksoniae* Interval Zone in the Danish part of the North Sea. Schiøler & Wilson show that *D. galeata* and *I. cooksoniae* occur together in their interval zone, and that *I. cooksoniae* was abundant in this interval. However *I. cooksoniae* has not been recorded together with *D. galeata* in West Greenland. Kirsch (1991) recorded *D. galeata* from middle to late Maastrichtian deposits in Oberbayern, Germany.

Cerodinium speciosum interval

Age. Late Paleocene.

Definition. The interval is defined as ranging from immediately above the last occurrence of *Wodehouseia spinata.*

Thickness and distribution. The interval is recorded from the upper part of three sections (Annertuneq, HNH 910718/1, Enclosure 35 and FGC 900813/7 Nord, Enclosure 36) on the north coast of Nuussuaq and the uppermost sample of section GKP 92 3 Qilak in central Nuussuaq (Enclosure 29). The lowermost sample in this section represents the early to middle Campanian *Aquilapollenites* interval, and the approximately 200 m of strata between the two samples are barren of dinoflagellate cysts.

Characteristic species. The interval is characterised by first occurrence of *Cerodinium speciosum, Deflandrea* aff. *D. galeata* and by the presence of the species *Phelodinium kozlowskii* and *Glaphyrocysta* sp. Dark brown specimens of the Jurassic species *Cribroperidinium? perforans* constitute up to 30% of the dinoflagellate assemblage in the lowermost sample of the interval at Annertuneq, and are considered as reworked.

Discussion. The species *Cerodinium speciosum* dates the sample as late Paleocene. In and around Great Britain the base of the range of the species correlates with NP5 (Heilmann-Clausen, 1985; Powell, 1992).

The 200 m of strata between the sample containing *I. microarmum* and the sample with *C. speciosum* (Enclosure 29) may represents the entire upper Campanian to upper Paleocene stratigraphic column. However it is considered more likely that there is a non-conformity within the strata between the two samples.

Comparison with macrofossil ages

Svartenhuk Halvø

Late Turonian, Coniacian, Santonian and early Campanian ammonites on south-east Svartenhuk Halvø (Fig. 12) were recorded by Birkelund (1965; fig. 2, table 1) in her monograph on Upper Cretaceous ammonites from West Greenland. The ammonite record was correlated with other macrofossil records by Rosenkrantz & Pulvertaft (1969) in their review of Cretaceous–Tertiary stratigraphy and tectonics in northern West Greenland.

Birkelund (1965) recorded *in situ* ammonites indicating the presence of lower Coniacian deposits at the ammonite locality at Umiivik. This locality corresponds to the uppermost part of the core hole GGU 400712 Svar (Enclosure 8) which has been referred to the *Laciniadinium arcticum* interval (Coniacian) of this study. From the same locality Birkelund (1965) recorded ammonites of Santonian and early Campanian ages in displaced blocks.

The loose, possibly reworked, specimens of ammonites recorded from the Store Tange V locality at Umiivik indicate a late Turonian age (Birkelund, 1965). This locality corresponds to the locality C12 Svartenhuk (Enclosure 12) collected by Catherine A. Croxton which, according to the dinoflagellates recorded here, is of Coniacian or early Santonian age. At Lille Tange V a little north of the Store Tange V locality Birkelund (1965) recorded ammonites of early Santonian age *in situ* at 180–200 m above sea level, which correlate well with the age indicated by dinoflagellates from the upper part of section C12 Svartenhuk (Enclosure 12).

Central Nuussuaq

Santonian, Campanian and Maastrichtian ammonites in central Nuussuaq (Fig. 13) were recorded by Birkelund (1965; fig. 2, table 1). Birkelund (1965) recorded ammonites suggesting the presence of Santonian deposits at the Nordre Baculiteskløft locality in Agatdalen. This locality is very close to the core hole GGU 400704 Cnuu (Enclosure 18). In this study a late Santonian age to early Campanian is proposed. From the Scaphitesnæsen locality Birkelund (1965) recorded ammonites of early Campanian age. The section FGC900731/2 (Enclosure 14) from Agatdalen is from the same locality, and the dinoflagellate assemblage from Scaphitesnæsen suggests an early or ?'middle' Campanian age.

The ammonites recorded from Tunoqqu and Ilugissoq (5 km west of Qilikitsoq) in central Nuussuaq (Fig. 5) indicate an early Santonian age (Birkelund, 1965). The dinoflagellate cyst assemblage from the section GKP 92 V 2 Qilak. (Enclosure 32), which may be the same as Birkelund's (1965) Ilugissoq section, suggests a late Santonian age. The studied sections from Tunoqqu (Enclosures 20–25) contain dinoflagellate cysts suggesting an early or 'middle' Campanian age.

Northern Nuussuaq

Santonian, Campanian and Maastrichtian ammonites between Niaqornat and Ikorfat on the north coast of Nuussuaq (Fig. 14) were recorded by Birkelund (1965; table 1, plate 48). Birkelund (1965) recorded ammonites indicating the presence of Santonian deposits at the Tupersuartaa locality (Fig. 6); all organic material from this area is thermally overmature. The record of late Campanian and Maastrichtian ammonites (Birkelund, 1965) between Scaphiteskløften and Skiferperidotitnæsen at Kuuk Anernilik (Fig. 6) correlates with the study of palynomorphs from the Annertuneq section (Enclosure 33), the Kangilia HN-H section (Enclosure 34) and the

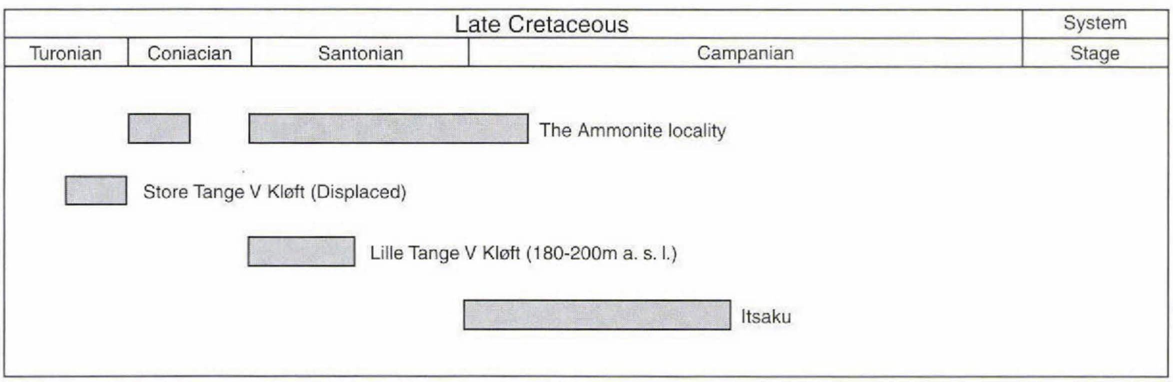


Fig. 12. Ammonite dates at Svartenhuk Halvø obtained from Birkelund (1965).

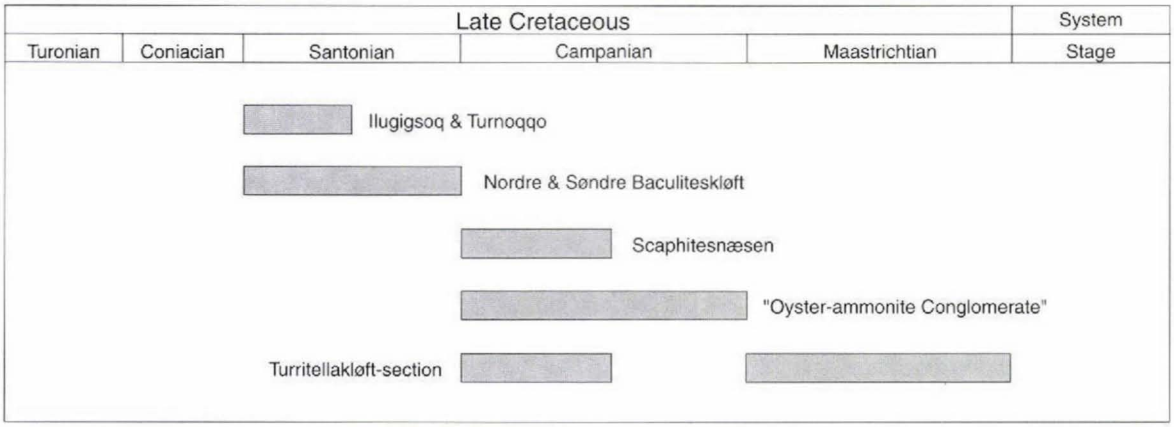


Fig. 13. Ammonite dates in central Nuussuaq obtained from Birkelund (1965).

section HNH 910718/1–3 (Enclosure 35, Birkelund, 1965, table 1). The record by Birkelund of late Campanian ammonites from 550 to 665 m above sea level from Brudkløft at Ikorfat, is not in conflict with the record of Coniacian or Santonian dinoflagellate cysts from the locality HNH 920824/2 Nnuu (Enclosure 37) situated at 350 to 375 m above sea level at Brudkløft.

The ammonites recorded from Ikorfatnæsen and Ikorfat Pass (Fig. 6) indicate a Maastrichtian age (Birkelund, 1965). The dinoflagellate cyst assemblage from the section FGC 900813/7 Nord (Enclosure 36), which is very close to these two sections, also suggests a Maastrichtian age.

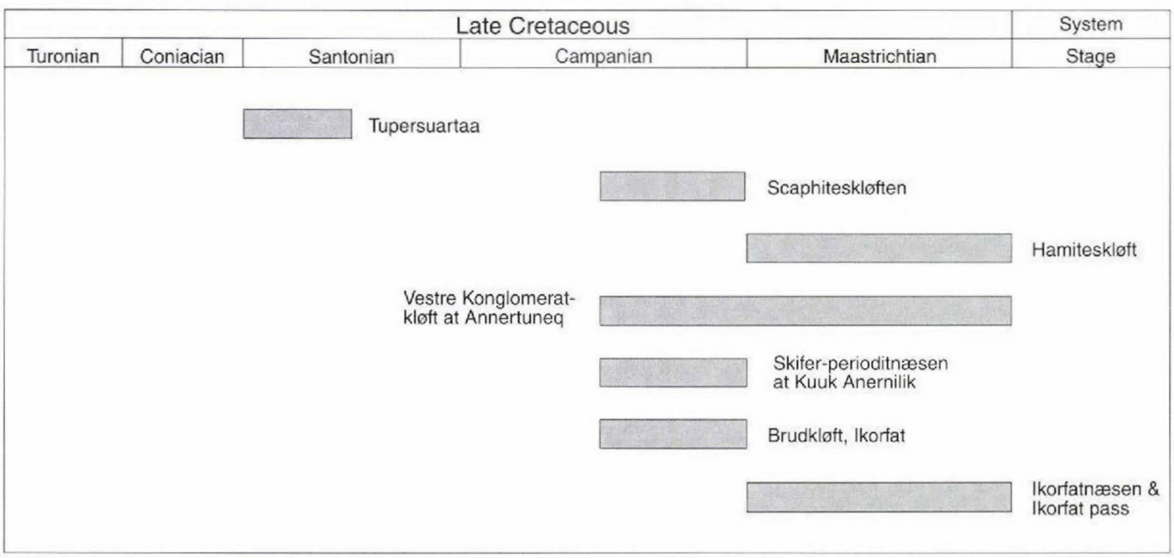


Fig. 14. Ammonite dates on the north coast of Nuussuaq obtained from Birkelund (1965).

Systematic and stratigraphic notes on selected dinoflagellate cysts

In this paper the systematics of Lentin & Williams (1993) are followed, except for *Odontochitina striatoperforata* where Singh (1971) has been followed concerning the systematic position of the species. References to species not discussed below and not listed in the References are to be found in Lentin & Williams (1993).

The different forms recorded within the genera *Arvalidinium, Chatangiella* and *Isabelidinium* from West Greenland are described and illustrated. Additionally *Cerodinium* and *Alterbidinium*? species are commented on and described.

Division Dinoflagellata (Butschli, 1885) Fensome *et al.*, 1993
Class Dinophyceae Pascher, 1914
Subclass Peridiniphycidae Fensome *et al.*, 1993

Genus *Alterbidinium* Lentin & Williams, 1985; emend. Khowaja-Ateequzzaman *et al.* 1991

Alterbidinium? ulloriaq sp. nov.

Plate 14, Figs 4–12

Origin of name. Ulloriaq; Greenlandic: star

Description

Cyst type. Circumcavate to cornucavate.

Shape. Star-like; dorso-ventrally compressed elongate pericyst with 3 horns and an extended cingulum. The shape of the endocyst is ellipsoidal to spherical, and equatorially centred. The apical horn is broad based, elongate and often broken distally, as illustrated on the holotype. The two; more or less equal antapical horns are also relatively broad based, elongate, with a blunt to pointed tip. The angle between the base of the antapical horns is usually 90° or more. The lateral extension of cingulum are short (4–10 μ), with weak indented termination.

Wall relationship. The cyst is composed of a smooth to scattered granulate pericyst and endocyst. Both pericyst and endocyst are rather thin-walled and almost hyaline.

Tabulation. Paratabulation is indicated by the archeopyle and the pronounced cingulum. Granulae on the surface of the pericyst occasionally occur in rows indicating a peridinioid tabulation pattern and defining the cingulum.
Archeopyle. Periarcheopyle, intercalary (2a) steno- to iso-deltaform, operculum free. The form of the endoarcheopyle seems to be broader and not as elongate as the periarcheopyle, the exact form is difficult to distinguish (Plate 14, Figs 7, 12), the endoarcheopyle is most likely of type I.

Holotype. Plate 14 Fig. 4 MGUH 23927 from GGU 408887–4, 41.0–93.0, Z41 1.

Type locality. Sample GGU 408887, Kangilia Formation, Annertuneq section, north coast of Nuussuaq, West Greenland (Figs 6, 7, Enclosure 33)

Dimensions. Holotype: length of pericyst 104 μ (tips of apical and antapical horns broken), width of pericyst 76 μ, width of endocyst 58 μ, length of endocyst 51 μ.

Size. Length of pericyst 108 (120) 132 μ (2 specimens), width of pericyst 68 (75) 84 μ (10 specimens), length of endocyst 47 (53) 59 μ (10 specimens), width of endocyst 57 (60) 68 μ (10 specimens), length of apical horn 10 (11) 12 μ (14 specimens).

Discussion

The genus. The combination of the characteristic star-like shape of the cyst and a 2a archeopyle may indicate that this new species represents a new genus. The species has questionably been placed in the genus *Alterbidinium* due to the presence of a 2a hexa periarcheopyle of steno- to iso-deltaform type. This periarcheopyle shape is one of the characteristics for the genus *Alterbidinium* (Khowaja-Ateequzzaman *et al.*, 1991). The shape of the periarcheopyle in the new species *A.*? *ulloriaq* may suggest a placement in the genera *Cerodinium* or *Deflandrea*; the two genera have an iso-deltaform (*C.*) or a lati-deltaform (*D.*) periarcheopyle (Lentin & Williams, 1987). However the presence of the distinct lateral extension of the cingulum differentiates the new species from previously described species of the genera *Cerodinium* and *Deflandrea*. The distinctive outline of *A.*? *ulloriaq* is similar to the outline of some *Muderongia* species, which differ by having an apical archeopyle. The outline of the new species also has some similarities with the genus *Rhombodinium*, however *Rhombodinium* differs by its quadraform archeopyle and by its very reduced or vestigial right antapical horn.

The species. Alterbidinium? ulloriaq sp. nov. has almost the same distinctive outline of the pericyst and almost the same periarcheopyle form as described for *Deflandrea pentaradiata* (now *Alterbidinium? pentaradiatum pentaradiatum*) by Cookson & Eisenack (1965). However *A.? p. pentaradiatum* differs by the shape of the endocyst which is roughly oval in outline or tends to follow the outline of the pericyst, by the surface of the periphragm which is smooth or with fine longitudional striae, especially in the vicinity of the cingulum, by having almost parallel antapical horns and by the size: length of pericyst 159–171 µ, width of pericyst 116–130 µ, length of endocyst 76–97 µ, width of endocyst 82–96 µ. Lentin & Williams (1976, p. 49) questionably included the species in the genus *Alterbia* (now *Alterbidinium*) and mentioned that "the distinctive outline of the pericyst suggests it may be better placed in the genus *Rhombodinium*; however, the distinctively hexa archeopyle excludes it from that genus".

The questionable placement of the two species with pentaradiate shape in the genus *Alterbidinium*, may advocate the establishment of a new genus. However the author has not examined the type specimen of *Alterbidinium? pentaradiatum pentaradiatum* and the available specimens (10) of *Alterbidinium? ulloriaq* are considered too few to erect a new genus.

Occurrence. Alterbidinium? ulloriaq sp. nov, has been recorded from the lowermost Paleocene sample only, at the Annertuneq section on the north coast of Nuussuaq (Enclosure 33). *Alterbidinium? pentaradiatum pentaradiatum* was described from the Paleocene in Victoria in Australia by Cookson & Eisenack (1965), which may suggest that the distinctive outline was developed in Paleocene time.

Genus *Arvalidinium* Lentin & Vozzhennikova, 1990

Arvalidinium scheii (Manum, 1963) Lentin & Vozzhennikova, 1990

Plate 1, Figs 1–3

Remarks. The form and tabulation pattern observed on the *A. scheii* specimens from West Greenland are similar to that described by Manum (1963) for the type material, but the length of the cyst (65–80 µ) is less than the type material (82–116 µ).

Occurrence. Arvalidinium scheii is common in a rather narrow range in West Greenland situated at a level below *in situ* ammonites of early Coniacian age. Manum (1963) and Manum & Cookson (1964) suggested that their *A. scheii* specimens came from the upper Albian to lower Cenomanian Hassel Formation on Graham Island, arctic Canada, but Felix & Burbridge (1976) considered that the samples more likely represented the Kanguk Formation of late Cenomanian (or Turonian) to early Campanian age. Núñez-Betelu (1994) described some forms which look like *A. scheii* from a narrow level in the Kanguk Formation at Axel Heiberg Island. The level was dated late Coniacian by the presence of the ammonite *Scaphites depressus* (Hills *et al.*, 1994).

Genus *Cerodinium* Vozzhennikova, 1963; emend. Lentin & Williams, 1987

Cerodinium diebelii (Alberti, 1959b) Lentin & Williams, 1987

Plate 13, Figs 1–3

Remarks. Lentin & Vozzhennikova (1990) mention in their discussion of *Cerodinium leptodermum* that the species is often confused with *C. diebelii*, and that the specimens illustrated as *C. diebelii* from the Maastrichtian at the Horton River section, northern Canada by McIntyre (1975) are *C. leptodermum.* Lentin & Vozzhennikova (1990) mention that in *C. diebelii* the endocyst is more circular so that the body of the cyst between the apical and antapical horns is shorter than on *C. leptodermum* which has a well developed antapical pericoel that occurs below the endocyst and above the antapical horns. The author does not find it easy to distinguish the two species on these criteria. One of the *C. diebelii* specimens illustrated by Alberti (1959, pl. 9, fig 19) and perhaps also the holotype (Alberti, 1959b, pl. 9, fig. 18) appear to have a well developed antapical pericoel. In contrast some of the illustrations of *C. leptodermum* (Vozzhennikova, 1967, pl. 118, figs 3, 5, 7, 8, 10, pl. 119 figs 2–3) appear to have a narrow antapical pericoel.

The specimens recorded as *C. diebelii* here are forms with an oval to elongate endocyst and with a narrow or almost no antapical pericoel.

Occurrence. Cerodinium diebelii has been recorded from early Maastrichtian to late Paleocene in West Greenland. Alberti (1959) described *C. diebelii* from the late Senonian to the Paleocene in Germany and Kirsch (1991) and Marheinecke (1992) reported the species from early and late Maastrichtian in Germany. Costa & Davey (1992) and Powell (1992) reported a late Campanian to late Paleocene range from the North Sea area and Williams *et* *al.* (1993) reported a late Santonian to Paleocene range from the northern hemisphere. Lentin & Vozzhennikova (1990, p. 37) proposed that *C. diebelii* is represented in the Williams flora province whereas *C. leptodermum* is present in the McIntyre flora.

Cerodinium sp. cf. *C. diebelii* (Alberti, 1959b) Lentin & Williams, 1987

Plate 13, Figs 4–6

Remarks. Cerodinium sp. cf. *C. diebelii* represents irregular forms that differ from *C. diebelii sensu stricto* by having longer antapical horns and by its round endocyst (Plate 13 Fig. 4) or by its very antapical extended endocyst (Plate 13 Fig. 6).

Occurrence. In West Greenland *C.* sp. cf. *C. diebelii* occurs only in a very narrow stratigraphic interval in the early Maastrichtian where it occurs together with *C. diebelii.*

Genus *Chatangiella* Vozzhennikova, 1967; emend. Lentin & Williams, 1976

Chatangiella bondarenkoi (Vozzhennikova, 1967) Lentin & Williams, 1976; emend Lentin & Vozzhennikova, 1990

Plate 10, Figs 1–5

Remarks. The specimens observed from West Greenland are distinguished from the other *Chatangiella* species in this study by the large overall size (100–150μ). The form is characterised by an elongate bicavate body with weakly developed apical shoulders and a iso-omegaform archeopyle. The granulae on the almost round endocyst appear to increase at the apical and antapical margins. The specimens seen are, except for being slightly shorter, similar to the type material described by Vozzhennikova (1967) and Lentin & Vozzhennikova (1990). The small process on the top of the apical horn, mentioned in Vozzhennikova's (1967) original description, has been observed on one specimen (Plate 10, Fig. 5) from West Greenland.

Occurrence. Chatangiella bondarenkoi is not very common in West Greenland, where it has been recorded only from the early or 'middle' Campanian in central Nuussuaq. Lentin & Vozzhennikova (1990) recorded the species from Santonian of Western Siberia and Santonian to Campanian of arctic Canada.

Chatangiella ditissima (McIntyre, 1975) Lentin & Williams, 1976

Plate 10, Figs 6–7

Remarks. The specimens observed from West Greenland are very similar to the forms, described by McIntyre (1975), which are characterised by a bicavate cyst with a broad-based apical horn, cingulum divided into ridges with arcs of intratabular pustules, endocyst with folded apical and antapical ends and a relatively large rounded intercalary eury-omegaform archeopyle.

Occurrence. Chatangiella ditissima sensu stricto is not very commom in West Greenland where it has been recorded from ?early or late Santonian to early Campanian sediments. McIntyre (1975) described a continuous range for the species from Santonian to 'middle' Campanian and sporadic occurrences in late Campanian and early Maastrichtian in the Horton River section, northern Canada. Ioannides (1986) recorded the species from his Santonian–Campanian palynological interval I on Bylot Island, arctic Canada. Costa & Davey (1992) reported an early Turonian to late Campanian range from the North Sea area and Williams *et al.* (1993) reported a Santonian to early Campanian range from the northern hemisphere.

Chatangiella sp. cf. *C. ditissima* (McIntyre, 1975) Lentin & Williams, 1976

Plate 1, Figs 11–12

Remarks. The specimens here described as *C.* sp. cf. *C. ditissima* differ from *C. ditissima sensu stricto* by having a shorter (10–15 μ) blunt-ended, broad-based apical horn compared to the length (15–25 μ) of the apical horn on the type material of *C. ditissima. Chatangiella* sp. cf. *C. ditissima* is also distinguished from *C. ditissima* by the shape of the cingulum, which is seldom divided into paraplate related pieces, and by the shape of its apical shoulders which in general are more pronounced.

Occurrence. In West Greenland *C.* sp. cf. *C. ditissima* is quite common in the Coniacian to late Santonian and in the late Campanian and it appears to range up to the 'earliest' Maastrichtian.

Chatangiella granulifera (Manum, 1963) Lentin & Williams, 1976

Plate 1, Figs 4–7

Remarks. Specimens from West Greenland described as *C. granulifera* have granules on the epicyst. The endocyst is round or sometimes has folded apical and antapical ends. Most of the cysts have rounded apical shoulders and a rather narrow apical horn with slightly concave sides as Manum (1963) mentioned in his description of the type material, but forms with angular apical shoulders with a flat upper limit and a broad apical horn with a triangular outline are also recorded. The more angular forms are very similar to the species *C. verrucosa* except for the absence of a warty ornamentation on the pericyst.

Occurrence. Chatangiella granulifera is common in West Greenland where it has been recorded from Coniacian or early Santonian to early or ?late Campanian. Specimens referred to *C.* sp. aff. *C. granulifera* are common in a single sample (366589, Enclosure 33) in the early Maastrichtian at Annertuneq. This form is suggested as reworked due to its rather dark brown colour and its very restricted occurrence. Manum (1963) described *C. granulifera* from the Turonian to Campanian Kanguk Formation on Graham Island, arctic Canada. McIntyre (1975) reported a Santonian to 'middle' Maastrichtian range for the species at Horton River, northern Canada. Ioannides (1986) recorded the species from the lower part of his Santonian–Campanian palynological interval I and Ia on Bylot Island, arctic Canada. Schiøler (1992) reported *C. granulifera* from the Lower to 'mid'-Coniacian on the Danish island of Bornholm and Costa & Davey (1992) reported an early Turonian to late Campanian range from the North Sea area.

Chatangiella sp. cf. *C. hexacalpis* Harker & Sarjeant in Harker *et al.* 1990

Plate 10, Figs 11–12

Remarks. The overall form of specimens descibed as *C.* sp. cf. *C. hexacalpis* from West Greenland is very similar to the type material described by Harker & Sarjeant (1990). However *C.* sp. cf. *C. hexacalpis* differs by having a cingulum divided into 5 to 7 pieces and by the shape of its left antapical horn which is reduced to a bulge. The archeopyle on *C.* sp. cf. *C. hexacalpis* is similar to that on the type material of *C. hexacalpis*, but the specimens described by Harker & Sarjeant are larger.

Occurrence. Chatangiella sp. cf. *C. hexacalpis* is rare in West Greenland, where it has been recorded from the early to late Santonian in central Nuussuaq. Harker & Sarjeant (1990) described the species from late Campanian in the Western Interior, North America.

Chatangiella mcintyrei sp. nov.

Plate 2, Figs 4–9

Origin of name. After David J. McIntyre, who did a great pioneer work in 1975 when he described the morphologic changes in *Deflandrea* from the Campanian of the Horton River section, northern Canada.

Description

Cyst type. Circumcavate, peridinioid

Shape. Dorso-ventrally compressed cyst, elongate, almost box-shaped. The width of the cyst is almost the same from the broad apical shoulders to the antapical 'horns', except from the areas at the apical and antapical ends of the endocyst, where the periphragm has slightly concave sides. The epicyst and hypocyst are almost the same length. The apical horn is broad-based, short and blunt, with slightly concave sides. The left antapical horn is short and pointed, the right antapical horn is only represented by a bulge.

Wall relationship. The cyst is composed of a smooth to scattered granulate box shaped pericyst and a spherical to slightly apical-antapical compressed endocyst, equatorially centred. Both pericyst and endocyst are rather thin-walled and almost hyaline, which occasionally makes it difficult to distinguish the outline of the endocyst.

Tabulation. Paratabulation is indicated only by the archeopyle and the cingulum, which on both anterior and posterior margins is bordered by discontinuous ridges with tubercles. Five pairs of ridges have been observed; but more likely 7 pieces of anterior ridges and 5 pieces of postcingular ridges should be expected, as in most *Chatangiella* species. A large wide sulcus is present on the ventral surface.

Archeopyle. Intercalary (2a) rounded iso-omegaform archeopyle. Operculum often attached at posterior margin. One example of a 3I endoarcheopyle with the three plates attached along their posterior margins has been observed (Plate 2, Fig. 7). The complete archeopyle formula for the species is of type I/I or seldom type I/3I.

Holotype. Plate 2, Fig. 4, MGUH 23784 from GGU 400711–10–7, 35.3–96.6, W35 2.

Type locality. Core hole GGU 400711, Enclosure 10, Svartenhuk, West Greenland (Fig. 3).

Dimensions. Holotype: length of pericyst 101 μ, width of pericyst 70 μ, length of endocyst 52 μ, width of endocyst 56 μ, length of apical horn 11 μ.

Size range. Length of pericyst 87 (95) 108 μ, width of pericyst 53 (61) 70 μ, length of endocyst 36 (45) 52 μ, width of endocyst 40 (47) 56 μ, (15 specimens) length of apical horn 10 (11) 12 μ (14 specimens).

Discussion. The pericyst size and shape in the new species *Chatangiella mcintyrei* are quite similar to that of *C. granulifera* and *C. verrucosa*, from which it is easily distinguished by being circumcavate. The box-shaped outline of *C. mcintyrei* distinguishes it from the rhombic-shaped, circumcavate species *C. spectabilis.*

Occurrence. The species has been recorded from the Coniacian *Arvalidium cheii* and *Laciniadinium arcticum* intervals on Svartenhuk (Enclosures 1, 8,10).

Chatangiella sp. cf. *C. madura* Lentin & Williams, 1976, *nom. subst. pro Chatangiella manumii* (Cookson & Eisenack, 1970a)

Plate 2, Figs 1–3

Remarks. The specimens from West Greenland often have very pronounced apical schoulders and a broad-based short apical horn. The periphragm is ornamented by grana or baculae, the ornament is most pronounced equatorially, but paratabulation is very seldom distinguished. The endocyst often has folded apical and antapical ends. The intercalary archeopyle is rounded iso-omegaform to ?iso-thetaform. The holotype of *Chatangiella madura* (Cookson & Eisenack, 1970) differs from the present material by having a more prominent ornamented periphragm reflecting the paratabulation and a round to spherical endocyst.

Cookson & Eisenack (1970) mentioned that the shape and size of *C. madura* is close to that of *C. tripartita*, but that the paratabulation for the pre- and postcingular plate series on *C. madura* distinguishes the species from *C. tripartita.*

Ionannides (1986) mentioned in his remarks on the *C. madura* specimens recorded from Bylot Island, arctic Canada, that *C. madura* and *C. tripartita* in gross morphology are very similar and they perhaps form part of the intraspecific variability of a single species.

Occurrence. In West Greenland *Chatangiella* sp. cf. *C. madura* has been recorded only from the Coniacian *C.* sp. cf. *C. madura* and *Spinidinium echinoideum* intervals from Svartenhuk Halvø. Cookson & Eisenack (1970) described *C. madura* from the Senonian of Western Australia. Ioannides (1986) recorded the species from the lower part of his Santonian–Campanian palynological interval I on Bylot Island, arctic Canada. Harker *et al.* (1990) recorded *C. madura* from a very narrow interval in the 'latest' Campanian in the Western Interior of the U.S.A.. They recorded the almost identical species *C. tripartita* from the 'latest' Santonian to 'earliest' Maastrichtian (which included the majority of their studied stratigraphical interval). Kirsch (1991) reported *C. madura* from the lower part of his Coniacian/Santonian *Raetiaedinium truncigerum* Zone and from his Campanian *Areoligera coronata* Zone in Oberbayern, Germany. Núñez-Betelu (1994) recorded *C. madura* from his Zone 2 (late Turonian to late Coniacian) and his Zone 3 (late Coniacian to early Campanian) at Glacier Fiord, arctic Canada. *Chatangiella tripartita* was described by Cookson & Eisenack (1960) from probable late Turonian to middle Senonian of Australia. Aurisano (1989) recorded an early Santonian to early late Campanian range for *C. tripartita* in the New Jersey Atlantic Coastal Plains, U.S.A. Schiøler (1992) reported *C. tripartita* from the early to 'mid'-Coniacian on the Danish island of Bornholm. Costa & Davey (1992) reported the *C. tripartita – victoriensis* complex from late Cenomanian to early Maastrichtian in the North Sea region. Marheinecke (1992) recorded the species as ranging up to the late part of the early Maastrichtian in Germany. Helby *et al.* (1987) reported *C. tripartita* from early Santonian (consistent) to middle and late Santonian (inconsistent).

Chatangiella sp. aff. *C. spectabilis* (Alberti 1959b) Lentin & Williams, 1976

Plate 2, Figs 10–12

Remarks. The specimens from West Greeenland described as *C.* aff. *C. spectabilis* are thin-walled, weakly granulate, almost hyaline, circumcavate cysts with fragmented cingulum ridges, all features of *C. spectabilis*. However *C.* sp. aff. *C. spectabilis* differs from *C. spectabilis* in having a very small right antapical horn and a less elongate and more spherical shape pericyst compared to the rhombic shape pericyst of the type material of *C. spectabilis.*

Occurrence. Chatangiella sp. aff. *C. spectabilis* is recorded from almost all the studied Coniacian to early Santonian sections (Enclosures 1–13) on Svatenhuk Halvø, West Greenland. Alberti (1959) described *C. spectabilis* from the late Senonian in Germany. McIntyre (1975) recorded a Santonian to 'middle' Campanian range for the species in the Horton River section, northern Canada. Ioannides (1986) recorded the species from the lower part of his Santonian–Campanian palynological interval I and Ia on Bylot Island, arctic Canada. Kirsch (1991) recorded *C. spectabilis* from the uppermost part of his *Raetiaedinium truncigerum* Zone and from his *Odontochitina costata* Zone both of Coniacian or Santonian age, Oberbayern, Germany. Costa & Davey (1992) reported a rather limited (early Campanian to earliest late Maastrichtian) stratigraphic range in the North Sea area.

Chatangiella verrucosa (Manum, 1963) Lentin & Williams, 1976

Plate 1, Figs 8–10

Remarks. The specimens recorded from West Greenland have the same angular apical shoulders and verrucae closely spaced in the equatorial area as described by Manum (1963) for the type material of *C. verrucosa.* Manum mentioned that examples with verrucae all over the cyst do occur; a single specimen densely covered with verrucae also has been observed from West Greenland (Plate 1, Fig. 9).

Occurrence. Chatangiella verrucosa is uncommon in West Greenland, where it has been recorded from the Coniacian to early Santonian on Svartenhuk Halvø. Manum (1963) described *C. verrucosa* from the Turonian to Campanian Kanguk Formation on Graham Island, arctic Canada. Ioannides (1986) recorded the species from his Santonian–Campanian palynological interval I and Ia on Bylot Island, arctic Canada. Prössl (1990) recorded a first occurrence in the late Turonian in Germany. Williams *et al.* (1993) reported a Santonian to late Campanian range from the northern hemisphere.

Genus *Isabelidinium* Lentin & Williams, 1977a

Isabelidinium acuminatum (Cookson & Eisenack, 1958) Stover & Evitt, 1978

Plate 11, Figs 1–6

Remarks. The specimens from West Greenland included in *I. acuminatum* are in general similar to the type material described by Cookson & Eisenack (1958). The specimens are pronounced circumcavate cysts with a small acuminate apical horn and a pointed left antapical horn. A cingulum has been recognized on most of the specimens. Both peri- and endocyst are hyaline with a psilate to scabrate surface. The form of the endocyst is spherical on all the observed specimens as illustrated by Cookson & Eisenack (1958, plate 4, fig. 8) and by Manum & Cookson (1964, plate 1, fig. 4), and not slightly pointed apicaly as illustrated by Cookson and Eisenack (1958, plate 4, figs 5–7). The forms with a granular endocyst as illustrated by McIntyre (1975, plate 2, figs 11 & 13) are not recorded from West Greenland.

Occurrence. Isabelidinium acuminatum is recorded only from the early to 'middle' Campanian on central Nuussuaq in West Greenland. Cookson & Eisenack (1958) described the species from Cenomanian to early Turonian in Australia. Manum & Cookson (1964) recorded the species from the Kanguk Formation, Graham Island, arctic Canada which, according to Felix & Burbridge (1976), is of late Cenomanian to early Campanian age. McIntyre (1975) recorded an early to 'middle' Campanian age in northern Canada. Williams & Brideaux (1975) recorded the species from Coniacian to Maastrichtian from Grand Banks, offshore eastern Canada. Ioannides (1986) recorded the species from the lower part of his Santonian–Campanian palynological intervals I and Ia, from his possible Maastrichtian interval II, and from the lower part of his Maastrichtian interval IIIa on Bylot Island, arctic Canada. Harker *et al.* (1990) recorded *I. acuminatum* from the late Sanonian to the early Campanian in Western Interior, North America and Costa & Davey (1992) mentioned that *I. acuminatum* first occurs, or first become consistent in the early Campanian.

Isabelidinium sp. aff. *I. acuminatum* (Cookson & Eisenack, 1958) Stover & Evitt, 1978

Plate 3, Figs 4–6

Remarks. The specimens from West Greenland, described as *I.* sp. aff. *I. acuminatum*, are generally similar to *I. acuminatum*, but differ by having a larger endocyst with a granulate ornamentation at the rim and psilate to shagreenate ornamentation on the main part of the dorsal and ventral surfaces. The apical horn is more pronounced and slightly longer on the *I.* sp. aff. *I. acuminatum* specimens recorded from West Greenland. The archeopyle on the pericyst is intercalary steno- to iso-thetaform, which differs from the more rounded archeopyle observed on *I. acuminatum.*

Occurrence. A few specimens of *I.* sp. aff. *I. acuminatum* have been recorded only from the very narrow late Santonian or early Campanian *Dinogymnium* sp. cf. *D. sibiricum* interval on Svartenhuk Halvø, West Greenland.

'*Isabelidinium* sp. aff. *I. bujakii*' Marheinecke, 1990

Plate 15, Figs 4–5

Remarks. According to Lentin & Williams (1993) the species name is not validly published since the lodgement of the holotype has not been specified by Marheinecke.

The specimens described as '*I.* sp. aff. *I. bujakii*', from West Greenland, are bicavate cysts with a circular to apical or antapical compressed endocyst, with an equatorially expanded pericyst. The shape of the epicyst is clearly concave between the apical part of the endocyst and the lower part of the pronounced angular apical shoulders. The broad-based blunt apical horn has slightly concave sides. The archeopyle is intercalary, type 2a/2a, stenotetraform. '*Isabelidinium* sp. aff. *I. bujakii*' differs from the material of Marheinecke (1992) by having an apical or antapical compressed endocyst, and by the shape of the apical shoulders which make the epicyst shape more complex than the quasi triangular epicyst described by Marheinecke (1992).

Both '*I.* sp. aff. *I. bujakii*' and '*I. bujakii*' differ from *I. bakeri* and *I. belfastense* which are described as circumcavate cysts with very apical shoulders.

Occurrence. In West Greenland '*I.* sp. aff. *I. bujakii*' is recorded from ?'latest' Campanian to late Maastrichtian on the north coast of Nuussuaq. Marheinecke recorded '*I. bujakii*' from the late early Maastrichtian in Germany.

Isabelidinium cooksoniae (Alberti, 1959b) Lentin & Williams, 1977a

Plate 15, Figs 6–10

Remarks. The variation in specimens included in the species *I. cooksoniae* is similar to the variation illustrated by Alberti (1959). Howewer specimens with a reduced apical horn and a shorter left antapical horn are dominant in West Greenland.

Occurrence. The species is recorded from Coniacian or Santonian to late Campanian in West Greenland, where it is very common in the late Campanian deposits at Annertuneq on the north coast of Nuussuaq.

Alberti (1959) described *I. cooksoniae* from the late Senonian in Germany. Ioannides (1986) recorded the species from the lower part of his Santonian–Campanian palynological interval Ia, from his possible Maastrichtian interval II and from the lower part of his Maastrichtian interval III on Bylot Island, arctic Canada. Costa & Davey (1992) reported *I. cooksoniae* from middle Turonian to latest Maastrichtian in the North Sea area.

Isabelidinium microarmum (McIntyre, 1975) Lentin & Williams, 1977a

Plate 10, Figs 9–10

Remarks. The specimens of *I. microarmum* recorded from the early to 'middle' Campanian in West Greenland are similar to the type material described by McIntyre (1975).

Occurrence. McIntyre (1975) recorded an early Campanian to 'middle' Maastrichtian range for the species in the Horton River section in northern Canada. Ioannides (1986) recorded the species from the lower part of his possible Maaastrichtian palynological interval II on Bylot Island, arctic Canada. Costa & Davey (1992) mention that *I. microarmum* does not seem to have persisted beyond the end of the Campanian in the Shetland Group, North Sea.

Isabelidinium svartenhukense sp. nov.

Plate 3, Figs 7–12

Origin of name. After Svartenhuk Halvø, the area in West Greenland from which this species is described.

Description

Cyst type. Hypocavate-circumcavate, peridinioid

Shape. Dorso-ventrally compressed cyst, with an almost ovoidal to elongate quasi-pentagonal outline. The apical horn on the ovoidal specimens is reduced to a small bulge and the left antapical horn is very short whereas the right antapical horn is only a bulge. Specimens with a more elongate outline have a small blunt apical horn and a short left antapical horn. The right antapical horn is very short or more commonly appears as a bulge. Both forms have a spherical endocyst.

Wall relationship. The cyst is composed of a smooth to scabrate, hyaline pericyst and a hyaline endocyst. The endophragm approaches the periphragm at the equator or just above and the two wall layers are parallel, with a very narrow epipericoel (1–3 μ), up to the apical part of the cyst where the epipericoel can extend up to 10 μ forming an apical horn or bulge. The hypopericoel on the ovoidal forms is smaller than on the more elongate forms.

Tabulation. Paratabulation is only indicated by the archeopyle and the cingulum, when present. Cingulum is most common on the elongate forms, where its anterior and posterior margins are bordered by ridges with small granulae. On the ovoidal specimens a very weak tabulation pattern and cingulum outline is occasionally indicated by rows of granulae.

Archeopyle. Intercalary (2a) thetaform archeopyle. Operculum often attached at posterior margin. It has not been possible to observe the endoarcheopyle.

Holotype. Plate 3, Fig. 7, MGUH 23799 from GGU 400712–26–4, 26.6–97.0, V26 2.

Paratype. Plate 3, Fig. 11, MGUH 23803 from GGU 400712–15–4, 35.5–102.1, P35 4.

Type locality. Core hole GGU 400712, Enclosure 8, Svartenhuk Halvø, West Greenland (Fig. 3)

Dimensions. Holotype: length of pericyst 65 μ, width of pericyst 58 μ, length of endocyst 45 μ. Paratype: length of pericyst 93 μ, width of pericyst 65 μ, length of endocyst 54 μ.

Size range. Ovoidal forms (10 specimens) length of pericyst 60 (71) 83 μ, width of pericyst 45 (55) 63 μ, length of epicyst 45 (52) 61 μ. Elongate forms (14 specimens) length of pericyst 74 (82) 93 μ, width of pericyst 43 (56) 65 μ, length of epicyst 43 (52) 60 μ.

Discussion. The shape of the pericyst, endocyst and very narrow epipericoel distinguish the new species *Isabelidinium svartenhukense* from most other *Isabelidinium* species. *I. svartenhukense* is very similar in shape to *I. variabile* Marshall (1988), especially the informally described subspecies A and D (Marshall, 1988, p. 207, 211). However *I. variabile* differs by having a periphragm with closely spaced perforations and a scabrate, granulate or verrucate endophragm. The species *Eurydinium glomeratum* (Davey, 1970) Stover & Evitt 1978, is distinguished from *I. svartenhukense* by having a much smaller hypopericoel and by having an endocyst that is in contact with the periphragm except in the apical and antapical regions.

Occurrence. The species has been recorded from the Coniacian and early Santonian *Arvalidium scheii*, *Laciniadinium arcticum* and *Heterosphaeridium difficile* intervals on Svartenhuk (Enclosures 1, 8, 10, 11). The ovoidal form is most common in the *A. scheii* interval, whereas the elongate form first occurs in the top of the *A. scheii* interval. The somewhat similar species *I. variabile* has been described from the Santonian in southern Australia by Marshall (1988) and later recorded from the late Santonian to the late Campanian in the same area (Marshall, 1990).

Isabelidinium sp. 7 HNH

Plate 3, Figs 1–3

Remarks. The specimens described as *Isabelidinium* sp. 7 HNH are relatively large bicavate cysts, with a large spherical endocyst. The size range is: length 72 (85) 95 μ, width 50 (60) 65 μ, length of epicyst 47 (54) 58 μ (seven specimens). The apical shoulders are broad. The apical horn is small and blunt, a left antapical horn can be distinguished, but a right antapical horn is usually not seen. The periphragm is psilate to scabrate and hyaline, the endophragm is light yellow. Two very faint rows of granulae occasionally indicate a cingulum. The archeopyle on the pericyst is intercalary (2a) broad euryomegaform. Operculum often attached at its posterior margin. Examples of a 3I endoarcheopyle with the three plates attached along their posterior margins have been observed. The archeopyle formula is I/3I.

The form has been placed in the genus *Isabelidinium* due to the absence of a clear cingulum. The only other species *I.* sp. 7 can be compared with is *Isabelidinium korojense*, but *I.* sp 7 differs by the shape of its apical shoulders, the shape of its archeopyle and the outline of its endocyst, which on *I. korojense* is folded at its apical and antapical ends.

Occurrence. Isabelidinium sp. 7 HNH is recorded from the Coniacian *Chatangiella* sp. cf. *C. madura* and *Spinidinium echinoideum* intervals on Svartenhuk Halvø, West Greenland. The stratigraphic range is similar to the range of *C.* sp. cf. *C. madura.*

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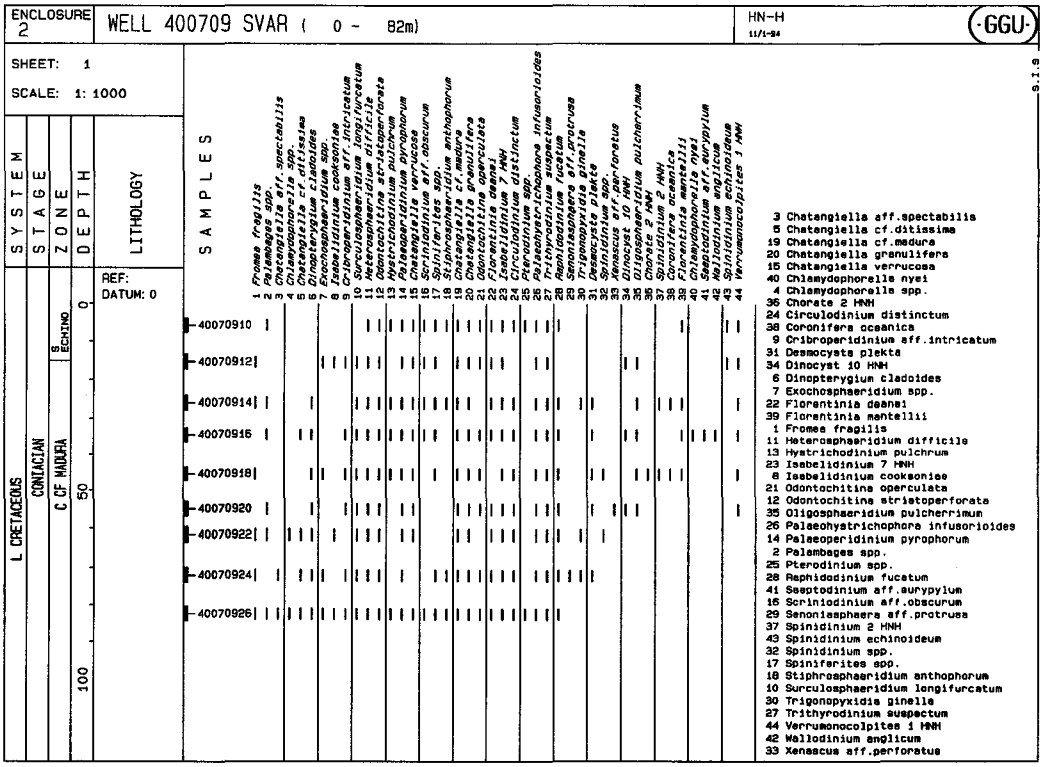
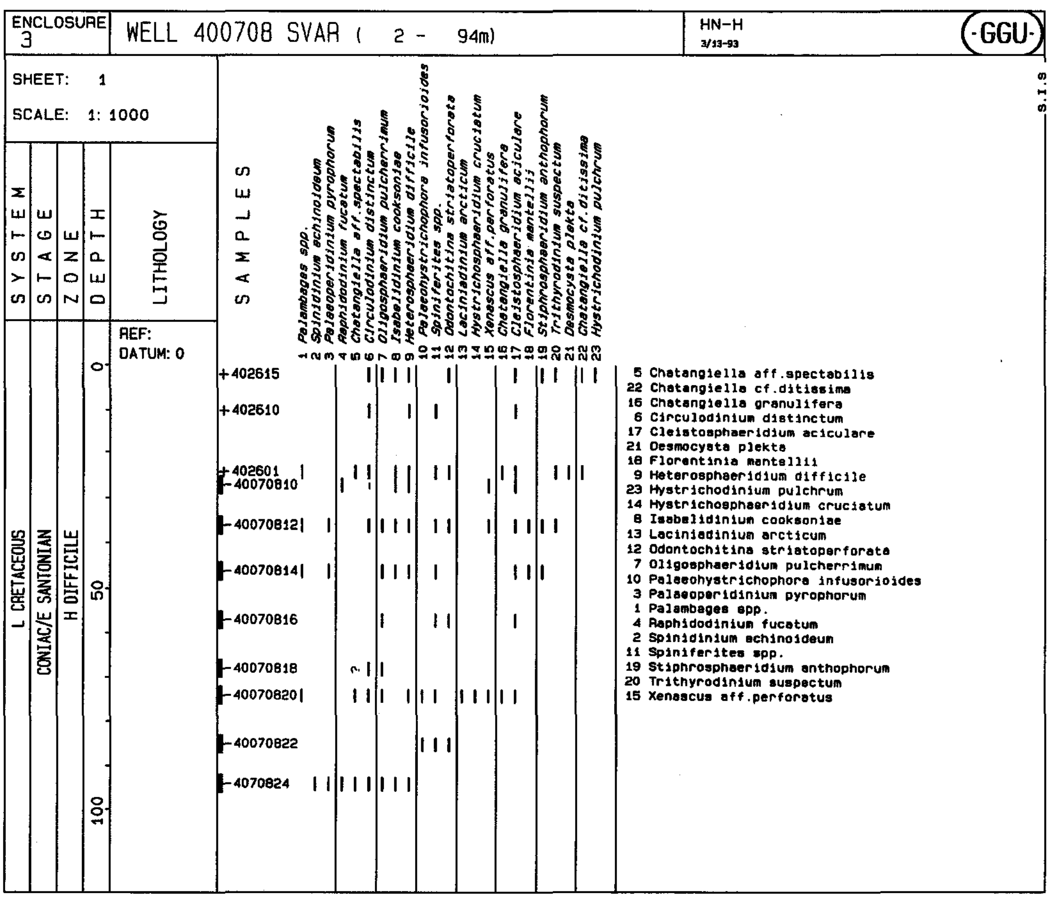
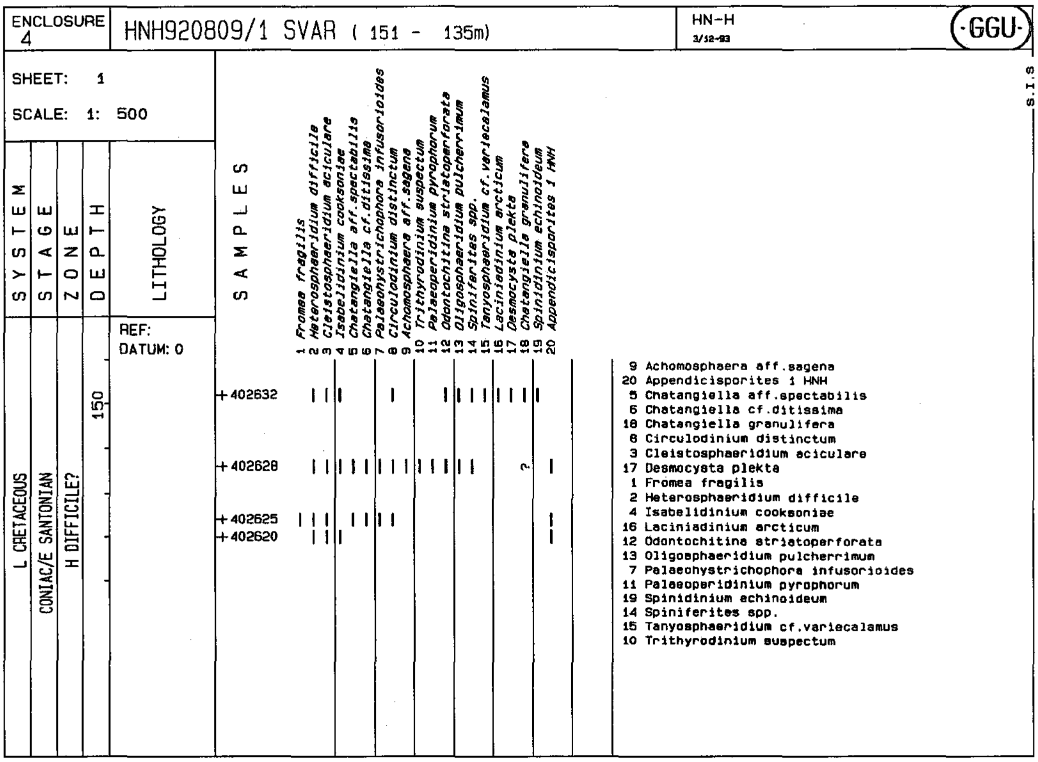
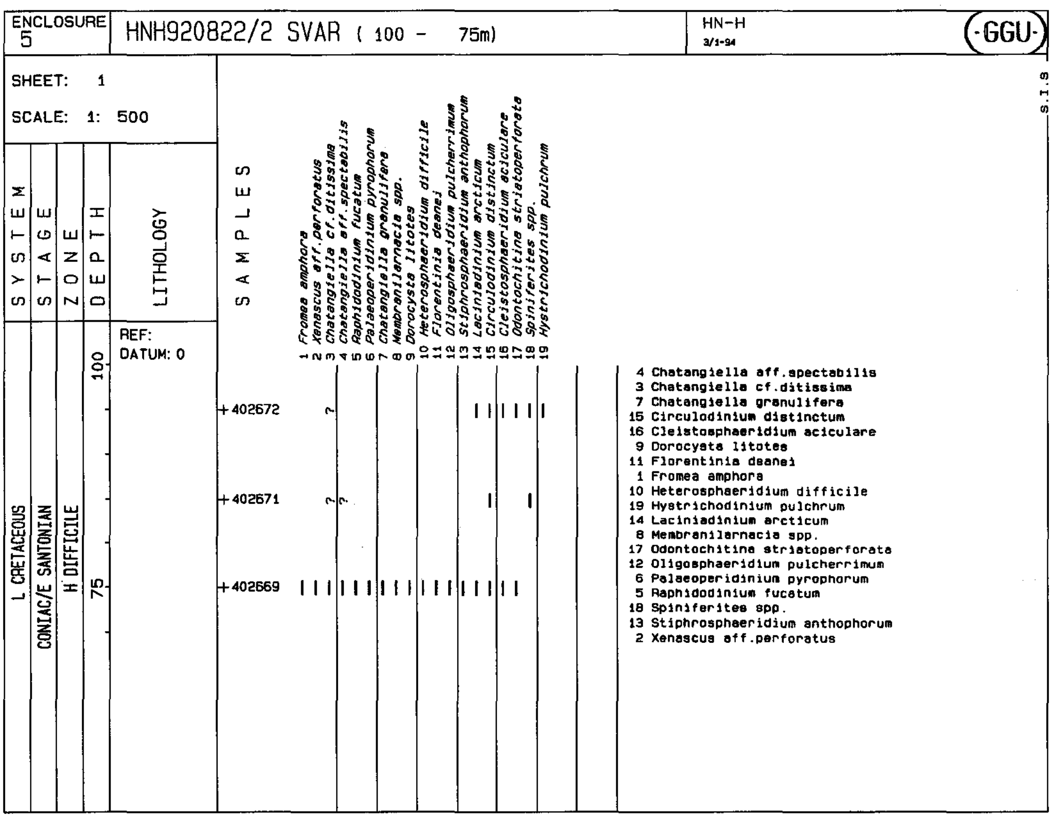
Enclosures 1, 13, 33 & 39 in pocket on back cover

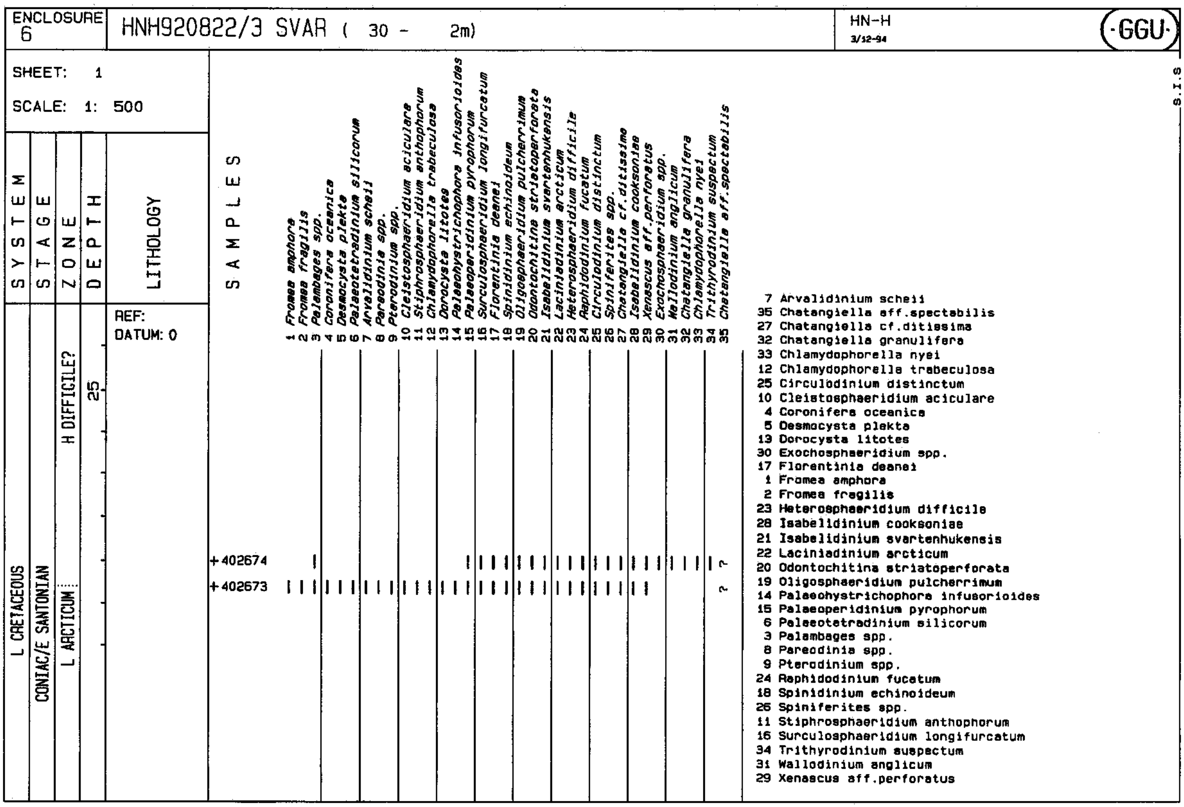
Enclosure 1 in pocket

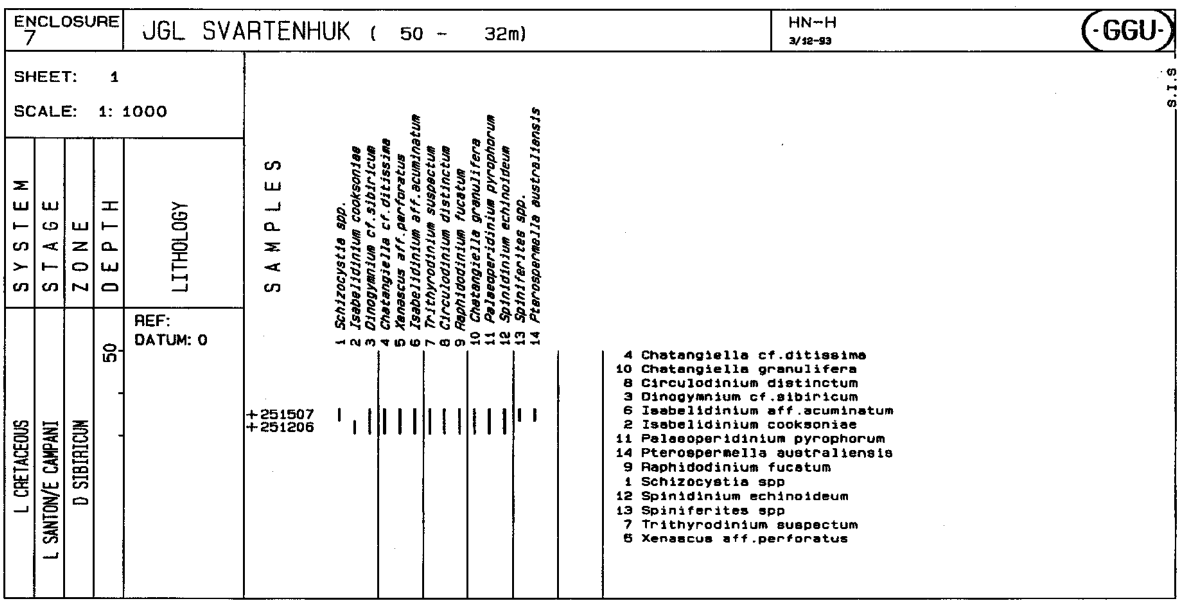

ENCLOSURE 2
WELL 400709 SVAR (0 - 82m)
HN-H
11/1-94
GGU
S.I.S
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
CONIACIAN
C CF MADURA
S ECHINO
0
50
100
40070910
40070912
40070914
40070916
40070918
40070920
40070922
40070924
40070926
3 Chatangiella aff.spectabilis
5 Chatangiella cf.ditissima
19 Chatangiella cf.madura
20 Chatangiella granulifera
15 Chatangiella verrucosa
40 Chlamydophorella nyei
4 Chlamydophorella spp.
36 Chorate 2 HNH
24 Circulodinium distinctum
38 Coronifera oceanica
9 Cribroperidinium aff.intricatum
31 Desmocysta plekta
34 Dinocyst 10 HNH
6 Dinopterygium cladoides
7 Exochosphaeridium spp.
22 Florentinia deanei
39 Florentinia mantellii
1 Fromea fragilis
11 Heterosphaeridium difficile
13 Hystrichodinium pulchrum
23 Isabelidinium 7 HNH
8 Isabelidinium cooksoniae
21 Odontochitina operculata
12 Odontochitina striatoperforata
35 Oligosphaeridium pulcherrimum
26 Palaeohystrichophora infusorioides
14 Palaeoperidinium pyrophorum
2 Palambages spp.
25 Pterodinium spp.
28 Raphidodinium fucatum
41 Saeptodinium aff.eurypylum
16 Scriniodinium aff.obscurum
29 Senoniasphaera aff.protrusa
37 Spinidinium 2 HNH
43 Spinidinium echinoideum
32 Spinidinium spp.
17 Spiniferites spp.
18 Stiphrosphaeridium anthophorum
10 Surculosphaeridium longifurcatum
30 Trigonopyxidia ginella
27 Trithyrodinium suspectum
44 Verrumonocolpites 1 HNH
42 Wallodinium anglicum
33 Xenascus aff.perforatus

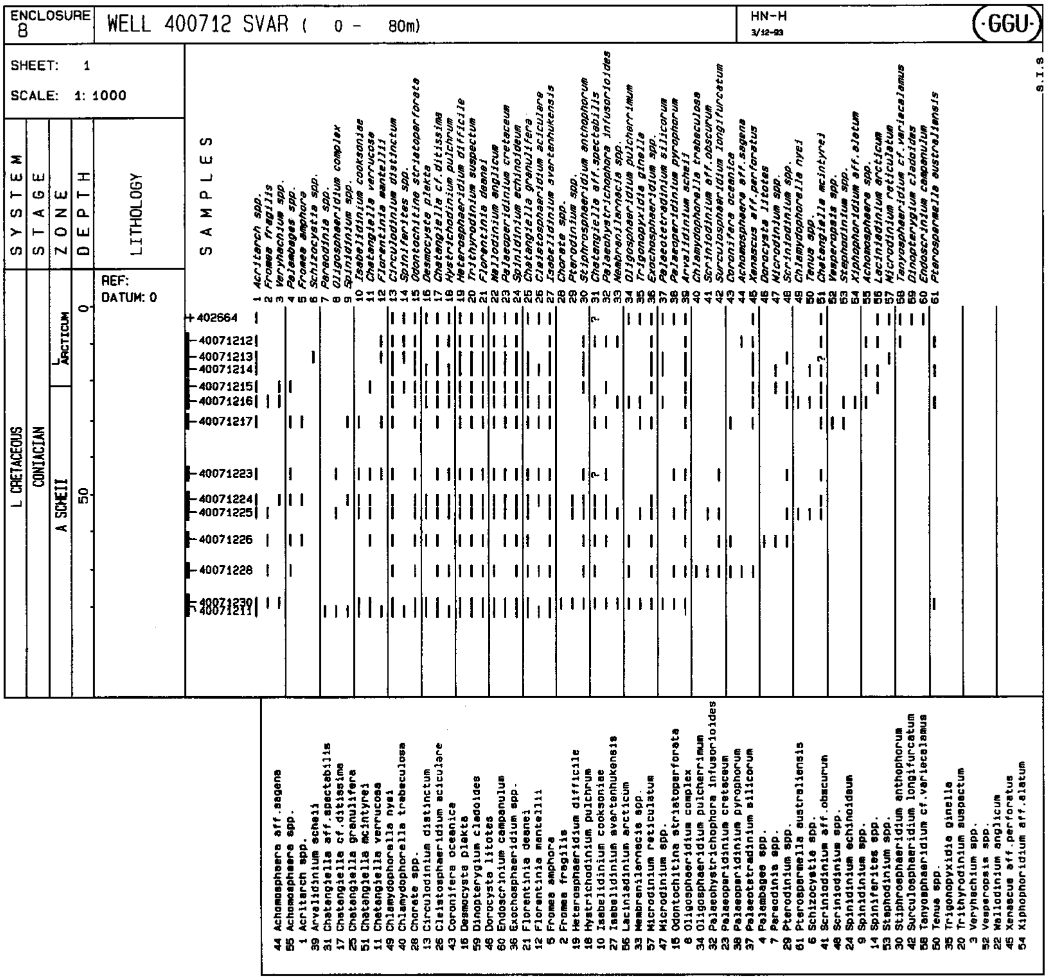

ENCLOSURE 3
WELL 400708 SVAR (2 - 94m)
HN-H
3/13-93
GGU
S.I.S
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE
0
50
100
+402615
+402610
+402601
40070810
40070812
40070814
40070816
40070818
40070820
40070822
4070824
5 Chatangiella aff.spectabilis
22 Chatangiella cf.ditissima
16 Chatangiella granulifera
6 Circulodinium distinctum
17 Cleistosphaeridium aciculare
21 Desmocysta plekta
18 Florentinia mantellii
9 Heterosphaeridium difficile
23 Hystrichodinium pulchrum
14 Hystrichosphaeridium cruciatum
8 Isabelidinium cooksoniae
13 Laciniadinium arcticum
12 Odontochitina striatoperforata
7 Oligosphaeridium pulcherrimum
10 Palaeohystrichophora infusorioides
3 Palaeoperidinium pyrophorum
1 Palambages spp.
4 Raphidodinium fucatum
2 Spinidinium echinoideum
11 Spiniferites spp.
19 Stiphrosphaeridium anthophorum
20 Trithyrodinium suspectum
15 Xenascus aff.perforatus


ENCLOSURE 4
HNH920809/1 SVAR (151 - 135m)
HN-H
3/12-93
GGU
SHEET: 1
SCALE: 1: 500
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Fromea fragilis
2 Heterosphaeridium difficile
3 Cleistosphaeridium aciculare
4 Isabelidinium cooksoniae
5 Chatangiella aff.spectabilis
6 Chatangiella cf.ditissima
7 Palaeohystrichophora infusorioides
8 Circulodinium distinctum
9 Achomosphaera aff.sagena
10 Trithyrodinium suspectum
11 Palaeoperidinium pyrophorum
12 Odontochitina striatoperforata
13 Oligosphaeridium pulcherrimum
14 Spiniferites spp.
15 Tanyosphaeridium cf.variecalamus
16 Laciniadinium arcticum
17 Desmocysta plekta
18 Chatangiella granulifera
19 Spinidinium echinoideum
20 Appendicisporites 1 HNH
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE?
150
+402632
+402628
+402625
+402620
9 Achomosphaera aff.sagena
20 Appendicisporites 1 HNH
5 Chatangiella aff.spectabilis
6 Chatangiella cf.ditissima
18 Chatangiella granulifera
8 Circulodinium distinctum
3 Cleistosphaeridium aciculare
17 Desmocysta plekta
1 Fromea fragilis
2 Heterosphaeridium difficile
4 Isabelidinium cooksoniae
16 Laciniadinium arcticum
12 Odontochitina striatoperforata
13 Oligosphaeridium pulcherrimum
7 Palaeohystrichophora infusorioides
11 Palaeoperidinium pyrophorum
19 Spinidinium echinoideum
14 Spiniferites spp.
15 Tanyosphaeridium cf.variecalamus
10 Trithyrodinium suspectum
S.I.S


ENCLOSURE 5
HNH920822/2 SVAR (100 - 75m)
HN-H
3/1-94
GGU
SHEET: 1
SCALE: 1: 500
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Fromea amphora
2 Xenascus aff.perforatus
3 Chatangiella cf.ditissima
4 Chatangiella aff.spectabilis
5 Raphidodinium fucatum
6 Palaeoperidinium pyrophorum
7 Chatangiella granulifera
8 Membranilarnacia spp.
9 Dorocysta litotes
10 Heterosphaeridium difficile
11 Florentinia deanei
12 Oligosphaeridium pulcherrimum
13 Stiphrosphaeridium anthophorum
14 Laciniadinium arcticum
15 Circulodinium distinctum
16 Cleistosphaeridium aciculare
17 Odontochitina striatoperforata
18 Spiniferites spp.
19 Hystrichodinium pulchrum
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE
100
75
+402672
+402671
+402669
4 Chatangiella aff.spectabilis
3 Chatangiella cf.ditissima
7 Chatangiella granulifera
15 Circulodinium distinctum
16 Cleistosphaeridium aciculare
9 Dorocysta litotes
11 Florentinia deanei
1 Fromea amphora
10 Heterosphaeridium difficile
19 Hystrichodinium pulchrum
14 Laciniadinium arcticum
8 Membranilarnacia spp.
17 Odontochitina striatoperforata
12 Oligosphaeridium pulcherrimum
6 Palaeoperidinium pyrophorum
5 Raphidodinium fucatum
18 Spiniferites spp.
13 Stiphrosphaeridium anthophorum
2 Xenascus aff.perforatus
S.I.S


ENCLOSURE 6
HNH920822/3 SVAR (30 - 2m)
HN-H 3/12-94
GGU
SHEET: 1
SCALE: 1: 500
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE?
L ARCTICUM
25
+402674
+402673
1 Fromea amphora
2 Fromea fragilis
3 Palambages spp.
4 Coronifera oceanica
5 Desmocysta plekta
6 Palaeotetradinium silicorum
7 Arvalidinium scheii
8 Pareodinia spp.
9 Pterodinium spp.
10 Cleistosphaeridium aciculare
11 Stiphrosphaeridium anthophorum
12 Chlamydophorella trabeculosa
13 Dorocysta litotes
14 Palaeohystrichophora infusorioides
15 Palaeoperidinium pyrophorum
16 Surculosphaeridium longifurcatum
17 Florentinia deanei
18 Spinidinium echinoideum
19 Oligosphaeridium pulcherrimum
20 Odontochitina striatoperforata
21 Isabelidinium svartenhukensis
22 Laciniadinium arcticum
23 Heterosphaeridium difficile
24 Raphidodinium fucatum
25 Circulodinium distinctum
26 Spiniferites spp.
27 Chatangiella cf.ditissima
28 Isabelidinium cooksoniae
29 Xenascus aff.perforatus
30 Exochosphaeridium spp.
31 Wallodinium anglicum
32 Chatangiella granulifera
33 Chlamydophorella nyei
34 Trithyrodinium suspectum
35 Chatangiella aff.spectabilis
7 Arvalidinium scheii
35 Chatangiella aff.spectabilis
27 Chatangiella cf.ditissima
32 Chatangiella granulifera
33 Chlamydophorella nyei
12 Chlamydophorella trabeculosa
25 Circulodinium distinctum
10 Cleistosphaeridium aciculare
4 Coronifera oceanica
5 Desmocysta plekta
13 Dorocysta litotes
30 Exochosphaeridium spp.
17 Florentinia deanei
1 Fromea amphora
2 Fromea fragilis
23 Heterosphaeridium difficile
28 Isabelidinium cooksoniae
21 Isabelidinium svartenhukensis
22 Laciniadinium arcticum
20 Odontochitina striatoperforata
19 Oligosphaeridium pulcherrimum
14 Palaeohystrichophora infusorioides
15 Palaeoperidinium pyrophorum
6 Palaeotetradinium silicorum
3 Palambages spp.
8 Pareodinia spp.
9 Pterodinium spp.
24 Raphidodinium fucatum
18 Spinidinium echinoideum
26 Spiniferites spp.
11 Stiphrosphaeridium anthophorum
16 Surculosphaeridium longifurcatum
34 Trithyrodinium suspectum
31 Wallodinium anglicum
29 Xenascus aff.perforatus
S.I.S


ENCLOSURE 7
JGL SVARTENHUK (50 - 32m)
HN-H 3/12-93
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
L SANTON/E CAMPANI
D SIBIRICUM
50
+251507
+251206
1 Schizocystia spp.
2 Isabelidinium cooksoniae
3 Dinogymnium cf.sibiricum
4 Chatangiella cf.ditissima
5 Xenascus aff.perforatus
6 Isabelidinium aff.acuminatum
7 Trithyrodinium suspectum
8 Circulodinium distinctum
9 Raphidodinium fucatum
10 Chatangiella granulifera
11 Palaeoperidinium pyrophorum
12 Spinidinium echinoideum
13 Spiniferites spp.
14 Pterospermella australiensis
4 Chatangiella cf.ditissima
10 Chatangiella granulifera
8 Circulodinium distinctum
3 Dinogymnium cf.sibiricum
6 Isabelidinium aff.acuminatum
2 Isabelidinium cooksoniae
11 Palaeoperidinium pyrophorum
14 Pterospermella australiensis
9 Raphidodinium fucatum
1 Schizocystia spp
12 Spinidinium echinoideum
13 Spiniferites spp
7 Trithyrodinium suspectum
5 Xenascus aff.perforatus
S.I.S


ENCLOSURE 8
WELL 400712 SVAR (0 - 80m)
HN-H 3/12-93
GGU
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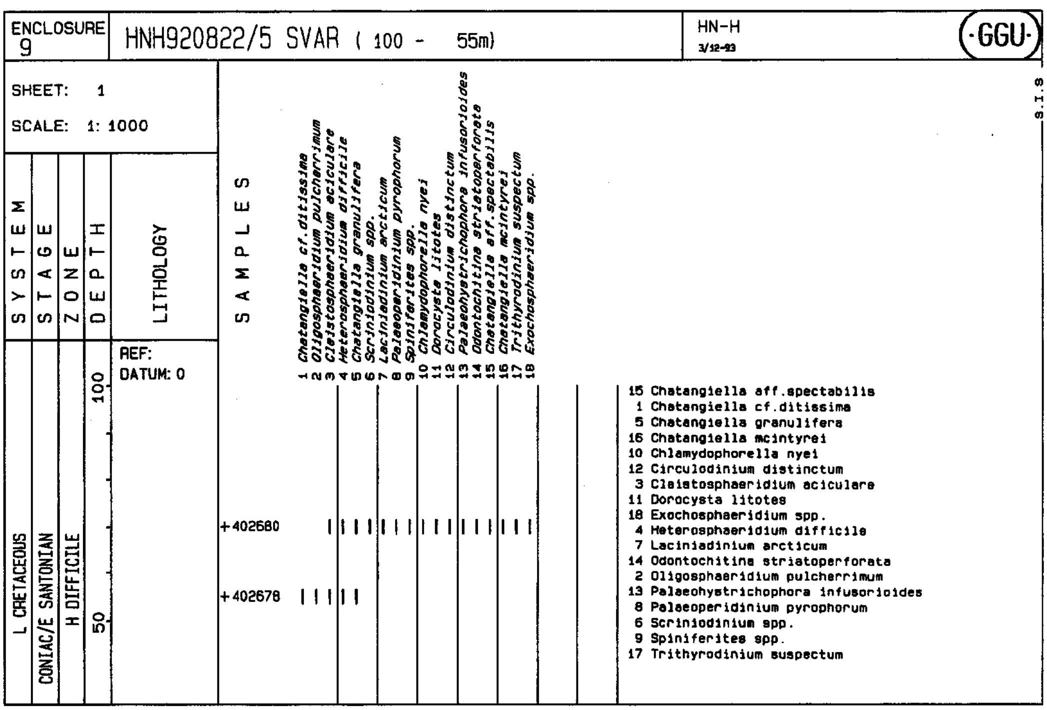
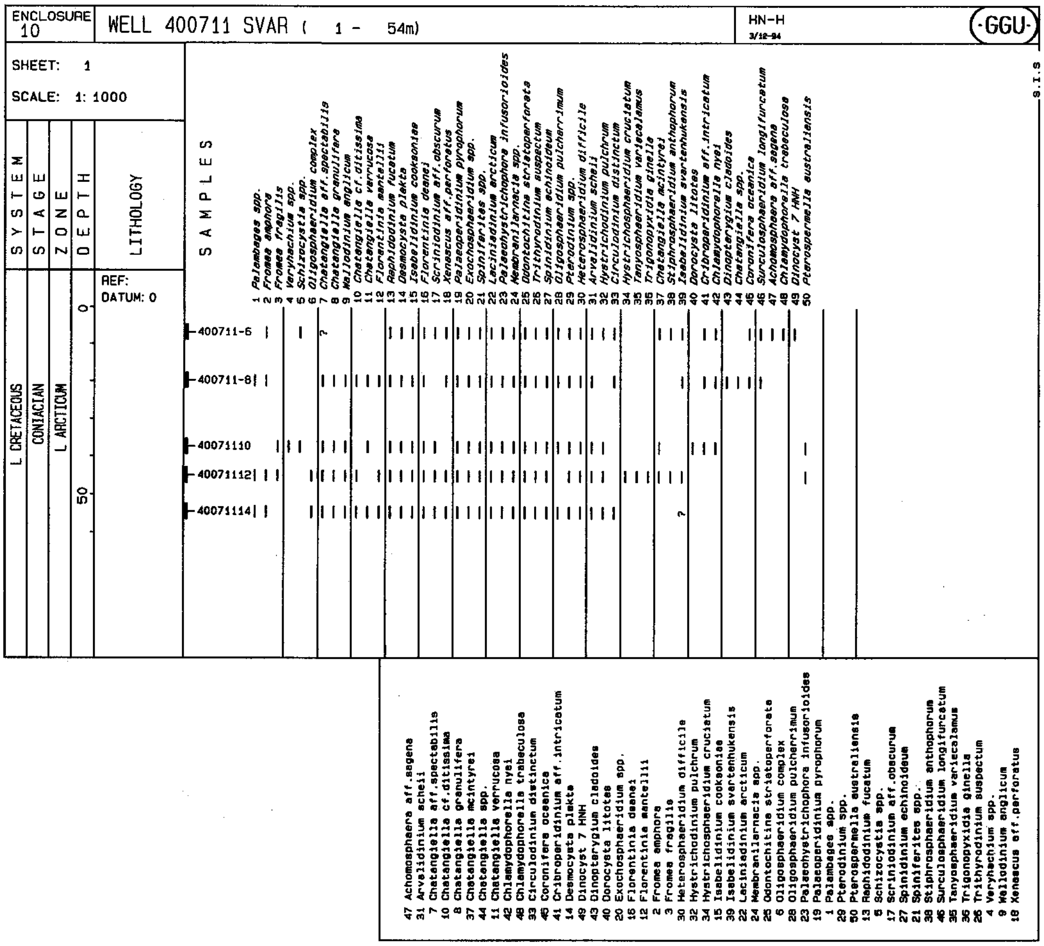
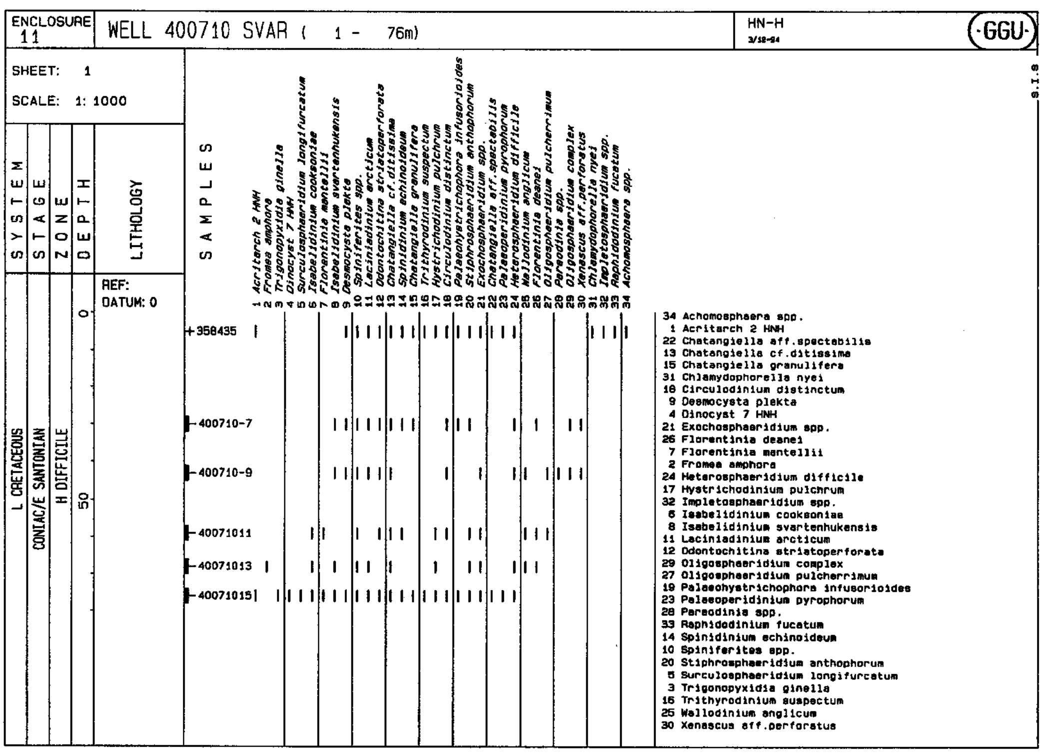
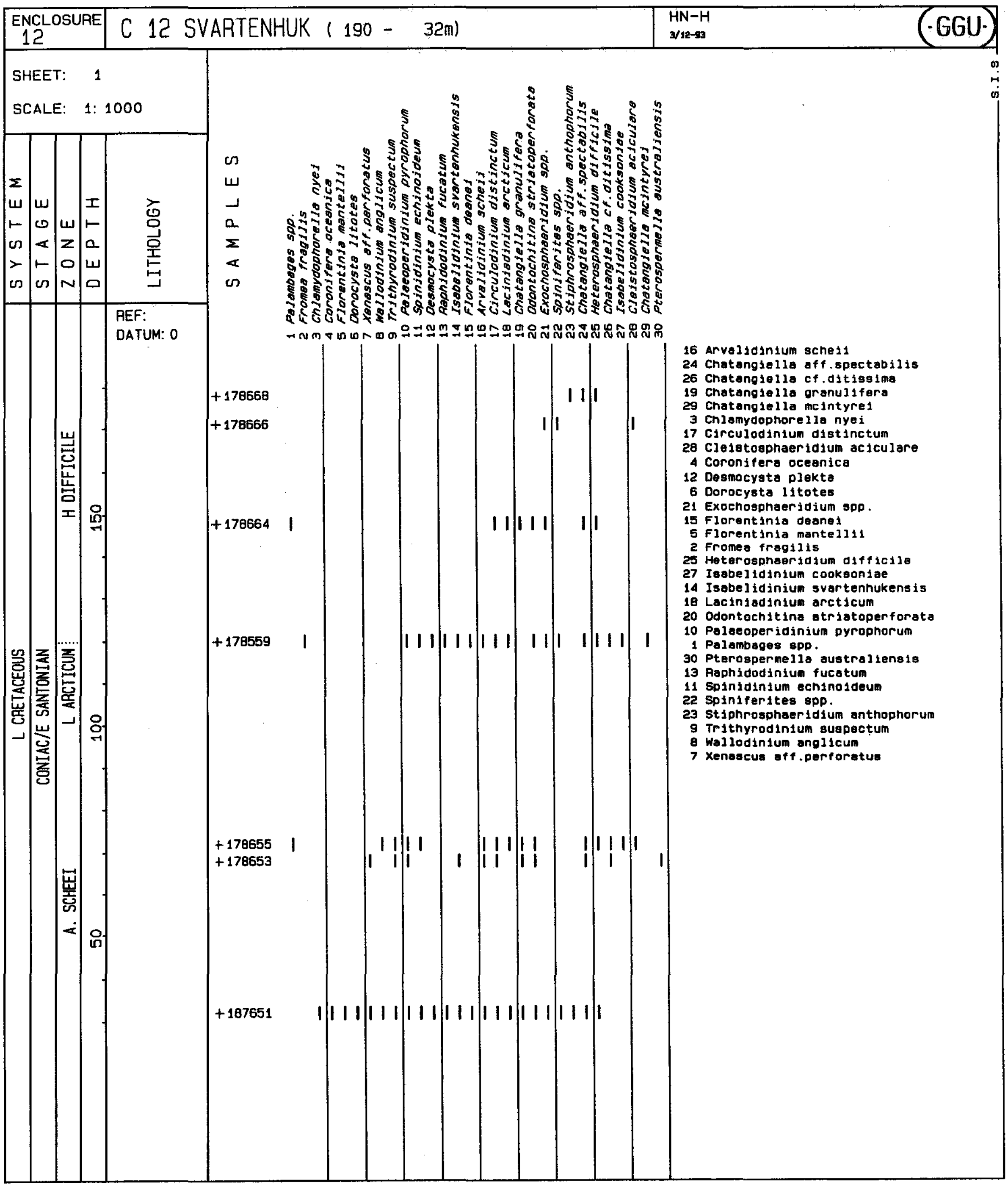
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
L CRETACEOUS
CONIACIAN
L ARCTICUM
A SCHEII
0
50
+402664
40071212
40071213
40071214
40071215
40071216
40071217
40071223
40071224
40071225
40071226
40071228
40071230
40071211
1 Acritarch spp.
2 Fromea fragilis
3 Veryhachium spp.
4 Palambages spp.
5 Fromea amphora
6 Schizocystia spp.
7 Paradinia spp.
8 Oligosphaeridium complex
9 Spinidinium spp.
10 Isabelidinium cooksoniae
11 Chatangiella verrucosa
12 Florentinia mantellii
13 Circulodinium distinctum
14 Spiniferites spp.
15 Odontochitina striatoperforata
16 Desmocysta plekta
17 Chatangiella cf. ditissima
18 Hystrichodinium pulchrum
19 Heterosphaeridium difficile
20 Trithyrodinium suspectum
21 Florentinia deanei
22 Wallodinium anglicum
23 Palaeoperidinium cretaceum
24 Spinidinium echinoideum
25 Chatangiella granulifera
26 Cleistosphaeridium aciculare
27 Isabelidinium svartenhukensis
28 Chorate spp.
29 Pterodinium spp.
30 Stiphrosphaeridium anthophorum
31 Chatangiella aff. spectabilis
32 Palaeohystrichophora infusorioides
33 Membranilarnacia spp.
34 Oligosphaeridium pulcherrimum
35 Trigonopyxidia ginella
36 Exochosphaeridium spp.
37 Palaeotetradinium silicorum
38 Palaeoperidinium pyrophorum
39 Arvalidinium scheii
40 Chlamydophorella trabeculosa
41 Scriniodinium aff. obscurum
42 Surculosphaeridium longifurcatum
43 Coronifera oceanica
44 Achomosphaera aff. sagena
45 Xenascus aff. perforatus
46 Dorocysta litotes
47 Microdinium spp.
48 Scriniodinium spp.
49 Chlamydophorella nyei
50 Tenua spp.
51 Chatangiella mcintyrei
52 Vesperopsis spp.
53 Stephodinium spp.
54 Xiphophoridium aff. alatum
55 Achomosphaera spp.
56 Laciniadinium arcticum
57 Microdinium reticulatum
58 Tanyosphaeridium cf. variecalamus
59 Dinopterygium cladoides
60 Endoscrinium campanulum
61 Pterospermella australiensis
S.I.S

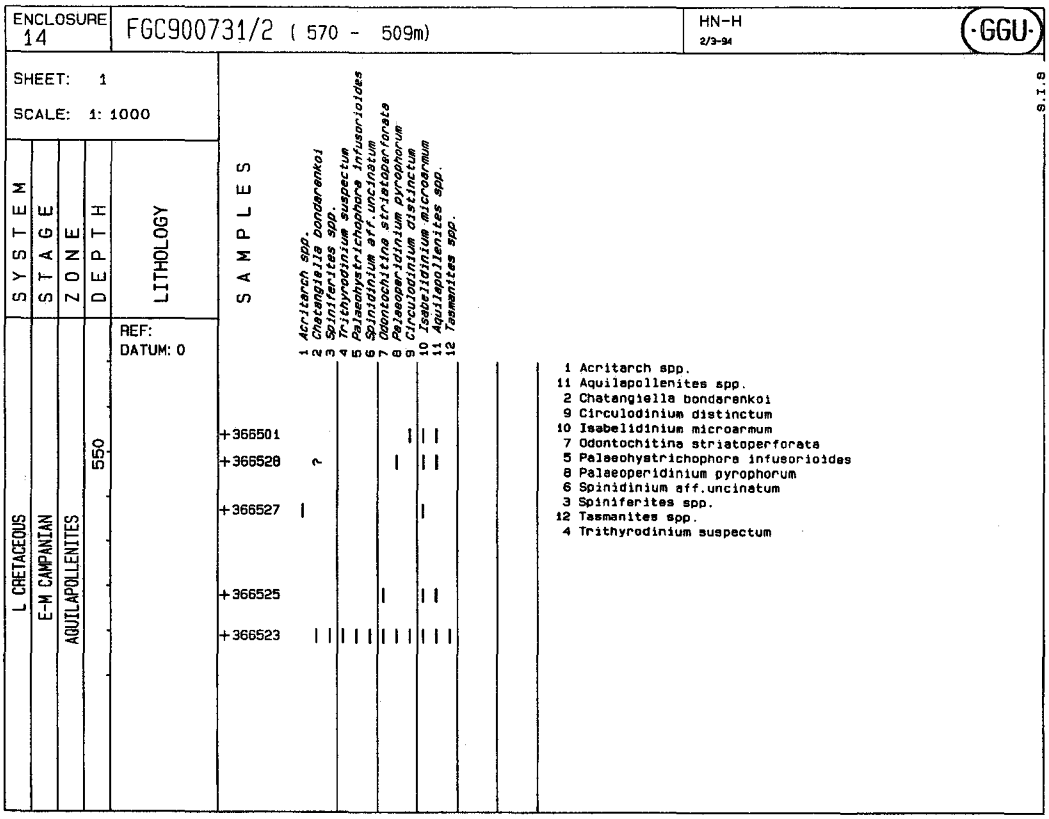

ENCLOSURE 9
HNH920822/5 SVAR (100 - 55m)
HN-H 3/12-93
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE
100
50
+402680
+402678
1 Chatangiella cf. ditissima
2 Oligosphaeridium pulcherrimum
3 Cleistosphaeridium aciculare
4 Heterosphaeridium difficile
5 Chatangiella granulifera
6 Scriniodinium spp.
7 Laciniadinium arcticum
8 Palaeoperidinium pyrophorum
9 Spiniferites spp.
10 Chlamydophorella nyei
11 Dorocysta litotes
12 Circulodinium distinctum
13 Palaeohystrichophora infusorioides
14 Odontochitina striatoperforata
15 Chatangiella aff. spectabilis
16 Chatangiella mcintyrei
17 Trithyrodinium suspectum
18 Exochosphaeridium spp.
15 Chatangiella aff.spectabilis
1 Chatangiella cf.ditissima
5 Chatangiella granulifera
16 Chatangiella mcintyrei
10 Chlamydophorella nyei
12 Circulodinium distinctum
3 Cleistosphaeridium aciculare
11 Dorocysta litotes
18 Exochosphaeridium spp.
4 Heterosphaeridium difficile
7 Laciniadinium arcticum
14 Odontochitina striatoperforata
2 Oligosphaeridium pulcherrimum
13 Palaeohystrichophora infusorioides
8 Palaeoperidinium pyrophorum
6 Scriniodinium spp.
9 Spiniferites spp.
17 Trithyrodinium suspectum
S.I.S

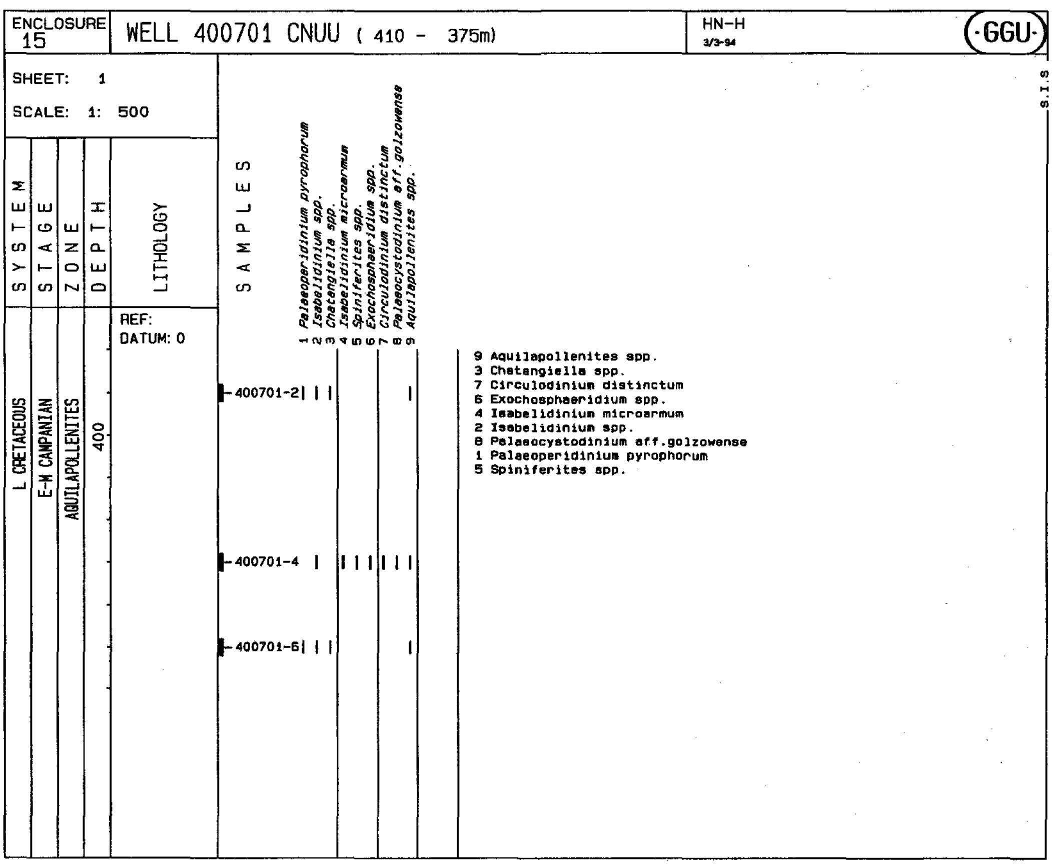

ENCLOSURE 10
WELL 400711 SVAR (1 - 54m)
HN-H
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
L CRETACEOUS
CONIACIAN
L ARCTICUM
400711-6
400711-8
40071110
40071112
40071114

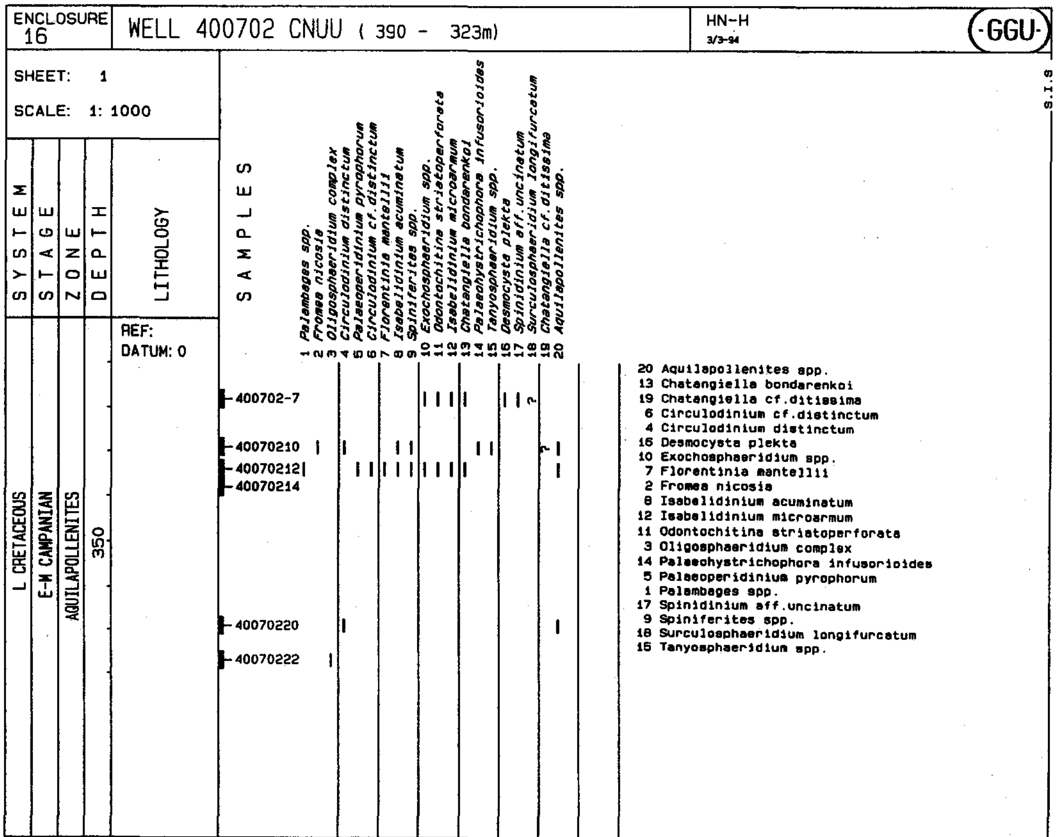

ENCLOSURE 11
WELL 400710 SVAR (1 - 76m)
HN-H
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
L CRETACEOUS
CONIAC/E SANTONIAN
H DIFFICILE
358435
400710-7
400710-9
40071011
40071013
40071015
34 Achomosphaera spp.
1 Acritarch 2 HNH
22 Chatangiella aff.spectabilis
13 Chatangiella cf.ditissima
15 Chatangiella granulifera
31 Chlamydophorella nyei
18 Circulodinium distinctum
9 Desmocysta plekta
4 Dinocyst 7 HNH
21 Exochosphaeridium spp.
26 Florentinia deanei
7 Florentinia mantellii
2 Fromea amphora
24 Heterosphaeridium difficile
17 Hystrichodinium pulchrum
32 Impletosphaeridium spp.
6 Isabelidinium cooksoniae
8 Isabelidinium svartenhukensis
11 Laciniadinium arcticum
12 Odontochitina striatoperforata
29 Oligosphaeridium complex
27 Oligosphaeridium pulcherrimum
19 Palaeohystrichophora infusorioides
23 Palaeoperidinium pyrophorum
28 Paraodinia spp.
33 Raphidodinium fucatum
14 Spinidinium echinoideum
10 Spiniferites spp.
20 Stiphrosphaeridium anthophorum
5 Surculosphaeridium longifurcatum
3 Trigonopyxidia ginella
16 Trithyrodinium suspectum
25 Wallodinium anglicum
30 Xenascus aff.perforatus

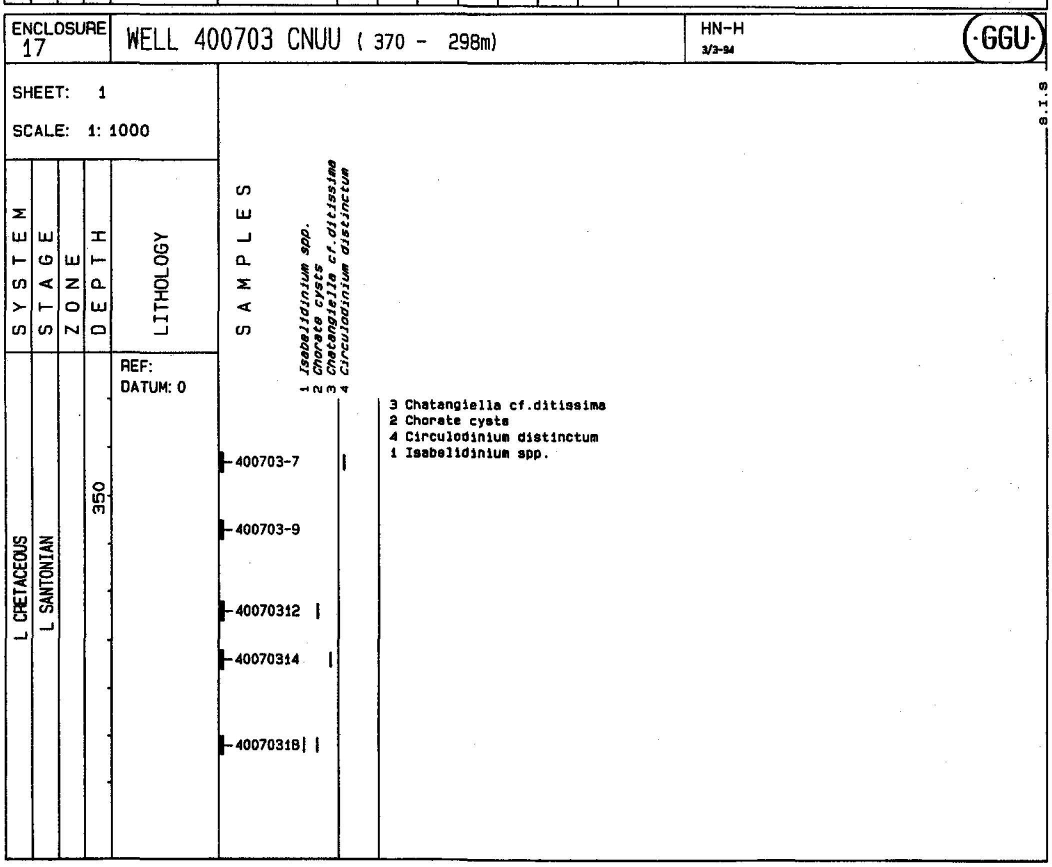


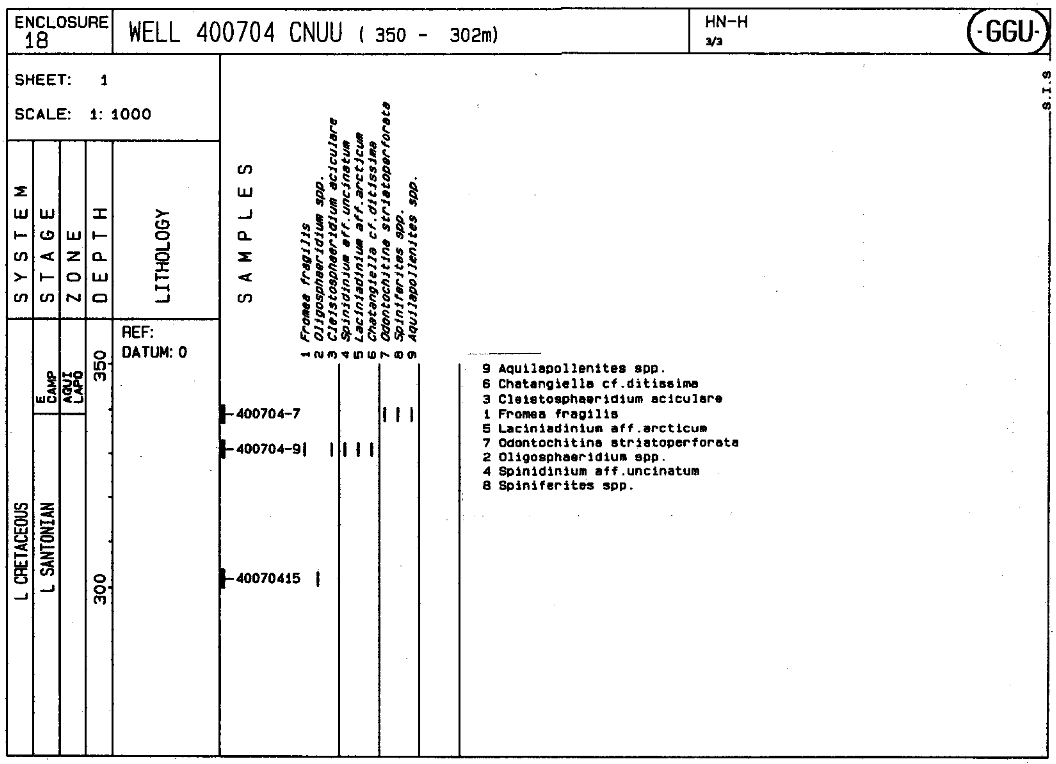
Enclosure 13 in pocket

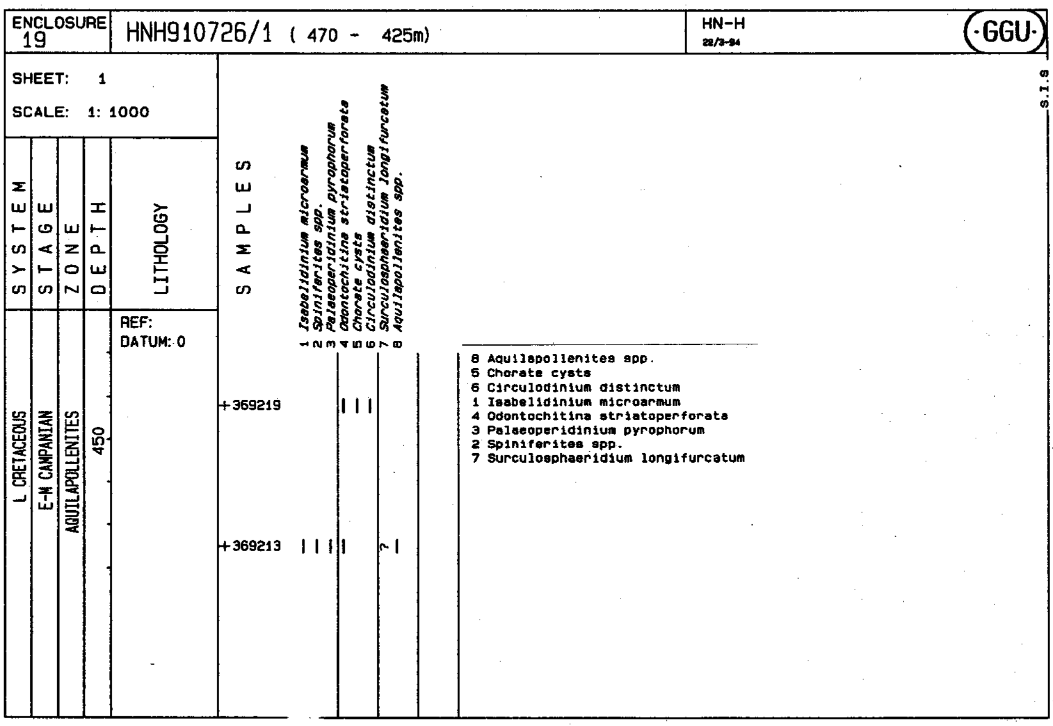

ENCLOSURE 14
FGC900731/2 (570 - 509m)
HN-H
2/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Acritarch spp.
2 Chatangiella bondarenkoi
3 Spiniferites spp.
4 Trithyrodinium suspectum
5 Palaeohystrichophora infusorioides
6 Spinidinium aff. uncinatum
7 Odontochitina striatoperforata
8 Palaeoperidinium pyrophorum
9 Circulodinium distinctum
10 Isabelidinium microarmum
11 Aquilapollenites spp.
12 Tasmanites spp.
550
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
+366501
+366528
+366527
+366525
+366523
1 Acritarch spp.
11 Aquilapollenites spp.
2 Chatangiella bondarenkoi
9 Circulodinium distinctum
10 Isabelidinium microarmum
7 Odontochitina striatoperforata
5 Palaeohystrichophora infusorioides
8 Palaeoperidinium pyrophorum
6 Spinidinium aff.uncinatum
3 Spiniferites spp.
12 Tasmanites spp.
4 Trithyrodinium suspectum
S.I.S

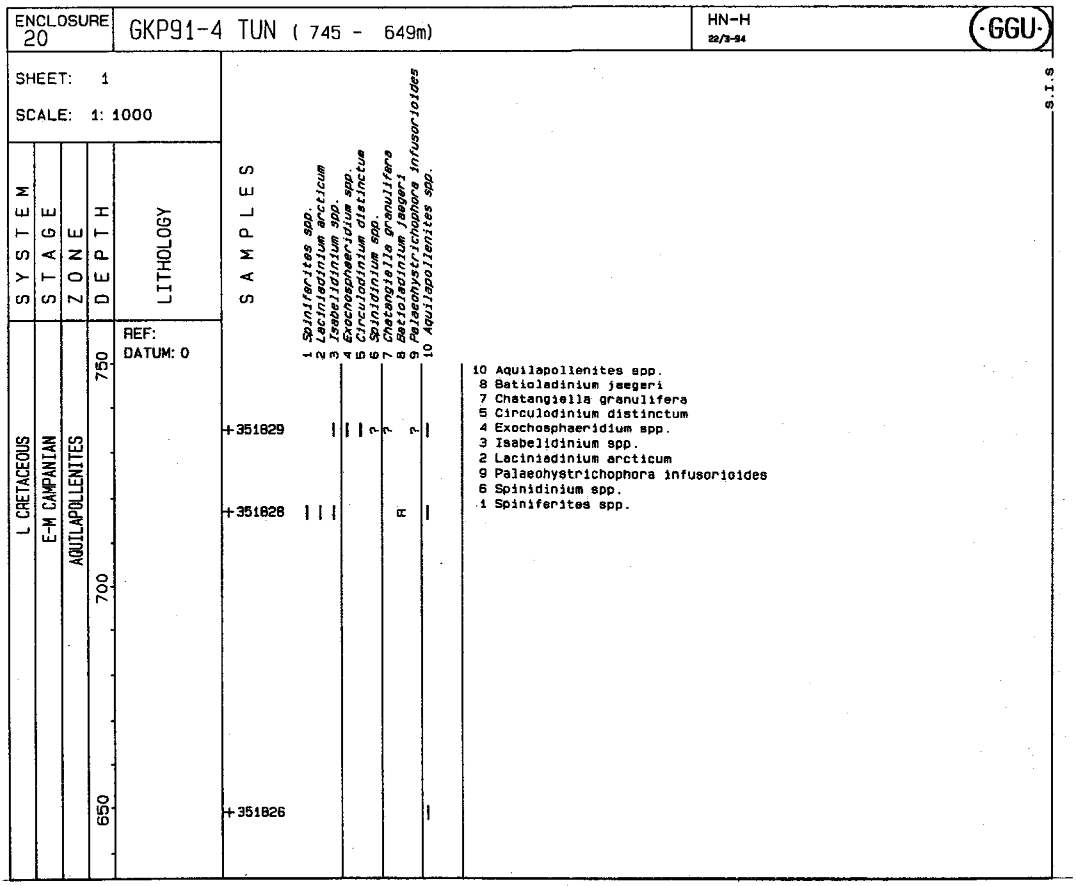

ENCLOSURE 15
WELL 400701 CNUU (410 - 375m)
HN-H
3/3-94
GGU
SHEET: 1
SCALE: 1: 500
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Palaeoperidinium pyrophorum
2 Isabelidinium spp.
3 Chatangiella spp.
4 Isabelidinium microarmum
5 Spiniferites spp.
6 Exochosphaeridium spp.
7 Circulodinium distinctum
8 Palaeocystodinium aff. golzowense
9 Aquilapollenites spp.
400
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
400701-2
400701-4
400701-6
9 Aquilapollenites spp.
3 Chatangiella spp.
7 Circulodinium distinctum
6 Exochosphaeridium spp.
4 Isabelidinium microarmum
2 Isabelidinium spp.
8 Palaeocystodinium aff.golzowense
1 Palaeoperidinium pyrophorum
5 Spiniferites spp.
S.I.S

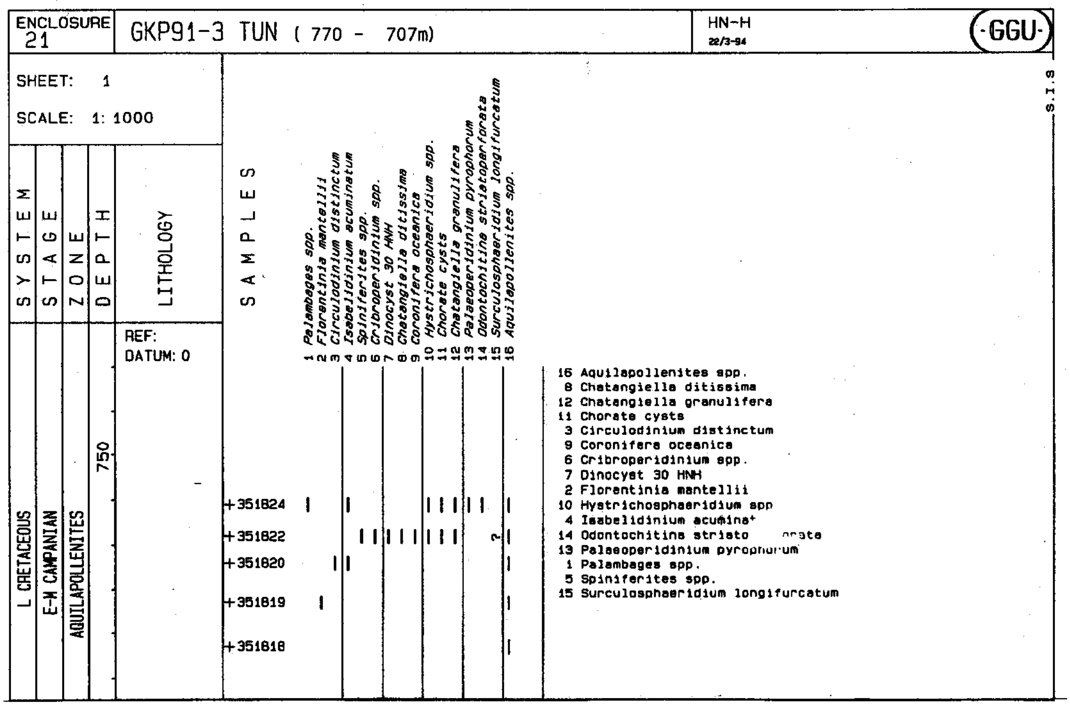

ENCLOSURE 16
WELL 400702 CNUU (390 - 323m)
HN-H
3/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
350
400702-7
40070210
40070212
40070214
40070220
40070222
1 Palambages spp.
2 Fromea nicosia
3 Oligosphaeridium complex
4 Circulodinium distinctum
5 Palaeoperidinium pyrophorum
6 Circulodinium cf.distinctum
7 Florentinia mantellii
8 Isabelidinium acuminatum
9 Spiniferites spp.
10 Exochosphaeridium spp.
11 Odontochitina striatoperforata
12 Isabelidinium microarmum
13 Chatangiella bondarenkoi
14 Palaeohystrichophora infusorioides
15 Tanyosphaeridium spp.
16 Desmocysta plekta
17 Spinidinium aff.uncinatum
18 Surculosphaeridium longifurcatum
19 Chatangiella cf.ditissima
20 Aquilapollenites spp.
20 Aquilapollenites spp.
13 Chatangiella bondarenkoi
19 Chatangiella cf.ditissima
6 Circulodinium cf.distinctum
4 Circulodinium distinctum
16 Desmocysta plekta
10 Exochosphaeridium spp.
7 Florentinia mantellii
2 Fromea nicosia
8 Isabelidinium acuminatum
12 Isabelidinium microarmum
11 Odontochitina striatoperforata
3 Oligosphaeridium complex
14 Palaeohystrichophora infusorioides
5 Palaeoperidinium pyrophorum
1 Palambages spp.
17 Spinidinium aff.uncinatum
9 Spiniferites spp.
18 Surculosphaeridium longifurcatum
15 Tanyosphaeridium spp.
S.I.S

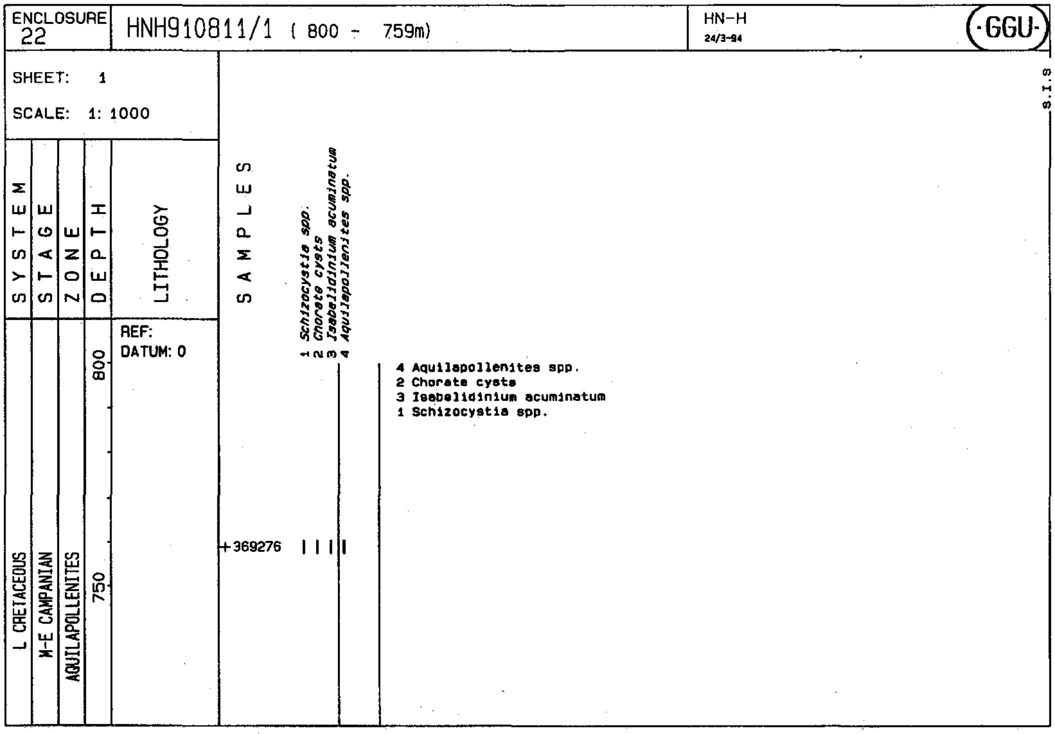

ENCLOSURE 17
WELL 400703 CNUU (370 - 298m)
HN-H
3/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
L CRETACEOUS
L SANTONIAN
350
400703-7
400703-9
40070312
40070314
40070318
1 Isabelidinium spp.
2 Chorate cysts
3 Chatangiella cf.ditissima
4 Circulodinium distinctum
3 Chatangiella cf.ditissima
2 Chorate cysts
4 Circulodinium distinctum
1 Isabelidinium spp.
S.I.S

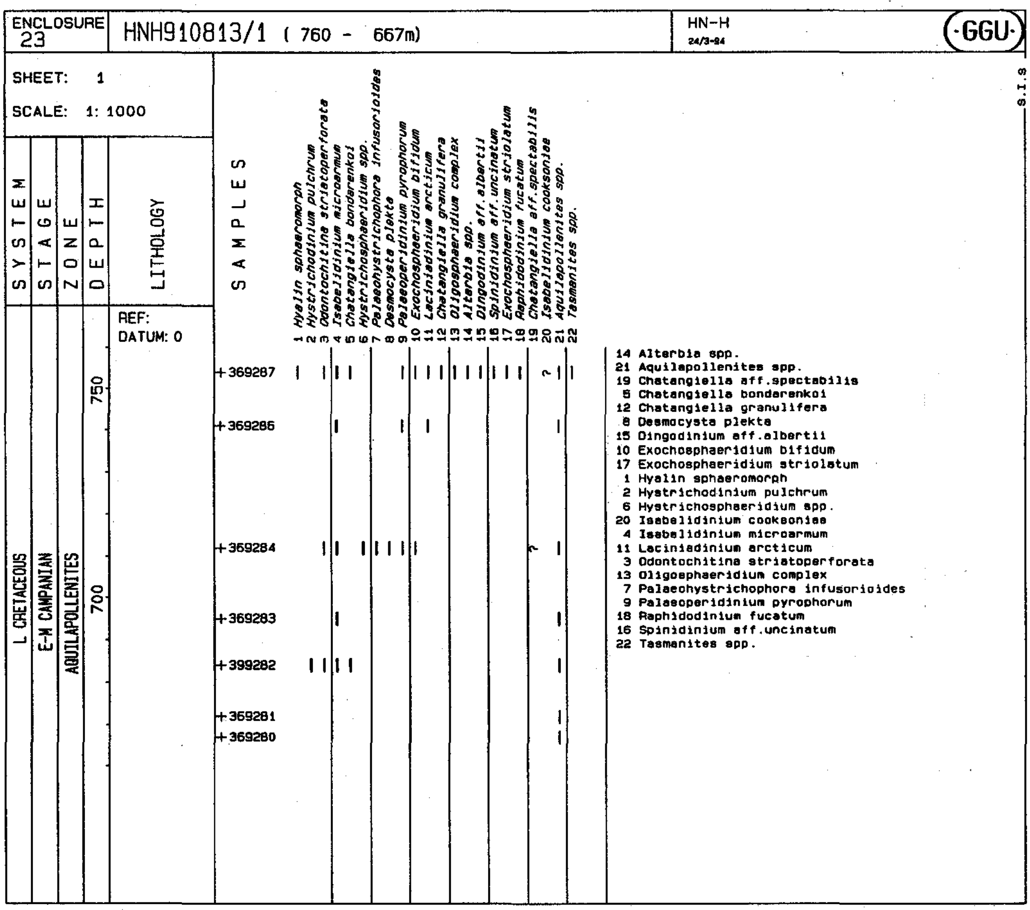

ENCLOSURE 18
WELL 400704 CNUU (350 - 302m)
HN-H
3/3
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Fromea fragilis
2 Oligosphaeridium spp.
3 Cleistosphaeridium aciculare
4 Spinidinium aff.uncinatum
5 Laciniadinium aff.arcticum
6 Chatangiella cf.ditissima
7 Odontochitina striatoperforata
8 Spiniferites spp.
9 Aquilapollenites spp.
L CRETACEOUS
E CAMP
L SANTONIAN
AQUI LAPO
350
300
400704-7
400704-9
40070415
9 Aquilapollenites spp.
6 Chatangiella cf.ditissima
3 Cleistosphaeridium aciculare
1 Fromea fragilis
5 Laciniadinium aff.arcticum
7 Odontochitina striatoperforata
2 Oligosphaeridium spp.
4 Spinidinium aff.uncinatum
8 Spiniferites spp.
S.I.S

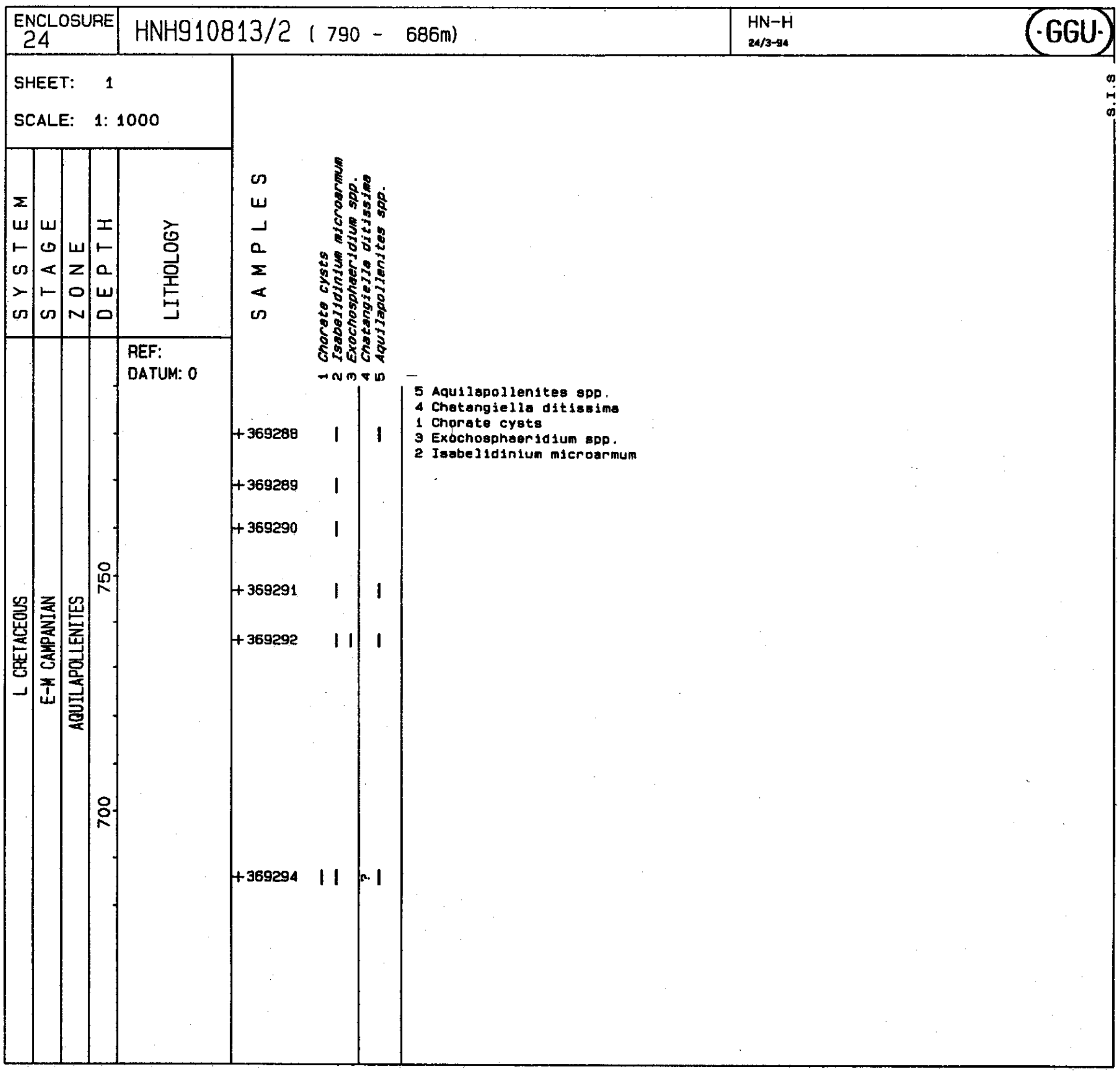

ENCLOSURE 19
HNH910726/1 (470 - 425m)
HN-H
22/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Isabelidinium microarmum
2 Spiniferites spp.
3 Palaeoperidinium pyrophorum
4 Odontochitina striatoperforata
5 Chorate cysts
6 Circulodinium distinctum
7 Surculosphaeridium longifurcatum
8 Aquilapollenites spp.
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
450
369219
369213
8 Aquilapollenites spp.
5 Chorate cysts
6 Circulodinium distinctum
1 Isabelidinium microarmum
4 Odontochitina striatoperforata
3 Palaeoperidinium pyrophorum
2 Spiniferites spp.
7 Surculosphaeridium longifurcatum
S.I.S

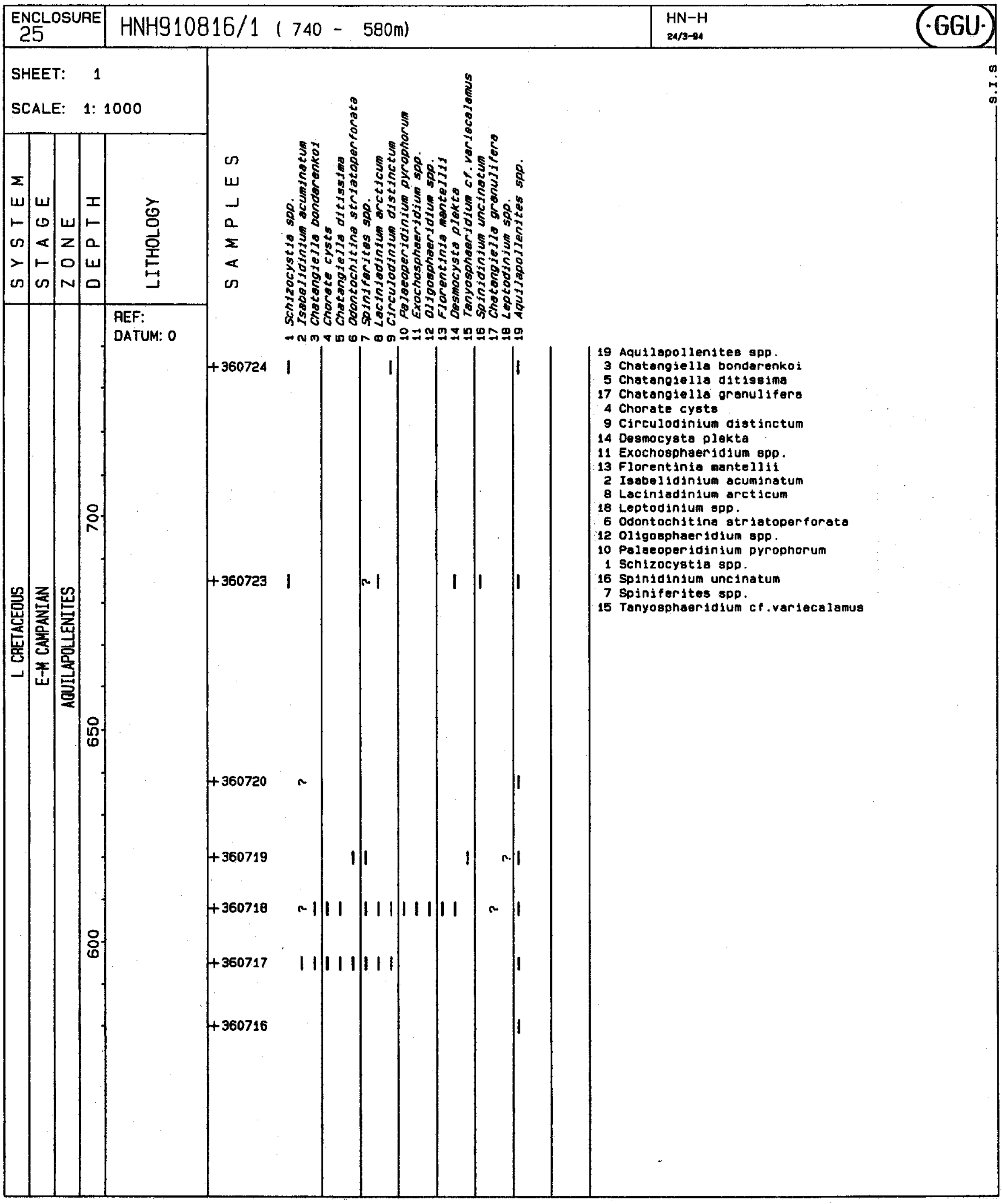

ENCLOSURE 20
GKP91-4 TUN (745 - 649m)
HN-H 22/3-94
·GGU·
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
S.I.S
REF: DATUM: 0
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
750
700
650
+351829
+351828
+351826
1 Spiniferites spp.
2 Laciniadinium arcticum
3 Isabelidinium spp.
4 Exochosphaeridium spp.
5 Circulodinium distinctum
6 Spinidinium spp.
7 Chatangiella granulifera
8 Batioladinium jaegeri
9 Palaeohystrichophora infusorioides
10 Aquilapollenites spp.
10 Aquilapollenites spp.
8 Batioladinium jaegeri
7 Chatangiella granulifera
5 Circulodinium distinctum
4 Exochosphaeridium spp.
3 Isabelidinium spp.
2 Laciniadinium arcticum
9 Palaeohystrichophora infusorioides
6 Spinidinium spp.
1 Spiniferites spp.

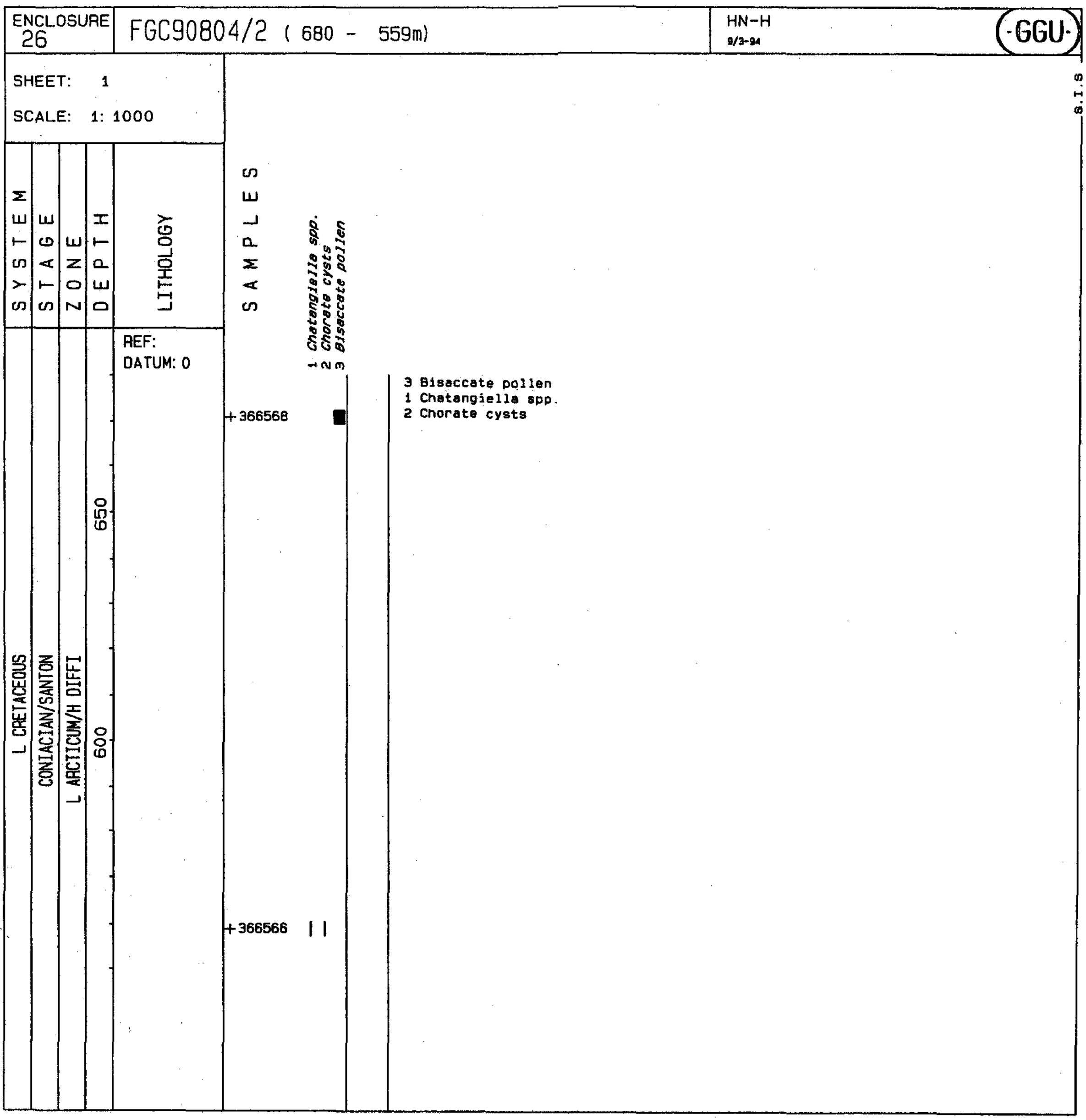

ENCLOSURE 21
GKP91-3 TUN (770 - 707m)
HN-H 22/3-94
·GGU·
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
S.I.S
REF: DATUM: 0
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
750
+351824
+351822
+351820
+351819
+351818
1 Palambages spp.
2 Florentinia mantellii
3 Circulodinium distinctum
4 Isabelidinium acuminatum
5 Spiniferites spp.
6 Cribroperidinium spp.
7 Dinocyst 30 HNH
8 Chatangiella ditissima
9 Coronifera oceanica
10 Hystrichosphaeridium spp.
11 Chorate cysts
12 Chatangiella granulifera
13 Palaeoperidinium pyrophorum
14 Odontochitina striatoperforata
15 Surculosphaeridium longifurcatum
16 Aquilapollenites spp.
16 Aquilapollenites spp.
8 Chatangiella ditissima
12 Chatangiella granulifera
11 Chorate cysts
3 Circulodinium distinctum
9 Coronifera oceanica
6 Cribroperidinium spp.
7 Dinocyst 30 HNH
2 Florentinia mantellii
10 Hystrichosphaeridium spp
4 Isabelidinium acuminatum
13 Palaeoperidinium pyrophorum
1 Palambages spp.
5 Spiniferites spp.
15 Surculosphaeridium longifurcatum

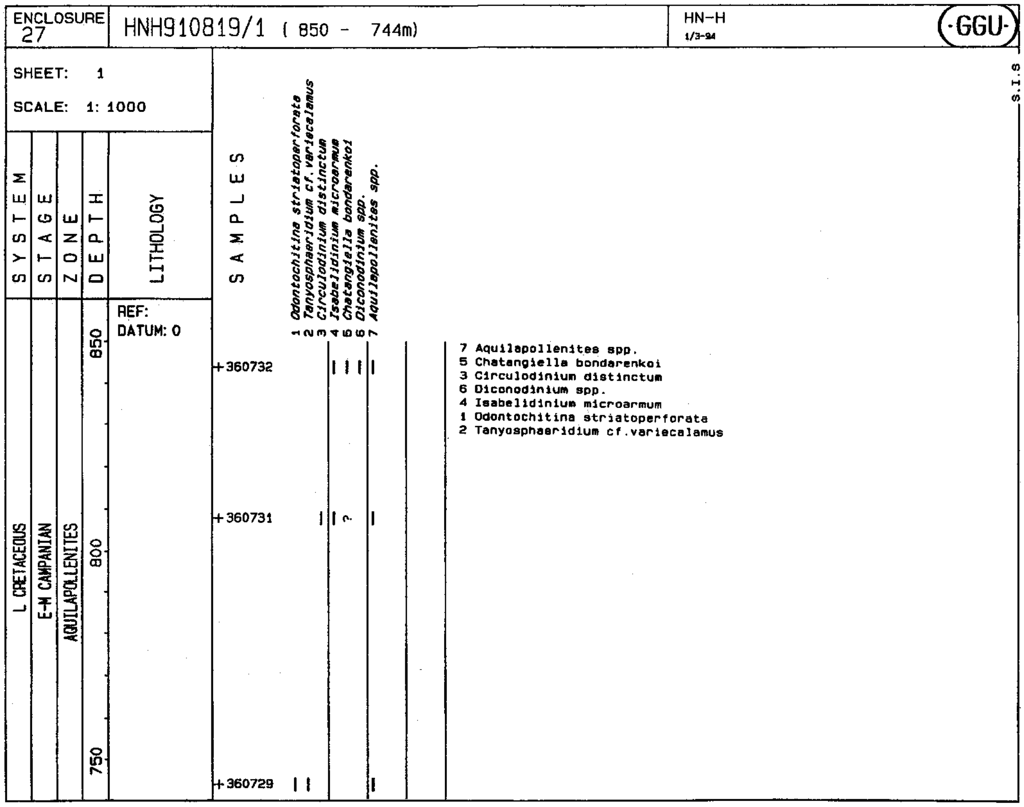

ENCLOSURE 22
HNH910811/1 (800 - 759m)
HN-H
24/3-94
GGU
S.I.S
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
800
750
L CRETACEOUS
M-E CAMPANIAN
AQUILAPOLLENITES
+369276
1 Schizocystia spp.
2 Chorate cysts
3 Isabelidinium acuminatum
4 Aquilapollenites spp.
4 Aquilapollenites spp.
2 Chorate cysts
3 Isabelidinium acuminatum
1 Schizocystia spp.

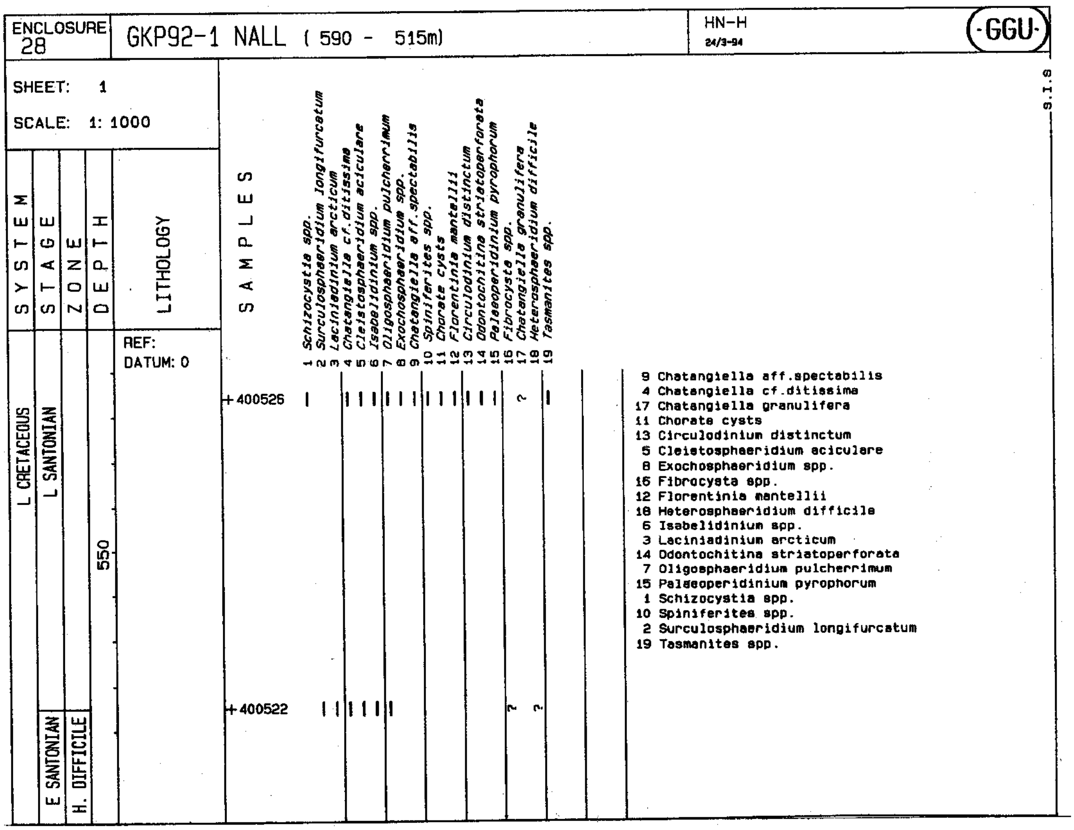

ENCLOSURE 23
HNH910813/1 (760 - 667m)
HN-H
24/3-94
GGU
S.I.S
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
750
700
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
+369287
+369286
+369284
+369283
+399282
+369281
+369280
1 Hyalin sphaeromorph
2 Hystrichodinium pulchrum
3 Odontochitina striatoperforata
4 Isabelidinium microarmum
5 Chatangiella bondarenkoi
6 Hystrichosphaeridium spp.
7 Palaeohystrichophora infusorioides
8 Desmocysta plekta
9 Palaeoperidinium pyrophorum
10 Exochosphaeridium bifidum
11 Laciniadinium arcticum
12 Chatangiella granulifera
13 Oligosphaeridium complex
14 Alterbia spp.
15 Dingodinium aff.albertii
16 Spinidinium aff.uncinatum
17 Exochosphaeridium striolatum
18 Raphidodinium fucatum
19 Chatangiella aff.spectabilis
20 Isabelidinium cooksoniae
21 Aquilapollenites spp.
22 Tasmanites spp.
14 Alterbia spp.
21 Aquilapollenites spp.
19 Chatangiella aff.spectabilis
5 Chatangiella bondarenkoi
12 Chatangiella granulifera
8 Desmocysta plekta
15 Dingodinium aff.albertii
10 Exochosphaeridium bifidum
17 Exochosphaeridium striolatum
1 Hyalin sphaeromorph
2 Hystrichodinium pulchrum
6 Hystrichosphaeridium spp.
20 Isabelidinium cooksoniae
4 Isabelidinium microarmum
11 Laciniadinium arcticum
3 Odontochitina striatoperforata
13 Oligosphaeridium complex
7 Palaeohystrichophora infusorioides
9 Palaeoperidinium pyrophorum
18 Raphidodinium fucatum
16 Spinidinium aff.uncinatum
22 Tasmanites spp.

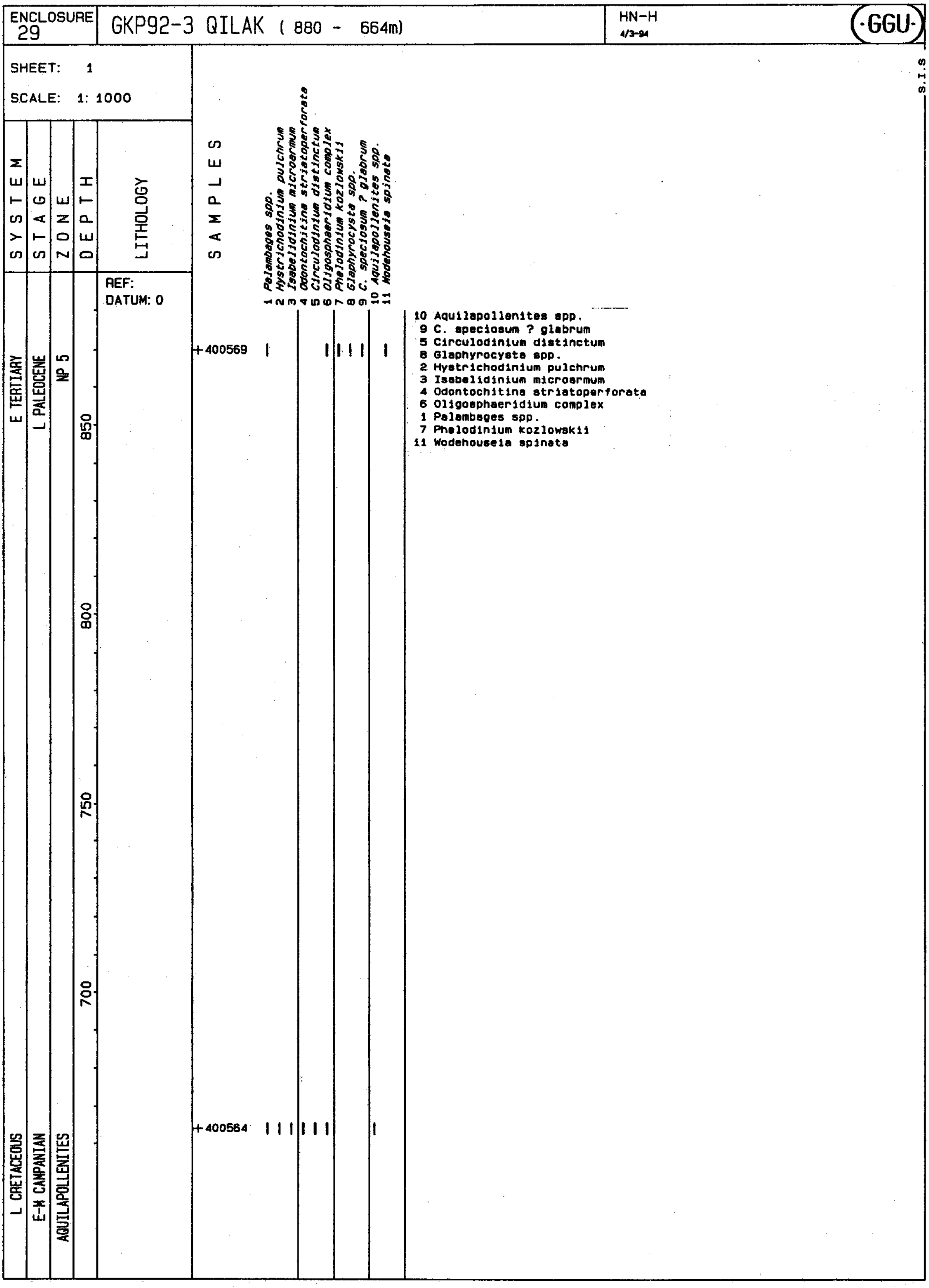

ENCLOSURE 24
HNH910813/2 (790 - 686m)
HN-H
24/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Chorate cysts
2 Isabelidinium microarmum
3 Exochosphaeridium spp.
4 Chatangiella ditissima
5 Aquilapollenites spp.
5 Aquilapollenites spp.
4 Chatangiella ditissima
1 Chorate cysts
3 Exochosphaeridium spp.
2 Isabelidinium microarmum
369288
369289
369290
369291
369292
369294
750
700
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
S.I.S

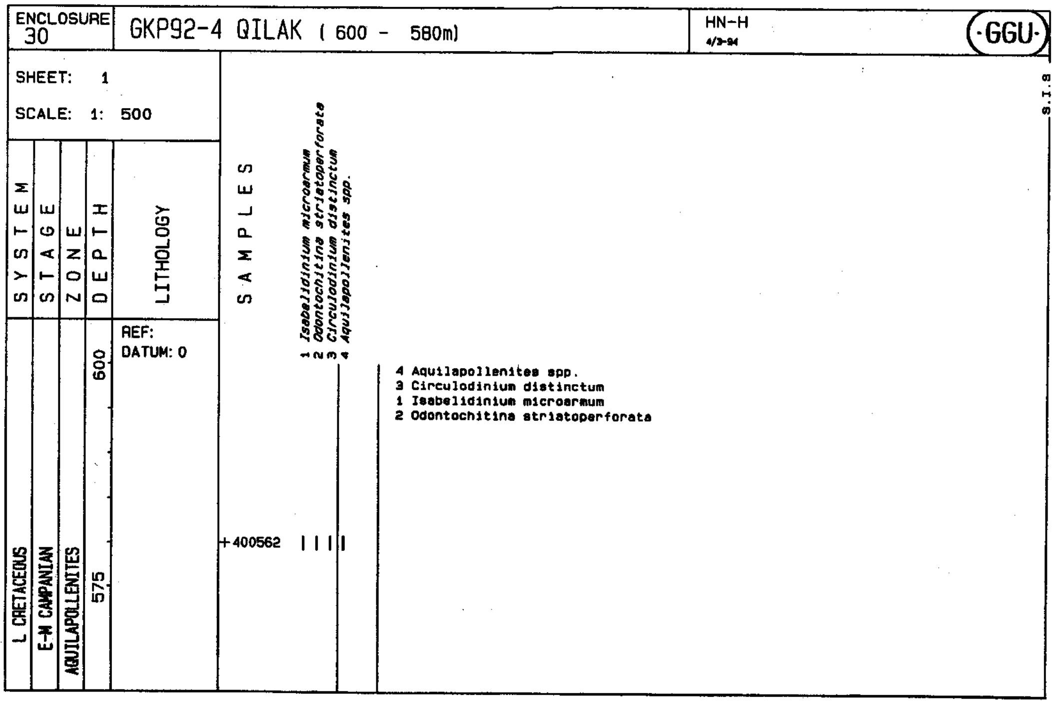

ENCLOSURE 25
HNH910816/1 (740 - 580m)
HN-H
24/3-94
·GGU·
S.I.S
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
700
650
600
+360724
+360723
+360720
+360719
+360718
+360717
+360716
1 Schizocystia spp.
2 Isabelidinium acuminatum
3 Chatangiella bondarenkoi
4 Chorate cysts
5 Chatangiella ditissima
6 Odontochitina striatoperforata
7 Spiniferites spp.
8 Laciniadinium arcticum
9 Circulodinium distinctum
10 Palaeoperidinium pyrophorum
11 Exochosphaeridium spp.
12 Oligosphaeridium spp.
13 Florentinia mantellii
14 Desmocysta plekta
15 Tanyosphaeridium cf. variecalamus
16 Spinidinium uncinatum
17 Chatangiella granulifera
18 Leptodinium spp.
19 Aquilapollenites spp.
19 Aquilapollenites spp.
3 Chatangiella bondarenkoi
5 Chatangiella ditissima
17 Chatangiella granulifera
4 Chorate cysts
9 Circulodinium distinctum
14 Desmocysta plekta
11 Exochosphaeridium spp.
13 Florentinia mantellii
2 Isabelidinium acuminatum
8 Laciniadinium arcticum
18 Leptodinium spp.
6 Odontochitina striatoperforata
12 Oligosphaeridium spp.
10 Palaeoperidinium pyrophorum
1 Schizocystia spp.
16 Spinidinium uncinatum
7 Spiniferites spp.
15 Tanyosphaeridium cf.variecalamus

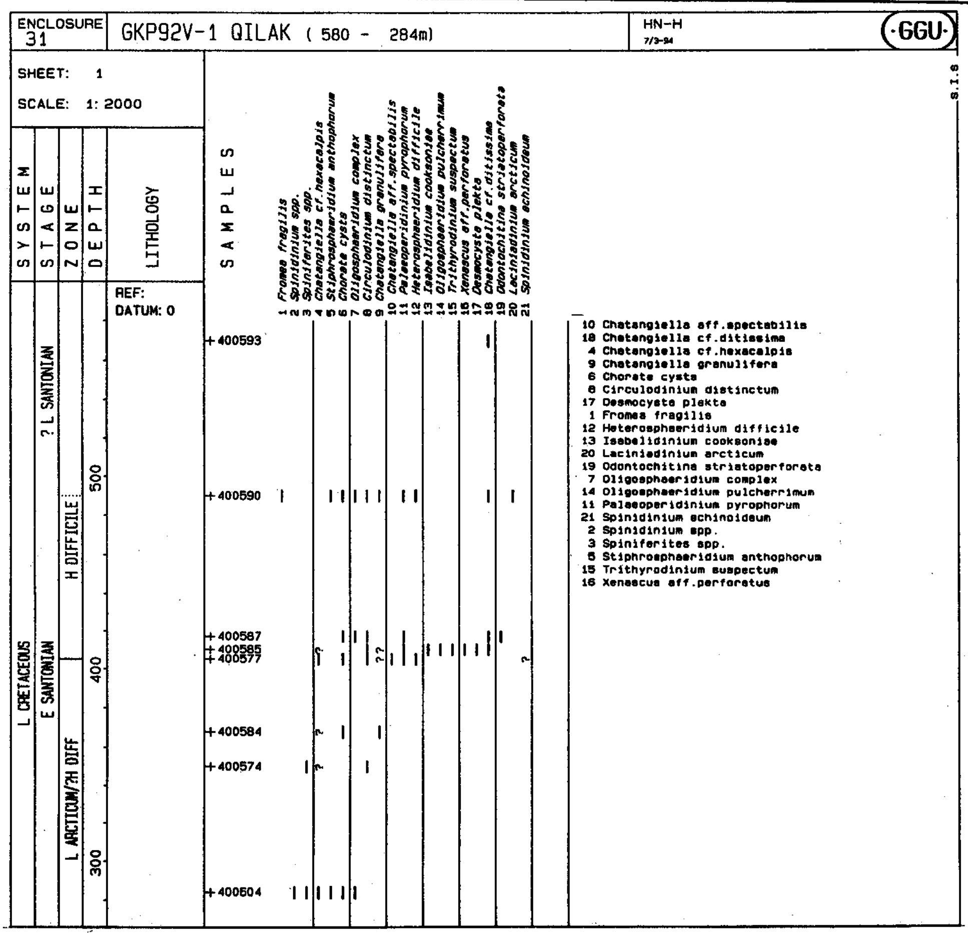

ENCLOSURE
26
FGC90804/2 (680 - 559m)
HN-H
9/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
1 Chatangiella spp.
2 Chorate cysts
3 Bisaccate pollen
REF:
DATUM: 0
3 Bisaccate pollen
1 Chatangiella spp.
2 Chorate cysts
366568
366566
650
600
L CRETACEOUS
CONIACIAN/SANTON
L ARCTICUM/H DIFFI
S.I.S

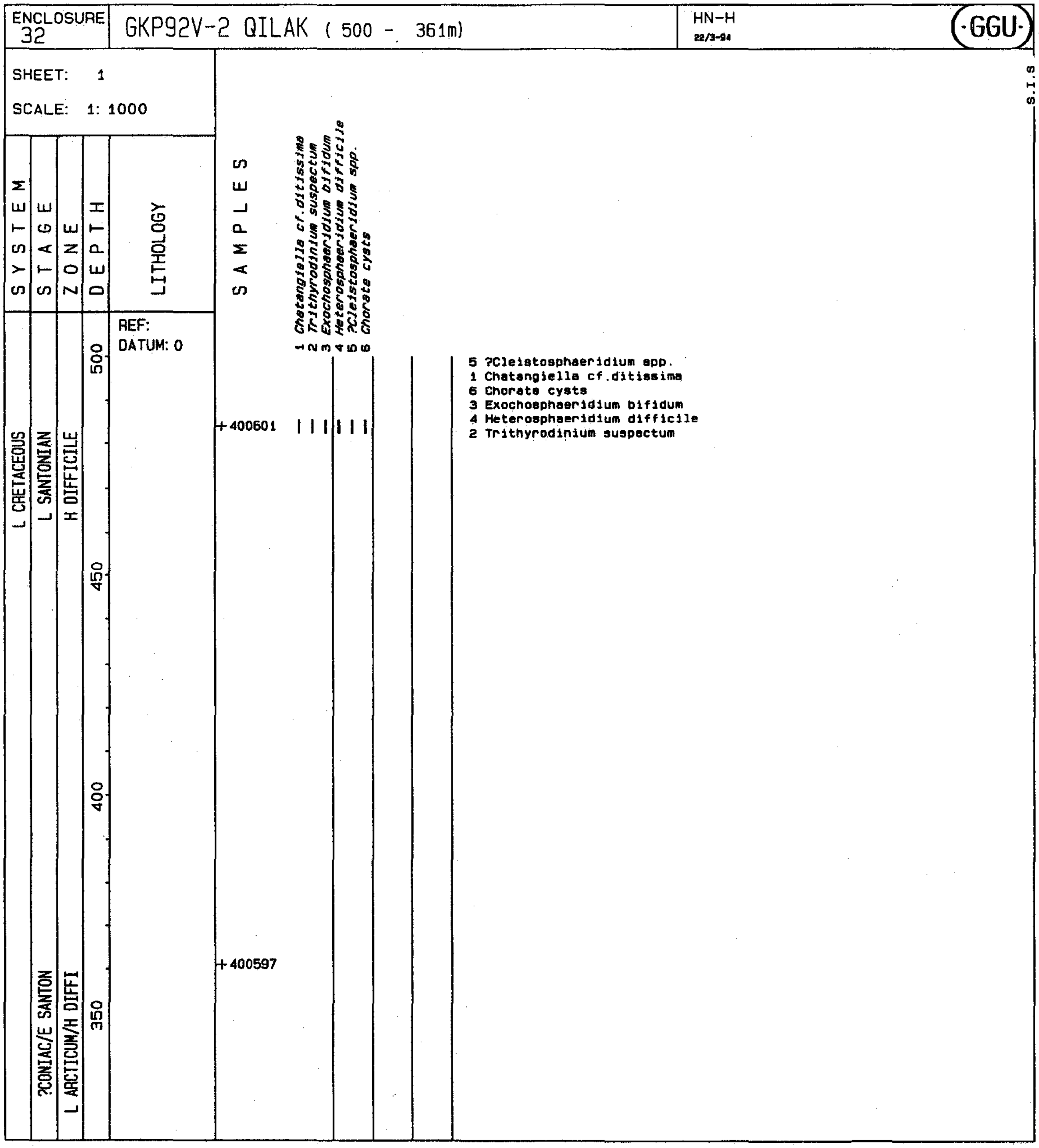

ENCLOSURE 27
HNH910819/1 (850 - 744m)
HN-H
1/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
S.I.S
1 Odontochitina striatoperforata
2 Tanyosphaeridium cf.variecalamus
3 Circulodinium distinctum
4 Isabelidinium microarmum
5 Chatangiella bondarenkoi
6 Diconodinium spp.
7 Aquilapollenites spp.
REF:
DATUM: 0
850
800
750
+360732
+360731
+360729
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
7 Aquilapollenites spp.
5 Chatangiella bondarenkoi
3 Circulodinium distinctum
6 Diconodinium spp.
4 Isabelidinium microarmum
1 Odontochitina striatoperforata
2 Tanyosphaeridium cf.variecalamus


ENCLOSURE 28
GKP92-1 NALL (590 - 515m)
HN-H
24/3-94
GGU
SHEET: 1
SCALE: 1: 1000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
S.I.S
1 Schizocystia spp.
2 Surculosphaeridium longifurcatum
3 Laciniadinium arcticum
4 Chatangiella cf.ditissima
5 Cleistosphaeridium aciculare
6 Isabelidinium spp.
7 Oligosphaeridium pulcherrimum
8 Exochosphaeridium spp.
9 Chatangiella aff.spectabilis
10 Spiniferites spp.
11 Chorate cysts
12 Florentinia mantellii
13 Circulodinium distinctum
14 Odontochitina striatoperforata
15 Palaeoperidinium pyrophorum
16 Fibrocysta spp.
17 Chatangiella granulifera
18 Heterosphaeridium difficile
19 Tasmanites spp.
REF:
DATUM: 0
550
+400526
+400522
L CRETACEOUS
L SANTONIAN
E SANTONIAN
H. DIFFICILE
9 Chatangiella aff.spectabilis
4 Chatangiella cf.ditissima
17 Chatangiella granulifera
11 Chorate cysts
13 Circulodinium distinctum
5 Cleistosphaeridium aciculare
8 Exochosphaeridium spp.
16 Fibrocysta spp.
12 Florentinia mantellii
18 Heterosphaeridium difficile
6 Isabelidinium spp.
3 Laciniadinium arcticum
14 Odontochitina striatoperforata
7 Oligosphaeridium pulcherrimum
15 Palaeoperidinium pyrophorum
1 Schizocystia spp.
10 Spiniferites spp.
2 Surculosphaeridium longifurcatum
19 Tasmanites spp.

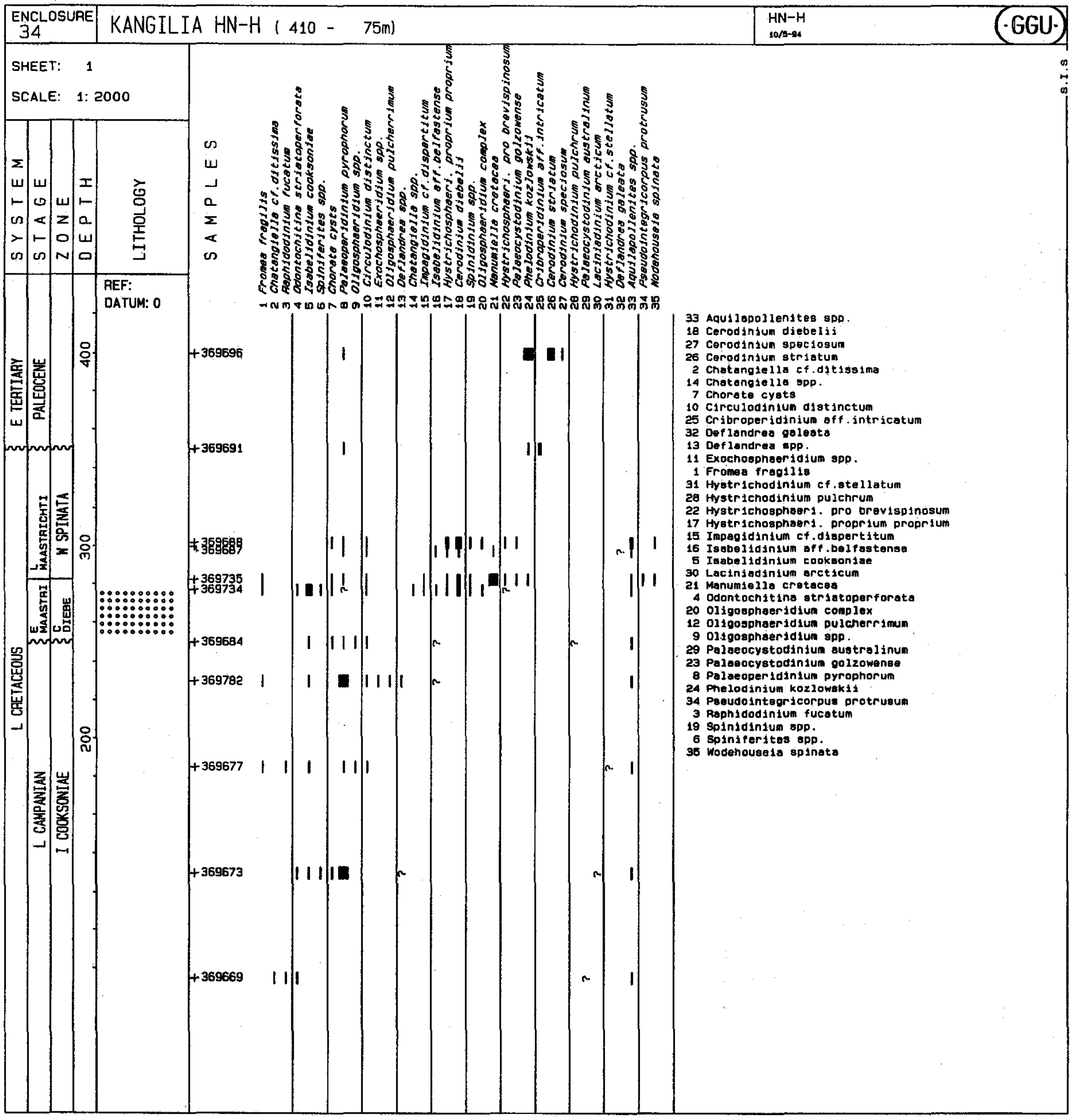

ENCLOSURE 29
GKP92-3 QILAK (880 - 664m)
HN-H
4/3-94
GGU
SHEET: 1
SCALE: 1: 1000
S.I.S
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF: DATUM: 0
1 Palambages spp.
2 Hystrichodinium pulchrum
3 Isabelidinium microarmum
4 Odontochitina striatoperforata
5 Circulodinium distinctum
6 Oligosphaeridium complex
7 Phelodinium kozlowskii
8 Glaphyrocysta spp.
9 C. speciosum ? glabrum
10 Aquilapollenites spp.
11 Wodehouseia spinata
10 Aquilapollenites spp.
9 C. speciosum ? glabrum
5 Circulodinium distinctum
8 Glaphyrocysta spp.
2 Hystrichodinium pulchrum
3 Isabelidinium microarmum
4 Odontochitina striatoperforata
6 Oligosphaeridium complex
1 Palambages spp.
7 Phelodinium kozlowskii
11 Wodehouseia spinata
E TERTIARY
L PALEOCENE
NP 5
+400569
850
800
750
700
+400564
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES

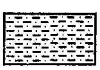

ENCLOSURE 30
GKP92-4 QILAK (600 - 580m)
HN-H
4/3-94
·GGU·
SHEET: 1
SCALE: 1: 500
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
1 Isabelidinium microarmum
2 Odontochitina striatoperforata
3 Circulodinium distinctum
4 Aquilapollenites spp.
REF:
DATUM: 0
600
575
400562
L CRETACEOUS
E-M CAMPANIAN
AQUILAPOLLENITES
4 Aquilapollenites spp.
3 Circulodinium distinctum
1 Isabelidinium microarmum
2 Odontochitina striatoperforata
S.I.S

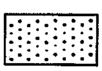

ENCLOSURE 31
GKP92V-1 QILAK (580 - 284m)
HN-H
7/3-94
·GGU·
SHEET: 1
SCALE: 1: 2000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
1 Fromea fragilis
2 Spinidinium spp.
3 Spiniferites spp.
4 Chatangiella cf.hexacalpis
5 Stiphrosphaeridium anthophorum
6 Chorate cysts
7 Oligosphaeridium complex
8 Circulodinium distinctum
9 Chatangiella granulifera
10 Chatangiella aff.spectabilis
11 Palaeoperidinium pyrophorum
12 Heterosphaeridium difficile
13 Isabelidinium cooksoniae
14 Oligosphaeridium pulcherrimum
15 Trithyrodinium suspectum
16 Xenascus aff.perforatus
17 Desmocysta plekta
18 Chatangiella cf.ditissima
19 Odontochitina striatoperforata
20 Laciniadinium arcticum
21 Spinidinium echinoideum
REF:
DATUM: 0
500
400
300
400593
400590
400587
400585
400577
400584
400574
400504
L CRETACEOUS
? L SANTONIAN
E SANTONIAN
H DIFFICILE
L ARCTICUM/?H DIFF
10 Chatangiella aff.spectabilis
18 Chatangiella cf.ditissima
4 Chatangiella cf.hexacalpis
9 Chatangiella granulifera
6 Chorate cysts
8 Circulodinium distinctum
17 Desmocysta plekta
1 Fromea fragilis
12 Heterosphaeridium difficile
13 Isabelidinium cooksoniae
20 Laciniadinium arcticum
19 Odontochitina striatoperforata
7 Oligosphaeridium complex
14 Oligosphaeridium pulcherrimum
11 Palaeoperidinium pyrophorum
21 Spinidinium echinoideum
2 Spinidinium spp.
3 Spiniferites spp.
5 Stiphrosphaeridium anthophorum
15 Trithyrodinium suspectum
16 Xenascus aff.perforatus
S.I.S

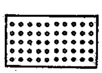


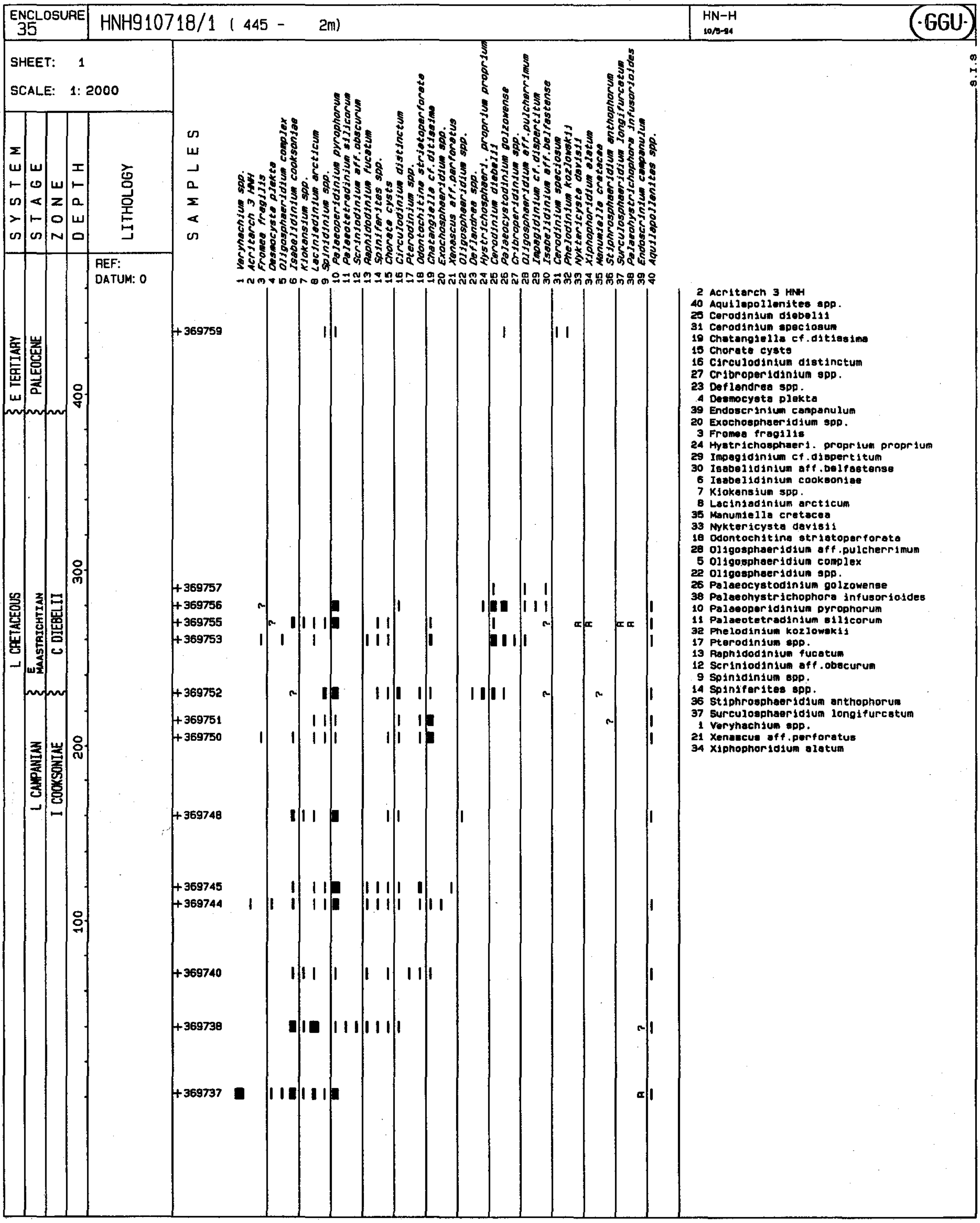
Enclosure 33 in pocket

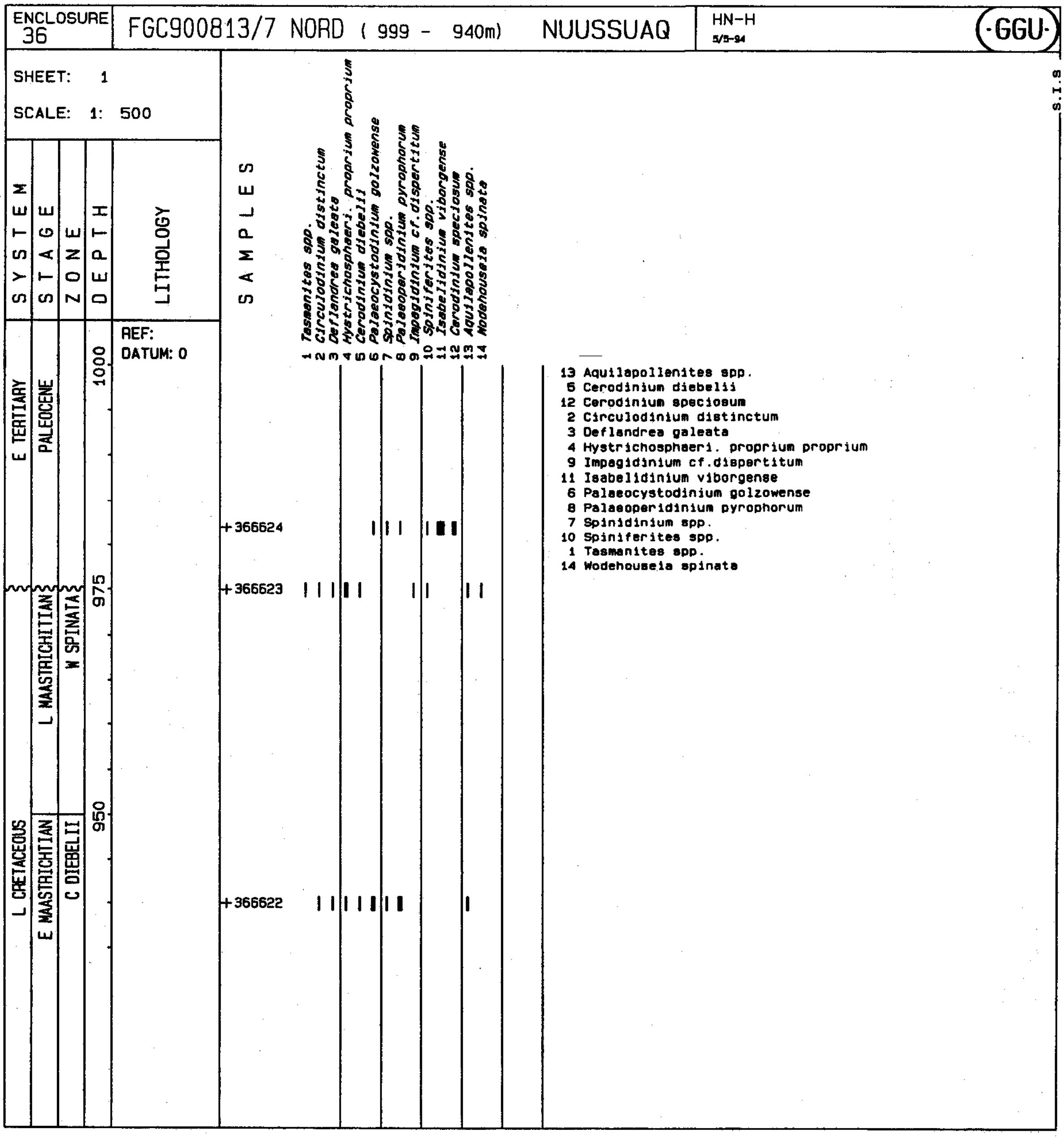



Mudstone


Medium to coarse grained sandstone


Conglomerate

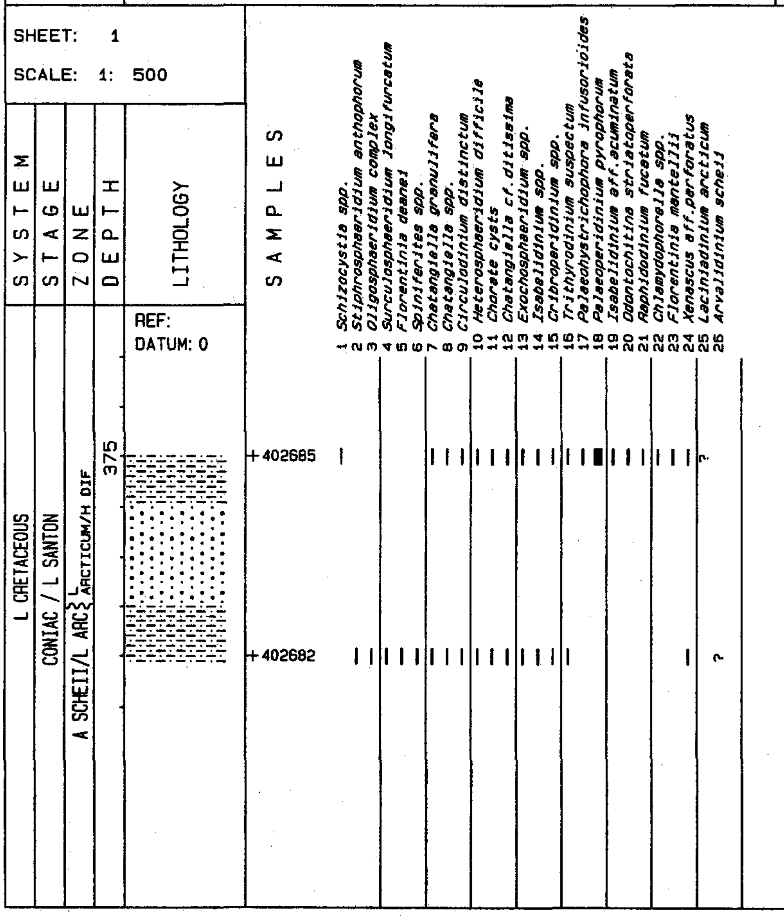

ENCLOSURE 35
HNH910718/1 (445 - 2m)
HN-H
10/5-94
GGU
SHEET: 1
SCALE: 1: 2000
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
E TERTIARY
PALEOCENE
L CRETACEOUS
E MAASTRICHTIAN
C DIEBELII
L CAMPANIAN
I COOKSONIAE
400
300
200
100
+369759
+369757
+369756
+369755
+369753
+369752
+369751
+369750
+369748
+369745
+369744
+369740
+369738
+369737
1 Veryhachium spp.
2 Acritarch 3 HNH
3 Fromea fragilis
4 Desmocysta plekta
5 Oligosphaeridium complex
6 Isabelidinium cooksoniae
7 Kiokansium spp.
8 Laciniadinium arcticum
9 Spinidinium spp.
10 Palaeoperidinium pyrophorum
11 Palaeotetradinium silicorum
12 Scriniodinium aff.obscurum
13 Raphidodinium fucatum
14 Spiniferites spp.
15 Chorate cysts
16 Circulodinium distinctum
17 Pterodinium spp.
18 Odontochitina striatoperforata
19 Chatangiella cf.ditissima
20 Exochosphaeridium spp.
21 Xenascus aff.perforatus
22 Oligosphaeridium spp.
23 Deflandrea spp.
24 Hystrichosphaeri. proprium proprium
25 Cerodinium diebelii
26 Palaeocystodinium golzowense
27 Cribroperidinium spp.
28 Oligosphaeridium aff.pulcherrimum
29 Impagidinium cf.dispertitum
30 Isabelidinium aff.belfastense
31 Cerodinium speciosum
32 Phelodinium kozlowskii
33 Nyktericysta davisii
34 Xiphophoridium alatum
35 Manumiella cretacea
36 Stiphrosphaeridium anthophorum
37 Surculosphaeridium longifurcatum
38 Palaeohystrichophora infusorioides
39 Endoscrinium campanulum
40 Aquilapollenites spp.
2 Acritarch 3 HNH
40 Aquilapollenites spp.
25 Cerodinium diebelii
31 Cerodinium speciosum
19 Chatangiella cf.ditissima
15 Chorate cysts
16 Circulodinium distinctum
27 Cribroperidinium spp.
23 Deflandrea spp.
4 Desmocysta plekta
39 Endoscrinium campanulum
20 Exochosphaeridium spp.
3 Fromea fragilis
24 Hystrichosphaeri. proprium proprium
29 Impagidinium cf.dispertitum
30 Isabelidinium aff.belfastense
6 Isabelidinium cooksoniae
7 Kiokensium spp.
8 Laciniadinium arcticum
35 Manumiella cretacea
33 Nyktericysta davisii
18 Odontochitina striatoperforata
28 Oligosphaeridium aff.pulcherrimum
5 Oligosphaeridium complex
22 Oligosphaeridium spp.
26 Palaeocystodinium golzowense
38 Palaeohystrichophora infusorioides
10 Palaeoperidinium pyrophorum
11 Palaeotetradinium silicorum
32 Phelodinium kozlowskii
17 Pterodinium spp.
13 Raphidodinium fucatum
12 Scriniodinium aff.obscurum
9 Spinidinium spp.
14 Spiniferites spp.
36 Stiphrosphaeridium anthophorum
37 Surculosphaeridium longifurcatum
1 Veryhachium spp.
21 Xenascus aff.perforatus
34 Xiphophoridium alatum
S.I.S


ENCLOSURE 36
FGC900813/7 NORD (999 - 940m)
NUUSSUAQ
HN-H
5/5-94
GGU
SHEET: 1
SCALE: 1: 500
S.I.S
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
REF:
DATUM: 0
1 Tasmanites spp.
2 Circulodinium distinctum
3 Deflandrea galeata
4 Hystrichosphaeri. proprium proprium
5 Cerodinium diebelii
6 Palaeocystodinium golzowense
7 Spinidinium spp.
8 Palaeoperidinium pyrophorum
9 Impagidinium cf.dispertitum
10 Spiniferites spp.
11 Isabelidinium viborgense
12 Cerodinium speciosum
13 Aquilapollenites spp.
14 Wodehouseia spinata
1000
975
950
E TERTIARY
PALEOCENE
L CRETACEOUS
L MAASTRICHTIAN
E MAASTRICHTIAN
W SPINATA
C DIEBELII
+366624
+366623
+366622
13 Aquilapollenites spp.
5 Cerodinium diebelii
12 Cerodinium speciosum
2 Circulodinium distinctum
3 Deflandrea galeata
4 Hystrichosphaeri. proprium proprium
9 Impagidinium cf.dispertitum
11 Isabelidinium viborgense
6 Palaeocystodinium golzowense
8 Palaeoperidinium pyrophorum
7 Spinidinium spp.
10 Spiniferites spp.
1 Tasmanites spp.
14 Wodehouseia spinata

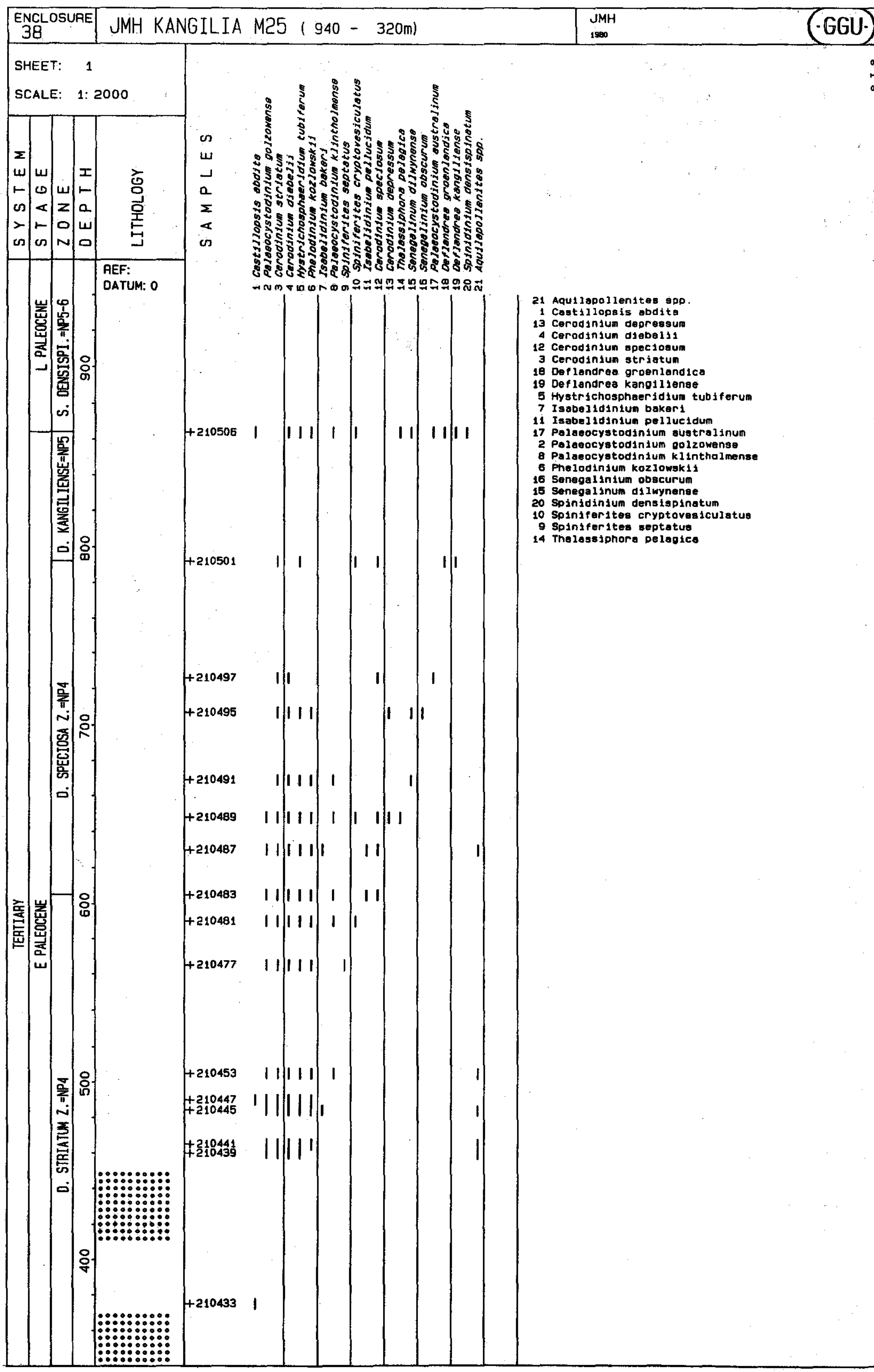
ENCLOSURE 37 | HNH920824/2 NNUU (385 - 355m) | HN-H 10/5-94 | GGU

SHEET: 1

SCALE: 1: 500



26 Arvalidinium scheii
12 Chatangiella cf.ditissima
7 Chatangiella granulifera
8 Chatangiella spp.
22 Chlamydophorella spp.
11 Chorate cysts
9 Circulodinium distinctum
15 Cribroperidinium spp.
13 Exochosphaeridium spp.
5 Florentinia deanei
23 Florentinia mantellii
10 Heterosphaeridium difficile
19 Isabelidinium aff.acuminatum
14 Isabelidinium spp.
25 Laciniadinium arcticum
20 Odontochitina striatoperforata
3 Oligosphaeridium complex
17 Palaeohystrichophora infusorioides
18 Palaeoperidinium pyrophorum
21 Raphidodinium fucatum
1 Schizocystia spp.
6 Spiniferites spp.
2 Stiphrosphaeridium anthophorum
4 Surculosphaeridium longifurcatum
16 Trithyrodinium suspectum
24 Xenascus aff.perforatus



Enclosure 39 in pocket

Plate 1. Svartenhuk

Fig. 1. *Arvalidinium scheii*, GGU 400711–12–4, 45.6–107.3; LVR 1.1352; MI 851; MGUH 23769.
Fig. 2. *Arvalidinium scheii*, GGU 400711–10–4, 22.1–94.7; LVR 1.1416; MI 902; MGUH 23770.
Fig. 3. *Arvalidinium scheii*, GGU 400712–15–4, 33.9–100.9; LVR 1.1661; MI 1119; MGUH 23771.
Fig. 4. *Chatangiella granulifera*, GGU 402680–4, HNH 920822/3; 51.2–97.0; LVR 1.1204; MI 722; MGUH 23772.
Fig. 5. *Chatangiella granulifera*, GGU 400709–26–3, 23.9–99.5; LVR 1.729; MI 408; MGUH 23773.
Fig. 6. *Chatangiella granulifera*, GGU 400709–26–3, 25.4–93.8; LVR 1.728; MI 407; MGUH 23774.
Fig. 7. *Chatangiella* sp. aff. *C. granulifera*, GGU 400709–14–3, 43.4–99.5; LVR 1.837; MI 509; MGUH 23775.
Fig. 8. *Chatangiella verrucosa*, GGU 400709–14–5, 29.6–94.8; LVR 1.829; MI 502; MGUH 23776.
Fig. 9. *Chatangiella verrucosa*, GGU 400709–26–3, 53.7–107.0; LVR 1.726; MI 405; MGUH 23777.
Fig. 10. *Chatangiella verrucosa*, GGU 400712–25–4, 43.1–102.9; LVR 1.1788; MI 1241; MGUH 23778.
Fig. 11. *Chatangiella* sp. cf. *C. ditissima*, GGU 400711–10–4; 38.9–108.5; LVR 1.1424; MI 907; MGUH 23779.
Fig. 12. *Chatangiella* sp. cf. *C. ditissima*, GGU 400712–25–3; 52.1–105.0; LVR 1.1792; MI 1245; MGUH 23780.

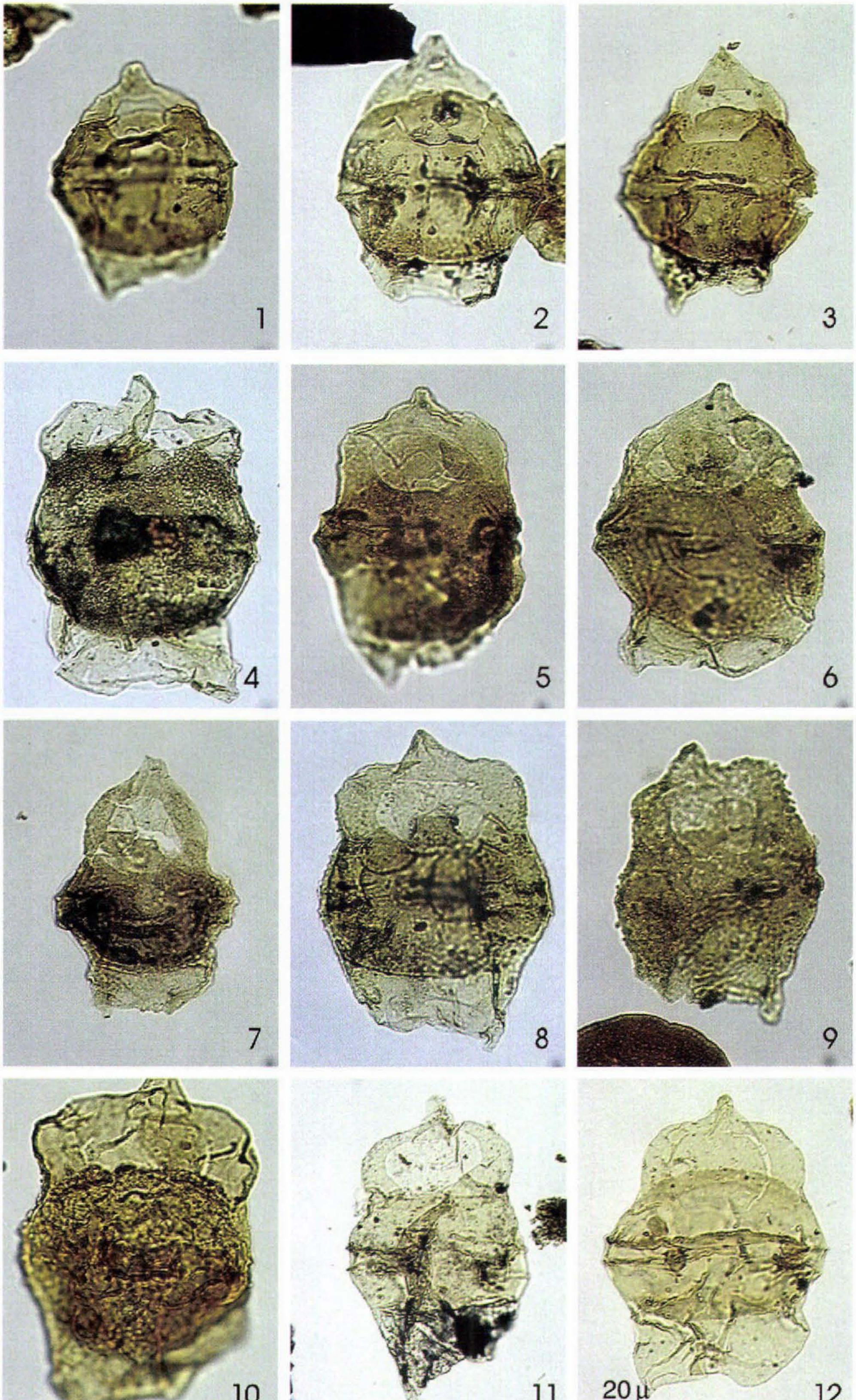

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Plate 2. Svartenhuk

Fig. 1. *Chatangiella* sp. cf. *C. madura*, GGU 400709–26–3; 46.9–102.5; LVR 1.724; MI 404; MGUH 23781.
Fig. 2. *Chatangiella* sp. cf. *C. madura*, GGU 400709–26–3; 53.7–107.0; LVR 1.725; MI 405; MGUH 23782.
Fig. 3. *Chatangiella* sp. cf. *C. madura*, GGU 400709–12–3; 48.5–96.0; LVR 1.842; MI 514; MGUH 23783.
Fig. 4. *Chatangiella mcintyrei* sp. nov. holotype, GGU 400711–10–7; 35.3–96.6; LVR 1.5706; MI 4344; MGUH 23784.
Fig. 5. *Chatangiella mcintyrei* sp. nov., GGU 400712–24–3; 34.2–103.1; LVR 1.1765; MI 1218; MGUH 23785.
Fig. 6. *Chatangiella mcintyrei* sp. nov., GGU 400712–23–3; 38.8–95.1; LVR 1.1732; MI 1188; MGUH 23786.
Fig. 7. *Chatangiella mcintyrei* sp. nov., GGU 400711–6–7; 29.0–101.6; LVR 1.1502; MI 979; MGUH 23787.
Fig. 8. *Chatangiella mcintyrei* sp. nov., GGU 400712–14–4; 47.8–98.0; LVR 1.1634; MI 1092; MGUH 23788.
Fig. 9. *Chatangiella mcintyrei* sp. nov., GGU 402664–7, 400712; 52.1–103.0; LVR 1.1618; MI 1077; MGUH 23789.
Fig. 10. *Chatangiella* sp. aff. *C. spectabilis*, GGU 400711–10–4; 29.6–105.0; LVR 1.1427; MI 910; MGUH 23790.
Fig. 11. *Chatangiella* sp. aff. *C. spectabilis*, GGU 400712–25–3; 37.6–101,3; LVR 1.1790; MI 1243; MGUH 23791.
Fig. 12. *Chatangiella* sp. aff. *C. spectabilis*, GGU 400711–8–4; 44,7–102.7; LVR 1.1457; MI 937; MGUH 23792.

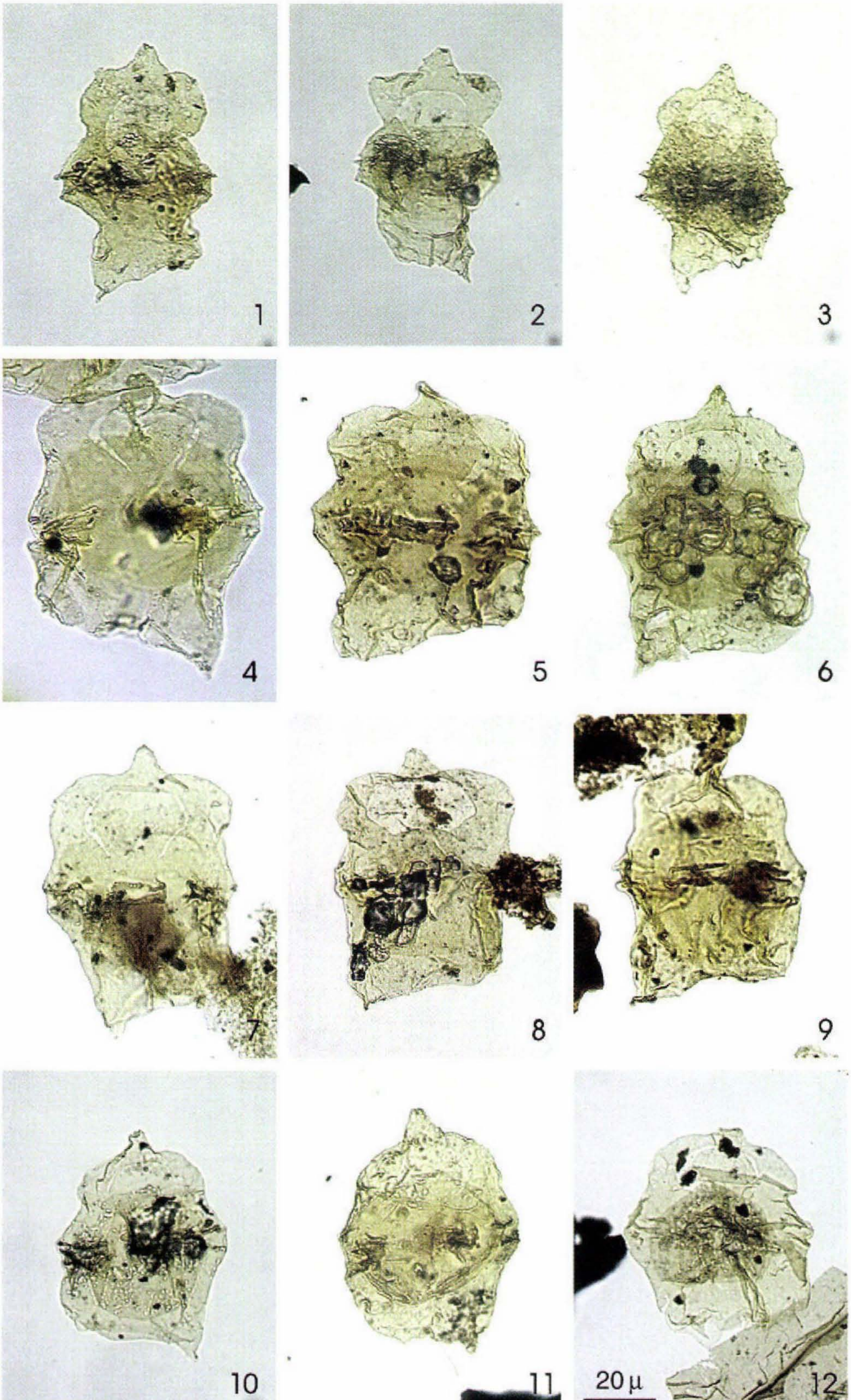
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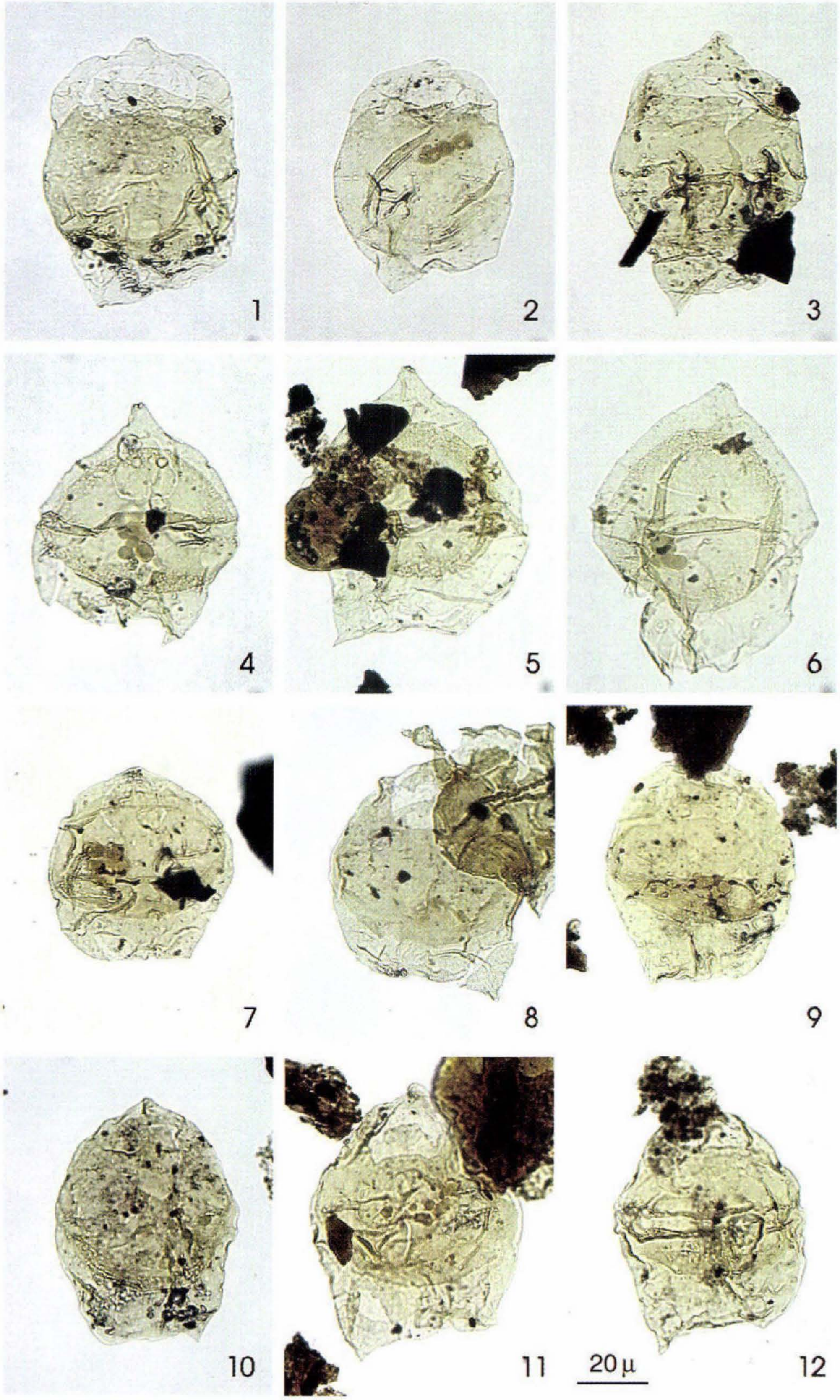
Plate 3. Svartenhuk

Fig. 1. *Isabelidinium* sp. 7 HNH, GGU 400709–22–3; 31.3–99.5; LVR 1.775; MI 451; MGUH 23793.
Fig. 2. *Isabelidinium* sp. 7 HNH, GGU 400709–12–3; 34.8–97.6; LVR 1.1126; MI 646; MGUH 23794.
Fig. 3. *Isabelidinium* sp. 7 HNH, GGU 400711–12–4; 50.3–103.0; LVR 1.1365; MI 861; MGUH 23795.
Fig. 4. *Isabelidinium* sp. aff. *I. acuminatum*, GGU 251506–,7 JGL; 26.1–103.0; LVR 1.701; MI 384; MGUH 23796.
Fig. 5. *Isabelidinium* sp. aff. *I. acuminatum*, GGU 251506–,7 JGL; 50.6–106.8; LVR 1.702; MI 385; MGUH 23797.
Fig. 6. *Isabelidinium* sp. aff. *I. acuminatum*, GGU 251507–,4 JGL; 22.6–106.3; LVR 1.707; MI 389; MGUH 23798.
Fig. 7. *Isabelidinium svartenhukensis* sp. nov. holotype, GGU 400712–26–4; 26.6–97.0; LVR 1824; MI 1274; MGUH 23799.
Fig. 8. *Isabelidinium svartenhukensis* sp. nov., GGU 400712–26–4; 46.1–103.9; LVR 1.1825; MI 1275; MGUH 23800.
Fig. 9. *Isabelidinium svartenhukensis* sp. nov., GGU 400712–11–8; 36,9–99.2; LVR 1.1866; MI 1316; MGUH 23801.
Fig. 10. *Isabelidinium svartenhukensis* sp. nov., GGU 400712–15–4; 28,9–106.4; LVR 1.1664; MI 1122; MGUH 23802.
Fig. 11. *Isabelidinium svartenhukensis* sp. nov., paratype, GGU 400712–15–4; 35,5–102.1; LVR 1.1666; MI 1124; MGUH 23803.
Fig. 12. *Isabelidinium svartenhukensis* sp. nov., GGU 400712–15–4; 45,0–104.3; LVR 1.1667; MI 1125; MGUH 23804.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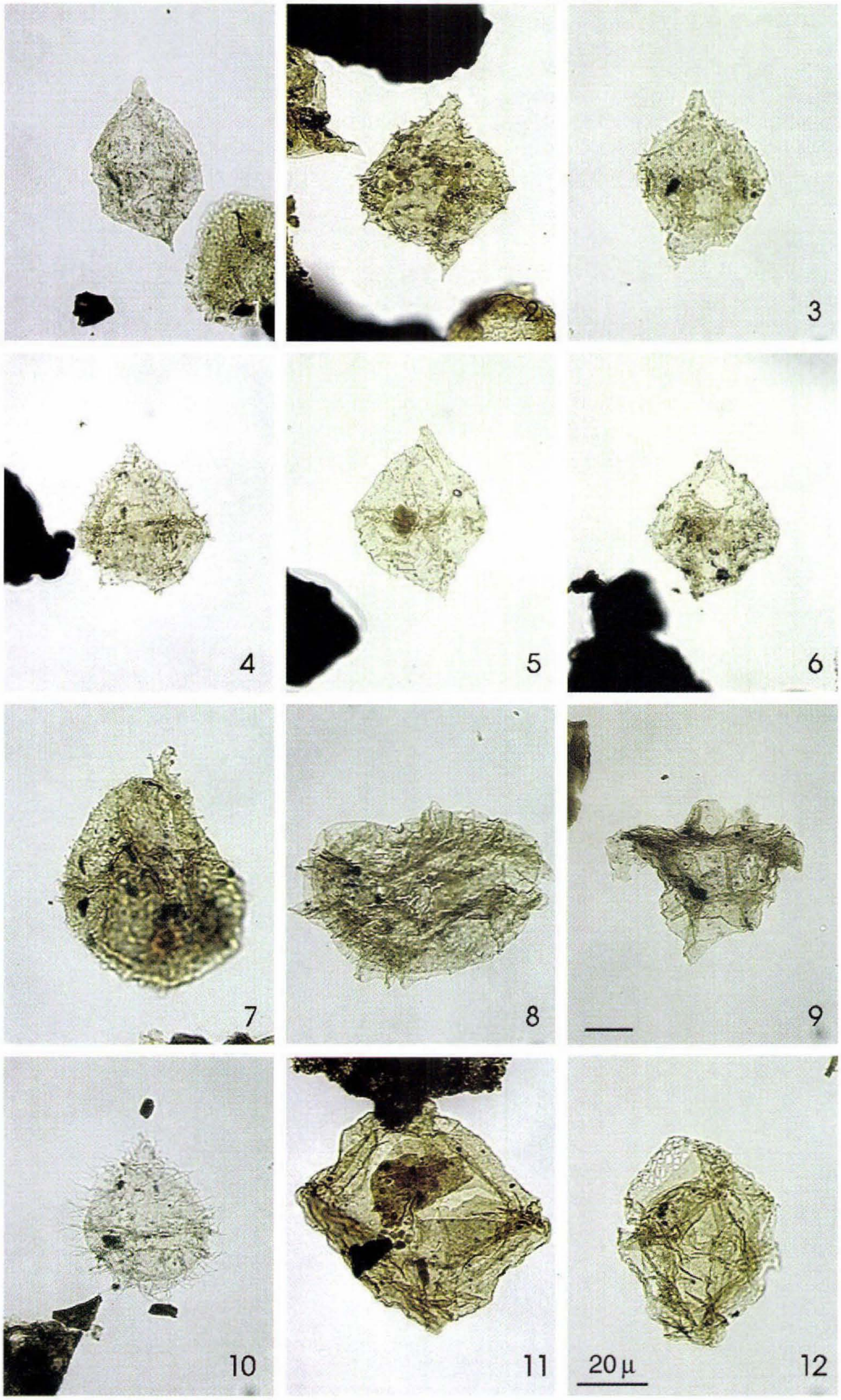
9
10
11
20 µ
12

Plate 4. Svartenhuk

Fig. 1. *Laciniadinium arcticum*, GGU 400711–8–4; 53.8–95.6; LVR 1.1458; MI 938; MGUH 23805.
Fig. 2. *Spinidinium echinoideum*, GGU 400712–26–3; 28.8–98.0; LVR 1.1836; MI 1286; MGUH 23806.
Fig. 3. *Spinidinium echinoideum*, GGU 400710–15–4; 30.8–106.0; LVR 1.1521; MI 994; MGUH 23807.
Fig. 4. *Spinidinium echinoideum*, GGU 400712–14–4; 52.9–109.4; LVR 1.1647; MI 1105; MGUH 23808.
Fig. 5. *Spinidinium echinoideum*, with very reduced echinae, GGU 400712–25–4; 51.2–98.9; LVR 1.1814; MI 1266; MGUH 23809.
Fig. 6. *Spinidinium echinoideum*, with very reduced echinae, GGU 400712–11–4; 18.3–110.0; LVR 1.1851; MI 1301; MGUH 23810.
Fig. 7. *Cribroperidinium* sp. aff. *C. intricatum*, GGU 400709–20–3; 22.7–103.8; LVR 1.786; MI 462; MGUH 23811.
Fig. 8. *Dinopterygiumm cladoides*, GGU 400709–24–3; 30.5–108.7; LVR 1.760; MI 437; MGUH 23812.
Fig. 9. *Dinopterygiumm cladoides*, GGU 400711–8–4; 50.8–95.6; LVR 1.1472; MI 951; MGUH 23813.
Fig. 10. *Palaeohystrichodinium infusorioides*, GGU 400709–24–3; 30.6–99.0; LVR 1.750; MI 427; MGUH 23814.
Fig. 11. *Endoscrinium campanula*, GGU 402664–8, 400712; 26.0–105.8; LVR 1.1620; MI 1079; MGUH 23815.
Fig. 12. *Scriniodinium*? sp., GGU 402680–7, HNH 920822/5; 53.8–98.6; LVR 1.1222; MI 740; MGUH 23816.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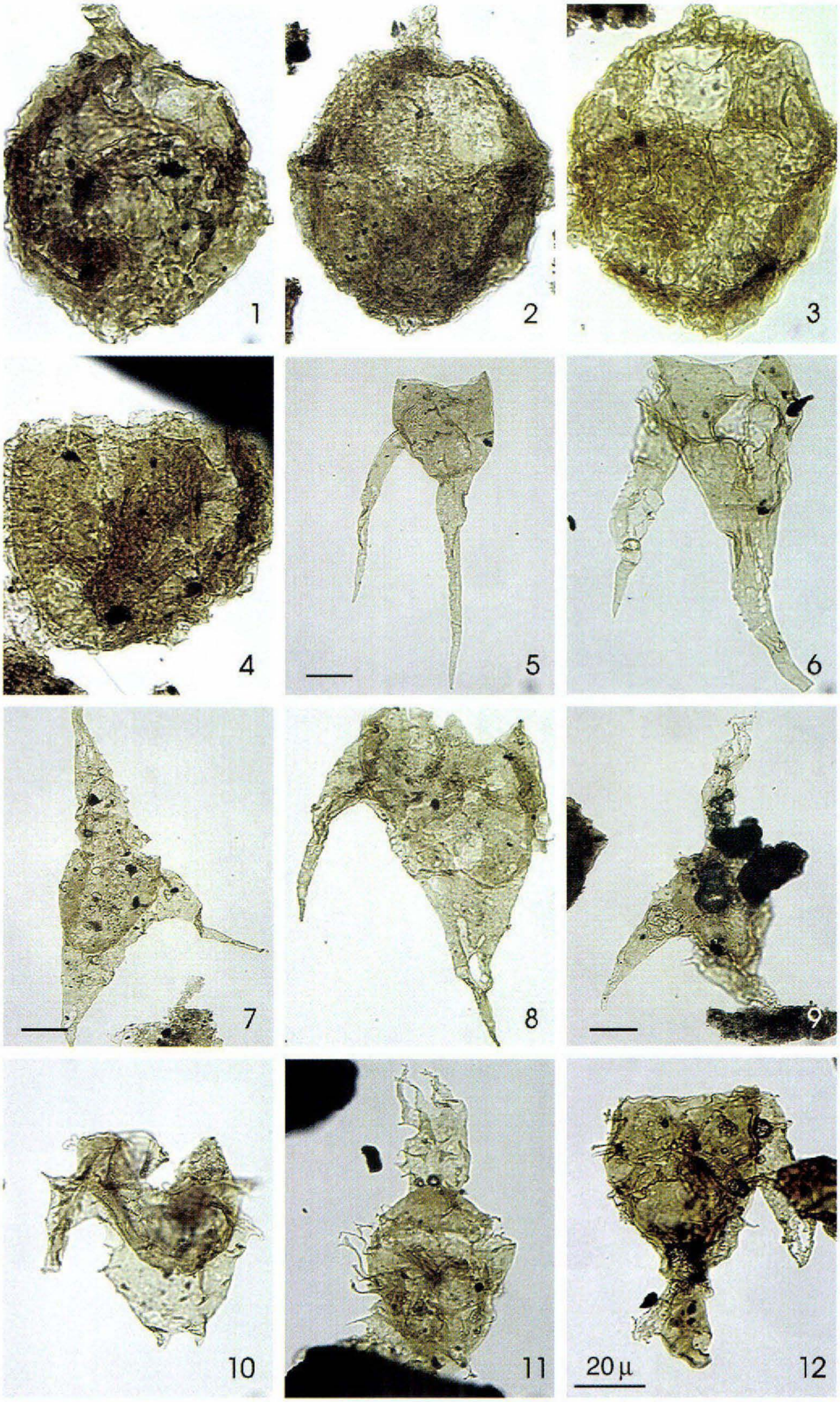
20 µ
12

Plate 5. Svartenhuk

Fig. 1. *Scriniodinium*? sp. aff. *S. obscurum*/*C. grossa*, GGU 400709–12–5; 37.6–101.2; LVR 1.1128; MI 648; MGUH 23817.
Fig. 2. *Scriniodinium*? sp. aff. *S. obscurum*/*C. grossa*, GGU 400712–15–4; 40.0–104.5; LVR 1.1678; MI 1136; MGUH 23818.
Fig. 3. *Scriniodinium*? sp. aff. *S. obscurum*/*C. grossa*, GGU 400712–26–3; 32.0–109.0; LVR 1.2204, MI 1566; MGUH 23819.
Fig. 4. *Chlamydophorella*? sp. aff. *C. grossa*, GGU 400712–25–4; 44.1–107.0; LVR 1.1803; MI 1256; MGUH 23820.
Fig. 5. *Odonthochitina striatoperforata*, GGU 400709–10–4, 42.8–107.3; LVR 1.1151; MI 669; MGUH 23821.
Fig. 6. *Odonthochitina striatoperforata*, GGU 400711–8–4, 47.9–108.0; LVR 1.1463; MI 943; MGUH 23822.
Fig. 7. *Odonthochitina striatoperforata*, GGU 400712–17–4, 35.6–94.5; LVR 1.1715; MI 1171; MGUH 23823.
Fig. 8. *Odonthochitina striatoperforata*, GGU 400712–25–4, 31.1–111.9; LVR 1.1800; MI 1253; MGUH 23824.
Fig. 9. *Xenascus* sp. aff. *X. perforatus*, GGU 400711–6–4, 49.5–109.0; LVR 1.1481; MI 959; MGUH 23825.
Fig. 10. *Xenascus* sp. aff. *X. perforatus*, GGU 400711–12–3, 47.8–109.7; LVR 1.1376; MI 869; MGUH 23826.
Fig. 11. *Xenascus* sp. aff. *X. perforatus*, GGU 400711–12–3, 56.2–101.9; LVR 1.1377; MI 870; MGUH 23827.
Fig. 12. *Xenascus* sp. aff. *X. perforatus*, GGU 402664–8, 400712, 46.8–103.4; LVR 1.1621; MI 1080; MGUH 23828.


1
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11
12
20μ

Plate 6. Svartenhuk

Fig. 1. *Microdinium reticulatum* 402664–9, 400712; 48.3–110.3; LVR 1.1626; MI 799; MGUH 23829.
Fig. 2. *Trithyrodinium suspectum*, GGU 402680–7, HNH 920822/5; 46.9–107.3; LVR 1.1221; MI 739; MGUH 23830.
Fig. 3. *Trithyrodinium suspectum*, GGU 400712–23–3; 31.5–100.6; LVR 1.1750; MI 1205; MGUH 23831.
Fig. 4. *Trithyrodinium suspectum*, GGU 400712–15–4; 41.8–96.0; LVR 1.1680; MI 1137; MGUH 23832.
Fig. 5. *Trithyrodinium suspectum*, GGU 400709–24–3; 36.9–104.5; LVR 1.752; MI 429; MGUH 23833.
Fig. 6. *Trithyrodinium*? sp., GGU 400712–14–4; 39.9–96.4; LVR 1.1650; MI 1108; MGUH 23834.
Fig. 7. *Oligosphaeridium complex*, GGU 400712–23–3, 32.4–101.7; LVR 1.1747; MI 1203; MGUH 23835.
Fig. 8. *Oligosphaeridium complex*, GGU 400711–12–4, 46.0–97.5; LVR 1.1407; MI 894; MGUH 23836.
Fig. 9. *Oligosphaeridium* sp. aff. *O. pulcherrimum*, GGU 400709–14–5, 41.2–106.0; LVR 1.831; MI 504; MGUH 23837.
Fig. 10. *Oligosphaeridium* sp. aff. *O. pulcherrimum*, GGU 400711–10–4, 44.8–111.9; LVR 1.1444; MI 926; MGUH 23838.
Fig. 11. *Stiphrosphaeridium* sp. aff. *S. anthophorum*, GGU 400711–12–4 44.3–106.4; LVR 1.1404; MI 892; MGUH 23839.
Fig. 12. *Hystrichodinium pulchrum*, GGU 400712–16–4, 30.6–112.9; LVR 1.1700; MI 1156; MGUH 23840.

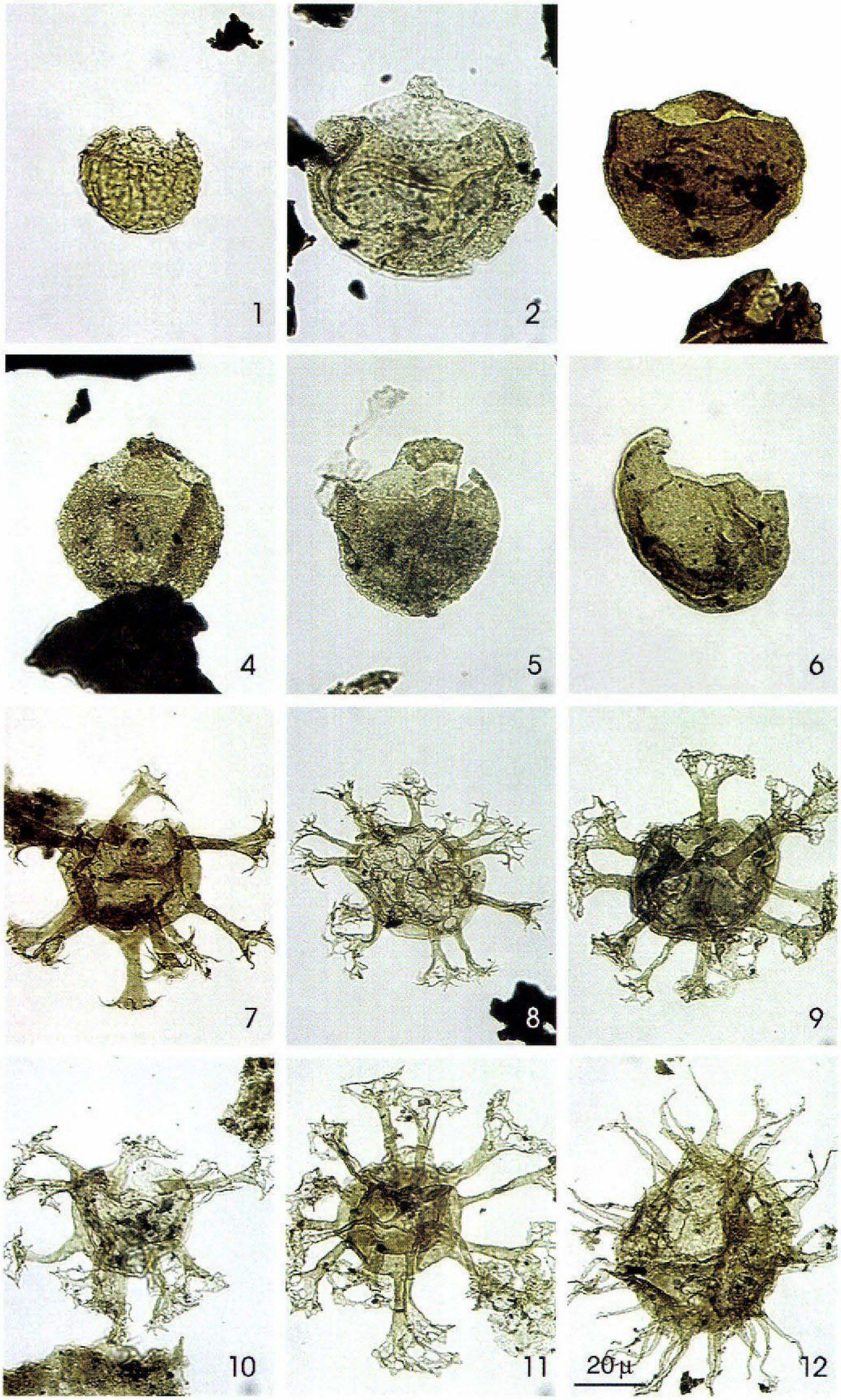
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Plate 7. Svartenhuk

Fig. 1. *Surculosphaeridium*? *longifurcatum*, GGU 400709–16–3, 55.3–100.6; LVR 1.826; MI 499; MGUH 23841.

Fig. 2. *Surculosphaeridium*? *longifurcatum*, GGU 400709–18–3, 24.6–106.4; LVR 1.810; MI 484; MGUH 23842.

Fig. 3. *Florentinia mantellii*, GGU 400709–16–4; 37.8–99.5; LVR 1.828; MI 501; MGUH 23843.

Fig. 4. *Florentinia deanei*, GGU 400712–26–5; 42.9–108.2; LVR 1.2203; MI 1565; MGUH 23844.

Fig. 5. *Florentinia deanei*, GGU 400712–25–5; 42.9–105.9; LVR 1.2208; MI 1570; MGUH 23845.

Fig. 6. *Florentinia mantellii*, GGU 400711–12–4; 58.7–100.6; LVR 1.1401; MI 888; MGUH 23846.

Fig. 7. *Florentinia mantellii*, GGU 400711–12–7; 24.1–102.6; LVR 1.2780; MI 2067; MGUH 23847.

Fig. 8. *Florentinia deanei*, GGU 400711–8–8; 37.0–109.2; LVR 1.2788; MI 2075; MGUH 23848.

Fig. 9. *Heterosphaeridium difficile*, GGU 400711–14–4; 28.3–104.2; LVR 1.1319; MI 822; MGUH 23849.

Fig. 10. *Heterosphaeridium difficile*, operculum, GGU 402680–7, HNH 920822/5; 19.6–105.0; LVR 1.1195; MI 7132; MGUH 23850.

Fig. 11. *Heterosphaeridium difficile*, GGU 400710–15–7; 25.1–98.7; LVR 1.1522; MI 995; MGUH 23851.

Fig. 12. *Heterosphaeridium difficile*, GGU 400712–26–4; 48.1–106.2; LVR 1.1842; MI 1292; MGUH 23852.

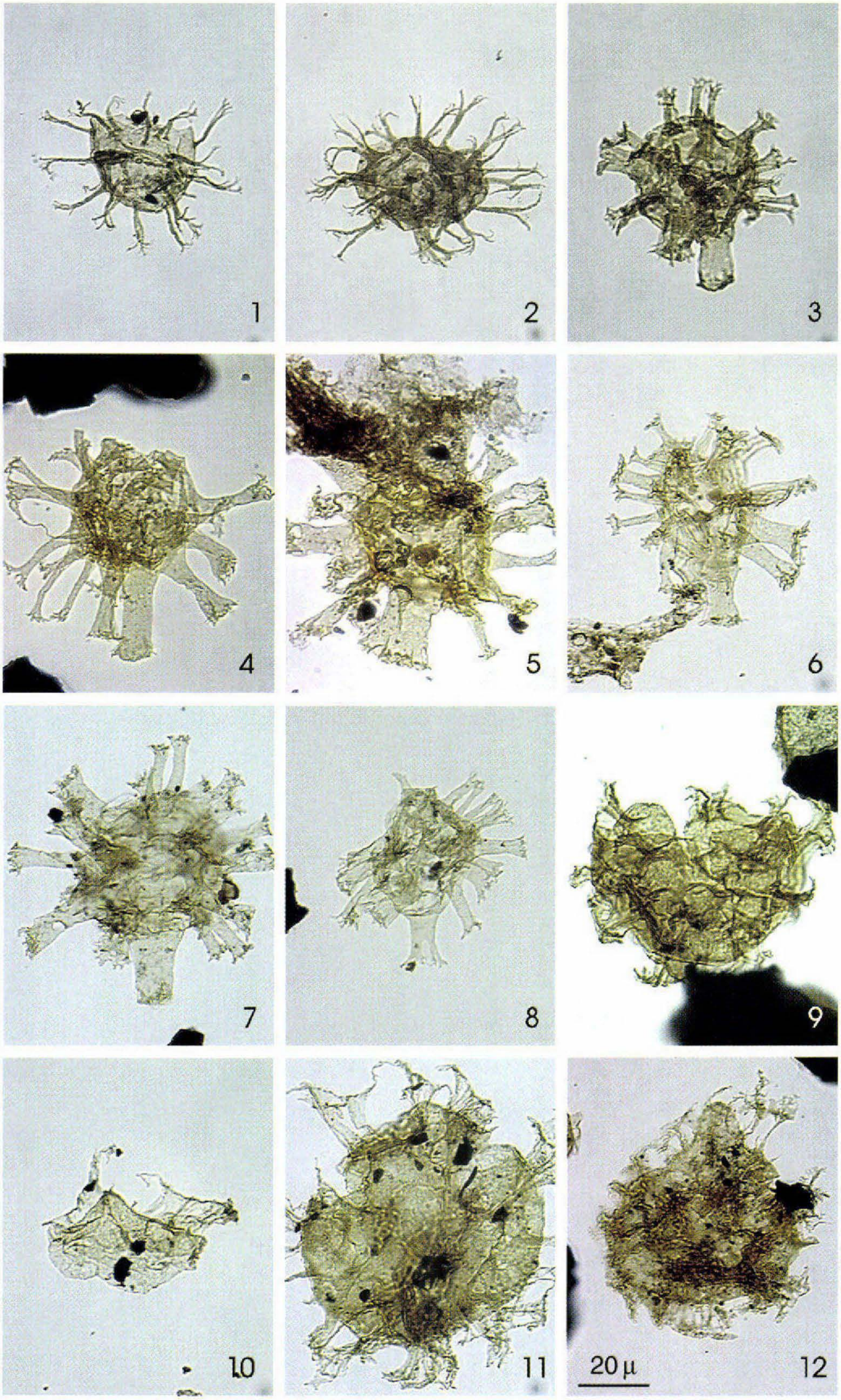
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Plate 8. Svartenhuk

Fig. 1. *Exochosphaeridium* sp. 2 HNH, GGU 400711–10–4; 48.6–99.9 LVR 1.1435; MI 918; MGUH 23853.
Fig. 2. *Exochosphaeridium* sp. 1 HNH, GGU 400710–15–7; 30.7–107.7 LVR 1.1530; MI 1002; MGUH 23854.
Fig. 3. *Exochosphaeridium* sp. 1 HNH, GGU 400712–17–4; 53.1–108.0 LVR 1.1724; MI 1180; MGUH 23855.
Fig. 4. *Chlamydophorella*? sp. 4 HNH, GGU 400712–14–4; 48.2–105.7; LVR 1.1635; MI 1093; MGUH 23856.
Fig. 5. *Spiniferites* sp., GGU 402680–4, HNH 920822/5; 53.0–106.0; LVR 1.1196; MI 714; MGUH 23857.
Fig. 6. Chorate sp. 15 HNH, GGU 400711–6–7; 30.5 97.7; LVR 1.1503; MI 980; MGUH 23858.
Fig. 7. *Cleistosphaeridium aciculare*, GGU 402628–4, HNH 920809/1; 23.2–109.9; LVR 1.1239; MI 756; MGUH 23859.
Fig. 8. *Cleistosphaeridium aciculare*, GGU 402664–9, 400712; 49.4–112.6; LVR 1.1625; MI 1084; MGUH 23860.
Fig. 9. *Cleistosphaeridium aciculare*, GGU 400712–24–3; 24.4–111.7; LVR 1.1773; MI 1226; MGUH 23861.
Fig. 10. *Veryhachium cruciatum*, GGU 400708–20–4; 28.2–107.8; LVR 1.1287; MI 793; MGUH 23862.
Fig. 11. *Veryhachium cruciatum*, GGU 400711–12–4; 33,0–106.7; LVR 1.1386; MI 876; MGUH 23863.
Fig. 12. *Raphidodinium fucatum*, GGU 400709–24–3; 47.9–96.3; LVR 1.765; MI 442; MGUH 23864.

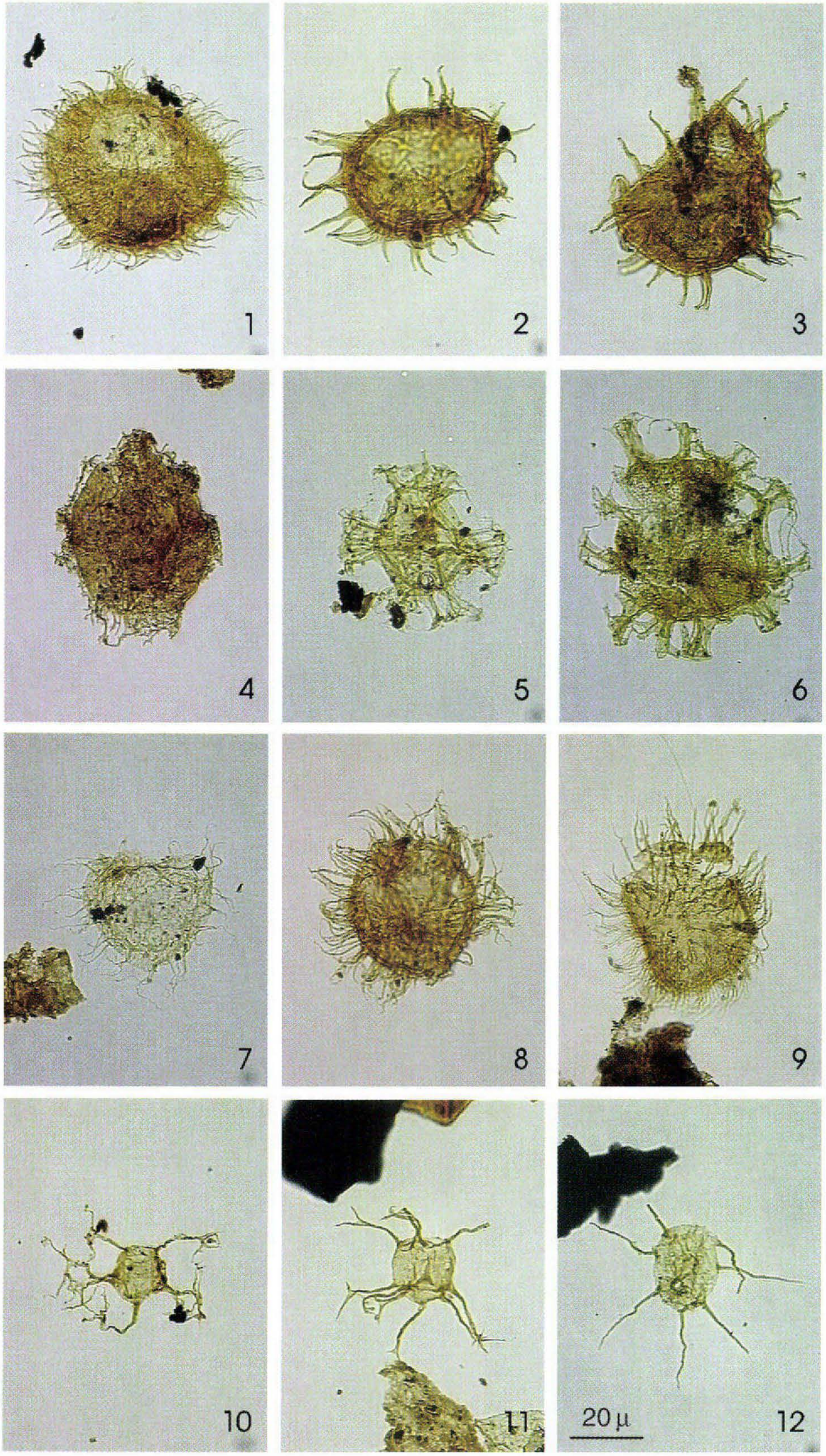
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Plate 9. Svartenhuk

Fig. 1. *Desmocysta plekta*, GGU 402601–4, HNH 92086/1; 34.8–92.5; LVR 1.1166; MI 685; MGUH 23865.
Fig. 2. *Desmocysta plekta*, GGU 400711–12–5; 30.0–105.7; LVR 1.1411; MI 898; MGUH 23866.
Fig. 3. *Desmocysta* sp. aff. *D. plekta*, GGU 400710–9–9; 27.9–101.9; LVR 1.2791; MI 2078; MGUH 23867.
Fig. 4. *Dinogymnium* sp. cf. *D. sibiricum*, GGU 251506–8, JGL; 48.8–100.4; LVR 1.705; MI 388; MGUH 23868.
Fig. 5. *Dinogymnium* sp. cf. *D. sibiricum*, GGU 251507–4, JGL; 52.3–105.5; LVR 1.713; MI 394; MGUH 23869.
Fig. 6. Dinocyst sp. 7 HNH, GGU 400710–15–4; 44.2–91.7; LRV 1.1525; MI 997; MGUH 23870.
Fig. 7. *Fromea fragilis*, GGU 400709–26–3; 43.5–102.5; LVR 1.731; MI 410; MGUH 23871.
Fig. 8. *Fromea amphora*, GGU 400711–12–4; 47.0–96.5; LVR 1.1408; MI 895; MGUH 23872.
Fig. 9. *Wallodinium anglicum*, GGU 400712–23–3; 27.4–103.0; LVR 1.1745; MI 1201; MGUH 23873.
Fig. 10. *Palaeotetradinium silicorum*, GGU 402673–4, HNH 920822/3; 34.7–104.7; LVR 1.677; MI 361; MGUH 23874.
Fig. 11. *Trigonopyxidia ginella*, GGU 400709–24–3; 27.4–110.9; LVR 1.755; MI 432; MGUH 23875.
Fig. 12. *Trigonopyxidia ginella*, GGU 400709–22–3; 31.7–98.7; LVR 1.782; MI 458; MGUH 23876.

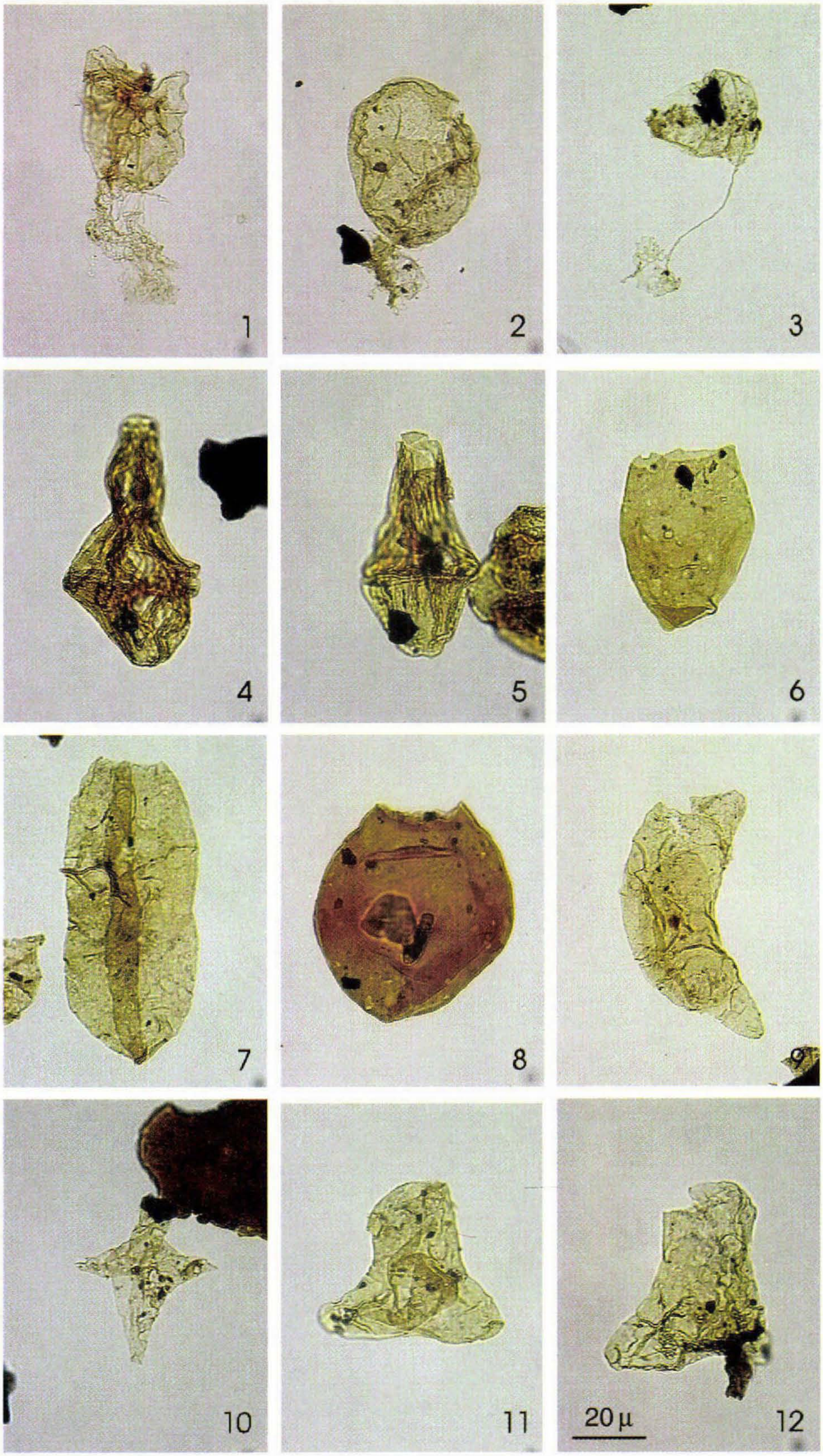
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Plate 10. Central Nuussuaq

Fig. 1. *Chatangiella bondarenkoi* , GGU 366523–3, FGC 900731/2, 47.5–92.9; LVR 1.1889; MI 1333; MGUH 23877.

Fig. 2. *Chatangiella bondarenkoi*, GGU 360732–6, HNH 910819/1, 33.9–103.3; LVR 1.1970; MI 1400; MGUH 23878.

Fig. 3. *Chatangiella bondarenkoi*, GGU 360717–5, HNH 910816/1, 22.3–98.8; LVR 1.1944; MI 1379; MGUH 23879.

Fig. 4. *Chatangiella bondarenkoi*, GGU 366523–6, FGC 900731/2, 19.4–103.1; LVR 1.1884; MI 1330; MGUH 23880.

Fig. 5. *Chatangiella bondarenkoi*, GGU 400702–12–9, 53.6–106.4; LVR 1.3090; MI 2337; MGUH 23881.

Fig. 6. *Chatangiella ditissima*, GGU 351822–3, GKP 91–3 Tun., 35.1–106.0; LVR 1.3107; MI 2354; MGUH 23882.

Fig. 7. *Chatangiella ditissima*, GGU 351822–3, GKP 91–3 Tun., 38.7–103.6; LVR 1.3108; MI 2355; MGUH 23883.

Fig. 8. *Laciniadinium arcticum*, GGU 369287–4, HNH 910813/1, 26.5–100.5; LVR 1.1907; MI 1348; MGUH 23884.

Fig. 9. *Isabelidinium microarmum*, GGU 360731–10, HNH 910819/1, 48.7–107.4; LVR 1.1962; MI 1394; MGUH 23885.

Fig. 10. *Isabelidinium microarmum*, GGU 360732–6, HNH 910819/1, 33.3–114.3; LVR 1.1969; MI 1399; MGUH 23886.

Fig. 11. *Chatangiella* sp. cf. *C. hexacalpis*, GGU 400577–4, GKP 92V2–3, 27.6–96.8; LVR 1.1973; MI 1402; MGUH 23887.

Fig. 12. *Chatangiella* sp. cf. *C. hexacalpis*, GGU 400577–4, GKP 92V2–3, 27.6–96.8; LVR 1.1974; MI 1402; MGUH 23887.

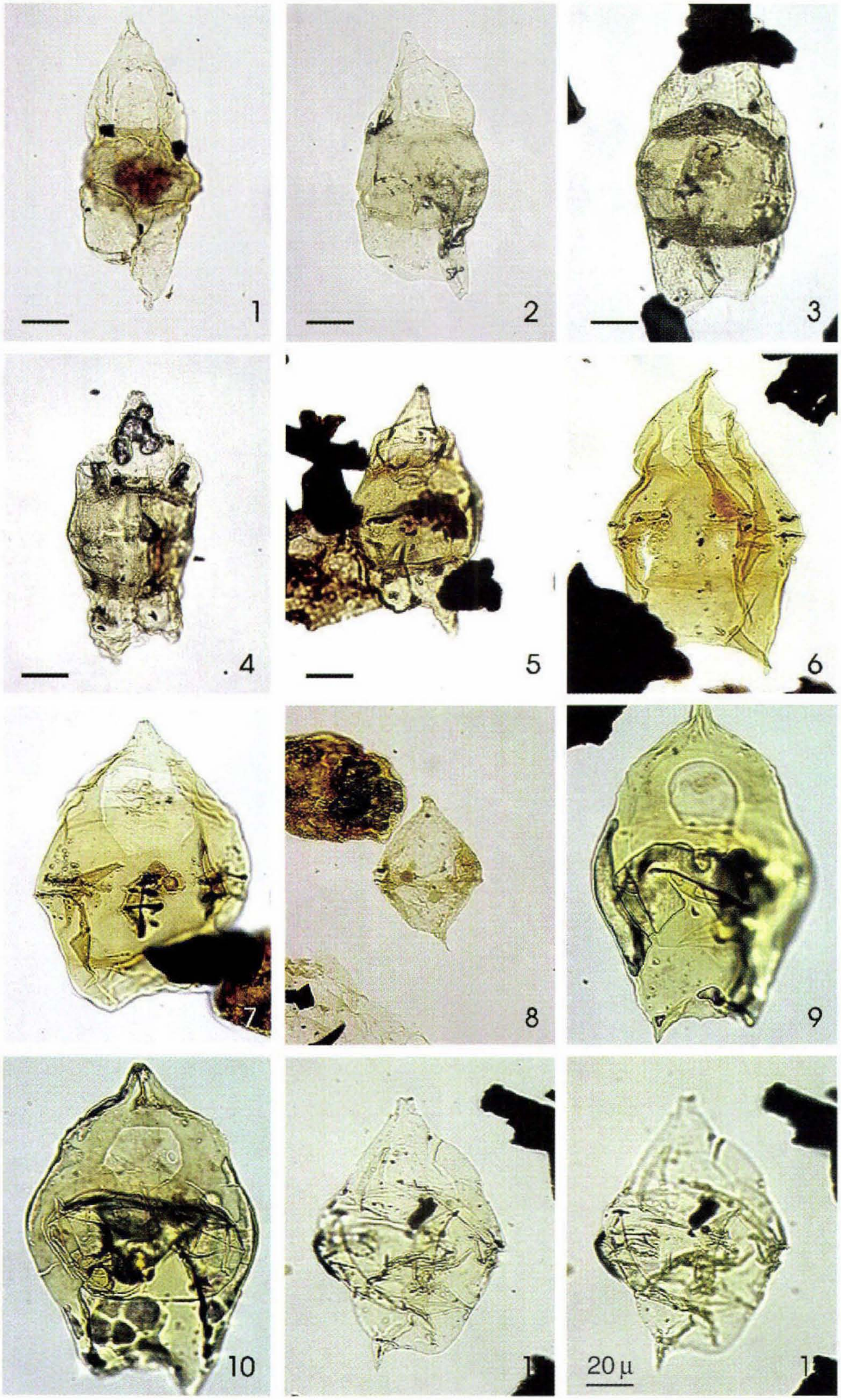
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Plate 11. Central Nuussuaq

Fig. 1. *Isabelidinium acuminatum*, GGU 360717–4, HNH 910816/1, 25.5–95.7; LVR 1.1946; MI 1381; MGUH 23888.
Fig. 2. *Isabelidinium acuminatum*, GGU 400702–12–9, 38.9–103.0; LVR 1.3081; MI 2329; MGUH 23889.
Fig. 3. *Isabelidinium acuminatum*, GGU 351824–3 GKP 91–3 Tun., 20.1–102.3; LVR 1.3082; MI 2330; MGUH 23890.
Fig. 4. *Isabelidinium acuminatum*, GGU 351824–3 GKP 91–3 Tun., 27.8–115.0; LVR 1.3083; MI 2331; MGUH 23891.
Fig. 5. *Isabelidinium acuminatum*, GGU 400702–12–9, 23.8–108.2; LVR 1.3078; MI 2326; MGUH 23892.
Fig. 6. *Isabelidinium acuminatum*, GGU 400702–12–9, 33.0–110.4; LVR 1.3080; MI 2328; MGUH 23893.
Fig. 7. *Odontochitina striatoperforata*, GGU 366523–4 FGC 900731/2, 48.6–108.0; LVR 1.1885; MI 1331; MGUH 23894.
Fig. 8. *Odontochitina striatoperforata* GGU 369287–6, HNH 910813/1, 55.1–106.0; LVR 1.1927; MI 1365; MGUH 23895.
Fig. 9. *Xenascus* sp. aff. *X. perforatus* GGU 400585–6, GKP 92 V1 Qilak., 33.2–104.0; LVR 1.1985; MI 1413; MGUH 23896.
Fig. 10. *Palaeocystodinium* sp. aff. *P. golzowenze* GGU 400701–4–9, 31.8–93.0; LVR 1.3096; MI 2343; MGUH 23897.
Fig. 11. *Batioladinium jaegeri* GGU 351828–2, GKP 91 4 Tun., 43.6–95.5; LVR 1.3109; MI 2356; MGUH 23898.
Fig. 12. *Batioladinium jaegeri* GGU 351828–3, GKP 91 4 Tun., 23.8–113.5; LVR 1.3110; MI 2357; MGUH 23899.

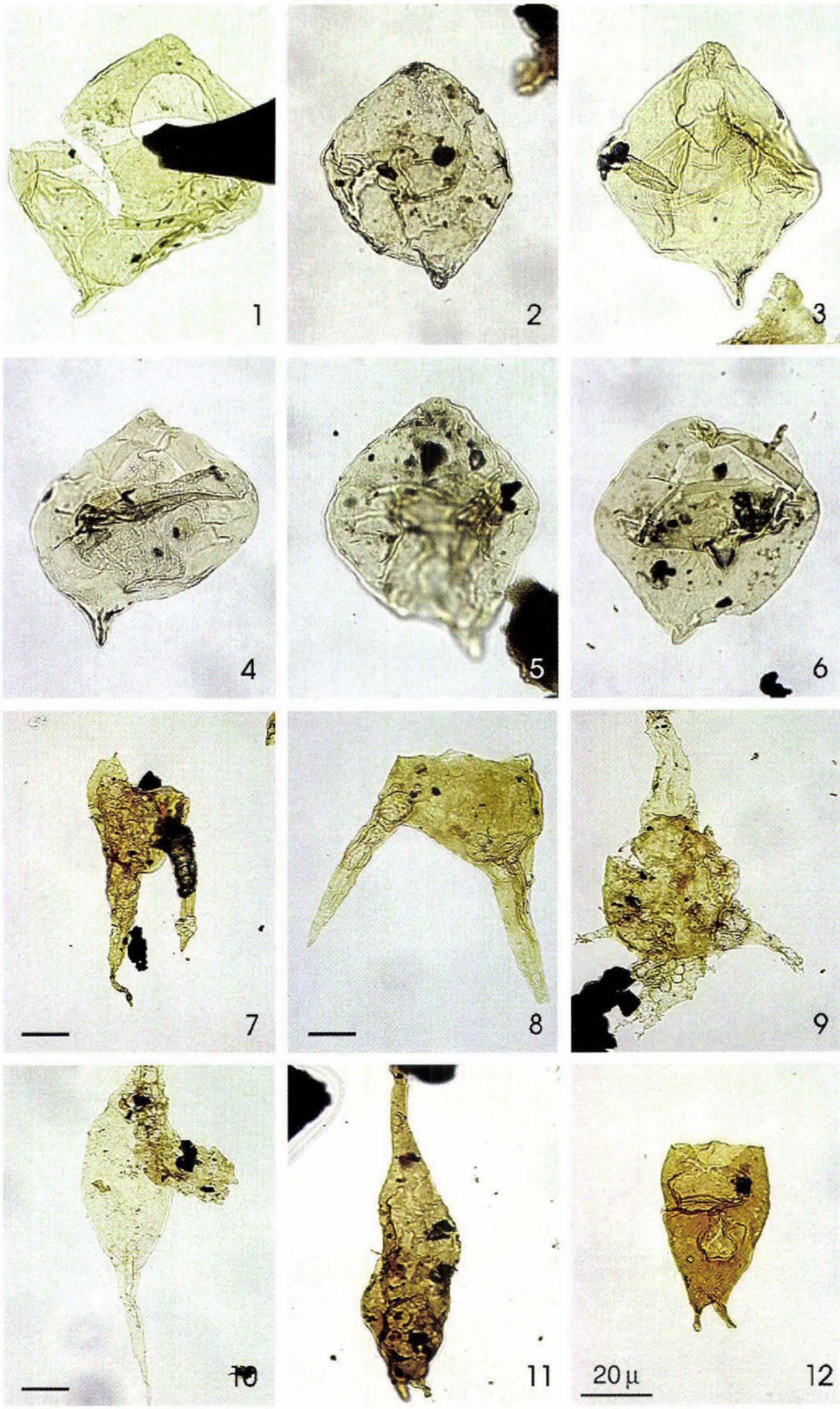
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Plate 12. Central Nuussuaq

Fig. 1. *Exochosphaeridium* sp. aff. *E. bifidum*, GGU 369284–6, HNH 910813/1, 55.9–100.5; LVR 1.1898; MI 1339; MGUH 23900.

Fig. 2. *Exochosphaeridium* sp. aff. *E. bifidum*, GGU 369284–4, HNH 910813/1, 18.9–108.9; LVR 1.1895; MI 1337; MGUH 23901.

Fig. 3. *Exochosphaeridium* sp. aff. *E. striolatum*, GGU 369287–6, HNH 910813/1, 45.8–96.8; LVR 1.1930; MI 1368; MGUH 23902.

Fig. 4. *Exochosphaeridium* sp. aff. *E. striolatum*, GGU 369287–9, HNH 910813/1, 47.4–96.9; LVR 1.1931; MI 1369; MGUH 23903.

Fig. 5. *Hystrichosphaeridium?* sp., GGU 351824–3 GKP 91–3 Tun., 49.4–103.7; LVR 1.3098; MI 2345; MGUH 23904.

Fig. 6. *Circulodinium distinctum*, GGU 360717–9, HNH 910816/1, 55.3–97.8; LVR 1.1943; MI 1378; MGUH 23905.

Fig. 7. *Circulodinium* sp. cf. *C. distinctum*, GGU 400702–12–3, 34.7–104.2; LVR 1.3092; MI 2339; MGUH 23906.

Fig. 8. *Circulodinium* sp. cf. *C. distinctum*, GGU 400702–12–7, 34.1–111.2; LVR 1.3093; MI 2340; MGUH 23907.

Fig. 9. *Trithyrodinium suspectum* GGU 400585–8, GKP 92 V1 Qilak., 35.5–100.2; LVR 1.1990; MI 1416; MGUH 23908.

Fig. 10. *Tanyosphaeridium variecalamus*, GGU 360729–4, HNH 910819/1, 28.0–100.2; LVR 1.1953; MI 1388; MGUH 23909.

Fig. 11. *Dinogymnium?* sp., GGU 369287–4, HNH 910813/1, 45.1–104.9; LVR 1.1916; MI 1356; MGUH 23910.

Fig. 12. *Fromea nicosia*, GGU 400702–10–7, 42.9–99.7; LVR 1.3075; MI 2323; MGUH 23911.

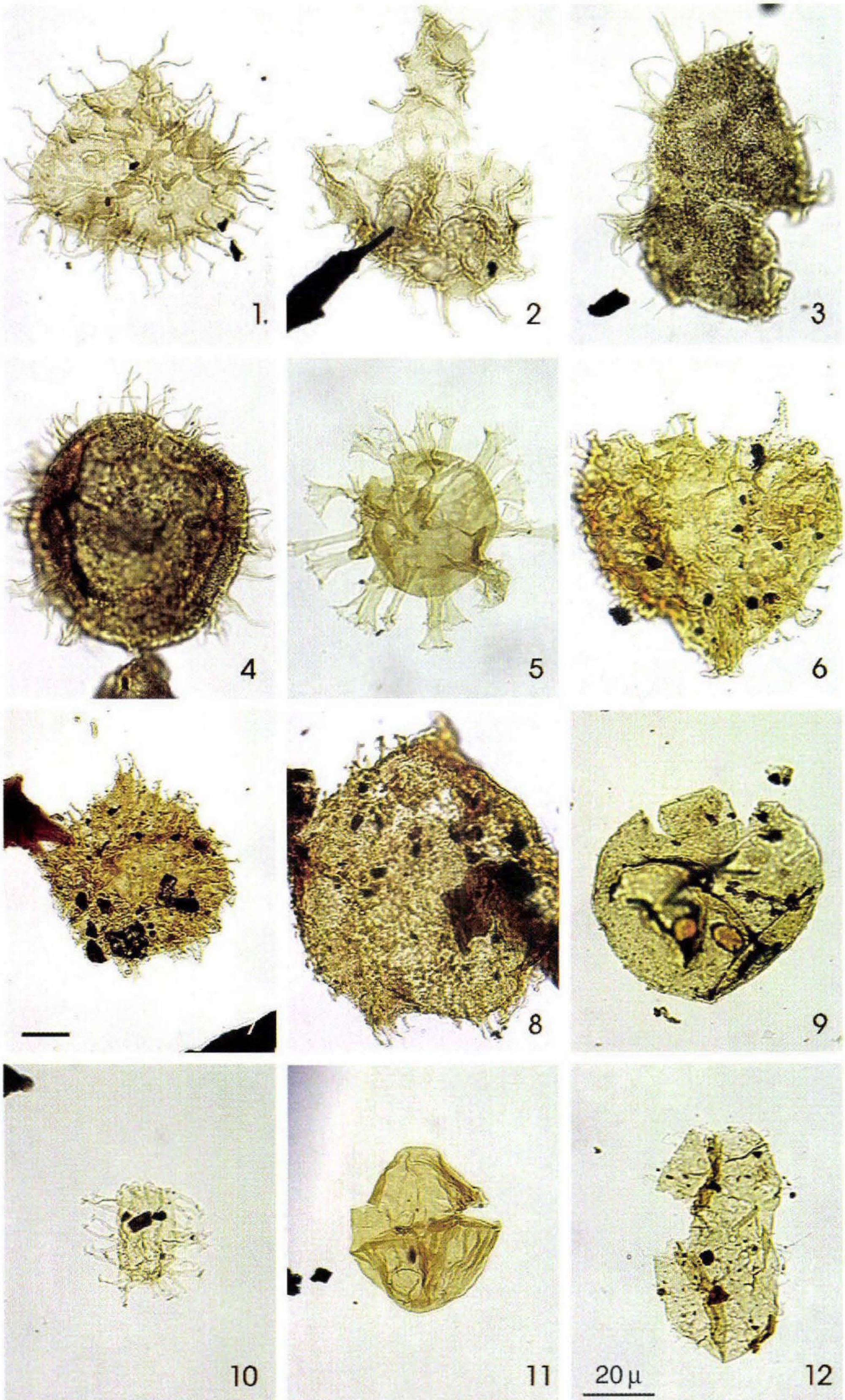
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Plate 13. Central Nuussuaq

Fig. 1. *Cerodinium diebelii*, GGU 366589–3, Annertuneq, 26.6–103.0; LVR 1.553; MI 256; MGUH 23912. × 40.
Fig. 2. *Cerodinium diebelii*, GGU 366906–10, Annertuneq, 48.6–103.9; LVR 1.597; MI 294; MGUH 23913. × 40.
Fig. 3. *Cerodinium diebelii*, GGU 408888–8, Annertuneq, 31.0–109.6; LVR 1.4050; MI 3008; MGUH 23914. × 40.
Fig. 4. *Cerodinium* sp. cf. *C. diebelii*, GGU 408880–4, Annertuneq, 28.0–99.4; LVR 1.4000; MI 2969; MGUH 23915. × 40.
Fig. 5. *Cerodinium* sp. cf. *C. diebelii*, GGU 408880–4, Annertuneq, 35.0–109.3; LVR 1.4001; MI 2970; MGUH 23916. × 40.
Fig. 6. *Cerodinium* sp. cf. *C. diebelii*, GGU 408881–4, Annertuneq, 44.1–108.4; LVR 1.4007; MI 2975; MGUH 23917. × 40.
Fig. 7. *Cerodinium speciosum*, GGU 408887–7, Annertuneq, 32.5–106.2; LVR 1.4066; MI 3022; MGUH 23918.
Fig. 8. *Cerodinium speciosum*, GGU 408887–4, Annertuneq, 23.7–101.6; LVR 1.4068; MI 3024; MGUH 23919.
Fig. 9. *Cerodinium speciosum*, GGU 366624–4, FGC 900813/7, Ikorfat, 23.5–100.4; LVR 1.4081; MI 3035; MGUH 23920.
Fig. 10. *Cerodinium speciosum*, GGU 408887–4, Annertuneq, 46.0–96.7; LVR 1.4067; MI 3023; MGUH 23921.
Fig. 11. *Phelodinium* sp. cf. *P. kozlowskii*, GGU 366593–4, Annertuneq, 53.7–102.8; LVR 1.663; MI 347; MGUH 23922.
Fig. 12. *Phelodinium kozlowskii*, GGU 366593–3, Annertuneq, 46.1–102.3; LVR 1.657; MI 342; MGUH 23923.

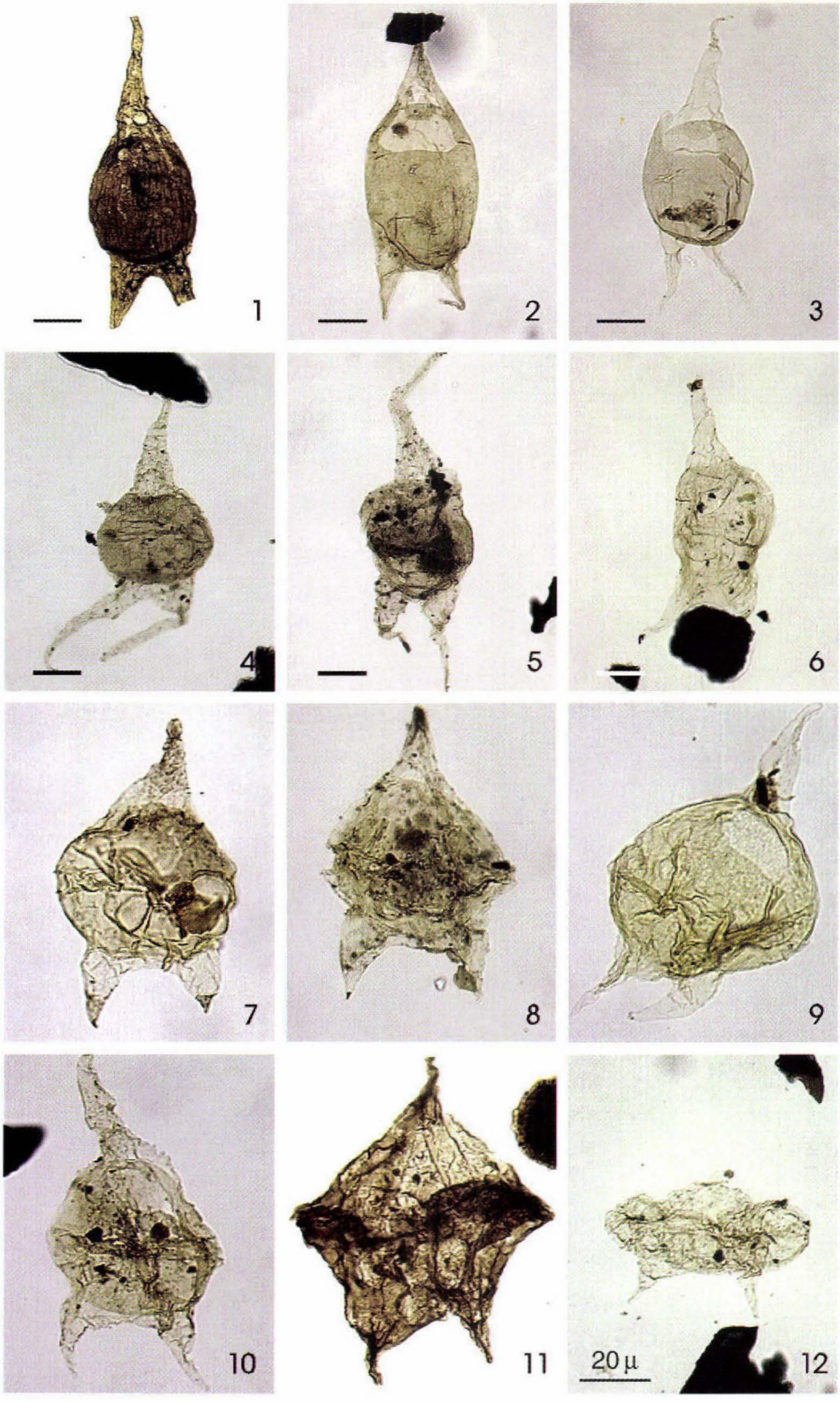
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Plate 14. Central Nuussuaq

Fig. 1. *Deflandrea galeata*, GGU 366591–5, Annertuneq, 56.1–112.8; LVR 1.633; MI 322; MGUH 23924.
Fig. 2. *Deflandrea galeata*, GGU 408885–2, Annertuneq, 22.3–104.7; LVR 1.4012; MI 2980; MGUH 23925.
Fig. 3. *Deflandrea galeata*, GGU 408893–4, Annertuneq, 24.4–112.4; LVR 1.4075; MI 3030; MGUH 23926.
Fig. 4. *Alterbidinium*? *ulloriaq* sp. nov., holotype, GGU 408887–4, Annertuneq, 41.0–93.0; LVR 1.4061; MI 3018; MGUH 23927.
Fig. 5. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–3, Annertuneq, 50.0–99.6; LVR 1.4060; MI 3017; MGUH 23928.
Fig. 6. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–7, Annertuneq, 24.5–95.0; LVR 1.4062; MI 3019; MGUH 23929.
Fig. 7. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–15, Annertuneq, 37.8–93.9; LVR 1.5719; MI 4354; MGUH 23930.
Fig. 8. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–14, Annertuneq, 46.7–106.8; LVR 1.5718; MI 4353; MGUH 23931.
Fig. 9. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–8, Annertuneq, 56.3–107.5; LVR 1.5708; MI 4346; MGUH 23932.
Fig. 10. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–17, Annertuneq, 51.2–110.3; LVR 1.5722; MI 4355; MGUH 23933.
Fig. 11. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–17, Annertuneq, 51.2–110.3; LVR 1.5721; MI 4355; MGUH 23933.
Fig. 12. *Alterbidinium*? *ulloriaq* sp. nov., GGU 408887–14, Annertuneq, 47.7–94.4; LVR 1.5717; MI 4352; MGUH 23934.

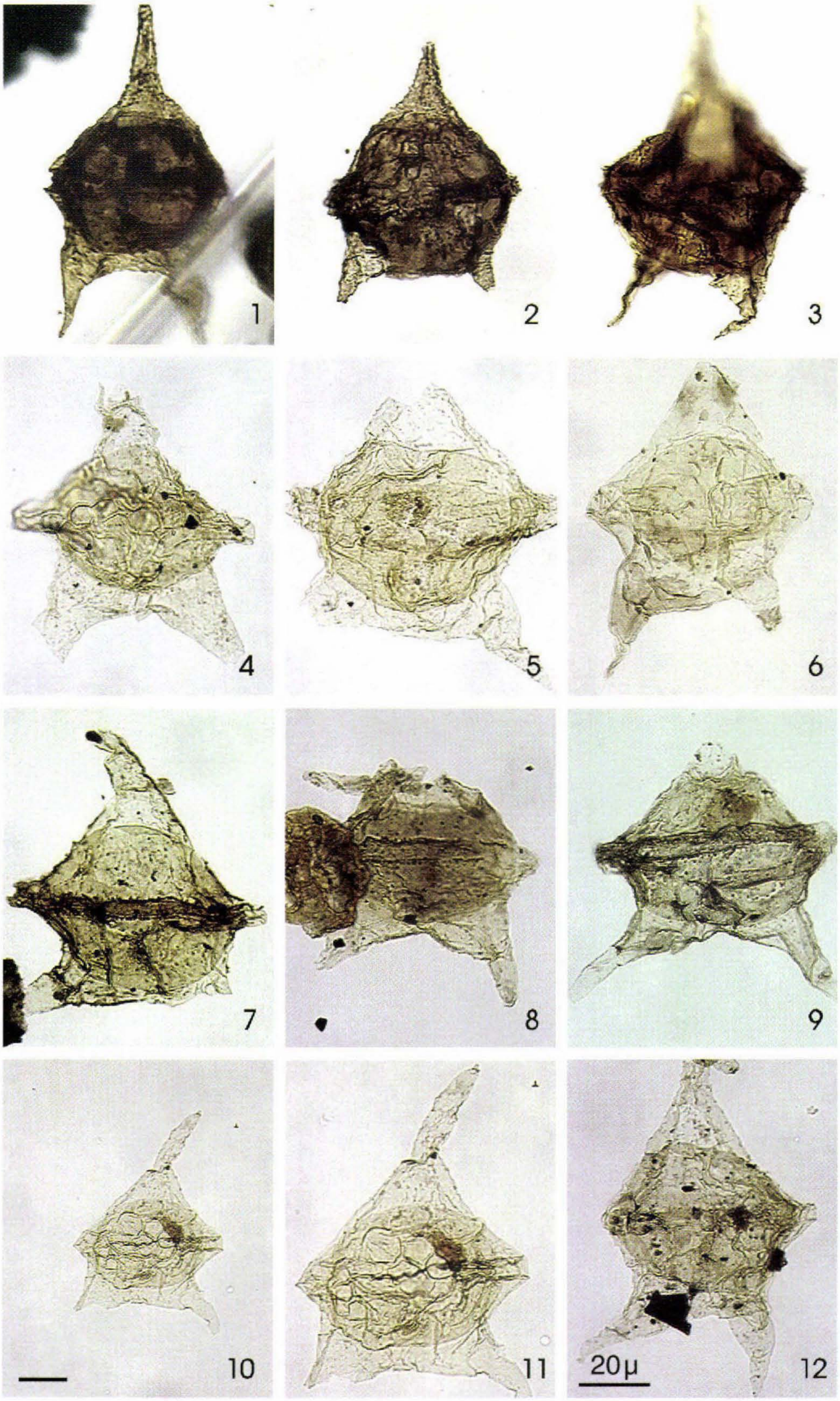
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Plate 15. Central Nuussuaq

Fig. 1. *Fromea fragilis*, GGU 366906–4, Annertuneq, 38.5–98.4; LVR 1.593; MI 290; MGUH 23935.
Fig. 2. *Palaeocystodinium golzowense* GGU 366906–8, Annertuneq, 41.9–108.1; LVR 1.622; MI 312; MGUH 23936.
Fig. 3. *Palaeocystodinium golzowense* GGU 366593–4, Annertuneq, 18.3–92.3; LVR 1.662; MI 346; MGUH 23937. 40×
Fig. 4. '*Isabelidinium* sp. aff. *I. bujakii*', GGU 408879–4, Annertuneq, 39.4–93.9; LVR 1.3998; MI 2967; MGUH 23938.
Fig. 5. '*Isabelidinium* sp. aff. *I. bujakii*', GGU 408880–4, Annertuneq, 40.6–105.8; LVR 1.4002; MI 2971; MGUH 23939.
Fig. 6. *Isabelidinium cooksoniae*, GGU 366583–4, Annertuneq, 42.8–102.7; LVR 1.447; MI 166; MGUH 23940.
Fig. 7. *Isabelidinium cooksoniae*, GGU 366585–4, Annertuneq, 56.4–98.4; LVR 1.479; MI 192; MGUH 23941.
Fig. 8. *Isabelidinium cooksoniae*, GGU 366584–4, Annertuneq, 43.4–104.0; LVR 1.452; MI 169; MGUH 23942.
Fig. 9. *Isabelidinium cooksoniae*, GGU 366584–4, Annertuneq, 28.5–95.3; LVR 1.456; MI 172; MGUH 23943.
Fig. 10. *Isabelidinium cooksoniae*, GGU 366579–4, Annertuneq, 26.5–108.7; LVR 1.87; MI 17; MGUH 23944.
Fig. 11. *Isabelidinium*? *viborgense*, GGU 366624–4, FGC 900813/7 Ikorfat, 24.0–104.2; LVR 1.4078; MI 3032; MGUH 23945.
Fig. 12. ?*Isabelidinium*? *viborgense*, GGU 366624–4, FGC 900813/7 Ikorfat, 47.0–105.5; LVR 1.4080; MI 3034; MGUH 23946.

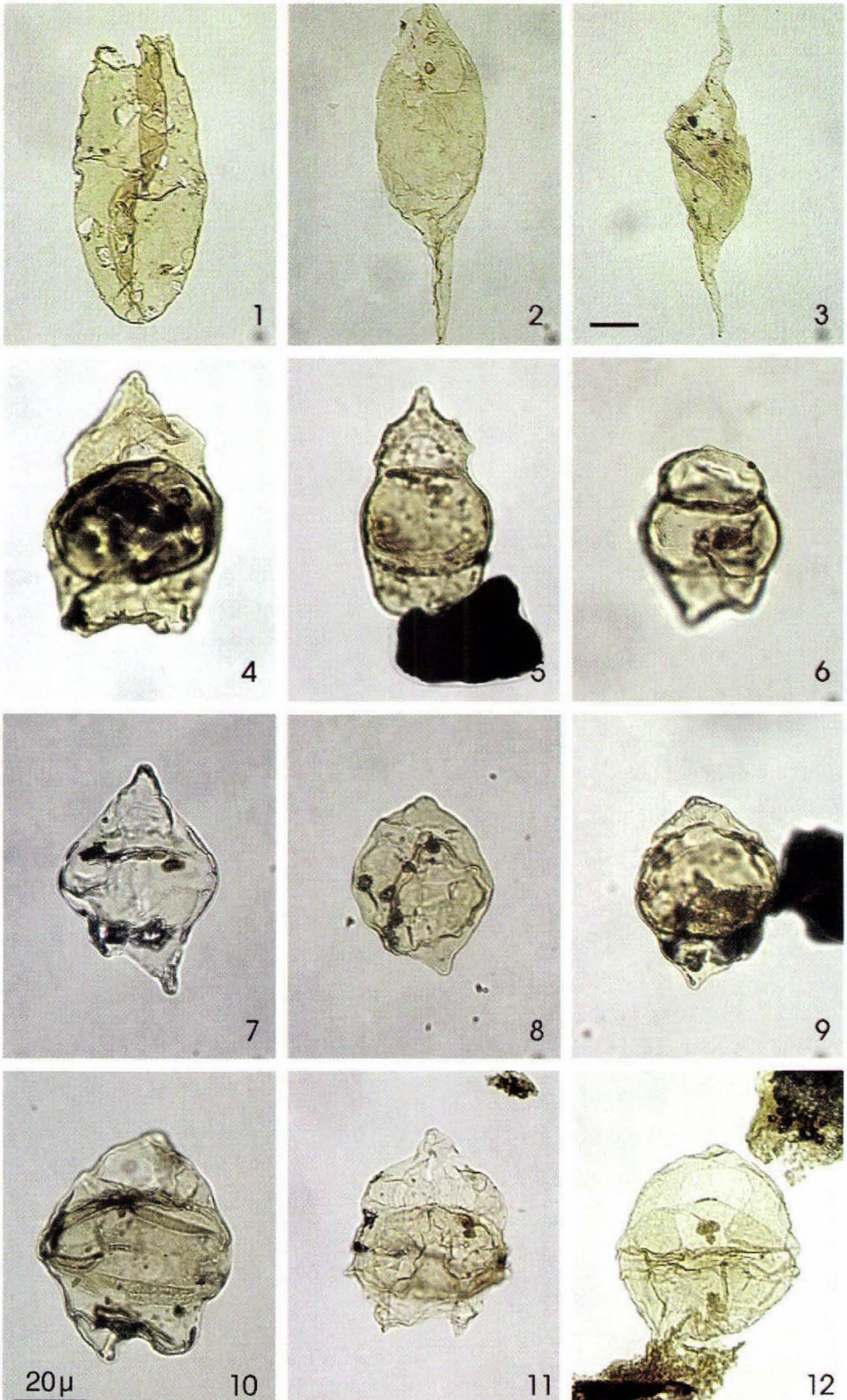
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Plate 16. Central Nuussuaq

Fig. 1. *'Hystrichosphaeridium proprium proprium'*, GGU 366589–3, Annertuneq, 50.6–93.9; LVR 1.542; MI 245; MGUH 23947.

Fig. 2. *'Hystrichosphaeridium proprium proprium'*, GGU 366589–7, Annertuneq, 48.0–95.0; LVR 1.545; MI 248; MGUH 23948.

Fig. 3. *'Hystrichosphaeridium proprium proprium'*, GGU 366590–8, Annertuneq, 23.5–109.2; LVR 1.581; MI 281; MGUH 23949.

Fig. 4. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408885–4, Annertuneq, 49.4–111.1; LVR 1.4016; MI 2983; MGUH 23950.

Fig. 5. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408886–4, Annertuneq, 41.1–106.0; LVR 1.4020; MI 2987; MGUH 23951.

Fig. 6. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408886–4, Annertuneq, 41.1–106.0; LVR 1.4022; MI 2987; MGUH 23951.

Fig. 7. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408886–8, Annertuneq, 35.4–103.5; LVR 1.4023; MI 2988; MGUH 23952.

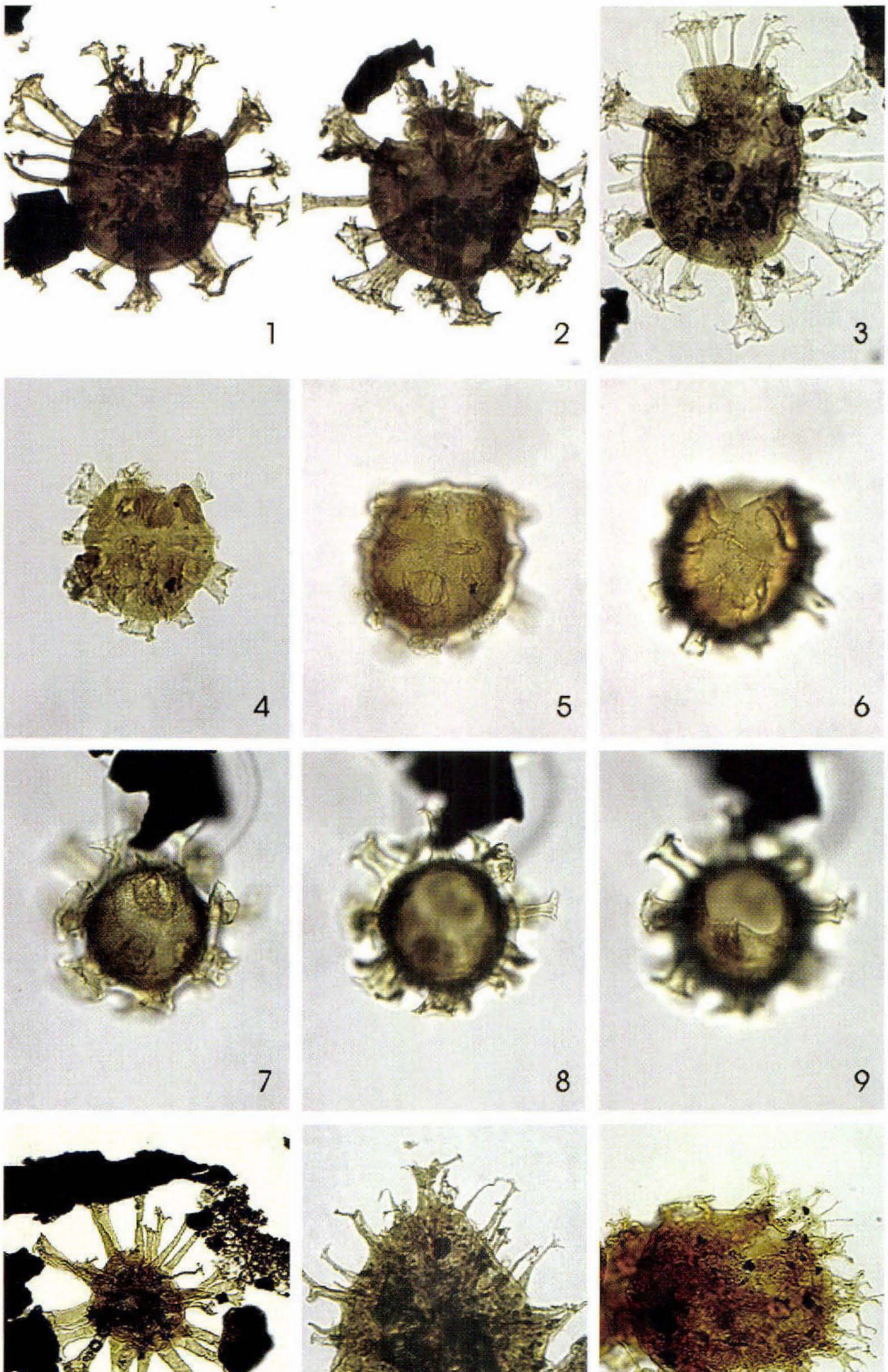
Fig. 8. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408886–8, Annertuneq, 35.4–103.5; LVR 1.4024; MI 2988; MGUH 23952.

Fig. 9. *'Hystrichosphaeridium proprium brevispinum'*, GGU 408886–8, Annertuneq, 35.4–103.5; LVR 1.4025; MI 2988; MGUH 23952.

Fig. 10. *Hystrichosphaeridium* sp. cf. *H. stellatum*, GGU 366586–4, Annertuneq, 45.9–102.3; LVR 1.500; MI 208; MGUH 23953.

Fig. 11. *Fibrocysta* sp. cf. *F. vectensis sensu* Ioannides (1986), GGU 366588–7, Annertuneq, 28.5–110.7; LVR 1.530; MI 233; MGUH 23954.

Fig. 12. *Glaphyrocysta* sp., GGU 408891–4, Annertuneq, 27.0–105.5; LVR 1.4069; MI 3025; MGUH 23955.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20μ
12

Plate 17. Central Nuussuaq

Fig. 1. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 33.0–107.0; LVR 1.4041; MI 3003; MGUH 23956.

Fig. 2. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 33.0–107.0; LVR 1.4042; MI 3003; MGUH 23956.

Fig. 3. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 33.0–107.0; LVR 1.4043; MI 3003; MGUH 23956.

Fig. 4. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 41.4–99.6; LVR 1.4044; MI 3004; MGUH 23957.

Fig. 5. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 41.4–99.6; LVR 1.4045; MI 3004; MGUH 23957.

Fig. 6. *Impagidinium* sp. cf. *I. dispertitum*, GGU 408886–8, Annertuneq, 41.4–99.6; LVR 1.4046; MI 3004; MGUH 23957.

Fig. 7. *Spinidinium*? sp. cf. *S. clavus*, GGU 366906–4, Annertuneq, 30.7–95.1; LVR 1.589; MI 287; MGUH 23958.

Fig. 8. *Laciniadinium arcticum*, GGU 366582–4, Annertuneq, 39.8–107.0; LVR 1.425; MI 148; MGUH 23959.

Fig. 9. *Laciniadinium arcticum*, GGU 366588–7, Annertuneq, 43.7–94.4; LVR 1.521; MI 225; MGUH 23960.

Fig. 10. *Chatangiella* sp. aff. *C. granulifera*, GGU 366589–4, Annertuneq, 49.6–106.2; LVR 1.538; MI 241; MGUH 23961.

Fig. 11. *Raphidodinium fucatum*, GGU 366582–4, Annertuneq, 56.1–96.1; LVR 1.422; MI 145; MGUH 23962.

Fig. 12. *Raphidodinium fucatum*, GGU 366583–4, Annertuneq, 34.6–100.7; LVR 1.451; MI 168; MGUH 23963.

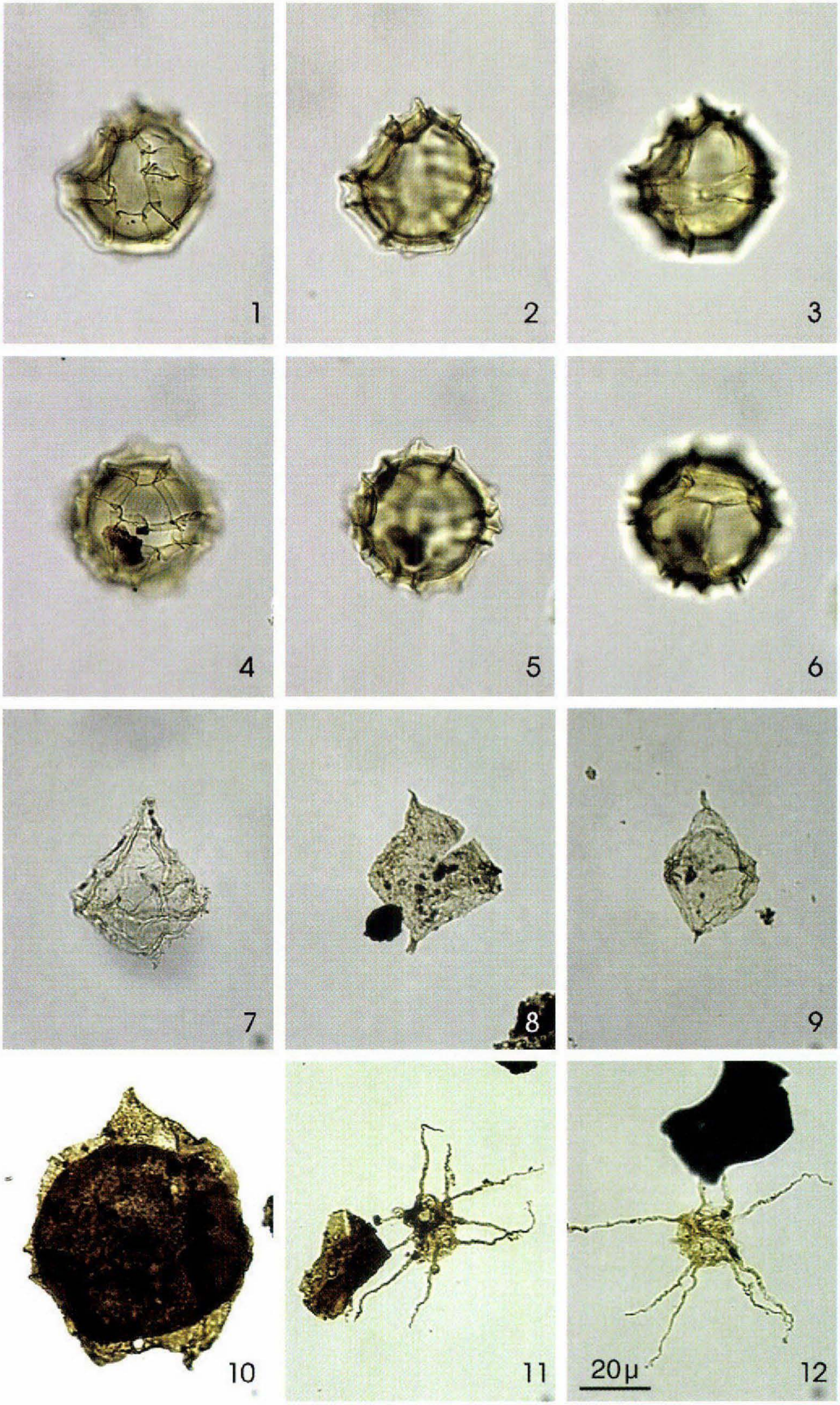
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Plate 18. Central Nuussuaq

Fig. 1. *Aquilapollenites stelckii*, GGU 366582–7, Annertuneq, 25.4–102.2; LVR 1.431; MI 153; MGUH 23964.
Fig. 2. *Aquilapollenites stelckii*, GGU 366583–4, Annertuneq, 23.0–96.1; LVR 1.432; MI 154; MGUH 23965.
Fig. 3. *Aquilapollenites stelckii*, GGU 366584–7, Annertuneq, 36.2–109.8; LVR 1.460; MI 176; MGUH 23966.
Fig. 4. *Aquilapollenites stelckii*, GGU 366906–4, Annertuneq, 47.3–102.0; LVR 1.599; MI 296; MGUH 23967.
Fig. 5a. *Aquilapollenites clarireticulatus*, GGU 366906–4, Annertuneq, 46.9–112.3; LVR 1.600; MI 297; MGUH 23968.
Fig. 5b. *Aquilapollenites clarireticulatus*, GGU 366906–4, Annertuneq, 46.9–112.3; LVR 1.601; MI 297; MGUH 23968.
Fig. 6a. *Aquilapollenites drumhellerensis*, GGU 366906–4, Annertuneq, 49.1–108.3; LVR 1.603; MI 299; MGUH 23969.
Fig. 6b. *Aquilapollenites drumhellerensis*, GGU 366906–4, Annertuneq, 39.3–101.3; LVR 1.604; MI 300; MGUH 23969.
Fig. 7. *Aquilapollenites* sp., GGU 366592–4, Annertuneq, 45.8–98.0; LVR 1.640; MI 328; MGUH 23970.
Fig. 8. *Aquilapollenites* sp., GGU 366586–3, Annertuneq, 55.5–99.4; LVR 1.493; MI 204; MGUH 23971.
Fig. 9. *Aquilapollenites clarireticulatus*, GGU 366906–4, Annertuneq, 38.7–95.7; LVR 1.602; MI 298; MGUH 23972.
Fig. 10. *Aquilapollenites* sp., GGU 408886–4, Annertuneq, 25.1–92.0; LVR 1.4026; MI 2989; MGUH 23973.
Fig. 11. *Pseudointegricorpus protrusum*, GGU 366589–7, Annertuneq, 44.6–111.5; LVR 1.566; MI 267; MGUH 23974.
Fig. 12. *Pseudointegricorpus protrusum*, GGU 366906–4, Annertuneq, 42.2–100.0; LVR 1.605; MI 301; MGUH 23975.

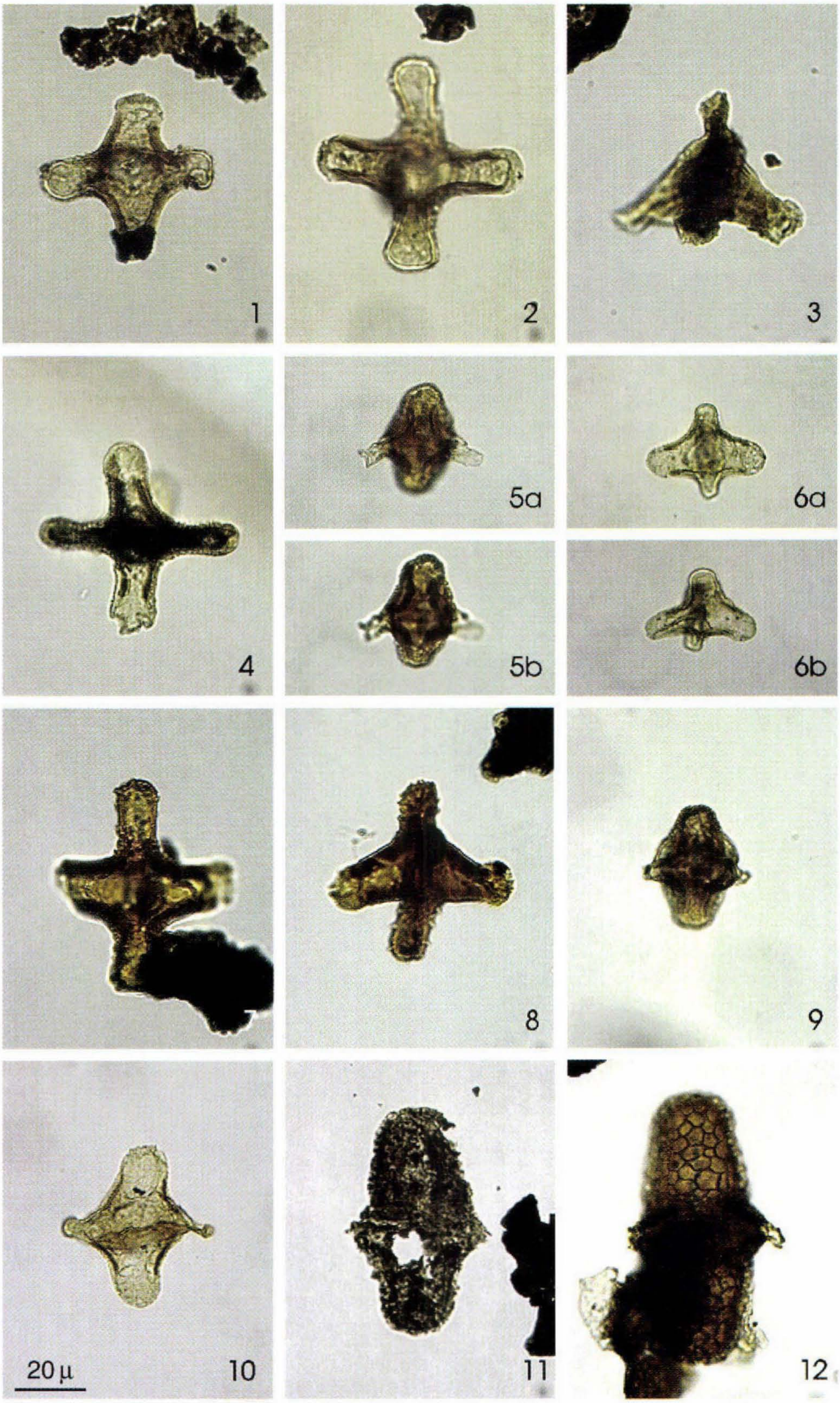
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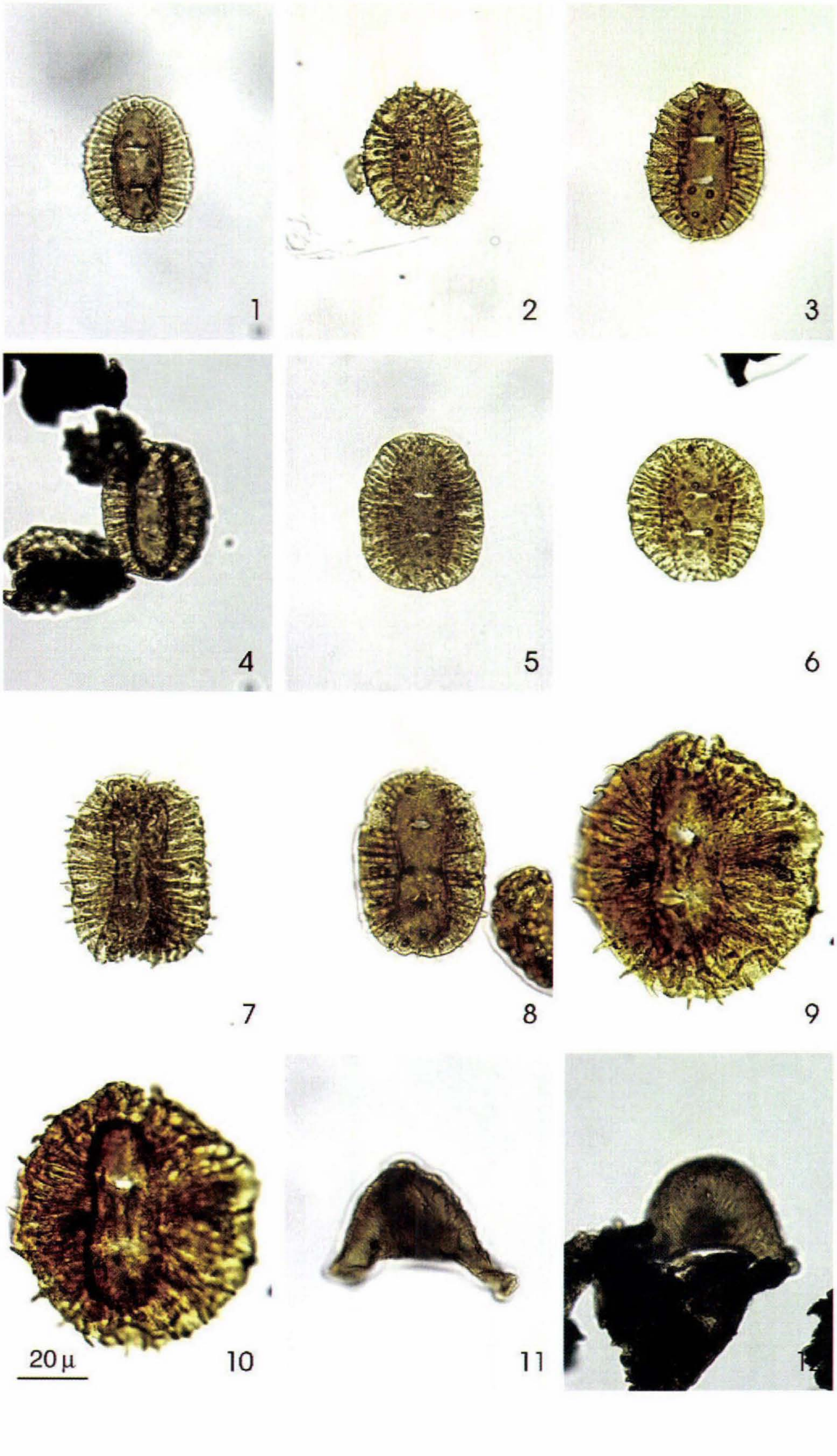
Plate 19. Central Nuussuaq

Fig. 1. *Wodehouseia spinata*, GGU 366906–4, Annertuneq, 38.7–96.2; LVR 1.596; MI 293; MGUH 23976.
Fig. 2. *Wodehouseia spinata*, GGU 408892–3, Annertuneq, 22.2–110.8; LVR 1.4071; MI 3027; MGUH 23977.
Fig. 3. *Wodehouseia spinata*, GGU 408893–7, Annertuneq, 41.3–101.7; LVR 1.4074; MI 3029; MGUH 23978.
Fig. 4. *Wodehouseia stanleyi*, GGU 366592–4, Annertuneq, 50.9–95.4; LVR 1.641; MI 329; MGUH 23979.
Fig. 5. *Wodehouseia stanleyi*, GGU 408886–4, Annertuneq, 25.6–109.1; LVR 1.4027; MI 2990; MGUH 23980.
Fig. 6. *Wodehouseia stanleyi*, GGU 408886–8, Annertuneq, 48.3–108.6; LVR 1.4032; MI 2994; MGUH 23981.
Fig. 7. *Wodehouseia quadrispina*, GGU 408886–4, Annertuneq, 35.4–103.7; LVR 1.4028; MI 2991; MGUH 23982.
Fig. 8. *Wodehouseia quadrispina*, GGU 408886–8, Annertuneq, 46.3–107.9; LVR 1.4030; MI 2993; MGUH 23983.
Fig. 9. *Wodehouseia* sp. cf. *W. fimbriata*, GGU 408892–4, Annertuneq, 41.7–101.4; LVR 1.4072; MI 3028; MGUH 23984.
Fig. 10. *Wodehouseia* sp. cf. *W. fimbriata*, GGU 408892–4, Annertuneq, 41.7–101.4; LVR 1.4073; MI 3028; MGUH 23984.
Fig. 11. ?*Scollardia* sp. cf. *S. trapaformis*, GGU 408886–8, Annertuneq, 29.2–98.7; LVR 1.4048; MI 3006; MGUH 23985.
Fig. 12. ?*Scollardia* sp. cf. *S. trapaformis*, GGU 366592–4, Annertuneq, 30.2–110.0; LVR 1.644; MI 331; MGUH 23986.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Index of figured species

Acritarchs

Pollen

In pocket

ENCLOSURE 1 SVARTENHUK (300 - 0m) COMPOSITE

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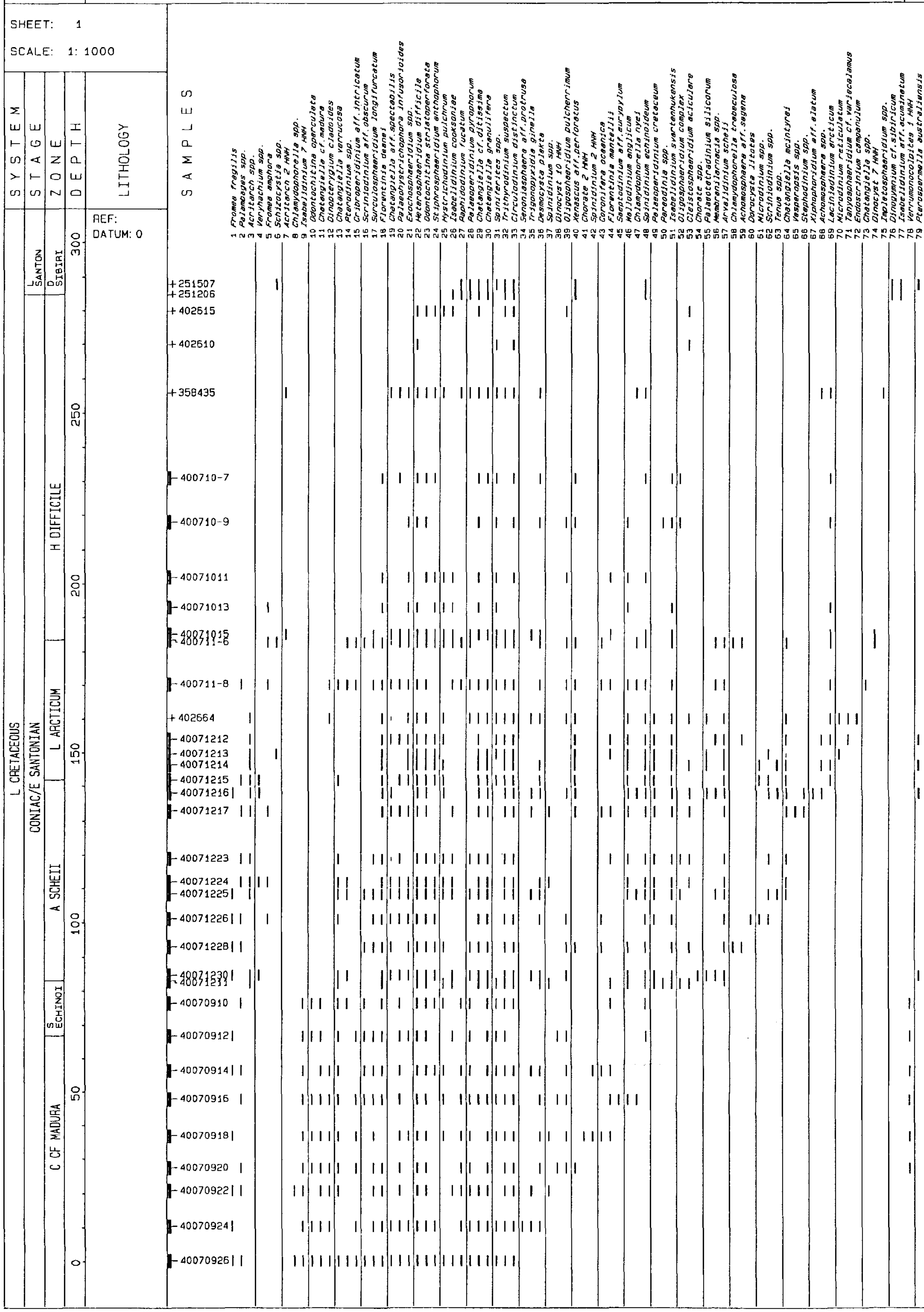
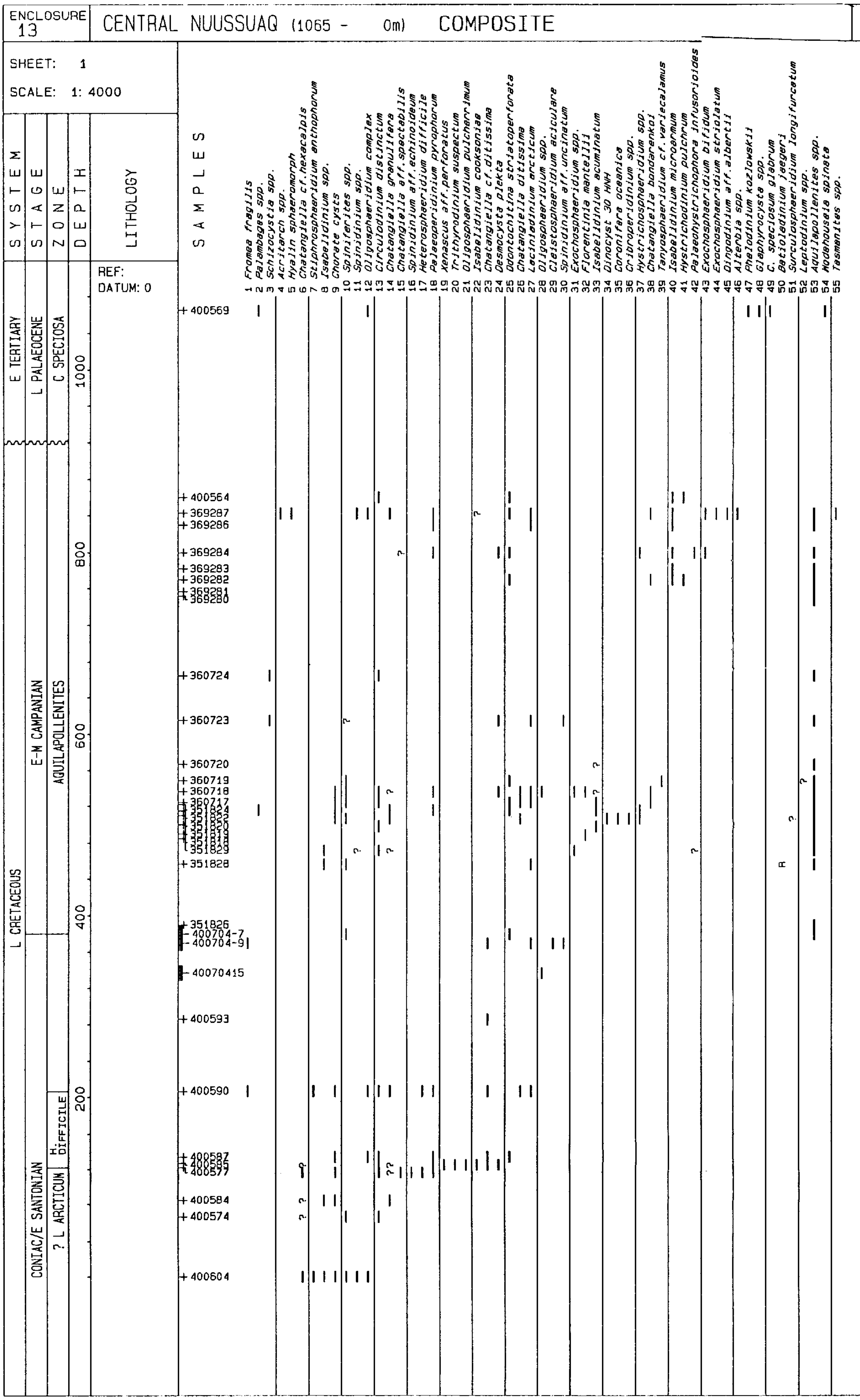


59 Achomosphaera aff.sagena
68 Achomosphaera spp.
7 Acritarch 2 HNH
3 Acritarch spp.
57 Arvalidinium scheii
19 Chatangiella aff.spectabilis
29 Chatangiella cf.ditissima
11 Chatangiella cf.madura
30 Chatangiella granulifera
64 Chatangiella mcintyrei
73 Chatangiella spp.
13 Chatangiella verrucosa
47 Chlamydophorella nyei
8 Chlamydophorella spp.
58 Chlamydophorella trabeculosa
41 Chorate 2 HNH
54 Chorate spp.
33 Circulodinium distinctum
53 Cleistosphaeridium aciculare
43 Coronifera oceanica
15 Cribroperidinium aff.intricatum
36 Desmocysta plekta
38 Dinocyst 10 HNH
74 Dinocyst 7 HNH
76 Dinogymnium cf.sibiricum
12 Dinopterygium cladoides
60 Dorocysta litotes
72 Endoscrinium campanulum
21 Exochosphaeridium spp.
18 Florentinia deanei
44 Florentinia mantellii
5 Fromea amphora
1 Fromea fragilis
22 Heterosphaeridium difficile
25 Hystrichodinium pulchrum
75 Impletosphaeridium spp.
9 Isabelidinium 7 HNH
77 Isabelidinium aff.acuminatum
26 Isabelidinium cooksoniae
51 Isabelidinium svartenhukensis
69 Laciniadinium arcticum
56 Membranilarnacia spp.
70 Microdinium reticulatum
61 Microdinium spp.
10 Odontochitina operculata
23 Odontochitina striatoperforata
52 Oligosphaeridium complex
39 Oligosphaeridium pulcherrimum
20 Palaeohystrichophora infusorioides
49 Palaeoperidinium cretaceum
28 Palaeoperidinium pyrophorum
55 Palaeotetradinium silicorum
2 Palambages spp.
50 Pareodinia spp.
14 Pterodinium spp.
79 Pterospermella australiensis
27 Raphidodinium fucatum
45 Saeptodinium aff.eurypylum
6 Schizocystia spp.
16 Scriniodinium aff.obscurum
62 Scriniodinium spp.
34 Senoniasphaera aff.protrusa
42 Spinidinium 2 HNH
48 Spinidinium echinoideum
37 Spinidinium spp.
31 Spiniferites spp.
66 Stephodinium spp.
24 Stiphrosphaeridium anthophorum
17 Surculosphaeridium longifurcatum
71 Tanyosphaeridium cf.variecalamus
63 Tenua spp.
35 Trigonopyxidia ginella
32 Trithyrodinium suspectum
78 Verrumonocolpites 1 HNH
4 Veryhachium spp.
65 Vesperopsis spp.
46 Wallodinium anglicum
40 Xenascus aff.perforatus
67 Xiphophoridium aff.alatum



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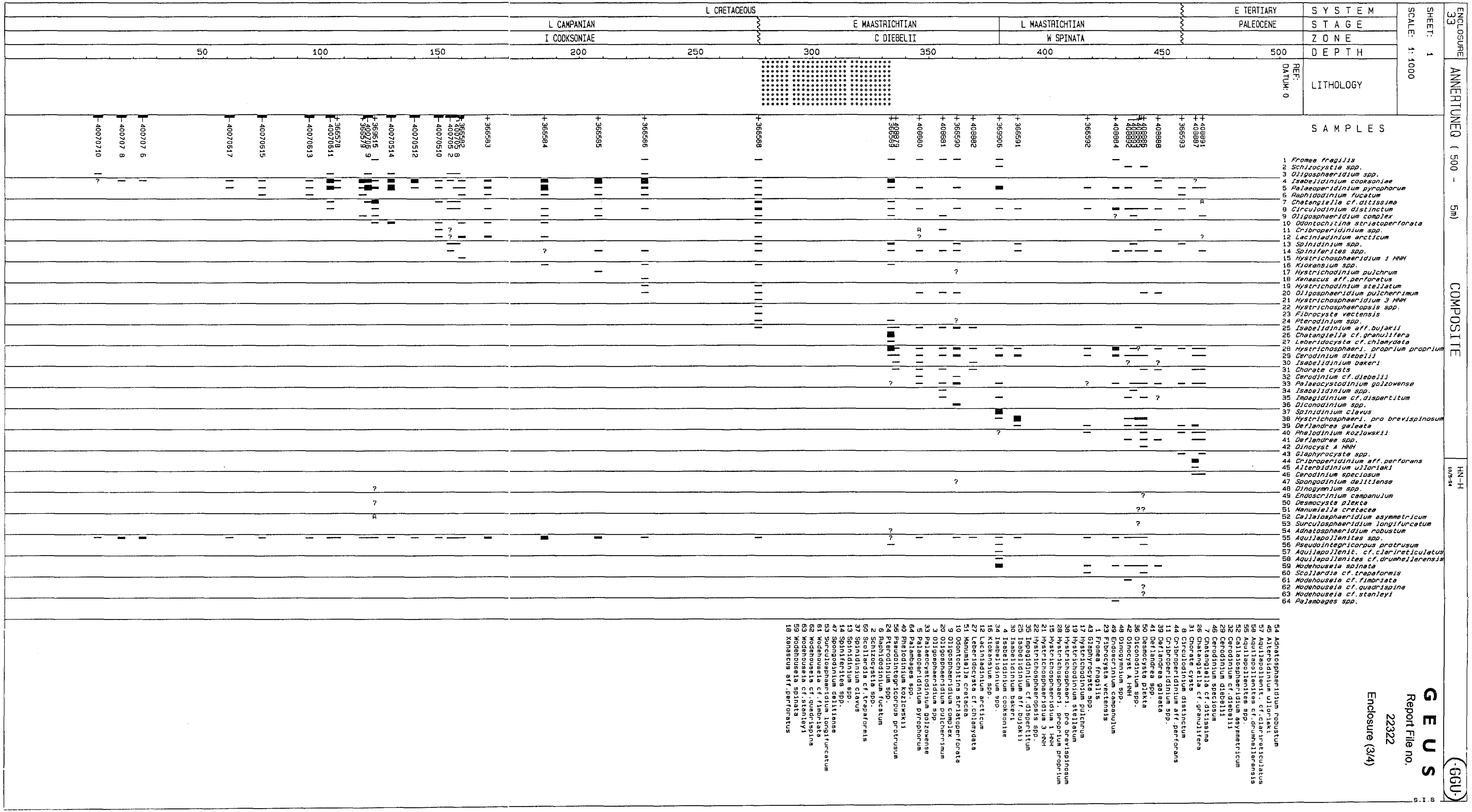
4 Acritarch spp.
46 Alterbia spp.
53 Aquilapollenites spp.
50 Batioladinium jaegeri
49 C. speciosum glabrum
15 Chatangiella aff.spectabilis
38 Chatangiella bondarenkoi
23 Chatangiella cf.ditissima
6 Chatangiella cf.hexacalpis
26 Chatangiella ditissima
14 Chatangiella granulifera
9 Chorate cysts
13 Circulodinium distinctum
29 Cleistosphaeridium aciculare
35 Coronifera oceanica
36 Cribroperidinium spp.
24 Desmocysta plekta
45 Dingodinium aff.albertii
34 Dinocyst 30 HNH
43 Exochosphaeridium bifidum
31 Exochosphaeridium spp.
44 Exochosphaeridium striolatum
32 Florentinia mantellii
1 Fromea fragilis
48 Glaphyrocysta spp.
17 Heterosphaeridium difficile
5 Hyalin sphaeromorph
41 Hystrichodinium pulchrum
37 Hystrichosphaeridium spp.
33 Isabelidinium acuminatum
22 Isabelidinium cooksoniae
40 Isabelidinium microarmum
8 Isabelidinium spp.
27 Laciniadinium arcticum
52 Leptodinium spp.
25 Odontochitina striatoperforata
12 Oligosphaeridium complex
21 Oligosphaeridium pulcherrimum
28 Oligosphaeridium spp.
42 Palaeohystrichophora infusorioides
18 Palaeoperidinium pyrophorum
2 Palambages spp.
47 Phelodinium kozlowskii
3 Schizocystia spp.
16 Spinidinium aff.echinoideum
30 Spinidinium aff.uncinatum
11 Spinidinium spp.
10 Spiniferites spp.
7 Stiphrosphaeridium anthophorum
51 Surculosphaeridium longifurcatum
39 Tanyosphaeridium cf.variecalamus
55 Tasmanites spp.
20 Trithyrodinium suspectum
54 Wodehouseia spinata
19 Xenascus aff.perforatus


ENCLOSURE 33
SHEET: 1
SCALE: 1: 1000
ANNERTUNEQ (500 - 5m)
COMPOSITE
SYSTEM
STAGE
ZONE
DEPTH
LITHOLOGY
SAMPLES
L CRETACEOUS
E TERTIARY
L CAMPANIAN
E MAASTRICHTIAN
L MAASTRICHTIAN
PALEOCENE
I COOKSONIAE
C DIEBELII
W SPINATA
50
100
150
200
250
300
350
400
450
500
REF: DATUM: 0
1 Fromea fragilis
2 Schizocystia spp.
3 Oligosphaeridium spp.
4 Isabelidinium cooksoniae
5 Palaeoperidinium pyrophorum
6 Raphidodinium fucatum
7 Chatangiella cf.ditissima
8 Circulodinium distinctum
9 Oligosphaeridium complex
10 Odontochitina striatoperforata
11 Cribroperidinium spp.
12 Laciniadinium arcticum
13 Spinidinium spp.
14 Spiniferites spp.
15 Hystrichosphaeridium 1 HNH
16 Kiokansium spp.
17 Hystrichodinium pulchrum
18 Xenascus aff.perforatus
19 Hystrichodinium stellatum
20 Oligosphaeridium pulcherrimum
21 Hystrichosphaeridium 3 HNH
22 Hystrichosphaeropsis spp.
23 Fibrocysta vectensis
24 Pterodinium spp.
25 Isabelidinium aff.bujakii
26 Chatangiella cf.granulifera
27 Leberidocysta cf.chlamydata
28 Hystrichosphaeri. proprium proprium
29 Cerodinium diebelii
30 Isabelidinium bakeri
31 Chorate cysts
32 Cerodinium cf.diebelii
33 Palaeocystodinium golzowense
34 Isabelidinium spp.
35 Impagidinium cf.dispertitum
36 Diconodinium spp.
37 Spinidinium clavus
38 Hystrichosphaeri. pro brevispinosum
39 Deflandrea galeata
40 Phelodinium kozlowskii
41 Deflandrea spp.
42 Dinocyst A HNH
43 Glaphyrocysta spp.
44 Cribroperidinium aff.perforans
45 Alterbidinium ulloriaki
46 Cerodinium speciosum
47 Spongodinium delitiense
48 Dinogymnium spp.
49 Endoscrinium campanulum
50 Desmocysta plekta
51 Manumiella cretacea
52 Callaiosphaeridium asymmetricum
53 Surculosphaeridium longifurcatum
54 Adnatosphaeridium robustum
55 Aquilapollenites spp.
56 Pseudointegricorpus protrusum
57 Aquilapollenit. cf.clarireticulatus
58 Aquilapollenites cf.drumhellerensis
59 Wodehouseia spinata
60 Scollardia cf.trapaformis
61 Wodehouseia cf.fimbriata
62 Wodehouseia cf.quadrispina
63 Wodehouseia cf.stanleyi
64 Palambages spp.
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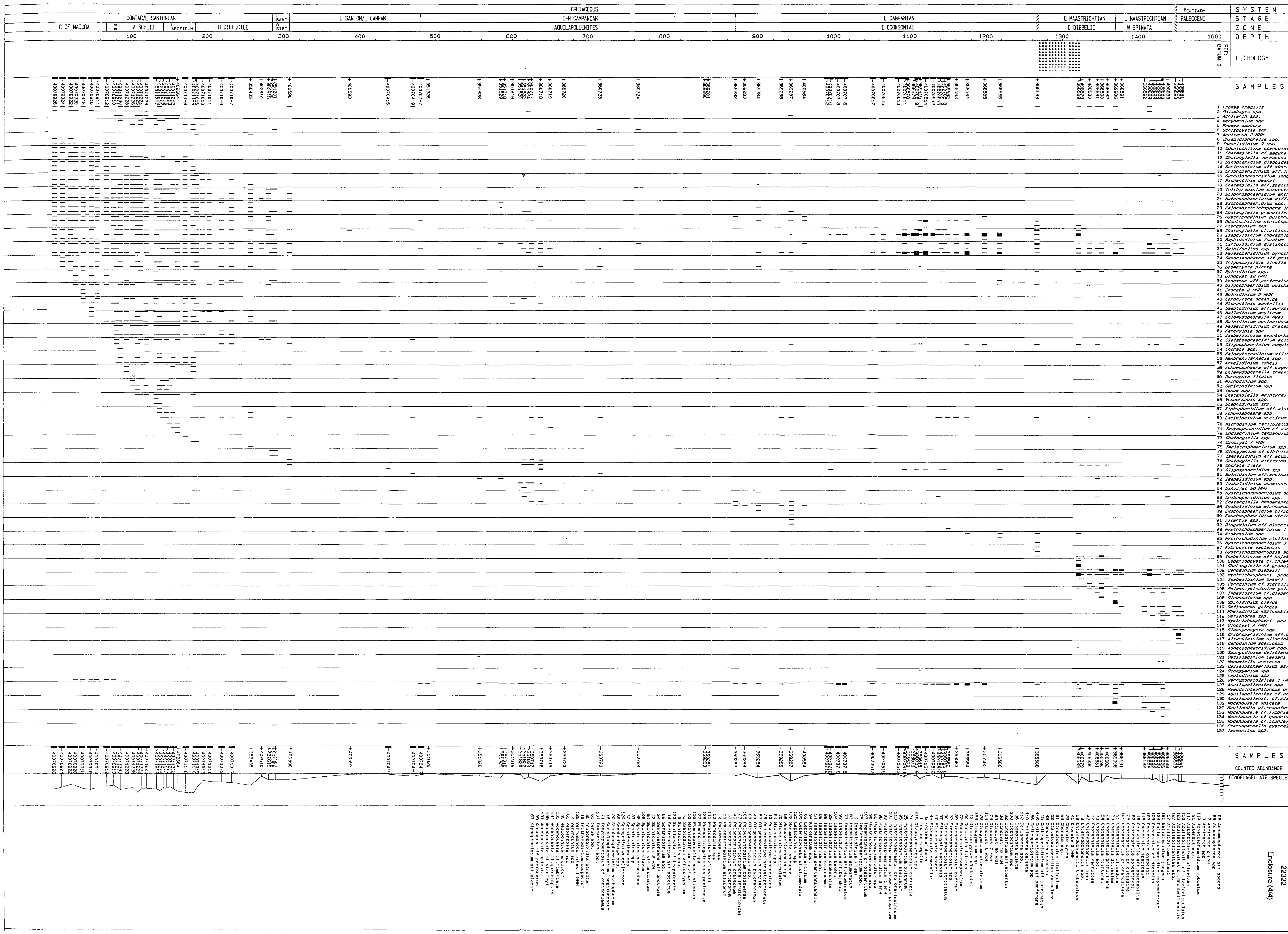
ENCLOSURE 39

SHEET: 1

SCALE: 1:2000

WEST GREENLAND (1490 - 0m) COMPOSITE



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