PALYNOLOGY AND GEOLOGY OF THE TRIASSIC SUCCESSION OF SVALBARD AND THE BARENTS SEA

Geological Survey of Norway Special Publication, 14

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Cover photo:
Dalsnuten in central Spitsbergen, with the valley Vendomdalen in the foreground. Also note the Quaternary pingo at the right-hand side. The scree slope covers the Lower Triassic Vikinghøgda Formation. The black cliff is the Botneheia Formation, and above this the shales of the Tschermakfjellet Formation grade upwards into the sandstone-rich De Geerdalen Formation.
Photo A. Mørk.

Palynology and geology of the Triassic succession of Svalbard and the Barents Sea

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Contents

Preface

Our study of the Triassic succession of Svalbard started with work by the University of Oslo Svalbard group in 1977 (DW & AM). We participated in Statoilorganised ship- and helicopter-based expeditions in 1977, 1979 and 1982. DW had already studied and recognised the special nature of the Wilhelmøya "Formation" on Wilhelmøya in 1970 and he studied the succession on Hopen in 1971 and on Kong Karls Land in 1973. AM moved from DW's University of Oslo group to IKU in 1979, where he focused on the Sassendalen Group. He was joined by Ragnar Knarud in 1980, who continued his own studies of the Kapp Toscana Group. Several UiO students participated in this work, and especially Arne Willy Forsberg studied the organic-rich Botneheia Formation, and worked with several of the sections in this study. The organic-rich Sassendalen Group was studied in detail at IKU (Malvin Bjorøy responsible) and JOV studied the kerogen of the hydrocarbon source rocks. The sections studied by Ragnar Knarud are extensively used in the present study.

Exploration drilling started in the Barents Sea in 1980, and JOV was responsible for the Triassic palynological studies of the first Norsk Hydro wells (7120/12–1, 2, 3) while AM and Knarud studied the sedimentology of the first well.

In 1984, the IKU Geo Program started and it continued as the IKU Correlation Program, focused on geological and palynological studies of Svalbard, the Barents Sea and other arctic areas such as the Sverdrup Basin of Canada and Eastern Siberia. GM started to work at IKU in 1988, and participated in these studies.

In 1984 IKU also started shallow stratigraphic coring in the Barents Sea, and Triassic strata were drilled on the Svalis Dome and on the Nordkapp Basin margins, while the basal Triassic beds were also cored close to the Finnmark coast. From 1990 to 2005, IKU, which meanwhile changed its name to SINTEF Petroleum Research, carried out several shallow-coring cruises for the Norwegian Petroleum Directorate (NPD), and most of these cores penetrated Triassic rocks. The sedimentology of the cores was analysed by IKU/SINTEF Petroleum Research, and the palynology of all IKU cores were also studied by IKU/SINTEF Petroleum Research, although Applied Petroleum Technology (Ingar Throndsen) participated in palynological analyses of cores from the last NPD cruises. GM completed her master thesis on shallow cores and received a permanent position at IKU in 1988. She continued to work mainly on the Triassic, also completing a PhD related to these programmes. Arnfinn Rømuld also completed a thesis in 1988 and some of his data are used in the present study. PAH started his palynological studies in the Barents Sea in 1985, then employed by Esso, and has worked together with JOV since then. The shallow cores contained good macrofossils, such as ammonoids, and these have been studied by Wolfgang Weitschat. He already had a long history of research from Svalbard, and he described material from cores as well as from exposures sampled and studied for magnetostratigraphy. Magnetostratigraphical studies, led by Mark W. Hounslow, of the Triassic succession started in 1995, and incorporate macrofossils and palynostratigraphy to date the magnetic succession. These studies are still ongoing and have given much invaluable data.

Letesamarbeidet, a joint project with the Norwegian Petroleum Directorate (NPD), Statoil, Norsk Hydro and Saga Petroleum, carried out fieldwork in 1995, and the palynological material from this work from Hopen, Edgeøya and Wilhelmøya was studied by JOV.

From 2006, NPD started a programme to study the Triassic succession of Svalbard and the northern Barents Sea. AM has been supervisor and participated in the work, and also several students from NTNU have been involved. The University Centre in Svalbard (UNIS) started a drilling programme in 2007 to investigate the possibility to store CO_2 in the Kapp Toscana Group below Longyearbyen. Several cores penetrate the Wilhelmøya Subgroup and two also into the De Geerdalen Formation. This material has been studied by AM and students. Several projects focused on the geology of the eastern Svalbard islands. Within these projects, Ingrid B. Hynne, Rita Sande Rød, Kristoffer H. Solvi, Gareth S. Lord and Marianne Ask successfully completed Master theses, and their results are included in the present work.

All these different projects and participants have contributed significantly to our understanding of the Triassic succession of Svalbard and the Barents Sea. Other geologists who have also contributed to our study and field participants are mentioned in the descriptions of the individual sections.

Measured sections used:

Ragnar Knarud
Arne W. Forsberg
Sigrunn Johnsen
Geir Elvebakk
Ingrid B. Hynne
Evy Glørstad-Clark
Gareth S. Lord

Participated in field work:

Torleiv Agdestein
Roger Konieczny
Rita Sande Rød
Terje Hellem
Espen Simonstad

Scientific participants:

Mark W. Hounslow
Arnfinn Rømuld
Ingar Throndsen
Wolfgang Weitschat

Illustrations and photos:

All drawings have been made by Atle Mørk.
The photos are by Atle Mørk unless otherwise noted.
The range-charts, tables and plates are compiled by Jorunn Os Vigran, for plates from the Svalis Dome from pictures taken by Gunn Mangerud.

Acknowledgements

Most of the sections and samples from the Kapp Toscana Group on Spitsbergen, Barentsøya and Edgeøya were supplied by Ragnar Knarud, without whose contribution the project would not been possible. Other scientific contributors are listed in the introduction or presented where their data are referred to in the text. We also thank the Norwegian Petroleum Directorate for allowing us to present palynological data from shallow stratigraphic cores on the northern Barents Shelf. We also thank reviewers Wolfram Kürschner and Sofie Lindström for their thorough work and many good recommendations. SINTEF Petroleumsforskning AS (SINTEF Petroleum Research) is thanked for financing the printing of this book and for providing office facilities for the main author during its compilation. The book benefited greatly from the expert and patient technical editing and graphic layout by Alfhild Borgen of Skipnes Kommunikasjon AS.

Introduction

Svalbard has been a key area for the study of Arctic Triassic successions for over a hundred years. Triassic rocks outcrop over large areas of the archipelago and the last three decades of offshore exploration have shown that they are also widespread in the subsurface of the Barents Shelf. The impressive, almost flat-lying sequences of central Spitsbergen drew early attention because of their rich fossil content, and the eastern islands of Barentsøya, Edgeøya and Hopen consist almost exclusively of Triassic outcrops. Along the western fold belt of Spitsbergen the succession is strongly folded and exposures show the spectacular interaction of competent sandstones with intensely deformed shales. The relatively easy accessibility of these high-latitude areas, especially in the summer months, when fjords and coasts are essentially ice free, made them a target for exploration already in the late 19th century. Rich fossil faunas of ammonoids, bivalves and vertebrates (fish, amphibians, ichthyosaurs, and plesiosaurs) have attracted the attention of many palaeontologists and stratigraphers over the years and the archipelago's scientifically and politically open status has resulted in work by a cosmopolitan community of investigators.

Studies of the Triassic rocks on Svalbard can be grouped into three epochs. The first clearly Triassic invertebrate fossils were identified by Lindström (1865) and from then until Norway was granted sovereignty by the Svalbard Treaty in 1925, Swedish scientists dominated investigations and made important stratigraphical and palaeontological contributions, many of which were synthesised by Nathorst (1910). After Norwegian independence from Sweden in 1905, mapping and sampling by Norwegians increased in importance, but the resultant collections were mainly studied and described by others. Data on the Triassic succession were included in maps and general descriptions of Svalbard, such as the detailed studies of the classical Festningen section of western Spitsbergen (Frebold 1929a, b, c, 1930a, b, c, 1931, 1935, 1936, 1939, 1951, Hoel and Orvin 1937).

After the Second World War, Norwegian geologists concentrated on geological mapping of the archipelago, producing regional maps showing most of the exposure areas of Triassic strata (southern Spitsbergen: Flood et al. 1971, Edgeøya: Winsnes and Worsley 1981), while stratigraphical studies were carried out by Russian, Polish and British scientists. The Russian studies covered the entire Mesozoic succession; papers mainly presented by their leading stratigrapher T.M. Pčelina (1964, 1965, 1967, 1972a, b, 1977, 1980, 1983, 1988, 1996) included palaeontological conclusions from a broad team of specialists. Polish work started before the 2nd World War, but the main synthesis of this work was first published by Różycki (1959). Stratigraphical studies, mainly on southern Spitsbergen, were continued by Polish groups after the war and resulted in several contributions, their stratigraphical results to date being summarised by Birkenmajer (1977). The CASP group from the University of Cambridge started systematic studies of the Triassic succession in 1962, resulting in detailed stratigraphical schemes for the different study areas. Buchan et al. (1965) concentrated on Spitsbergen and gave a thorough history of Triassic research on Svalbard until then and included a comprehensive index to Svalbard's Triassic macrofossils. This work was followed by stratigraphical descriptions of Hopen by Smith et al. (1975) and Barentsøya and Edgeøya by Lock et al. (1978). The stratigraphical subdivisions proposed by these authors have formed the framework for subsequent studies, although modified substantially by this later work.

The third and present phase of investigations started as preparations for petroleum exploration on the Barents Shelf in the 1970s and strongly influenced Norwegian geological research and demonstrated the need for much more background information from Svalbard. This resulted in ship- and helicopter-supported expeditions, which were largely organised by the Norwegian oil industry (mainly Statoil) from 1977 onwards. The excellent logistic support provided by these expeditions made it possible to visit and compare remote parts of the Svalbard archipelago in single field seasons. Sedimentological and stratigraphical studies of the post-Caledonian succession were carried out by research teams from the universities of Oslo and Bergen (Steel and Worsley 1984, Worsley et al. 1986) and numerous thesis studies were completed. The research group from Oslo (DW & AM) was responsible for work on the Triassic succession and this group also established close relationships with the Geological Survey of Canada, (notably Ashton Embry), enabling comparisons with the sedimentary successions in the Canadian Arctic. To compile geological information throughout the boreal areas, the Norwegian Continental Shelf Institute (IKU) started several regional projects with Canadian and other institutions, (including the Russian VNIIOkeangeologiya and Aerogeologiya) and with the mollusc specialist Wolfgang Weitschat working on the Svalbard fauna at the University of Hamburg. This international cooperation resulted in studies relating the Svalbard succession to neighbouring areas such as Greenland (Håkanson and Stemmerik 1984), Arctic Canada (Mørk et al. 1989), Arctic

Russia (Mørk et al. 1993) and Siberia (Egorov and Mørk 2000).

IKU (later SINTEF Petroleum Research) had a large staff of palynologists (including JOV & GM) who gave important biostratigraphical contributions. This work was highly relevant when exploration drilling started in the Norwegian part of the Barents Sea in 1980. IKU started shallow stratigraphic drilling in the Barents Sea in 1984 and cored Triassic sequences in several localities, including the Svalis Dome (Vigran et al. 1998, Mørk and Elvebakk 1999), the Finnmark Platform (Bugge et al. 1995) and the Nordkapp Basin (Bugge et al. 2002).

The first deep exploration wells in the southwestern Barents Sea revealed the presence of thick Triassic sequences under most of the shelf, with great similarities to the onland succession. Dating of this succession was necessarily based on palynostratigraphy (Hochuli et al. 1989 and see below), which has proved to be an essential tool for correlation throughout the Barents Sea area. It has been used in all exploration wells penetrating the Triassic succession and has also been applied in shallow stratigraphic coring projects, as well as in studies of outcrops in order to develop a more reliable stratigraphical framework and provide datings in sections where macrofossils are scarce. Numerous sections have been studied, but comparatively few records have been published. In many of the outcrops, palynological studies are hampered by the poor preservation of the palynomorphs and resultant low-diversity assemblages. In contrast, most studies of stratigraphic cores provide well preserved palynomorphs and have resulted in high-resolution records. The palynomorphs recovered from cores and exploration wells from the Barents Shelf are therefore crucial for regional correlation and dating of the Triassic succession. The more complete offshore successions also provide valuable features that help to understand and date the fragmentary records of the onshore section.

In the face of growing confusion as a result of informal operational terminologies, Worsley et al. (1988) presented a preliminary lithostratigraphical scheme for the Mesozoic succession of the shelf areas. The great lateral similarities of the Triassic and Lower Jurassic succession throughout Spitsbergen and further to Barentsøya and Edgeøya had already been noted by Edwards et al. (1979), Worsley and Mørk (1978) and Mørk and Worsley (1979), resulting in a regional synthesis of the depositional environments and stratigraphical nomenclature by Mørk et al. (1982). At the same time, Pčelina (1980, 1983) had published her partly bio- and chronostratigraphically driven nomenclature. All this work finally resulted in the formation of an international committee under the aegis of the Norwegian Polar Institute. This group agreed upon the presently accepted lithostratigraphical scheme (Mørk et al. 1999a),

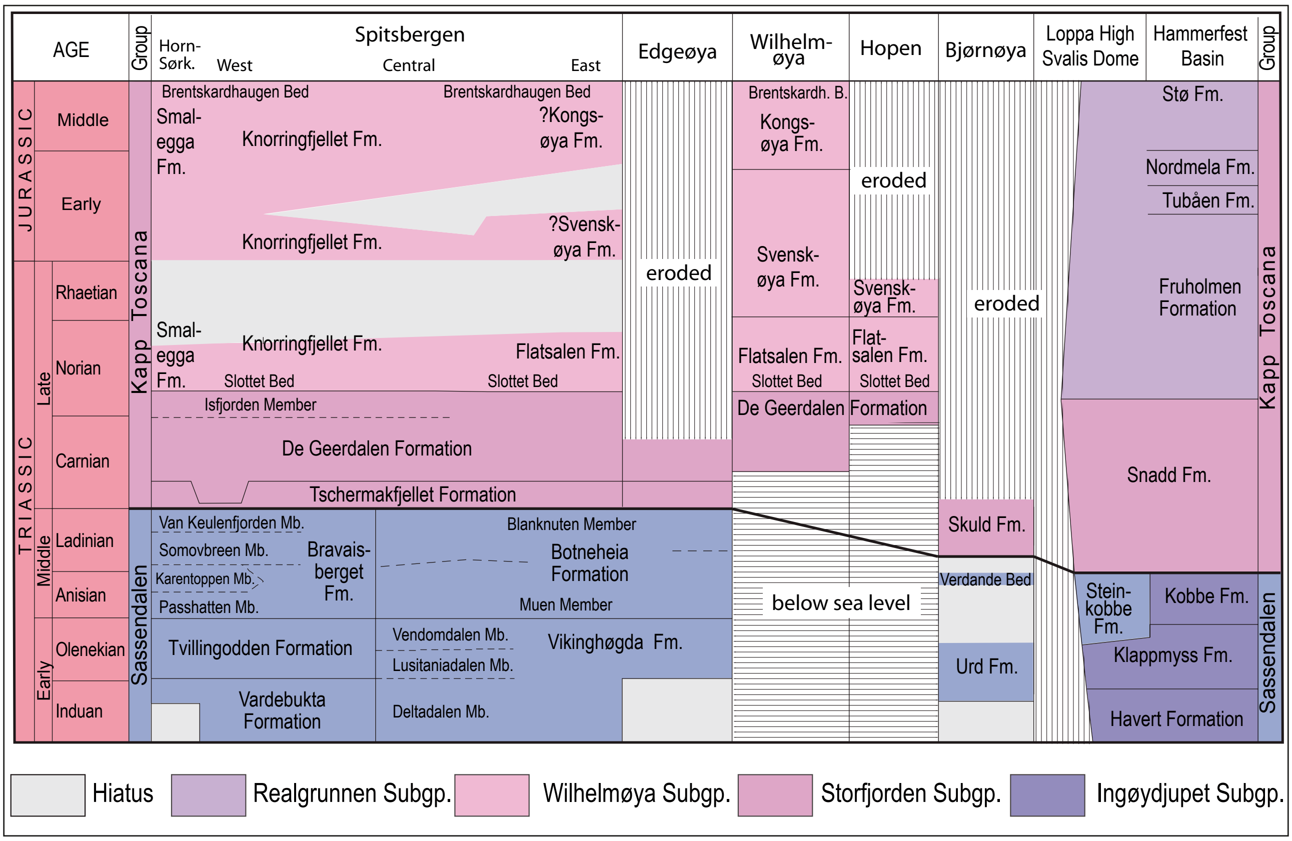


Figure 1. Lithostratigraphy of the Sassendalen and Kapp Toscana groups; modified from Mørk et al. (1999b). The Flatsalen Formation has been extended to eastern Spitsbergen, and the Muen Member of the Botneheia Formation included.

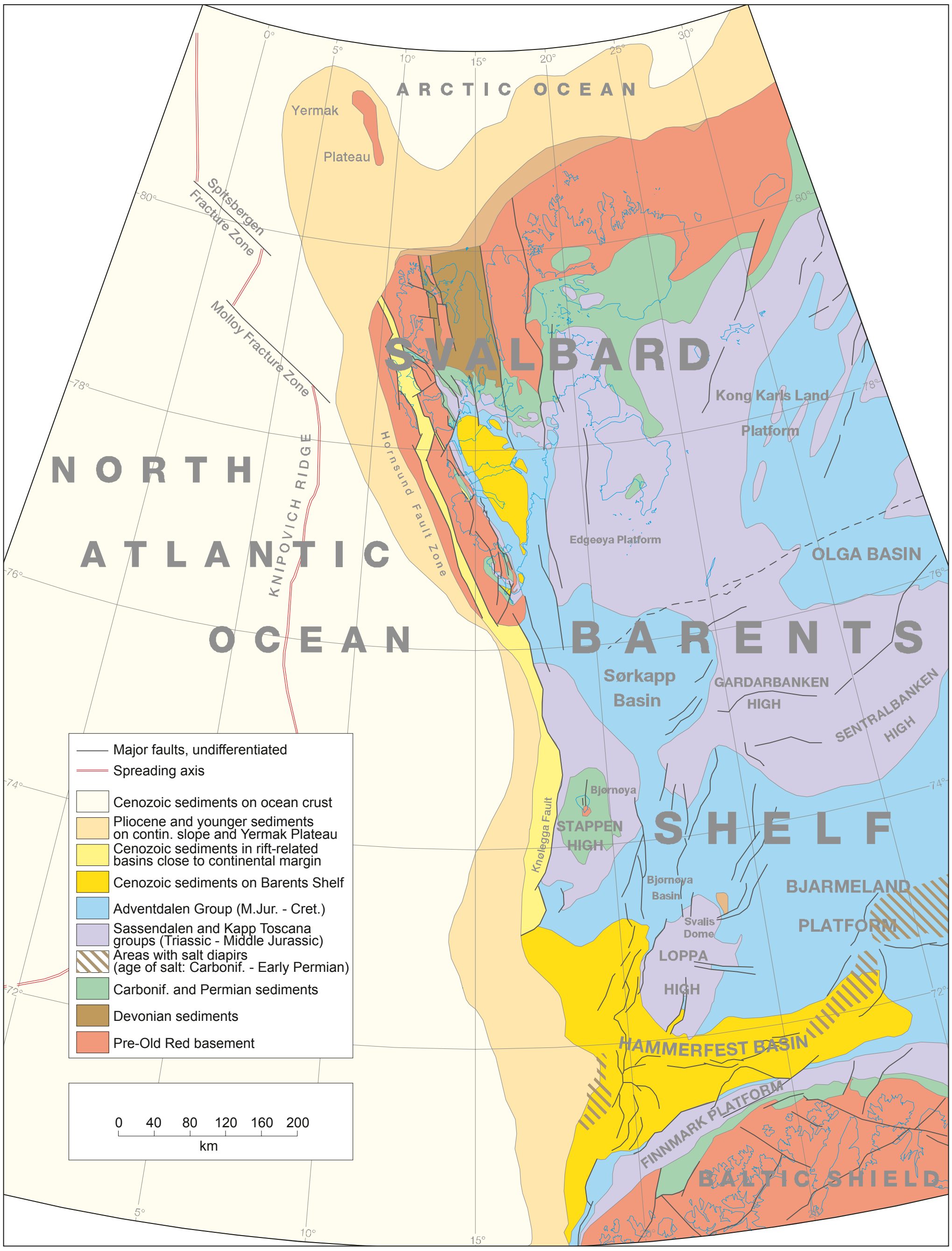


Figure 2. Geological bedrock map of Svalbard and the Barents Sea, simplified from Dallmann (1999).

which revised all previous proposals, integrating the Svalbard lithostratigraphical scheme with that of the Triassic sequences found throughout the subsurface of the Norwegian Barents Shelf. The Polish research groups have continued detailed studies of the Middle Triassic succession of Svalbard, and have revised the type sections and member subdivisons (Krajewski et al. 2007, Krajewski 2008). The main sedimentological development of this succession and the present lithostratigraphical framework are illustrated in Figure 1, together with a regional map (Figure 2) showing onshore Triassic exposures and the offshore structural features noted below.

The main lithostratigraphic units are described below, with comments on their biostratigraphical correlation where relevant. The entire onland sequence has been fairly well dated in the past on the basis of bivalves and ammonoids, but increasing palynostratigraphical understanding has contributed greatly to correlations, especially in the marginal to non-marine parts of the succession. Dating in the offshore shallow stratigraphic and deep exploration wells has relied almost entirely on palynostratigraphy; a compilation of existing palynostratigraphical studies and unpublished work is the main focus of this work, which also examines the environmental significance of the palynofloras. Additional information has also been provided in recent years by magnetostratigraphical studies of parts of the succession on Svalbard (see further comments below).

History of palynostratigraphic research

The earliest studies of the region's Triassic palynology focused on the Kapp Toscana Group of Hopen and Kong Karls Land and central Spitsbergen (Smith 1974, 1982, Bjærke 1977, Bjærke and Dypvik 1977, Bjærke and Manum 1977, Dypvik et al. 1985). The well-illustrated paper by Bjærke and Manum (1977) first recorded dinoflagellate cysts from the uppermost part of the succession. The assemblages presented in these papers correlated well with previously published palynological records from the Canadian Arctic and Alaska (Wiggins 1973, Fisher and Bujak 1975, Bujak and Fisher 1976, Felix and Burbridge 1978, Staplin 1978, Fisher 1979, Fisher and van Helden 1979) and formed an important basis for understanding the palynostratigraphy of the Late Triassic.

The first comprehensive Triassic palynostratigraphic framework for the entire western Barents Sea area (Hochuli et al. 1989) was based on material from outcrops on Svalbard, shallow stratigraphic cores from the Svalis Dome and exploration wells from the Norwegian Barents Shelf. The 16 palynological assemblages, "P" to "A", at that time not formally described as zones, represented material recovered from outcrops and shallow cores in the Sassendalen and lower Kapp Toscana groups. Most of the Late Triassic assemblages ('E' to 'A') were essentially based on material recorded from exploration wells. Mørk et al. (1990) discussed the Triassic palynology of Bjørnøya, recognising there equivalent assemblages to those described by Hochuli et al. (1989). These first palynostratigraphical papers were followed by papers addressing specific intervals of the succession, including the Late Triassic (Bakken, 1990), the Spathian to Anisian interval (Mangerud and Rømuld 1991), and the deposits spanning the Permian–Triassic contact, (Mangerud and Konieczny 1993, Mangerud 1994). Dypvik et al.

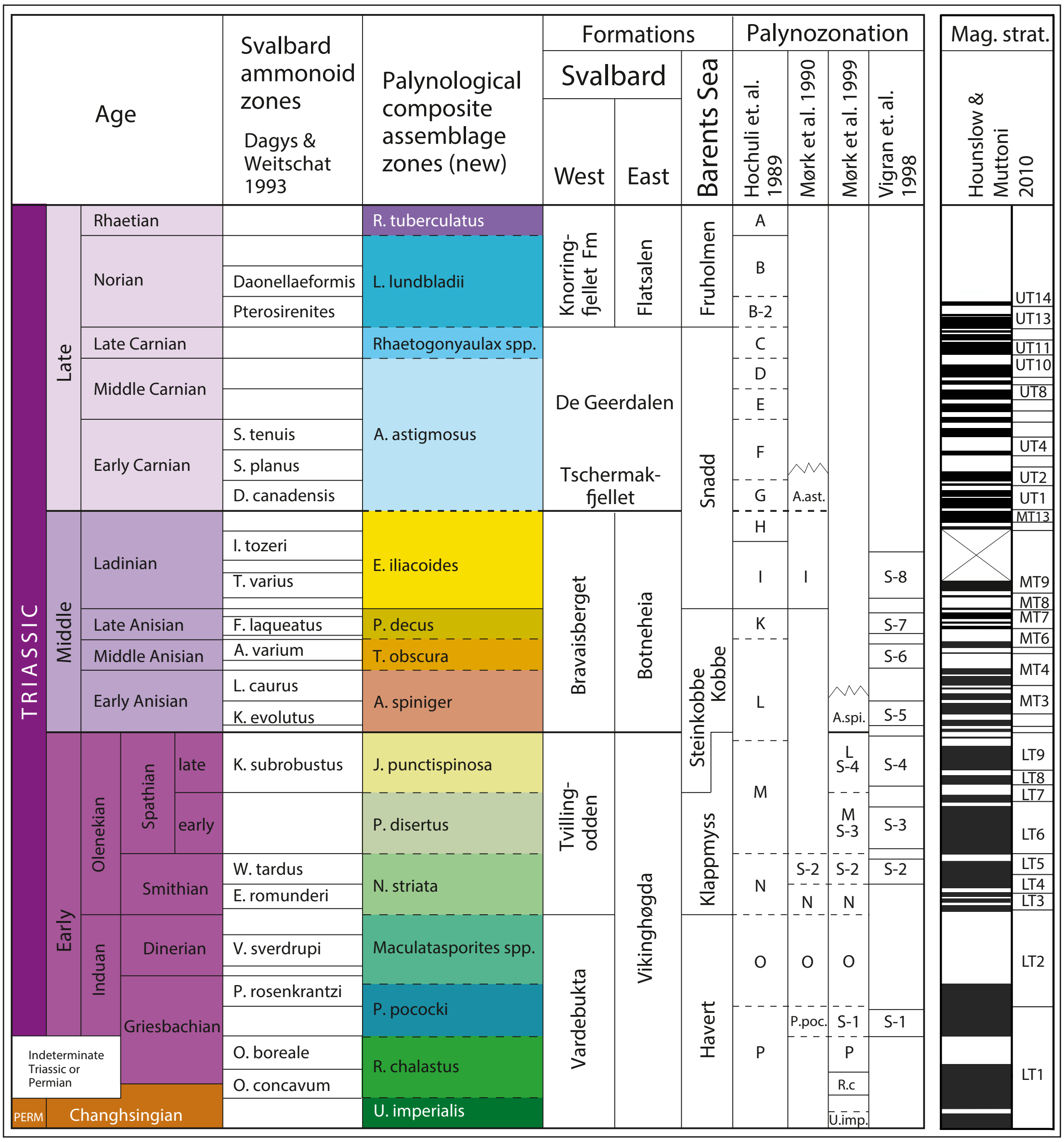


Figure 3a. Stratigraphy of the Triassic succession of Svalbard and the Barents Sea.

(1998) described material from outcrops and wells on Franz Josef Land, including palynological data from Anisian to Norian deposits (see also Dibner et al. 1962, Preobraženskaja et al. 1985a, b, Vasilevskaja 1985).

During the 1990s important calibration points, including new dating by other age-diagnostic faunas, were published. Warrington (1996) published a review of Triassic spores and pollen, discussing ranges in independently dated successions worldwide, also including the Arctic. In the Barents Sea area, Vigran et al. (1998) used excellent material from shallow stratigraphic cores drilled on the Svalis Dome to define eight Early and Middle Triassic concurrent range assemblages. Six of these zones were dated by ammonoids recovered from the cores. Mørk et al. (1999b) described the Lower Triassic type section of the Vikinghøgda Formation at Vikinghøgda, central Svalbard, including its palynostratigraphy. The dating of this material was based on previous zonations by Hochuli et al. (1989) and Vigran et al. (1998). Hounslow et al. (1996, 2007a, b, 2008a, b) published the magnetobiostratigraphy of Triassic deposits on Svalbard, concentrating on sections at Vikinghøgda, Dalsnuten and Milne Edwardsfjellet, linking magnetostratigraphic events to palynostratigraphy. More recently, Xu et al. (2009) contributed Re–Os geochronological dating of the Anisian–Ladinian, including global faunal correlations. Our lithostratigraphical scheme (Figure 1), the levels dated by co-occurring age-diagnostic faunas (Figure 3) and the corresponding age interpretations are based on Mørk et al. (1999a), Dagys and Weitschat (1993) and Hounslow et al. (2007a, b, c, 2008a, b).

The distribution of spores and pollen follows climatic patterns as reflected in past and present vegetation. Because of poor knowledge of the biological origin of early Mesozoic pollen and spores, attempts to

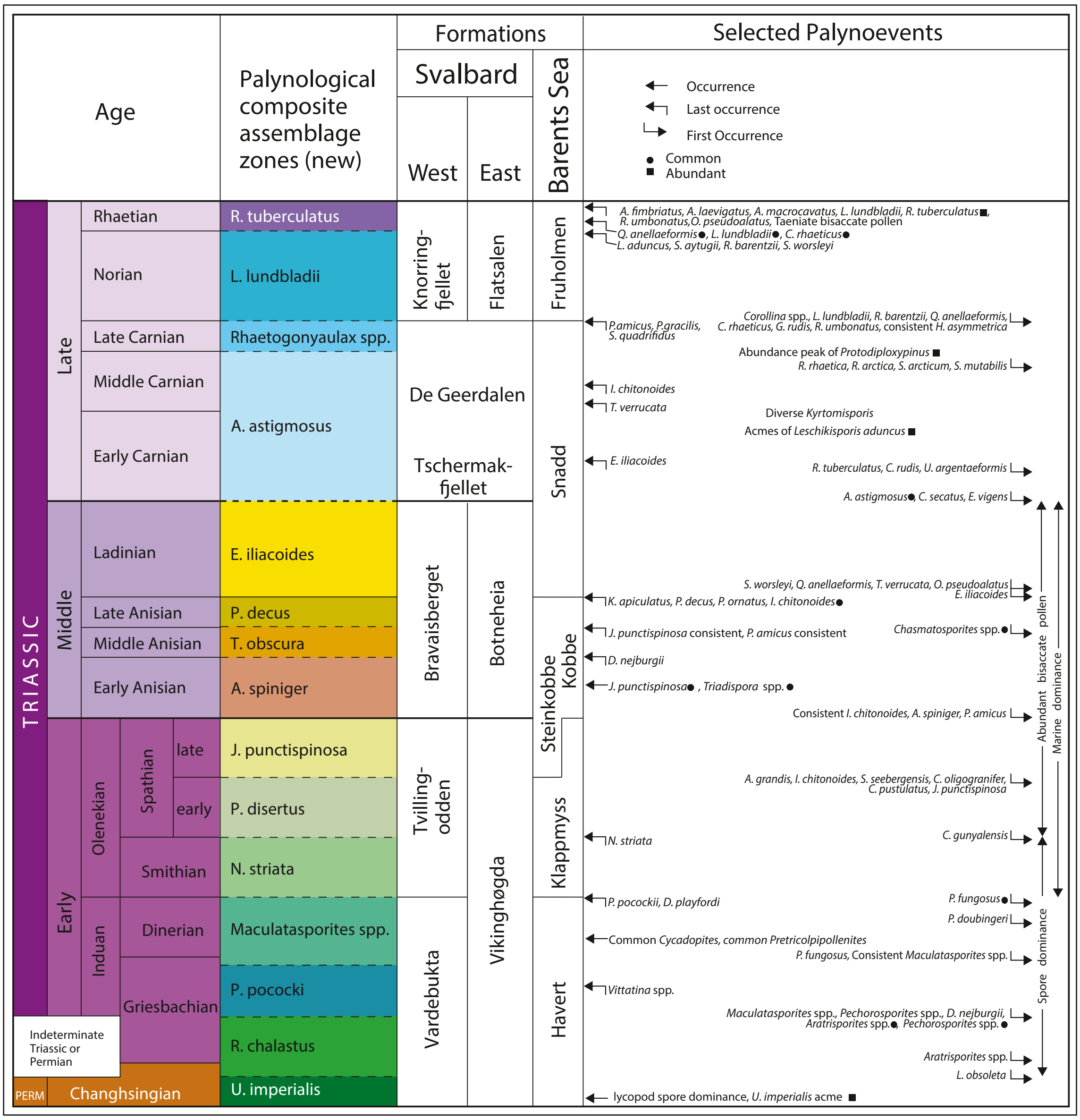


Figure 3b. Stratigraphy of Svalbard and the Barents Sea with definition/characterization of the palynozones described herein.

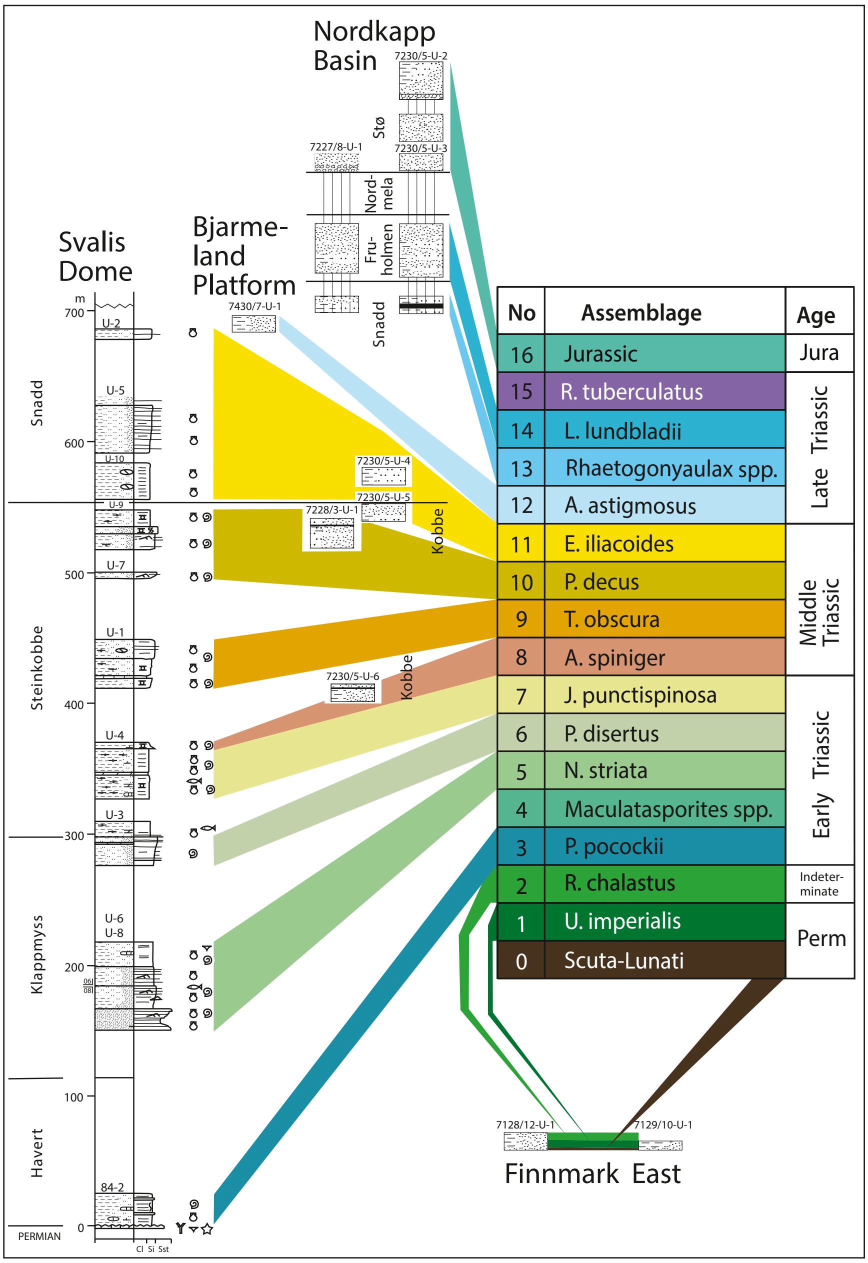


Figure 4. Stratigraphic overview of the palynological zonal system in the IKU/SINTEF shallow stratigraphical cores from the Svalis Dome (Vigran et al. 1998), Nordkapp Basin (Bugge et al. 2002), Finnmark East (Bugge et al. 1995 and Mangerud 1994) and core 7430/7-U-1.

use palynological assemblages as an environmental, in particular climatic, proxy are rare. However, palynological records can be used as reference points for other interpretations, such as the evolution of Triassic plant assemblages or environmental considerations (see for example Mangerud and Rømuld 1991). The high-resolution record of the Svalis Dome area calibrated with fauna has also proved to be an indispensible source of information for new approaches. The distribution of spores and pollen, grouped as hygrophytes and xerophytes, plotted against the $\delta^{13}C_{org}$ isotope curve from Svalbard (Galfetti et al. 2007) demonstrated that a major change in the spore-pollen record coincides with a major shift in the C isotopes. Correlation of the C-isotope curve from Svalbard with Tethyan areas provided the first clue for the discovery of a major climatic change near the Smithian/Spathian boundary. Recent palynological work in the same stratigraphic interval of the Salt Range and the Surghar Range in Pakistan confirmed the global extent of this major environmental crisis, which affected not only terrestrial but also marine environments (Galfetti et al. 2007, Hermann et al. 2011a). The changes observed in the palynological records reflecting major environmental shifts coincide with major changes in the marine realm, leading to faunal turnovers. Thus, this event boundary strongly affected ammonoids and conodonts (Brühwiler et al. 2010, Hermann et al. 2011b). Quantitative studies of well-preserved palynomorph assemblages in continuous sections have a great potential to provide palaeoclimatic information. An attempt to extract the palaeoclimatic implications of palynological data from an exploration well (7228/7–1 A) and from the Svalis Dome has been published by Hochuli and Vigran (2010). Although the data from 7228/7–1 A are essentially

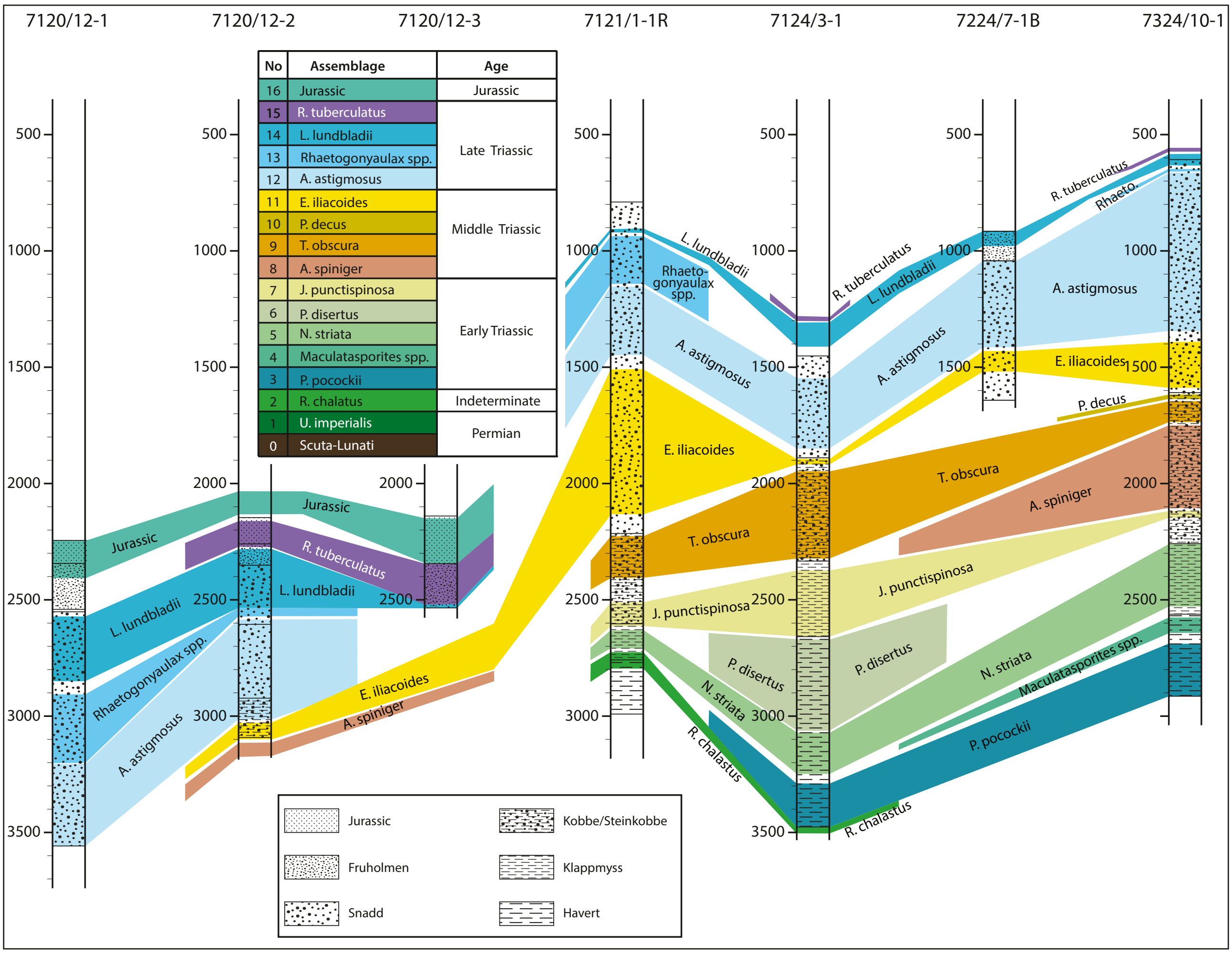


Figure 5. Correlation based on the defined palynozones in Barents Sea exploration wells.

based on counts from ditch-cutting samples, the results reveal several major shifts in the composition of the assemblages between the Smithian and the Rhaetian, interpreted in terms of climatic trends.

Together with Greenland and the Canadian Sverdrup Basin, the Barents Sea is a key area for the study of earliest Triassic sections and the effects of the end-Permian crisis and the subsequent recovery of marine and terrestrial biota. Recent palynological studies combined with C isotopes suggest that two shallow cores from the Finnmark Platform (7128/12–U–01 and 7129/10–U–01) probably provide the most complete floral record of the Permian/Triassic transition to date (Mangerud 1994, Hermann et al. 2010, Hochuli et al. 2010a, b). The results show the existence of a short-lived crisis related to the end-Permian event and a subsequent recovery of the terrestrial ecosystem within a very short time, perhaps within decades. Variations in the distribution of pollen and spores within the Early Triassic records are interpreted to reflect short-term climatic changes. Compared to older interpretations the data also allow for the definition of a distinct additional zone in the 'early Griesbachian' interval during which many of the typical Permian elements survived. The significance of other important changes observed in the spore-pollen assemblages remains to be discovered.

The panel in the Enclosure shows our present palynozonations applied to the geological sections of Svalbard. Figure 4 shows the zonation applied to the shallow cores of the Svalis Dome and Nordkapp Basin and Bjarmeland Platform, while Figure 5 shows the zonation applied to exploration wells in the southern Barents Sea.

Stratigraphic overview

Lower – Middle Triassic Sassendalen Group

The Permian/Triassic transition is still poorly understood throughout the region, but it appears that there was a significant hiatus within the latest Permian (Lopingian), particularly on highs and platforms. The abrupt change from highly cemented spiculitic shales to the overlying non-siliceous shales of the Sassendalen Group is dramatic, both in the outcrop and on seismic data. The so-called 'Permian Chert Event' was now at an end, and oceanic waters warmed significantly. Perhaps, as suggested by many authors, this warming was a contributory factor leading to the late Permian major marine extinction. The soft, poorly fossiliferous basal shales of the overlying group were first suggested to contain a Lopingian (Tatarian) palynoflora on outer platforms by Mangerud (1994) and in the palynology chapter we describe end-Permian Changhsinghian palynofloral assemblages from lowermost in the Havert Formation. In Spitsbergen exposures, the Permian/Triassic boundary as newly redefined by Yin et al. (2001) now occurs in the lower Vardebukta and Vikinghøgda formations. The ammonoid *Otoceras boreale* occurs lowermost in these formations. *Otoceras boreale* is now found both in the latest Permian and earliest Triassic (Ogg 2012), and no age diagnostic conodonts are found on Svalbard. We thus regard the Permian–Triassic boundary to lie within the lower part of these formations. A generally transgressive trend, punctuated by repeated coastal progradations throughout the early Triassic led to the progressive onlap and submergence of most positive highs and platforms. In more positive platform areas, macrofossils suggest an Induan age for basal shales. The most extreme onshore platform situation may be suggested by the central parts of Edgeøya, where the oldest Triassic sediments are of Olenekian (Smithian) age (Pčelina 1977 and observations by AM). However, the Loppa High only became the site of marine sedimentation in the Anisian/Ladinian.

The entire group is dominated by non-siliceous fine clastics—indeed this time span has been referred to as representing the 'Early Triassic silica gap' (Beauchamp and Baud 2002). High subsidence and sedimentation rates continued across the entire Barents Shelf during this depositional phase, a feature most marked in the southern and northern Barents basins of the Russian sector. Thicknesses range from 60–150 m on pre-existing structural highs to 700 m in western Spitsbergen, and exceed 1500 m on the southwestern shelf and several kilometres in the eastern basins. Sediment transport to these deep basins in the east

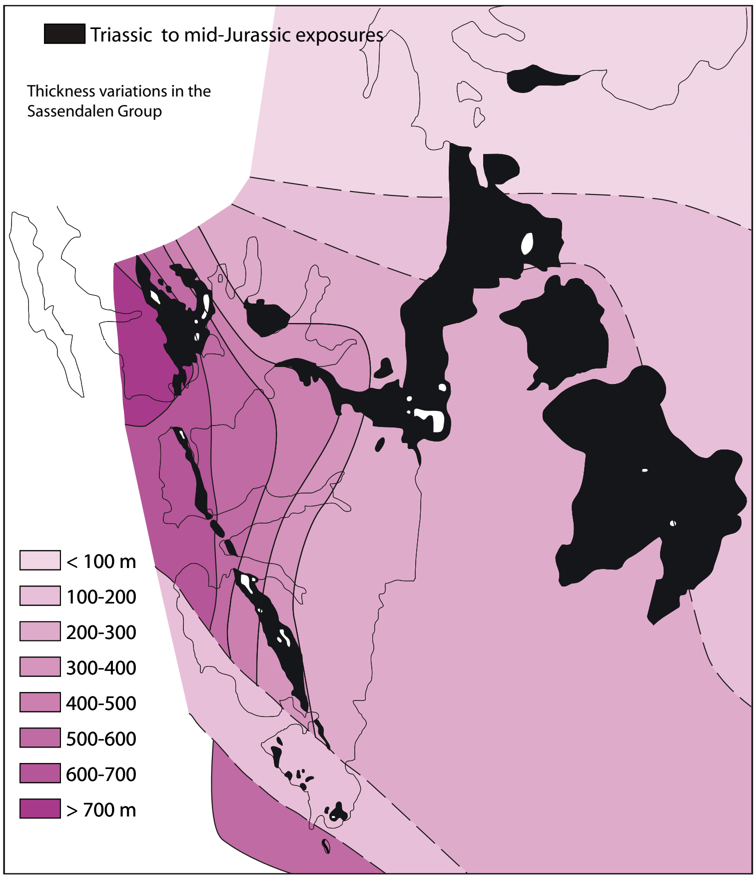


Figure 6. Thickness variation of the Sassendalen Group on Svalbard.

seems to have been from the central Urals, along the axis of the Timan–Pechora depression.

Significant sandstone intervals on Spitsbergen are apparently related to repeated coastal progradations from Greenland to the west, and several barrier bar or deltaic sandstone units are exposed along the western coast (Mørk et al. 1982). These authors regarded most of the thickness variations in the group, from more than 700 m in the (western) outer Isfjorden area to less than 200 m on Edgeøya, to have been largely caused by differential movements over underlying north-south-trending lineaments. A smoothed basin-fill model (Figure 6) based on the same data shows that the succession thins eastwards from a depocentre around the mouth of Isfjorden, while highly condensed sections are characteristic of the Sørkapp–Hornsund High.

Three formations define the group in western Spitsbergen (Figure 7), each representing major coastal progradations from the west following initial transgression and deepening, with the development of barrier bars and lagoons in the basal Vardebukta Formation, shallow marine bars and storm beds in the Tvillingodden Formation and deltaic lobes in the uppermost Bravaisberget Formation (Mørk et al. 1982, 1999a, Krajewski et al. 2007) (Figure 8). The Vikinghøgda Formation (Mørk et al. 1999b) of central and eastern Svalbard is equivalent to the two lower formations on the west coast, while the Botneheia Formation is a distal equivalent to the Bravaisberget Formation (Mørk et al. 1999a, Krajewski 2008) (Figures 7, 9, 10, 11). Organic-rich sediments characterise the Botneheia Formation and the lower prodeltaic parts of the Bravaisberget Formation; these organic-rich shales have been studied for their interesting hydrocarbon source potential (Mørk and Bjorøy 1984, Leith et al. 1993). The Botneheia Formation shows TOC values up to 10%, with a preponderance of marine kerogens, especially in eastern Svalbard. The presence of oil and bitumen in the cracks of septarian concretions led to the early name 'Oil Shale' for this unit in eastern Svalbard; the shales are, however, generally immature as regards hydrocarbon generation in this area.

Sedimentation did not start on the Sørkapp–Hornsund High until the mid-Induan (Nakrem and Mørk 1991). Polymictic basal conglomerates on Sørkapp Land directly overlie metamorphic basement or Palaeozoic rocks of different ages (Birkenmajer 1977, Worsley and Mørk 1978, Dallmann et al. 1993) and the overlying Lower Triassic succession has a relatively condensed aspect (Figure 7).

Bjørnøya is the southernmost island in the Svalbard Archipelago and the Triassic succession there was studied by Pčelina (1972a) and Mørk et al. (1990), both studies noting the development of repeated transgressive/regressive cycles. Here, sedimentation started in the late Induan (Dienerian) and fine-grained clastics rest directly on upper Permian silicified dolomites. A phosphate nodule remanié conglomerate containing Anisian fossils rests on late Olenekian (Smithian) sediments with ammonoids. This conglomerate may represent remains of the Anisian succession similar to that on Spitsbergen, and erosion and condensation must have taken place in the late Anisian/early Ladinian as the overlying sediments are dated to the Ladinian. The sedimentary and tectonic history of Bjørnøya on the Stappen High were summarised by Worsley et al. (2001), and this area shows a clear resemblance to other neighbouring positive structural elements in the Barents Sea, such as the Loppa High farther to the southeast and the Sørkapp-Hornsund High on Spitsbergen itself. All display Triassic clastic sediments progressively onlapping older basement and Upper Palaeozoic sequences. The Loppa High shows the most extreme development, where the crest of the high was not transgressed until the mid-Triassic.

The stepwise transgression seen in these areas is restricted to these local highs and platforms and both central Spitsbergen and southwestern basins were probably sites of almost continuous sedimentation from the late Permian to early Triassic (Mørk et al. 1989). In the Barents Sea, Permian to Triassic beds have been penetrated by shallow stratigraphic cores on the Svalis Dome (Nilsson et al. 1996, Vigran et al. 1998) and on the Finnmark Platform off the coast of northern Norway (Bugge et al. 1995), where the lowermost section of fine-grained clastics resting concordantly on the upper Permian resembles the Sassendalen Group succession of onshore Svalbard. Deep wells drilled in the Hammerfest Basin show continuous and up to 900 m-thick sequences ranging from the latest Permian, which have also been assigned to the Sassendalen Group (Worsley et al. 1988). Lower to middle Triassic successions in wells drilled to date indicate repeated coastal progradations from the Baltic Shield and from the newly developed Urals to the southeast, (Riis et al. 2008, Glørstad-Clark et al. 2010, 2011), but generally without any major coarse clastic input from the shield itself, apart from the lower to middle Triassic reservoirs of the Goliat Field. Through much of the early to mid-Triassic, most of the south-western shelf was distal to an oscillating, but generally northwesterly prograding, coastline, with sand provenance being first from the Baltic Shield and then increasingly derived from the Urals (cf., Mørk 1999). By the mid-Anisian, a NNE-trending system of clinoforms, prograding to the west-northwest, extended over the Hammerfest Basin and on to the Bjarmeland Platform; these clinoforms may have been situated close to the palaeocoast, with the possibility for sand deposition in delta-front/shoreface environments (Rasmussen et al. 1993, Van Veen et al. 1993). Hydrocarbon-bearing sandstones in the Kobbe

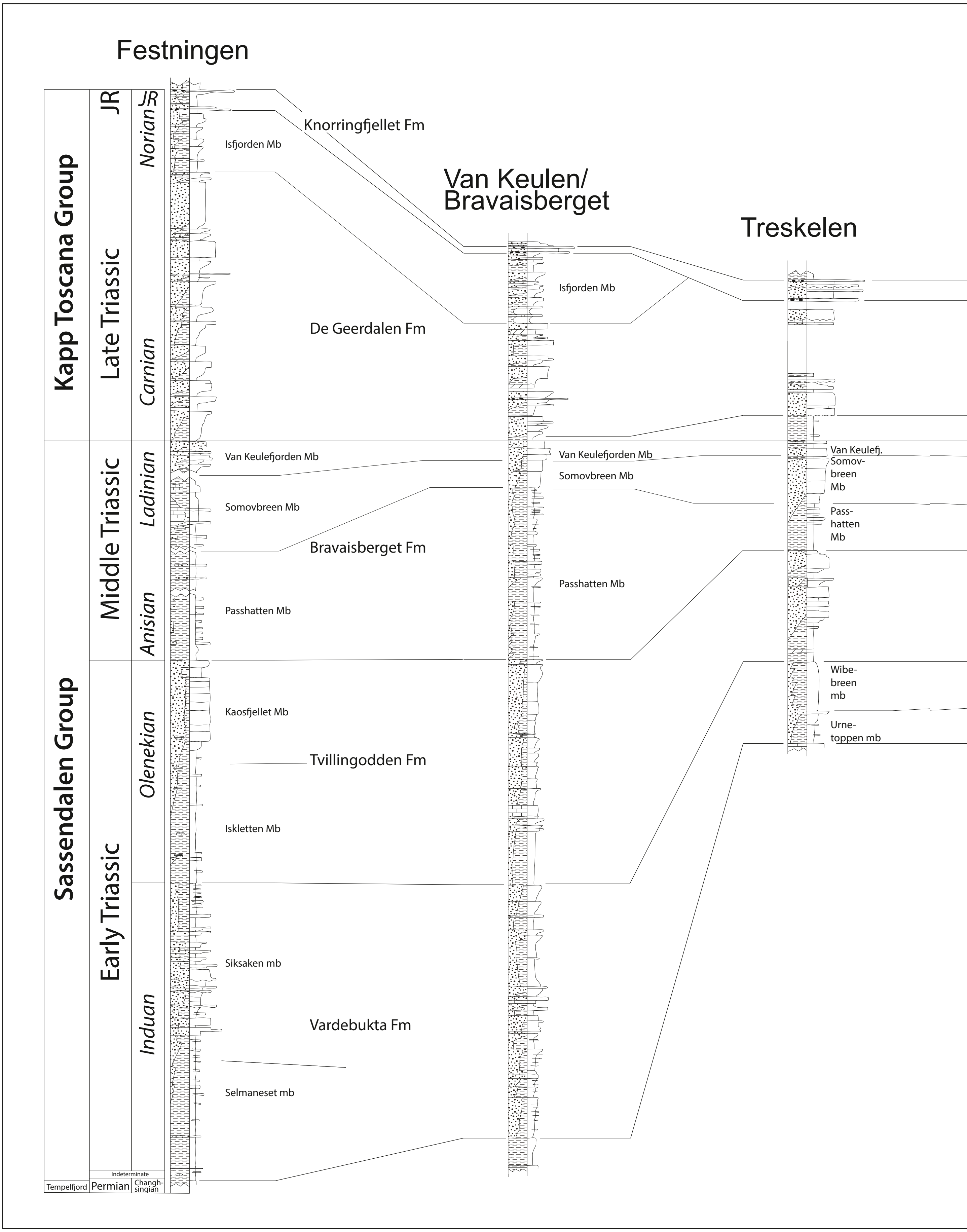
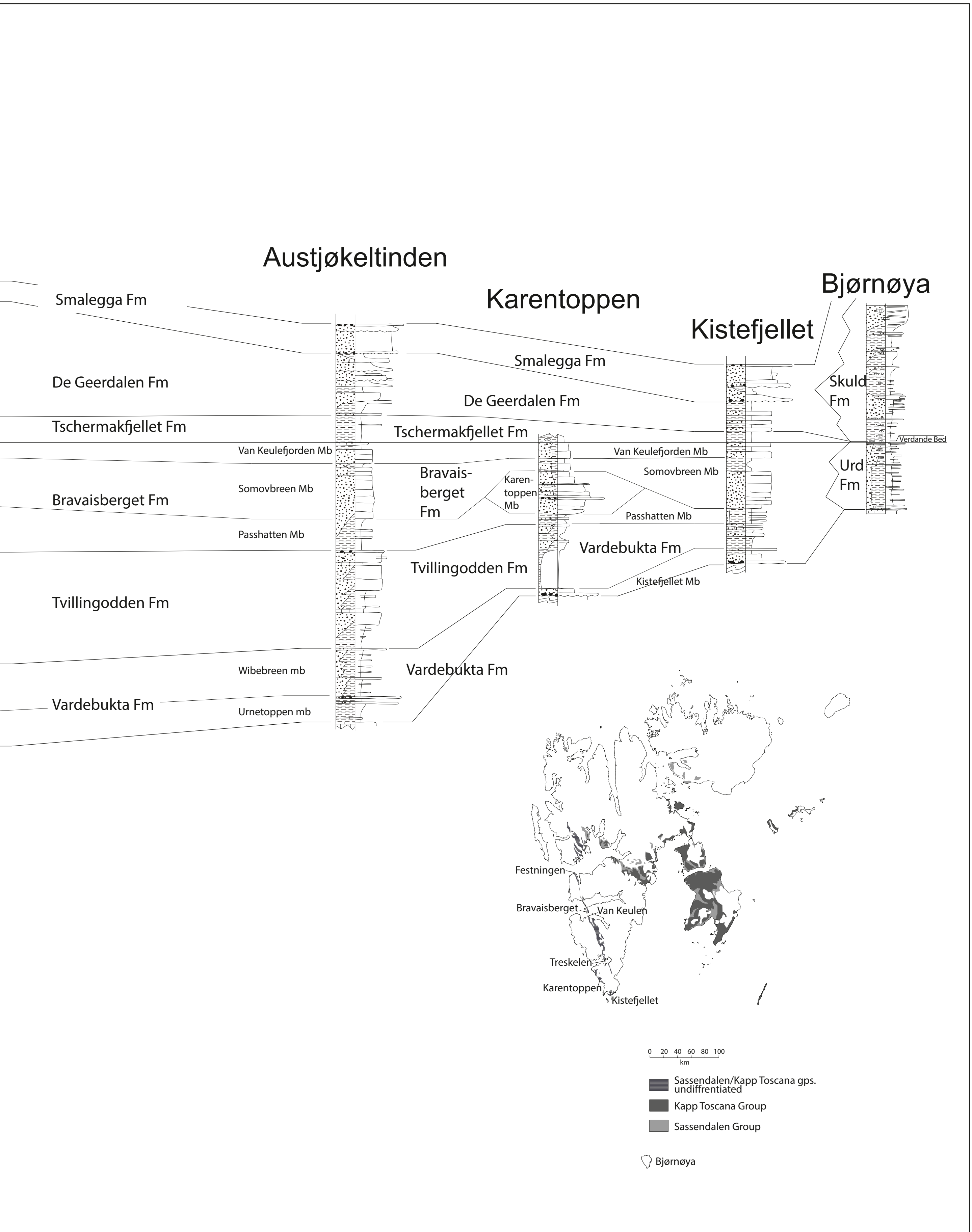


Figure 7. Lithostratigraphical development along western Spitsbergen.


Austjøkeltinden
Karentoppen
Kistefjellet
Bjørnøya
Smalegga Fm
De Geerdalen Fm
Tschermakfjellet Fm
Van Keulefjorden Mb
Somovbreen Mb
Bravaisberget Fm
Passhatten Mb
Tvillingodden Fm
Wibebreen mb
Vardebukta Fm
Urnetoppen mb
Smalegga Fm
De Geerdalen Fm
Tschermakfjellet Fm
Bravais-
berget
Fm
Karen-
toppen
Mb
Van Keulefjorden Mb
Somovbreen Mb
Passhatten Mb
Vardebukta Fm
Tvillingodden Fm
Kistefjellet Mb
Vardebukta Fm
Skuld
Fm
Verdande Bed
Urd
Fm
Festningen
Bravaisberget
Van Keulen
Treskelen
Karentoppen
Kistefjellet
0 20 40 60 80 100
km
Sassendalen/Kapp Toscana gps. undiffrentiated
Kapp Toscana Group
Sassendalen Group
Bjørnøya

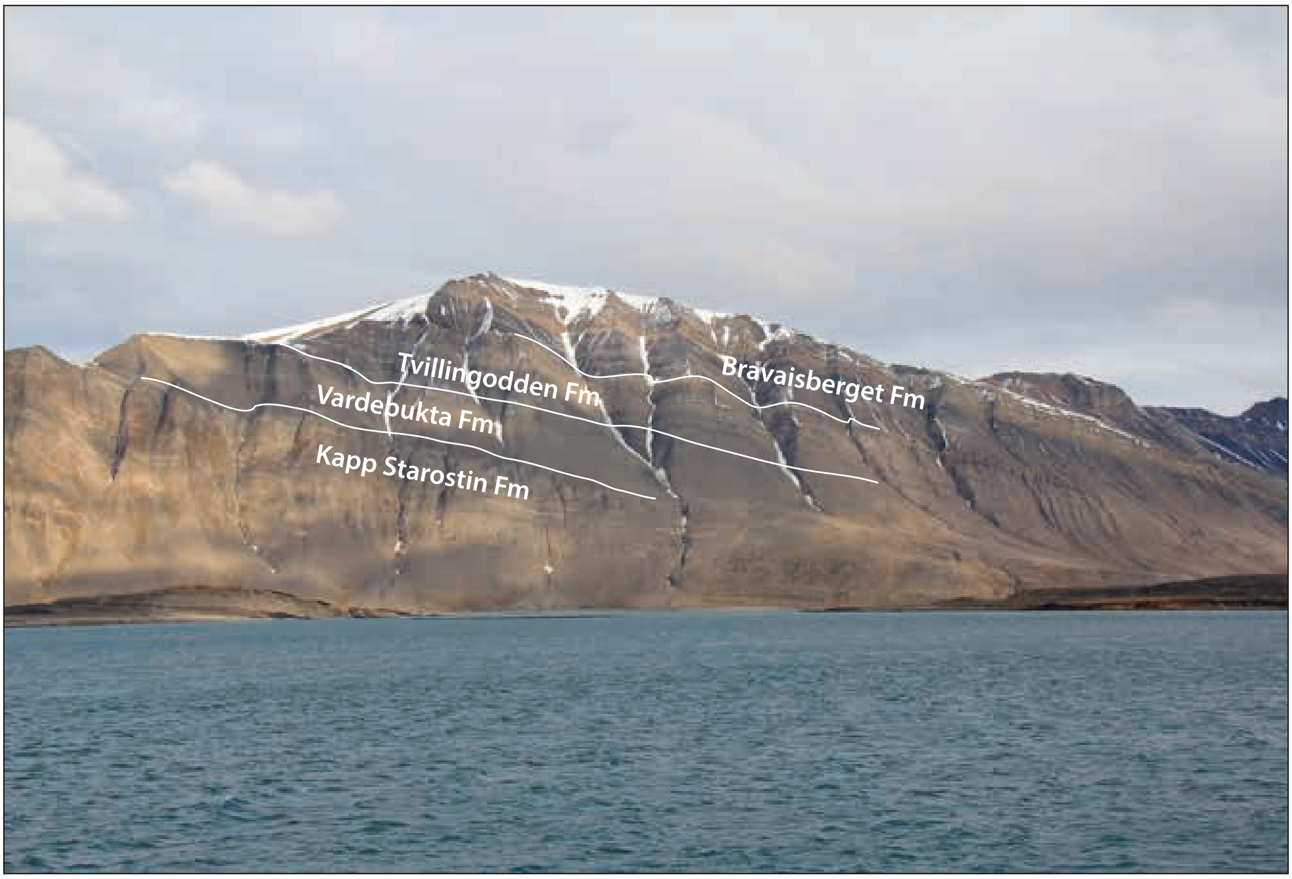


Figure 8. Bravaisberget on Western Spitsbergen. Overlying the Permian Kapp Starostin Formation, the Vardebukta, Tvillingodden and Bravaisberget formations form the Sassendalen Group.

Formation of the Statoil Obesum find belong to this trend. The Obesum hydrocarbon source rocks are not yet in the public domain, but they are likely to be organic-rich shales, which are time-equivalents of the Botneheia Formation.

Upper Triassic to Middle Jurassic Kapp Toscana Group

The Kapp Toscana Group includes sediments ranging in age from the Ladinian (southwestern Barents Shelf) or Carnian (Svalbard) to the Bajocian/Bathonian, all with greater sandstone content than underlying units. The group has a composite thickness of up to 475 m on Svalbard, thickening to over 1,000 m in southern shelf areas. Two major subdivisions represent quite different sedimentational regimes. The Ladinian to lowermost Norian Storfjorden Subgroup shows major deltaic progradations, still mainly from southeastern provenance areas, with high subsidence and depositional rates. The overlying mid-Norian to Bathonian Wilhelmøya (Svalbard Platform) and Realgrunnen (southwestern shelf) subgroups represent coastal to shallow-marine regimes, with lower rates of deposition and extensive marine reworking.

Prodeltaic shales of the Ladinian Tschermakfjellet Formation and deltaic deposits of the Carnian to early Norian De Geerdalen Formation thicken eastwards and northeastwards over the archipelago (Figures 9, 10), in contrast to the western depocentre indicated by underlying units (Lock et al. 1978, Mørk et al. 1982). Most localities, especially in western and central Spitsbergen, demonstrate the dominance of shallow marine reworking and redistribution of deltaically

Figure 9. Blanknuten on western Edgeøya. The whole Triassic succession is exposed in this mountain. A = the gorge with the type Section 22a of the Blanknuten Bed. B = Section 22c along the ridge of Blanknuten. C = Section 22b up the cliff of Blanknuten. D = the hypostratotype of the Blanknuten Bed.

introduced sediments. Deltaic incursions from the west decreased through the Carnian, while progradation from eastern provenance areas provided ongoing dramatic influx of texturally and mineralogically immature sands. New data from the northern Barents Sea east of Hopen show major clinofoms representing an extensive northwesterly directed deltaic progradation in this area, continuing the trend already initiated further to the southeast in the Anisian (Riis et al. 2008, Glørstad-Clark et al. 2010, 2011, Høy and Lundschien 2011). Subsurface sequences in southwestern shelf areas are also dominated by coastal progradations.

In the Norian, a transgression resulted in a dramatic change in depositional regimes throughout the region. Western and central Spitsbergen were now a largely emergent platform, only transgressed at times of maximum highstand, with preserved exposures showing only a few metres of condensed and fragmentary sequences. The Billefjorden Lineament was reactivated and eastern areas show a thicker (<200 m) and somewhat more complete latest Triassic to mid-Jurassic succession. Southwestern shelf areas, especially the Hammerfest Basin, show a mineralogically mature sandstone-dominated sequence ranging in age from the Norian to Bajocian and up to 500 m thick (Worsley et al. 1988, Bergan and Knarud 1993, Worsley 2008).

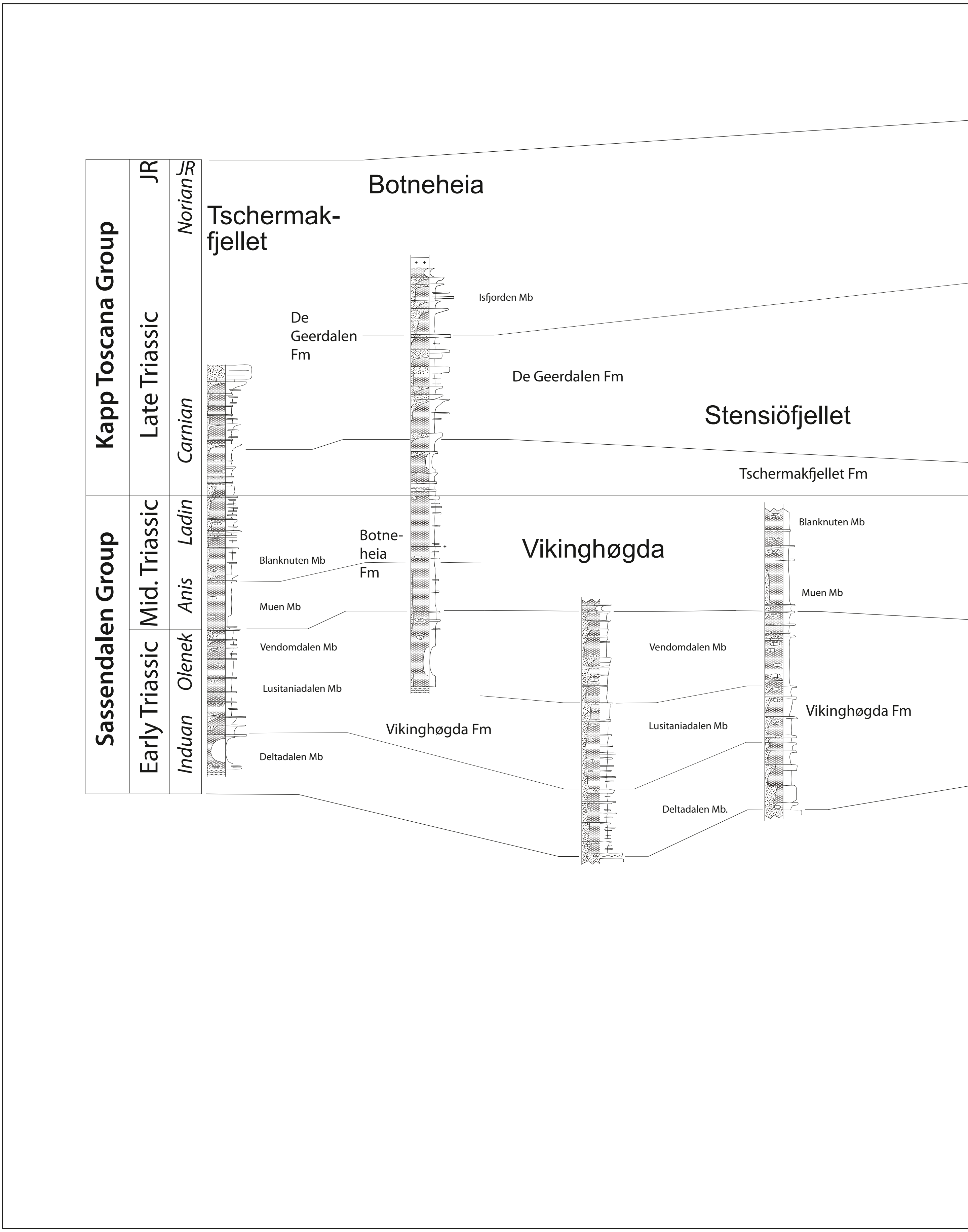
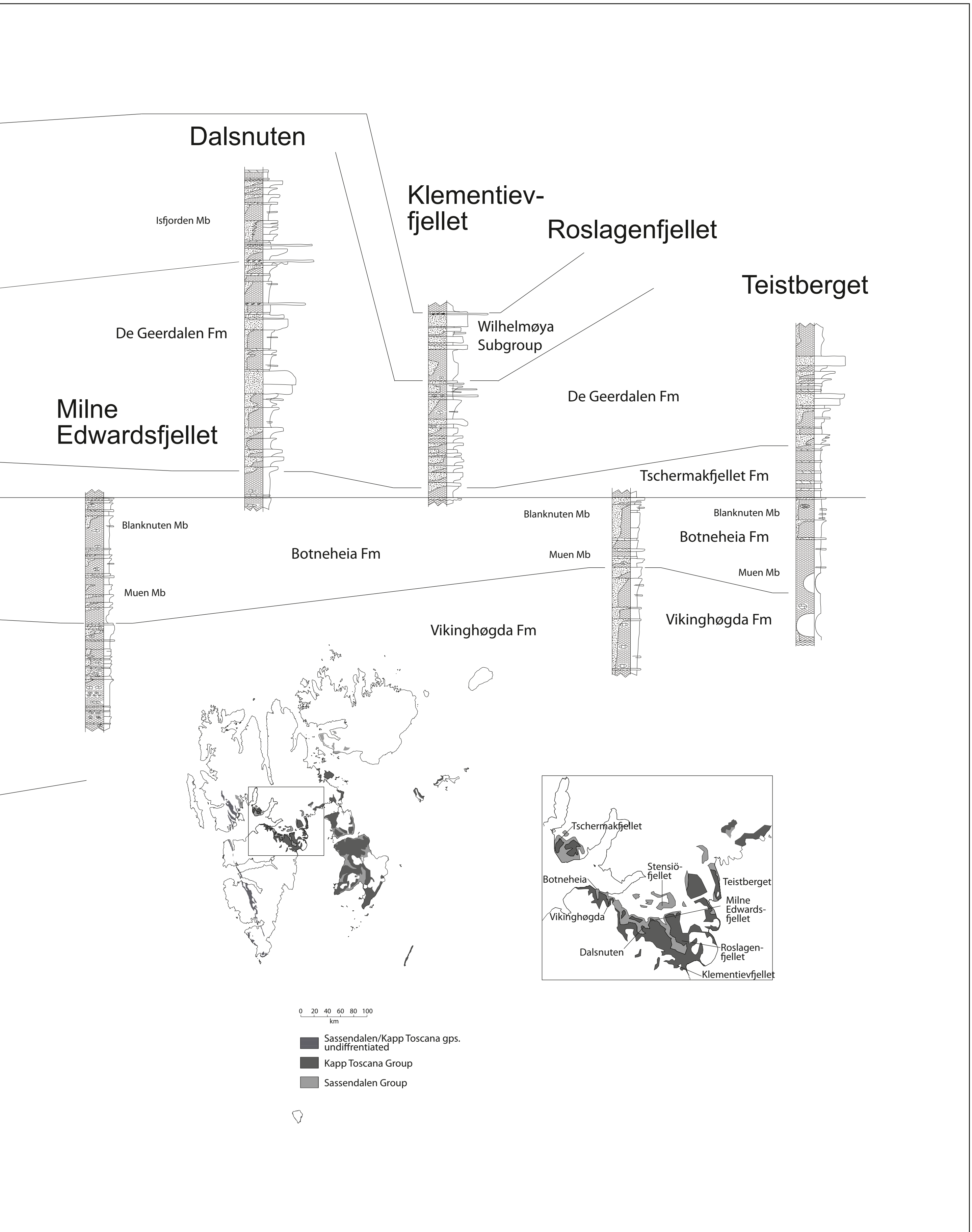


Figure 10. Lithostratigraphical development west-east across central Spitsbergen.



Dalsnuten
Isfjorden Mb
De Geerdalen Fm
Klementiev-
fjellet
Roslagenfjellet
Wilhelmøya
Subgroup
De Geerdalen Fm
Teistberget
Milne
Edwardsfjellet
Tschermakfjellet Fm
Blanknuten Mb
Botneheia Fm
Muen Mb
Blanknuten Mb
Muen Mb
Blanknuten Mb
Botneheia Fm
Muen Mb
Vikinghøgda Fm
Vikinghøgda Fm
Tschermakfjellet
Stensiö-
fjellet
Botneheia
Teistberget
Milne
Edwards-
fjellet
Vikinghøgda
Dalsnuten
Roslagen-
fjellet
Klementievfjellet
0 20 40 60 80 100
km
Sassendalen/Kapp Toscana gps. undiffrentiated
Kapp Toscana Group
Sassendalen Group

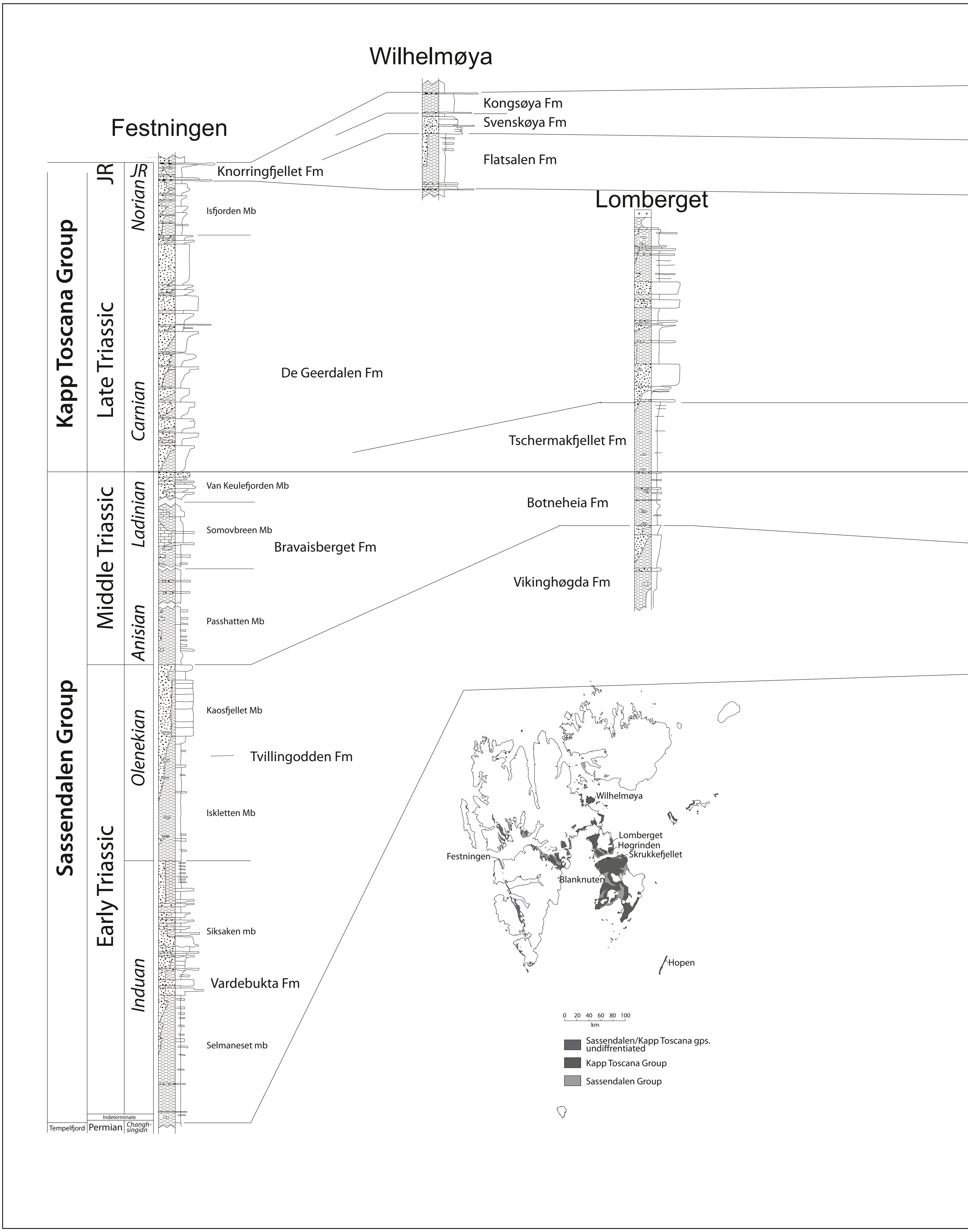
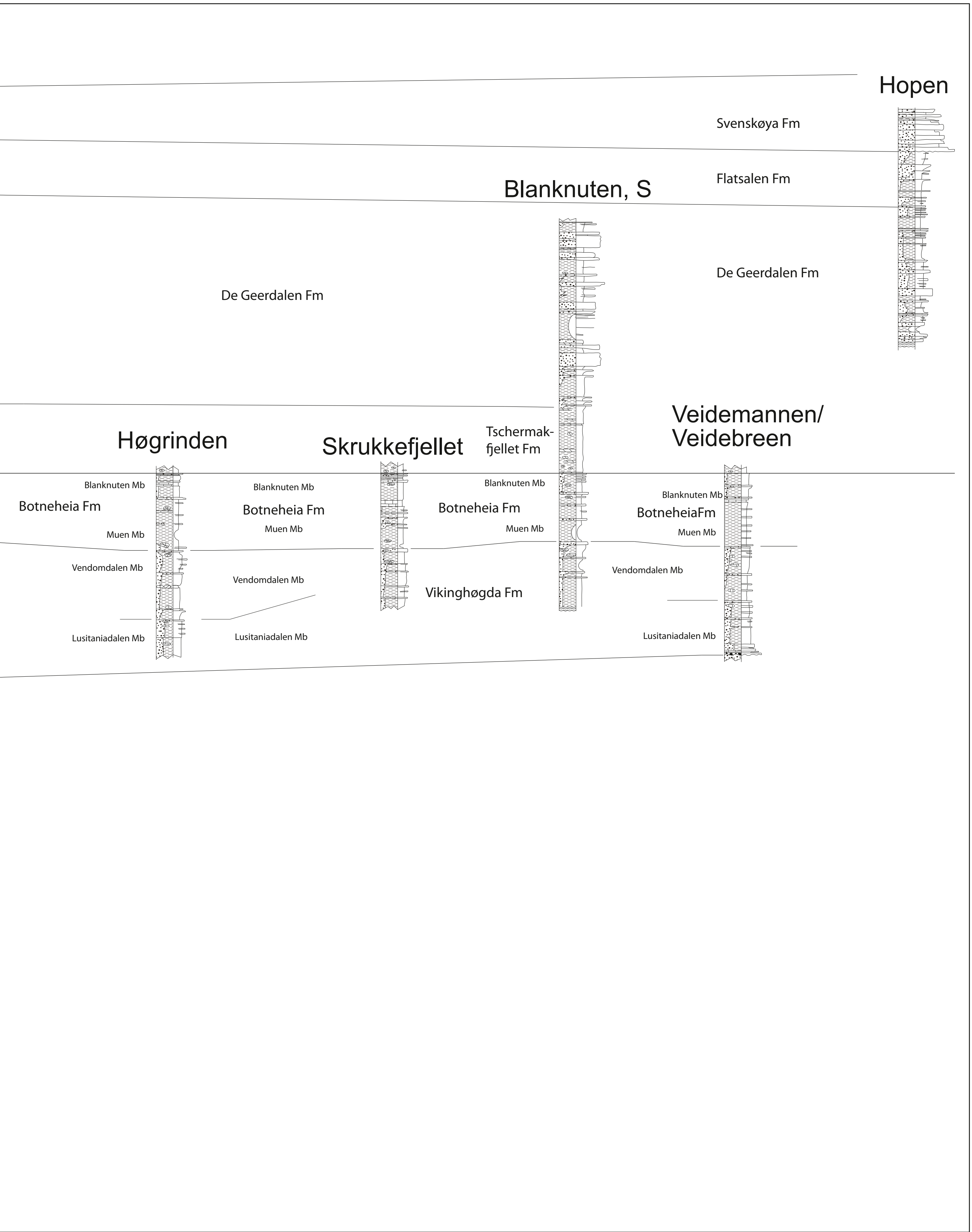


Figure 11. Lithostratigraphial development through the eastern Islands of Svalbard to Bjørnøya, with the Festningen section as reference.



Hopen
Svenskøya Fm
Flatsalen Fm
De Geerdalen Fm
Blanknuten, S
De Geerdalen Fm
Veidemannen/
Veidebreen
Høgrinden
Skrukkefjellet
Tschermak-
fjellet Fm
Blanknuten Mb
Botneheia Fm
Muen Mb
Vendomdalen Mb
Lusitaniadalen Mb
Blanknuten Mb
Botneheia Fm
Muen Mb
Vendomdalen Mb
Lusitaniadalen Mb
Blanknuten Mb
Botneheia Fm
Muen Mb
Vikinghøgda Fm
Blanknuten Mb
BotneheiaFm
Muen Mb
Vendomdalen Mb
Lusitaniadalen Mb

Triassic arctic sequences

The transgressive/regressive sequences of Svalbard and the Barents Shelf can be compared with those of the Sverdrup Basin and East Siberia, focusing on the very good correlation of transgressive beds which also mark stage boundaries, indicating a global synchroneity for these sequences (Embry 1997, Egorov and Mørk 2000, Mørk and Smelror 2001, Embry and Mørk 2006), (Figure 12), all located on the northern margin of Pangaea facing the Panthalassa Ocean (Figure 13). The general similarities of the different Arctic Mesozoic successions have previously been noted in detailed stratigraphical and palaeontological studies by many workers. The transgressive/regressive cycle patterns of Svalbard, the Barents Shelf and the Sverdrup Basin (Embry 1988, Mørk et al. 1989) clearly parallel each other, as do those of Svalbard, the Barents Shelf and eastern regions (Mørk et al. 1993) and such cycles have now been correlated throughout the Arctic (Egorov and Mørk 2000) (Figure 12).

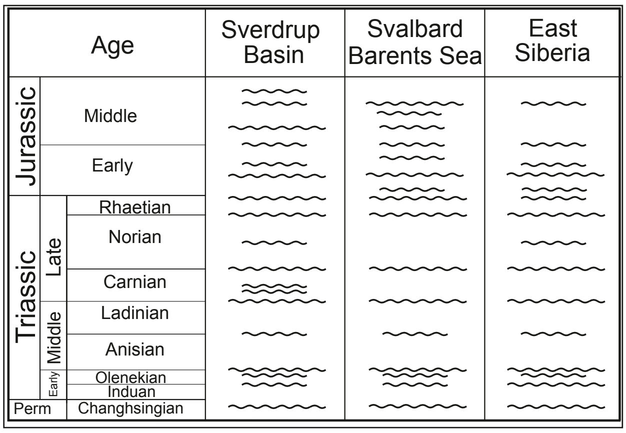


Figure 12. Correlation of sequence boundaries throughout the Arctic, modified from Egorov and Mørk (2000).

Franz Josef Land represents the northernmost Triassic exposures on the Barents Shelf and displays an almost 5,000 m-thick Triassic succession. Only the uppermost 800 m are exposed, while the lower parts have been penetrated by three wells, which show important differences through the archipelago. The whole Triassic succession, however, seems to form one major megasequence (Preobraženskaja et al. 1985a, b, Dypvik et al. 1998) composed of subcycles mainly corresponding to stages and substages, arranged in coarsening-upward patterns indicating a similar cyclicity as described for Svalbard and the Sverdrup Basin (Mørk et al. 1989). Only coarse clastics of Early Triassic age have been reported from Novaya Zemlya, but on Kolguyev Island a thick succession (<1317 m represented by four formations) continues from the Timan–Pechora Basin (Gramberg et al. 1988). Lower and Middle Triassic clastics also continue offshore further into the southeastern Barents Shelf, where a more than 1500 m-thick development has been reported. The Lower Triassic there comprises multicoloured, red and grey fine-grained clastics with sandstone interbeds decreasing in abundance into the Middle Triassic. In the Upper Triassic, grey mixed clastics are similar to those extending over large parts

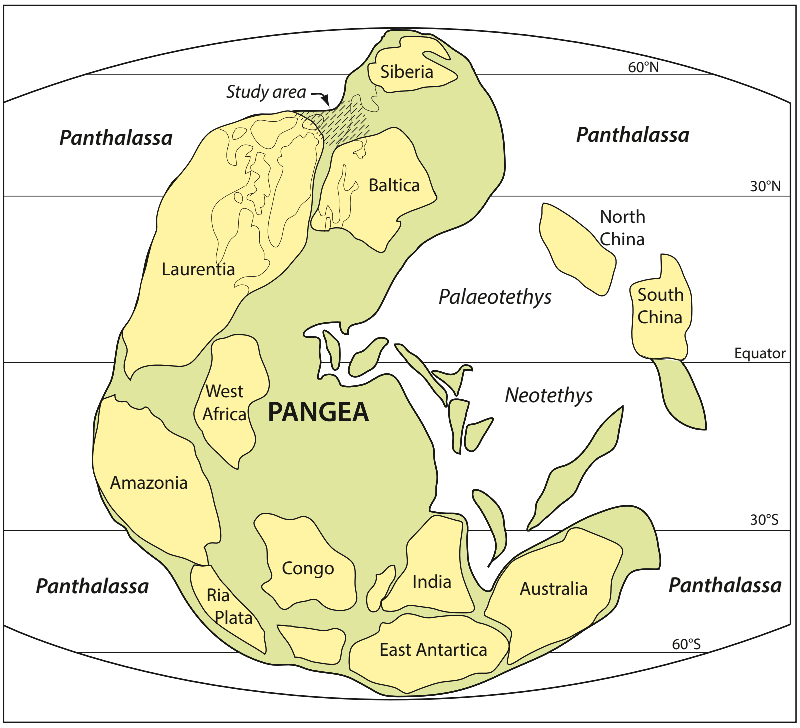


Figure 13. Localisation of the study area on the northern margin of the Pangea supercontinent facing the world ocean Panthalassa. Base map from Torsvik and Cocks (2005).

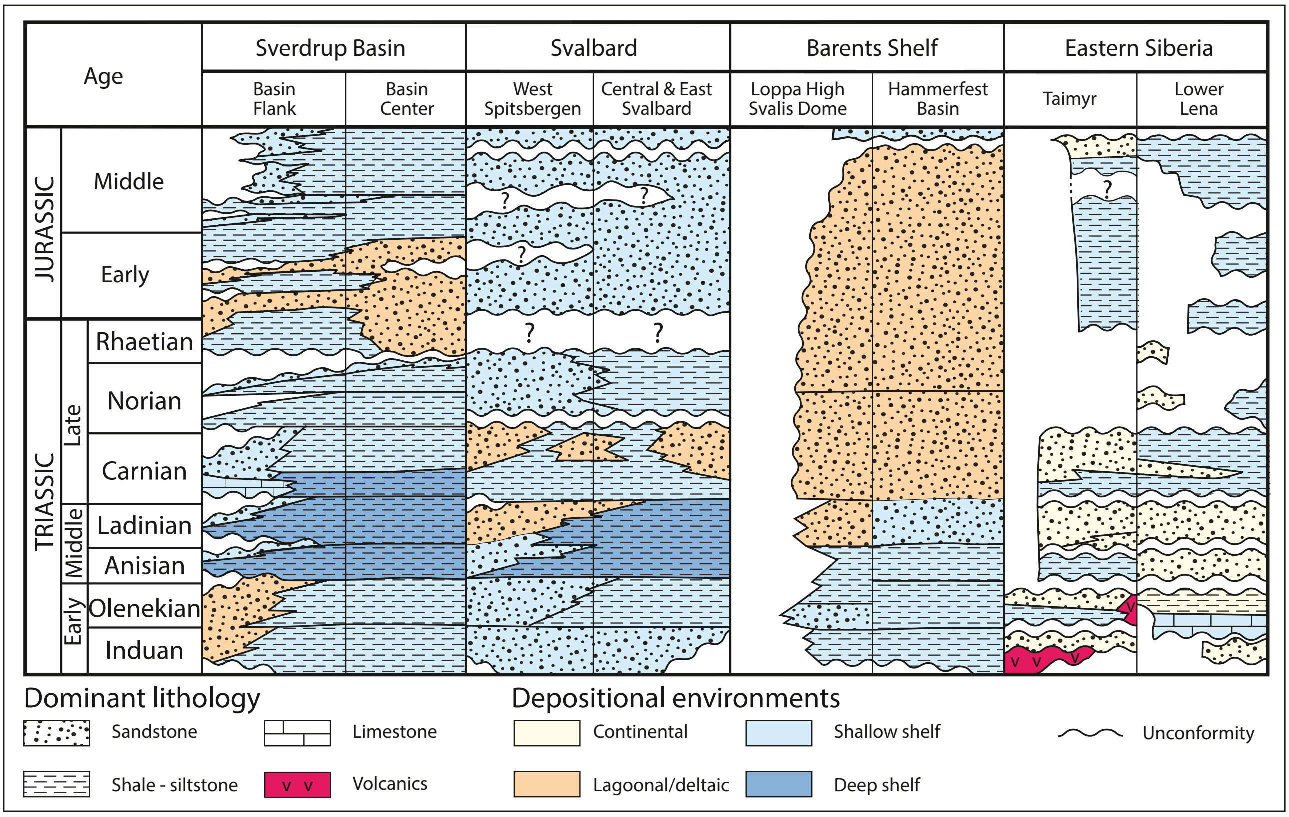


Figure 14. Correlation of sequences throughout the Arctic, modified from Mørk and Smelror (2001).

of the Barents Shelf and represent coastal-marine depositional environments, with increasing local marine influence upwards.

A circum-Arctic comparison and evaluation of Triassic transgressive/regressive sequences was presented to the Subcomission on Triassic Stratigraphy at a symposium in 1991 (Mørk 1994). This reflected data gathered on a field excursion in East Siberia, which enabled Siberia to be incorporated into the Svalbard–Sverdrup Basin framework (Weitschat and Dagys 1989, Dagys and Weitschat 1993), (Figure 14). The fact that these circum-Arctic transgressions all started very early in a stage, as dated by the fossil acmes in the transgressive systems tracts, was further extrapolated to imply that these transgressions had a much wider geographic extension than the boreal areas of the AmEurAsian plate (Mørk 1994, Embry 1997, 2006, Embry and Mørk 2006).

The indication of a fixed number of high-order sequences throughout the Boreal Triassic that can be further recognised world-wide implies a common control on the formation of these sequences, a suggestion leading to the idea of global tectonics as the driving force (Embry 2006, Embry and Mørk 2006). In comparison to the high correspondence of Triassic sequence boundaries throughout the Arctic, Jurassic sequence boundaries also show a fairly good correlation (cf., Smelror 1994), while the correlation of Cretaceous sequence boundaries is poor (Mørk and Smelror 2001). This indicates major global control of the development of the Triassic sequences while variations in age and development of the Jurassic and Cretaceous sequence boundaries indicate progressively greater effects of local to regional tectonic processes, possibly as a response to the break-up of the Pangaea Supercontinent, followed by the development of the present-day Polar Basin.

Local lithostratigraphical variation

The lithostratigraphical subdivisions in this contribution generally follow the revision presented in the Lithostratigraphic Lexicon of Svalbard (Mørk et al. 1999a). The only revisions since that work have been a more detailed description and slightly revised type section of the Bravaisberget Formation by Krajewski et al. (2007) and a redefinition of the Botneheia Formation type section at Edgeøya, introducing a lower Muen Member (Krajewski 2008). We have adopted the nomenclature presented in these two contributions, but present our own lithological sections to ensure comparison with our other sections. We have now defined the Hopen Member as the upper part of the De Geerdalen Formation on Hopen (Mørk et al. 2013) (Figure 15) and it correlates with the Isfjorden Member

Figure 15. Photo 15 Lyngefjellet at Hopen. A = Section 32a, B is the approximate location of palynological samples presented in column LYN and LY in Table A.23.1 and A.23.2 plotted along the Section 32a, and C and D is the composite Section 32b, while E is the approximate location of samples presented in column LYS in Table A.23.1 and A.23.2.

Figure 16. The Triassic succession at Miseryfjellet, Bjørnøya. The cliff is formed by the limestones of the Miseryfjellet Formation, which overlie Devonian clastics.

of Spitsbergen. The type section of the Flatsalen Formation at Hopen has been amended after fieldwork in 2012, and the formation is now also recognised on eastern Spitsbergen. We still retain the local lithostratigraphy of Bjørnøya (Figure 16) (Mørk et al. 1990), although we recognise the close similarities with both Svalbard and southern Barents Sea nomenclature.

Below we present stratigraphical sections from throughout Svalbard (Figure 17). For simplicity these are grouped together in areas with similar developments (Table 1). An overview of all sections has been presented in the panels Figures 7, 10, 11. A legend to the figures is given in Figure 18.

Table 1. Areas used for description of the geological successions.
Outer Isfjorden – Bellsund
Hornsund - Sørkapp Land
Central to eastern Spitsbergen
Wilhelmøya
Barentsøya and Edgeøya
Hopen
Bjørnøya

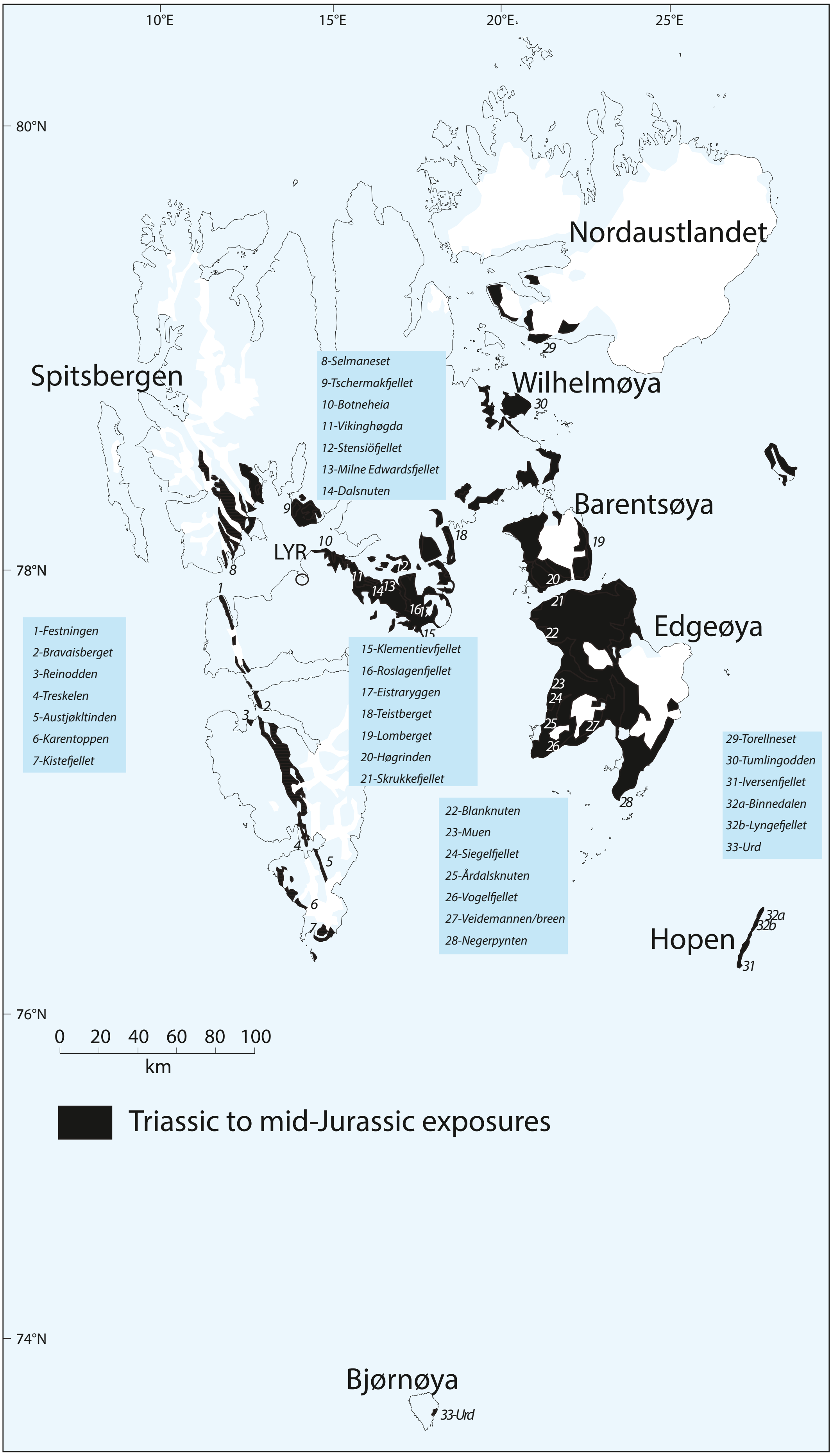


Figure 17. Locality map with the studied sections from Svalbard.

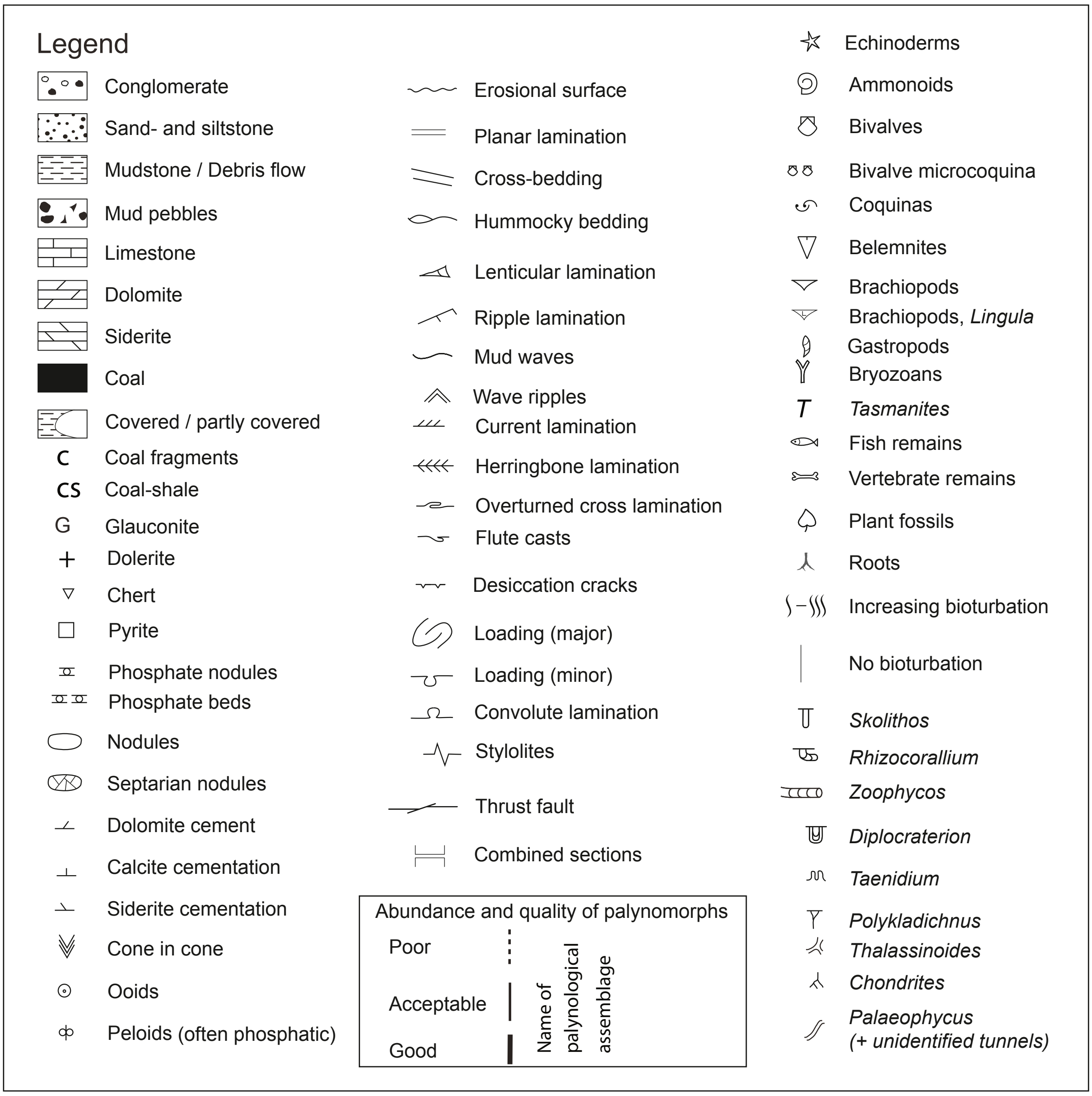
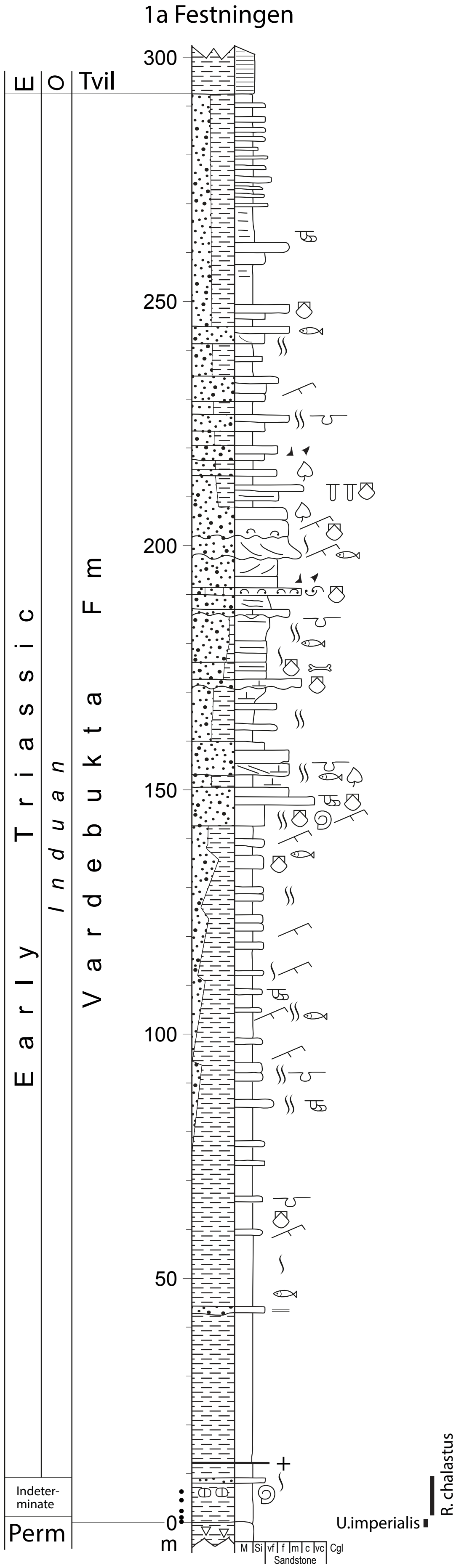


Figure 18. Legend to sections.

Stratigraphical sections



Outer Isfjorden–Bellsund
(Sections 1–3, Figures 19–26)

This area contains the thickest and most complete succession exposing all unit boundaries. The shore exposures west of Festningen clearly show all units at sea level because early Cenozoic folding has folded the rocks into steeply dipping to vertical exposures. Numerous faults have intersected the sediments and make thickness estimates uncertain. The most extensive folding has taken place in the shales of the Bravaisberget Formation. The same pattern is also seen north of Isfjorden, at Selmaneset, where safe thickness estimates could not be made. We thus only present palynological results from there, accepting that the samples have been collected in correct succession. In Bellsund our composite section is from Bravaisberget, Bravaisodden and Kapp Toscana.

Figure 19a. Section 1a Festningen – Vardebukta Formation. The section was measured by S. Johnsen, A.W. Forsberg and A. Mørk. The lithostratigraphical transition from the underlying Kapp Starostin Formation to the Vardebukta Formation takes place over a few centimetres, where soft shales rest on well cemented siliceous shale. No evidence of erosion or exposure is seen at this boundary. The lowermost part of the succession is almost devoid of any trace fossils, but the ammonoid Otoceras boreale *is found in these beds (Korchinskaya 1986 and AM pers. obs.).*
*The lower 150 m forms a coarsening upwards succession grading into a bivalve rich (*Myalina *sp.) bank deposit 70 m thick. A* Skolithos *rich bed overlain by a plant fragment rich unit marks the shallowest part of the succession, interpreted as a barrier and lagoonal sequence. A slow transgression then resulted in gradually finer sediments towards the top of the formation.*

Figure 19b. The base of the Vardebukta Formation is on top of the silicified shale to the right, while the Permian – Triassic boundary is some metres above, in the shale. A diabase sill forms the cliff at the right side of the photo.

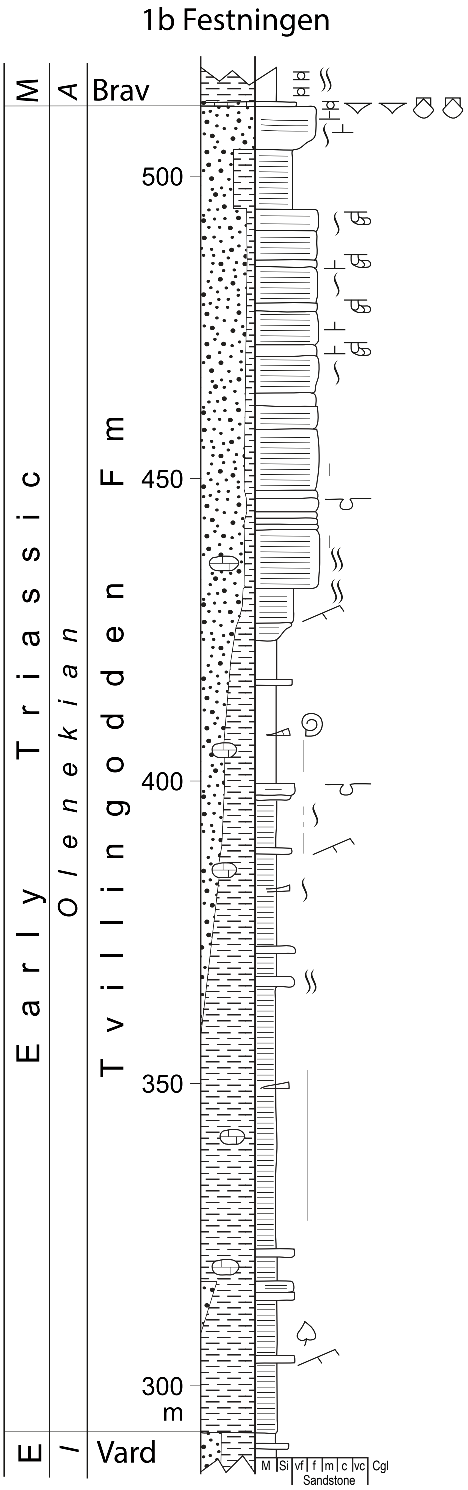


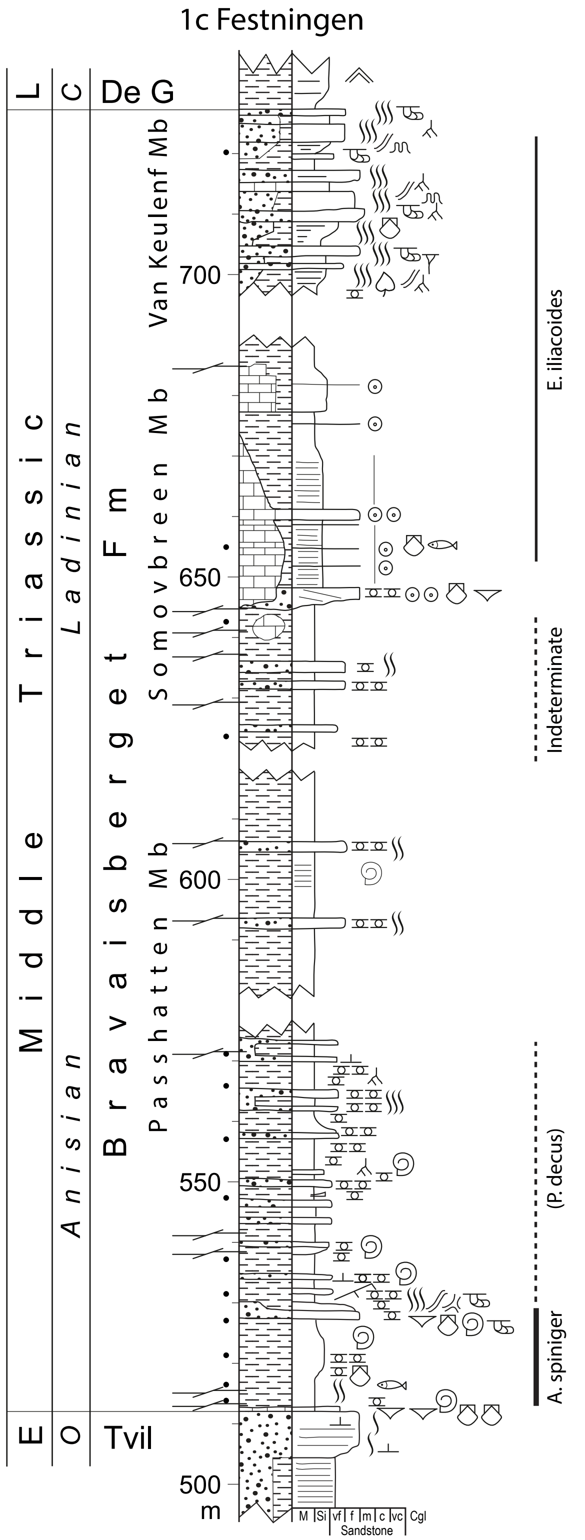
Figure 20a. Section 1b Festningen – Tvillingodden Formation. The section was measured by S. Johnsen, D. Worsley and A. Mørk. At base finely laminated unbioturbated mudstones rest directly on top of silty shales of the underlying unit. The formation displays a pronounced coarsening upward succession and the upper 70 m consist of moderately bioturbated silt to very fine-grained sandstone. In the upper part improved living conditions are demonstrated by a succession of larger Rhizocorallium *trace fossils (Worsley and Mørk 2001).*

Figure 20b. The steeply dipping beds consist of siltstone and very fine-grained sandstone forming the top of the Tvillingodden Formation. The boundary to the Bravaisberget Formation is where dark shale overlies the sandstones.

Figure 21a. Section 1c Festningen – Bravaisberget Formation. The section was measured by A. Mørk. Extensive tectonic disturbance has taken place in this unit, making it impossible to measure a complete section through the formation. The regional flooding event at its base is marked by a conglomeratic sandstone rich in bivalves and brachiopods. The lower part (approximately 60 m) consists of dark shale with abundant siltstone beds. Phosphate nodules occur on bedding surfaces and as reworked phosphate conglomerates, often at bases of siltstone beds. These nodules were interpreted as modified Thalassinoides *trace infillings by Mørk and Bromley (2008). Poorly preserved phosphatised ammonoids are abundant.*
The lower middle part of the succession is dominated by dark shale, but with some siltstone beds rich in phosphate nodules. These two lower parts of the unit constitute the Passhatten Member.
The middle upper part of the succession (around 650 m on the figure) grades into a finely laminated limestone consisting of phosphatised ooids and small fossil fragments forming a local bank. There are no other distinctive sedimentary structures. This part of the formation is included in the Somovbreen Member.
The upper 25 m consist of very strongly bioturbated, chert and dolomite-cemented, very fine-grained sandstones. Abundant interference ripple marks indicate shallow depositional depths. This interval is assigned to the Van Keulenfjorden Member.

Figure 21b. Massive siltstone beds with a basal phosphate conglomerates of the Passhatten Member.

Figure 21c. Folded shales uppermost in the Passhatten Member.



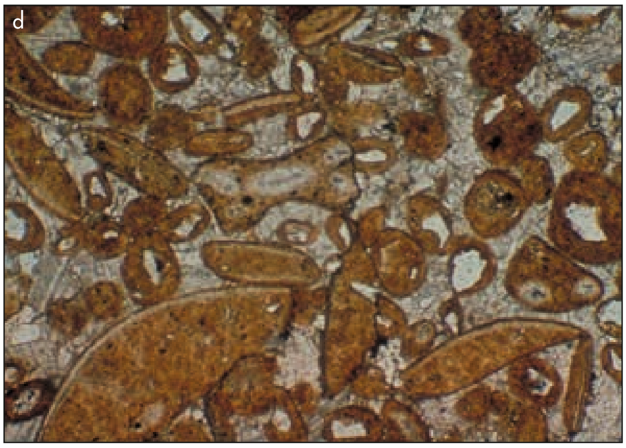


Figure 21d. Grainstone of shell debris and ooids, booth with phosphatic cementation. From the oolite bed in the Somovbreen Member.

Figrue 21e. A large Rhizocorralium *burrow from the Van Keulen-fjorden Member.*

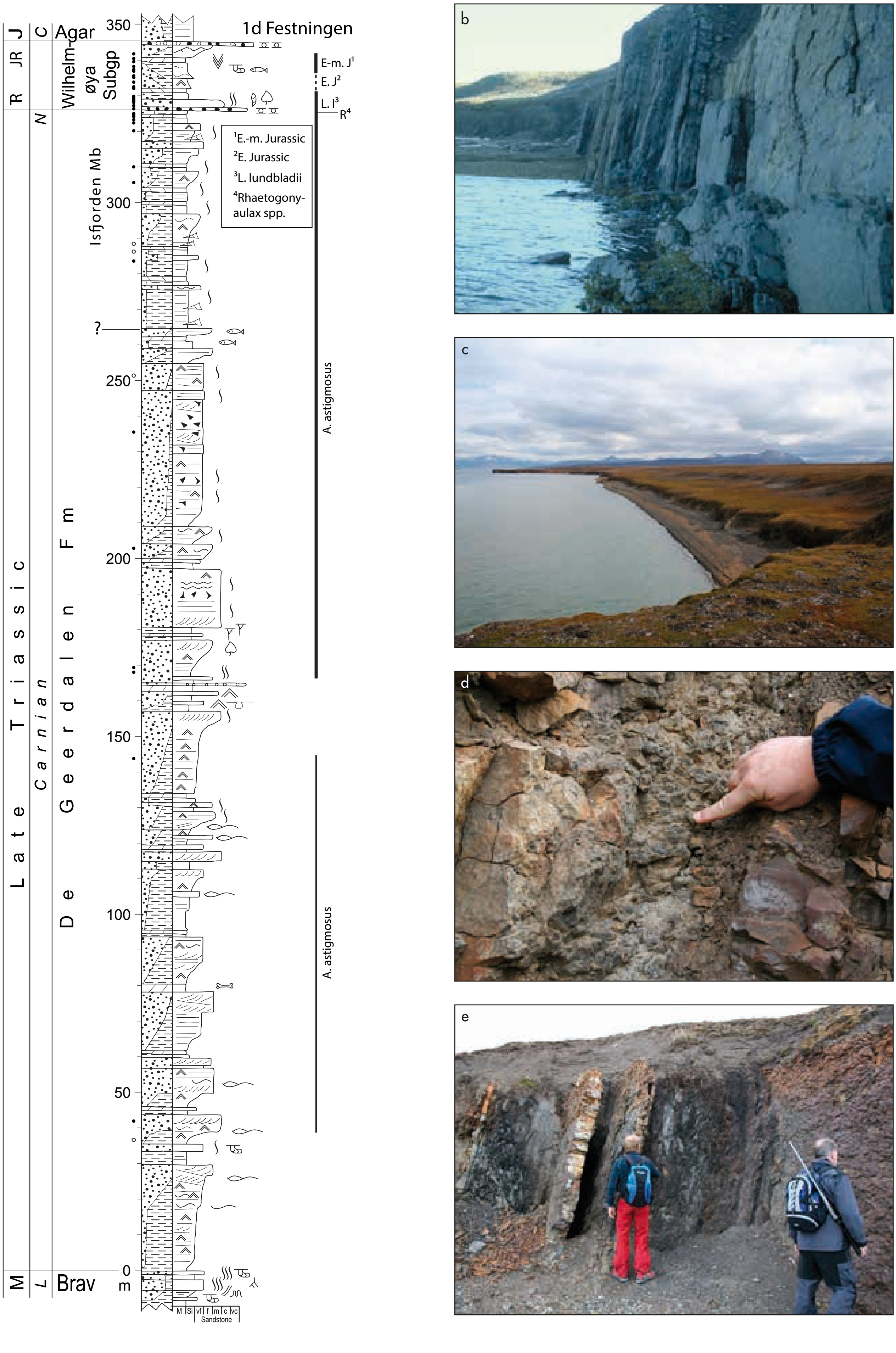

1d Festningen
Agar
Wilhelmøya Subgp
Isfjorden Mb
De Geerdalen Fm
Brav
Late Triassic
Carnian
N
L
C
J
JR
R
M
350
300
250
200
150
100
50
0
m
?
E.-m. J[1]
E. J[2]
L. l[3]
R[4]
[1]E.-m. Jurassic
[2]E. Jurassic
[3]L. lundbladii
[4]Rhaetogonyaulax spp.
A. astigmosus
A. astigmosus
M Si vf f m c vc
Sandstone
b
c
d
e

Figure 22a. Section 1d Festningen – Kapp Toscana Group. This succession was measured by R. Knarud. The Kapp Toscana Group is approximately 350 m thick. At the base a few metres of scree occur above the top of the Bravaisberget Formation. This scree may cover the Tschermakfjellet Formation which is either very thin or absent at this locality.
The De Geerdalen Formation is 325 m thick and consists of abundant coarsening upwards units ranging from a few to maximum 50 m in thickness. Thin carbonate beds (10-50 cm) occur repeatedly, and are either structureless or show irregular lamination. Sedimentary structures in sandstones are small and large scale cross-bedding and hummocky cross-bedding. Mud flake conglomerates are abundant in the upper (but not uppermost) part of the formation. Bioturbation is sparse. These observations indicate deposition in deep too moderately deep shelf environments.
The upper 60 m of the formation is shale dominated, and slightly more bioturbated. Red and green claystone is present. This interval is included in the Isfjorden Member.
The upper ca 20 m are assigned to the Knorringfjellet Formation of the Wilhelmøya Subgroup. At its base is a thin conglomerate of phosphate pebbles overlain by a highly burrowed sandstone bed. This conglomerate and sandstone are assigned to the Slottet Bed. The overlying succession consists of siltstones and siderite cemented beds that are strongly bioturbated. The top of the formation occurs in a creek where it is possible to excavate a phosphate conglomerate representing the Brentskardhaugen Bed.

Figure 22b. The top of the Van Keulenfjorden Member with the base De Geerdalen Formation at top.

Figure 22c. The De Geerdalen Formation at the Festningen section.

Figure 22d. The phosphatic conglomerate forming the Slottet Bed.

Figure 22e. The lower part of the Wilhelmøya Subgroup, with the Triassic – Jurassic boundary approximately in the eroded cave.

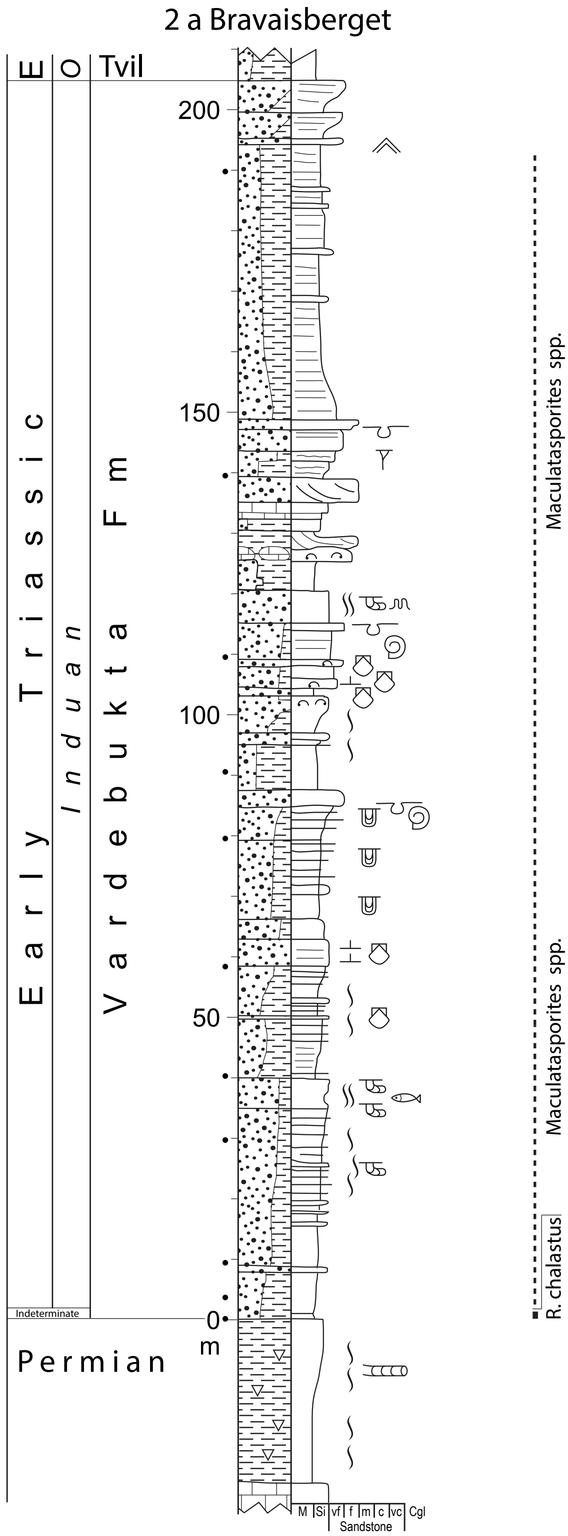
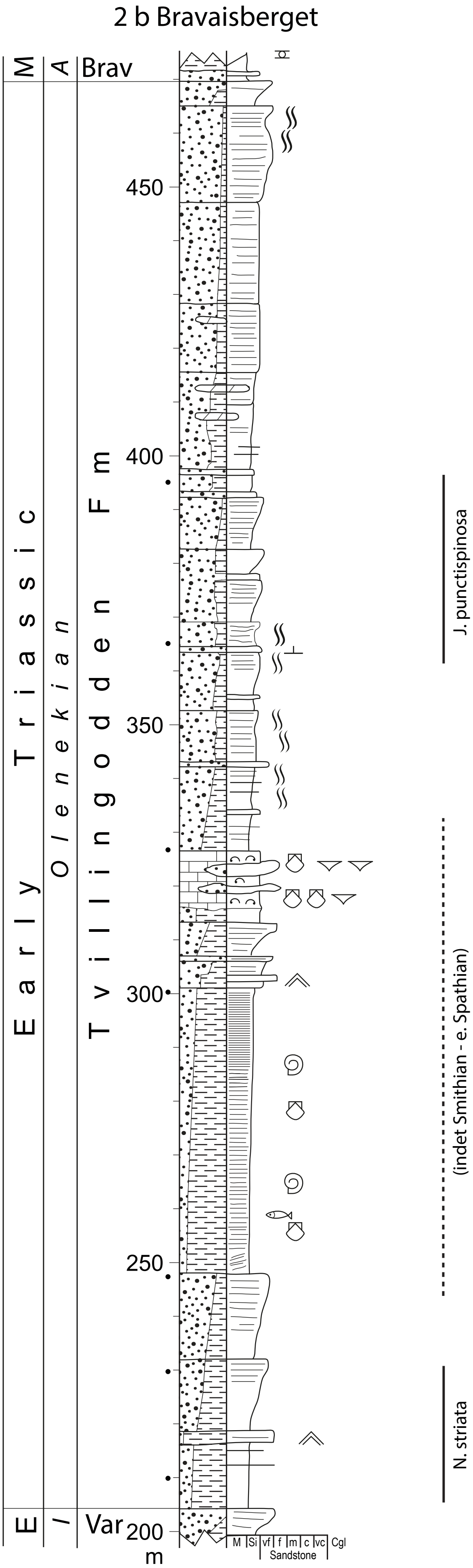


*Figure 23a. Section 2a Bravaisberget – Vardebukta Formation. The section was measured by A. Mørk, R. Knarud and A.W. Forsberg (see photo Figure 8). Soft silty shales rest sharply, but without any apparent erosion, on top of siliceous shales of the Kapp Starostin Formation. The Vardebukta Formation shows a coarsening upward succession grading from silty shale to fine-grained sandstone at between 100 and 150 m. The upper part is a fining upward succession of shale and siltstone. The coarsest beds have abundant bivalves (*Myalina*). No bioturbation is seen in the lower part, while moderate bioturbation, including the high energy form* Diplocraterion, *occurs in the middle part of the formation. The formation is interpreted as representing shelf sediments shallowing into a bar complex and then deepening again.*

Figure 23b. The Sassendalen Group at Bravaisberget forms three coarsening upwards successions on top of the cherty cliff of the Permian Kapp Starostin Formation.



The soft shales of the Vardebukta Formation rest with a sharp, but non-erosive, contact on the cherty shales of the Kapp Starostin Formation throughout this area. Distal shelf shales with storm siltstones grade up into bank deposits with abundant bivalves before a gradual transgressive trend led to finer-grained deposits.

A pronounced transgression at the base of the Tvillingodden Formation resulted in finely laminated, unbioturbated sediments being deposited on top of the underlying silty shales. The formation forms a major coarsening-upward sequence at Festningen, while it consists of several coarsening-upward units, altogether forming a larger such sequence, at Bravaisberget.

The Bravaisberget Formation consists of several members, together forming a coarsening-upward succession. At the base, the phosphate-rich shales and siltstones of the Passhatten Member represent shelf sediments deposited between normal and storm base level. The overlying Somovbreen Member contains oolitic sandstone at Festningen and fine-grained bioturbated sand at Bravaisberget. The member shows a shallowing to the developments of distal banks at Festningen.

Figure 24a. Section 2b Bravaisberget – Tvillingodden Formation. The section was measured by A. Mørk and R. Knarud (see photo Figure 8). The unit consists of a series of minor coarsening upwards successions with a prominent limestone bed (the Skilisen Bed) in the middle. Bioturbation is sparse except above the limestone bed and at the top of the succession. The formation is interpreted as deposited in shallow shelf environments, with the limestone bed marking the shallowest episode.

Figure 24b. The silicified shales of the Permian Kapp Starostin Formation are sharply overlain by shales of the Vardebukta Formation.

Figure 25a. Section 2c Bravaisberget (and Bravaisodden) – Bravaisberget Formation.
The section was measured by A. Mørk (see photo Figure 8). Most of the section was measured on one of the ridges at Bravaisberget, while the uppermost part was measured on the shore of Bravaisodden as the mountain was too steep for any measurements to be made. A much more detailed section has been presented by Krajewski et al. (2007) where they moved the lower boundaries of both the Somovbreen and Van Keulenfjorden members upwards from the suggestion of Mørk et al. (1999a). This approach is also followed here.
The lower Passhatten Member forms most of the formation at Bravaisberget. It is dominated by shale, but with abundant siltstone and fine-grained sandstone in thin beds. In the lower part these beds have abundant phosphate nodules, and the beds are heavily bioturbated. The upper part contains much darker shale, and sandstone beds that contain neither phosphate nodules nor bioturbation. The inarticulate brachiopod Lingula *is abundant in this part of the succession.*
A 30 m thick very fine to fine-grained sandstone, thoroughly burrowed, forms the Somovbreen Member.
The uppermost part of the succession is represented by the highly burrowed Van Keulenfjorden Member. At base this unit has a marked phosphatic bed. The member is cemented by both dolomite and silica and displays small scale cross-bedding.

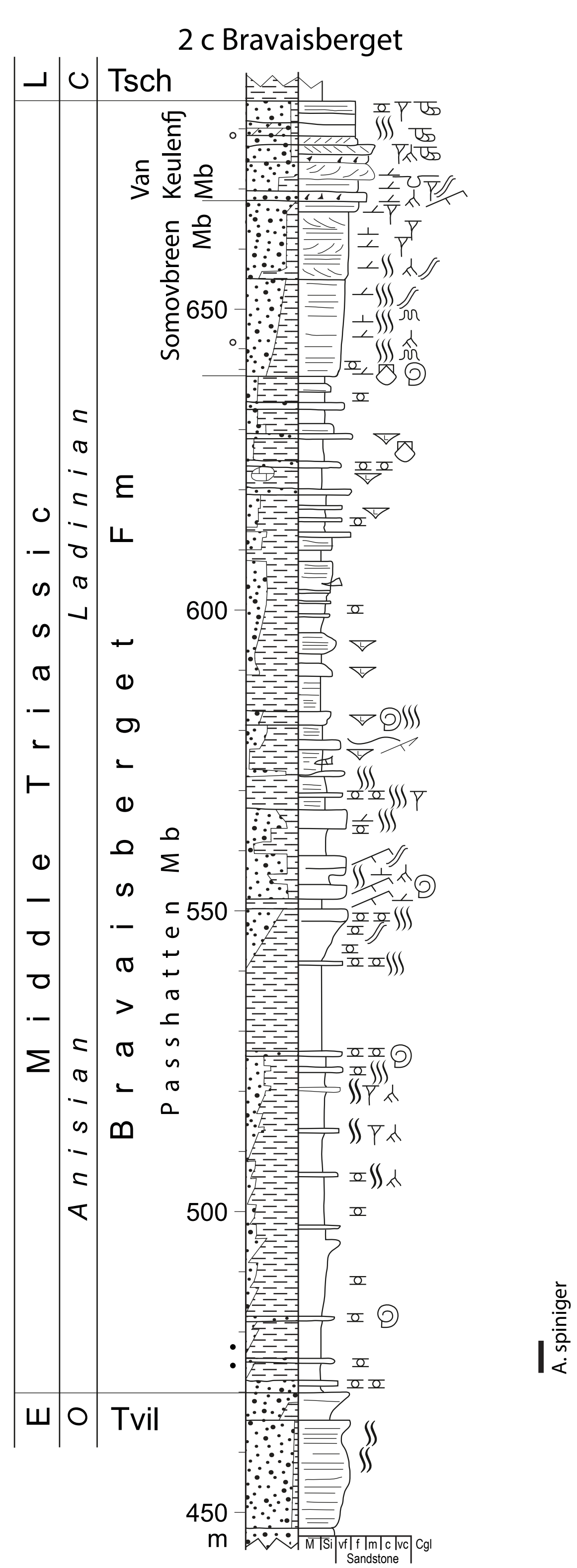


Figure 25b. The dark shales are the Passhatten Member, while the overlying cliff forming sandstones form the Somovbreen Member, with the Van Keulenfjorden Member at top.

Figure 25c. Abundant Polykladichnus *traces (Mørk and Bromley 2008) in the Van Keulenfjorden Member.*

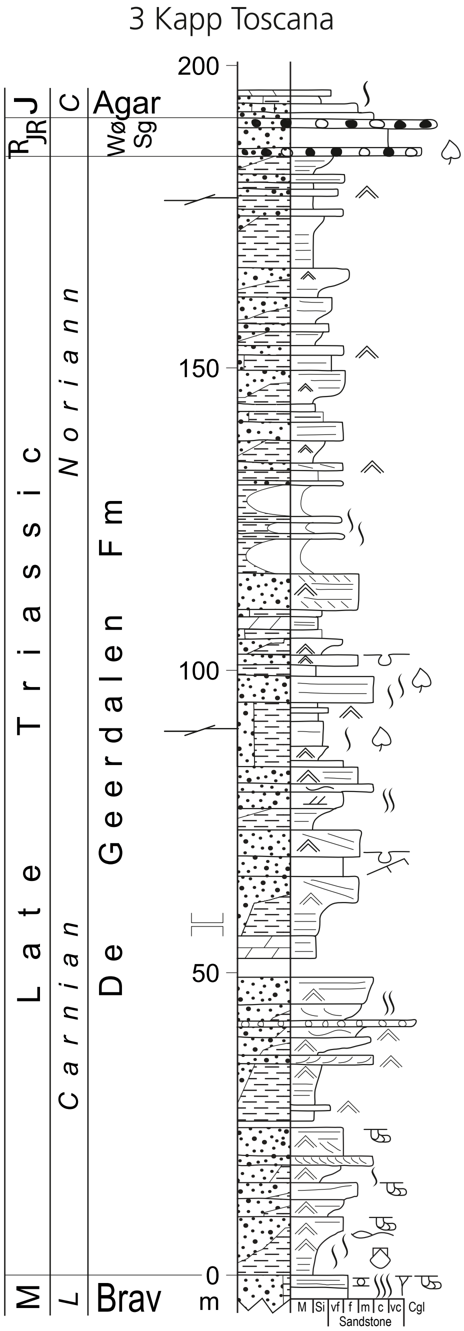


Figure 26a. Section 3 Bravaisodden and Kapp Toscana – Kapp Toscana Group.
The lowermost part of the section was measured at Bravaisodden, while the rest was measured across the fjord at Kapp Toscana. Both localities were studied by R. Knarud. The contact with the underlying Bravaisberget Formation is sharp, but without signs of erosion. Although there is a thin shale bed at base it can hardly be included in the Tschermakfjellet Formation, which is probably not present in this area.
The De Geerdalen Formation consists of many few metre thick coarsening-upward sequences. Wave and current cross-bedding is abundant. A few thin limestone beds are present. The uppermost ca 20 m consist of shales and thin sandstone beds and may represent the Isfjorden Member.
The Wilhelmøya Subgroup is quite thin at this locality and has phosphate conglomerates at its base (Slottet Bed) and at top (Brentskardhaugen Bed), with sandstone in between.

The Tschermakfjellet Formation, which occurs at the base of the Kapp Toscana Group throughout Svalbard, is not documented in this area. The De Geerdalen Formation consists of abundant coarsening-upward sequences throughout the area. Shallow-water structures indicate deposition above normal wave base. The formation shows a clearly more distal development than further east. In the upper part, a more shaly development with thin sandstone beds is assigned to the Isfjorden Member.

The Wilhelmøya Subgroup, at Festningen represented by the Knorringfjellet Formation, is marked at its base by the phosphatic conglomerate of the Slottet Bed, and at its top by the phosphatic remanié nodules of the Brentskardhaugen Bed. In-between there are sandstones and shales representing shallow-water deposits. Trace fossils and microfossils (Nagy and Berge 2008) indicate marine environments with fresh-water influx. This area, together with the nearby Sassenfjorden exposures, has the thinnest development of the Wilhelmøya Subgroup at Svalbard.

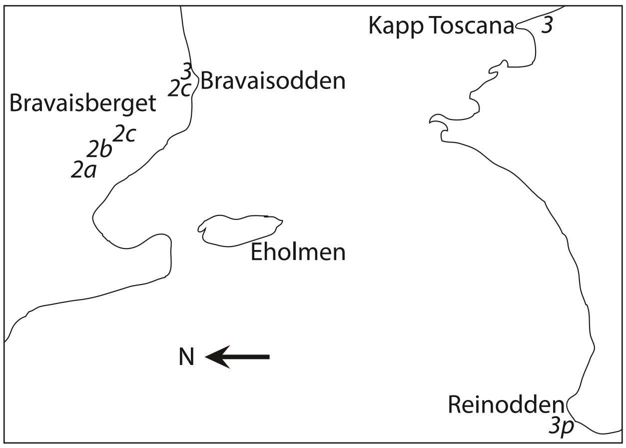


Figure 26b. Sketch map of localities in Bellsund. 2a,2b,2c are localities in the steep western hillside of Bravaisberget. The top of the Bravaisberget Formation is measured on Bravaisodden, also marked by 2c. The lowermost part of the Kapp Toscana Group, section 3, is measured at Bravaisodden, while the remainder is measured close to the Kapp Toscana cape. The palyno-samples were collected at Reinodden by a different field team (3p).

Hornsund–Sørkapp Land (Sections 4–7, Figures 27–32)

In this area we have studied Treskelen on the shores of the Hornsund and a series of sections on Sørkapp Land. All sections on Sørkapp Land are thin compared with surrounding areas as a result of deposition on the Permian Hornsund–Sørkapp High, which still controlled sedimentation during the Triassic (Worsley and Mørk 1978). A detailed stratigraphical description of the Triassic succession in this area was given by Birkenmajer (1977), and based on our own fieldwork an amendment of this subdivision was given by Worsley and Mørk (1978), and then further incorporated in the overall stratigraphy of Svalbard by Mørk et al. (1982). Thanks to a more extensive overview of Svalbard we were able to include some of the earlier defined units in the present lithostratigraphy as reviewed in the Stratigraphic Lexicon by Mørk et al. (1999a).

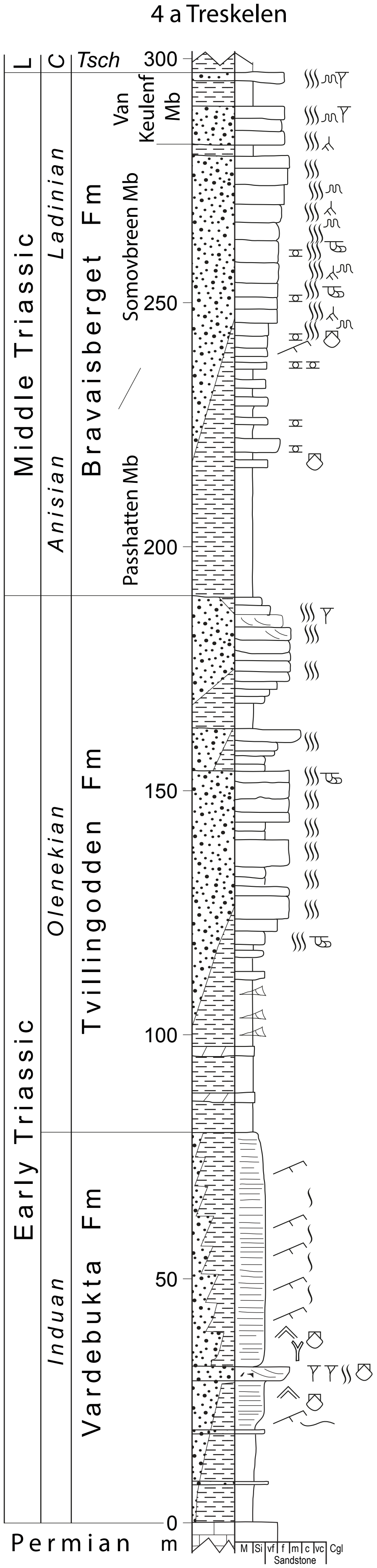


Figure 27a. Section 4a Treskelen – Sassendalen Group.
The section was measured by A. Mørk and D. Worsley, and the section follows Creek 4 of Birkenmajer (1977) on the western slopes of Treskelen, inner Hornsund.
The contact with the condensed underlying Kapp Starostin Formation is sharp and conformable. The Vardebukta Formation consists of silty shale. A red-weathering sandy unit 30 m above base contains abundant bivalves and bryozoans. The formation coarsens up to this bed and then fines up to the top of the unit.
The Tvillingodden Formation rests with a sharp contact on top of the Vardebukta Formation. Laminated, unbioturbated shales rest directly on the Vardebukta silty shales. The unit forms a major coarsening-upward sequence, grading into fine sandstones that are extensively bioturbated.
The Bravaisberget Formation also forms a major coarsening-upward succession. The lower shaly Passhatten Member is dark grey and has a gradual transition to the silt- and fine-grained sandstones of the Somovbreen Member. The Somovbreen Member weathers yellow grey, and is intensively bioturbated. Phosphate nodules are abundant, especially in the lower part of the member. The uppermost part of the formation consists of fine-grained sandstones and is strongly cemented, mainly by dolomite; it is assigned to the Van Keulenfjorden Member.

Figure 27b. Taenidium *feeding traces traces from the Somovbreen Member.*

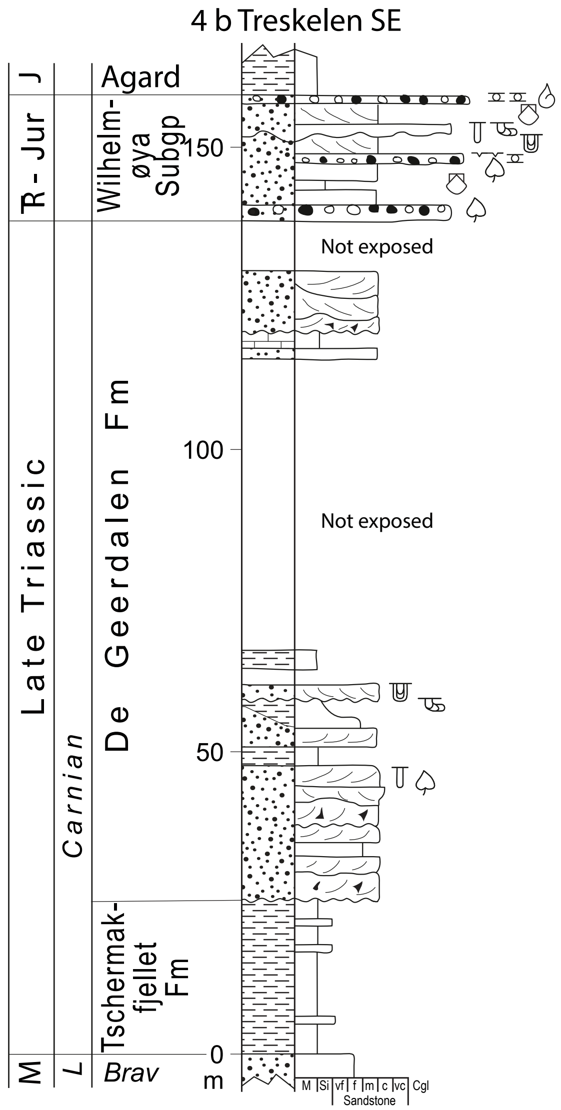


Figure 28. Section 4b Treskelen SE – Kapp Toscana Group.
The section was measured by R. Knarud. The unit can be studied on the eastern shore of Treskelen. At low tide the section is exposed on the shore at the head of Treskelbukta and also close to the point of the peninsula on its eastern side. Due to folding in the area, the upper part of the succession is repeated and exposed twice.
The lower 25 m consist of dark shales representing the Tschermakfjellet Formation. The De Geerdalen Formation is initiated by cross-bedded medium-grained sandstones that overlie the Tschermakfjellet shales with an erosive contact. Marine trace fossils are abundant in the upper part of this lower sandstone unit. A similar sandstone unit also occurs above a 50 m covered section.
The Wilhelmøya Subgroup, here represented by the Smalegga Formation, has a basal phosphatic conglomerate (Slottet Bed) and at its top the phosphatic Brentskardhaugen Bed. The sandstone between these marker beds is fine- to medium-grained, and contains some conglomerates. Marine trace fossils and bivalves are present, and one horizon contains desiccation cracks.

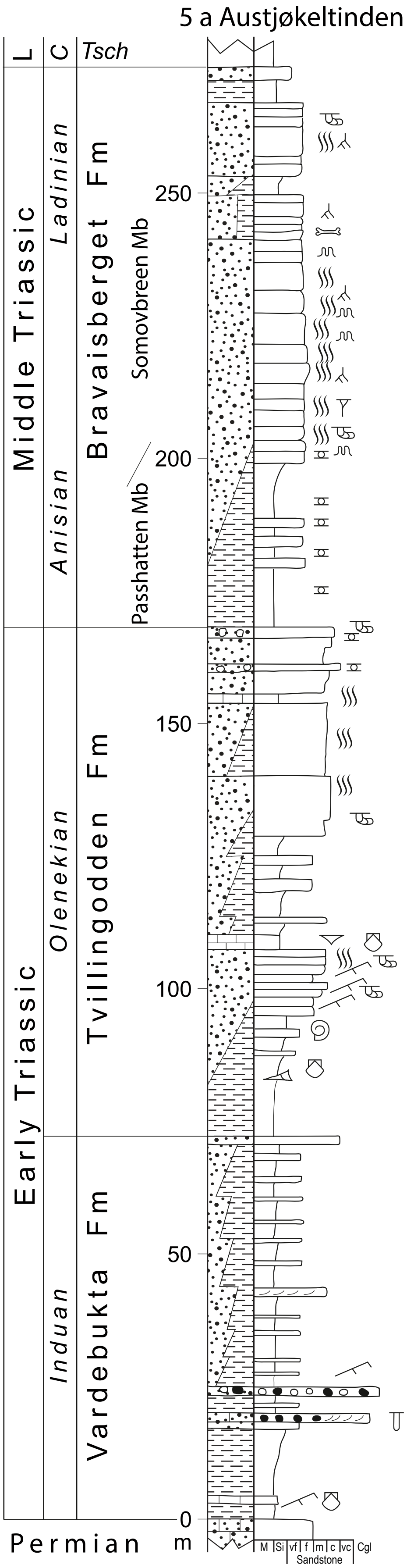
The base Triassic either rests on the condensed Permian Kapp Starostin Formation (Treskelen, Austjøkeltinden), or on metamorphic basement (Karentoppen, Kistefjellet), where a local conglomerate is named the Brevassfjellet Bed (Worsley and Mørk 1978). The sections on Treskelen and Austjøkeltinden were probably deposited on the margins of the Hornsund–Sørkapp High as they show a thickness development intermediate between that seen further north and sections on the high itself.

The Vardebukta Formation at Treskelen and Austjøkeltinden forms a faintly coarsening-upwards succession. Cross bedding, moderate bioturbation and a conglomerate, which at Treskelen contains both bivalves and bryozoans and at Austjøkeltinden is polymictic with *Skolithos* trace fossils, all indicate shallow-marine depositional conditions. On the Hornsund–Sørkapp High the polymictic conglomerate rests on metamorphic basement as a transgressive conglomerate. Fossils indicate that the high was not transgressed before the Dienerian (Nakrem and Mørk 1991).

The Tvillingodden Formation consists of coarsening-upward sequences. Fossils from the thin Skilisen carbonate bed indicate a Smithian or Spathian age (Nakrem and Mørk 1991), indicating that the transgression at the base of the formation represents the widespread base Olenekian (Smithian) transgression. The extensive bioturbation of the sandstones in the upper part of this unit indicates that after the initial transgression the basin was gradually filled with sediment.

Figure 29a. Section 5a Austjøkeltinden – Sassendalen Group.
The section, measured by D. Worsley and A. Mørk, can be studied on top of a narrow mountain ridge surrounded by glaciers in central Sørkapp Land.
The Vardebukta Formation shows a gradual transition from shale to silty shale with thin sandstone beds. The basal contact with the condensed Kapp Starostin Formation is sharp. Conglomerates occur approximately 20 m above formational base.
The Tvillingodden Formation consists of three coarsening upward sequences. A limestone bed on top of the lowermost unit is assigned to the Skilisen Bed. Marine trace fossils and a few bivalves and ammonoids are present.
The Bravaisberget Formation sharply overlies the sandstones of the Tvillingodden Formation. The Passhatten Member has dark grey shales, rich in phosphate nodules and has a relative thin development at this locality. There is a gradual transition into the very fine-grained sandstone-dominated Somovbreen Member. This member is extensively bioturbated. From our present data we cannot decide whether the upper 20 – 25 m represent the Somovbreen- or Van Keulenfjorden Member.

Figure 29b. Diplocraterion *protective burrows from the Wilhelmøya Subgroup. The sample was collected at Bautaen, a mountain between Treskelen and Austjøkeltinden.*



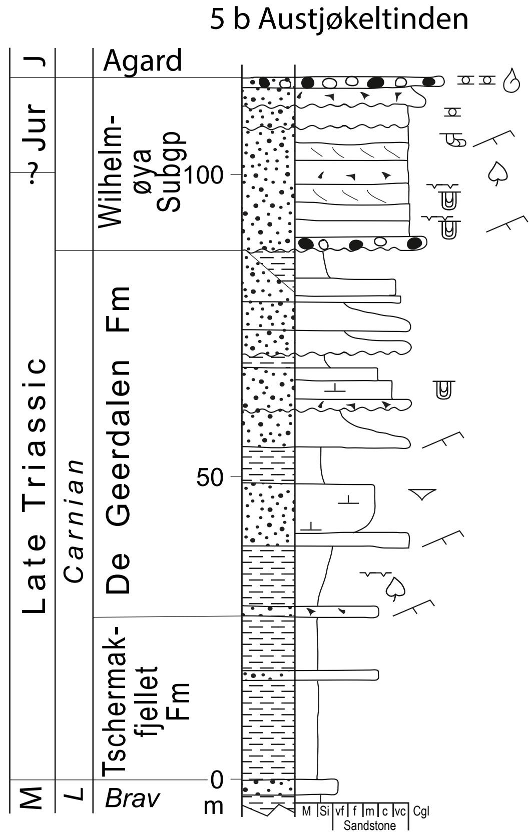
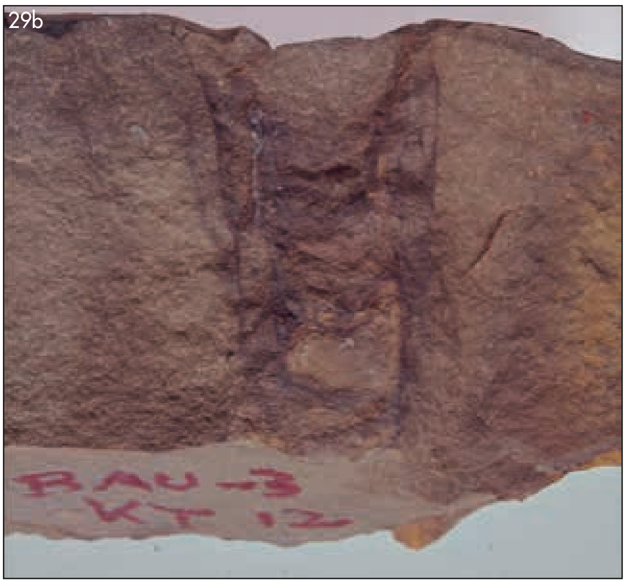


Figure 30. Section 5b Austjøkeltinden – Kapp Toscana Group. The section was measured by D. Worsley. The Tschermakfjellet Formation rests with a sharp contact on the Bravaisberget Formation and it consists of dark grey slightly silty shales. The De Geerdalen Formation has sandstone beds of fine to medium grain-size. Mud flake conglomerates occur in the basal bed and in an erosional base to a sandstone bed in the middle of the unit. Several of the beds show a fining-upward trend. The Wilhelmøya Subgroup has a polymictic conglomerate (?Slottet Bed) at its base and a phosphatic polymictic conglomerate, the Brentskardhaugen Bed at top. The sandstone in between is very coarse-grained and contains abundant marine trace fossils.



The Bravaisberget Formation shows clear similarities throughout the area, but there is also clear developmental variation. The Passhatten Member comprises dark shale with phosphatic nodules and can be followed throughout the area. The transition to the overlying Somovbreen Member is gradational, but the unit is dominated by heavily bioturbated silt- or sandstone. The phosphate nodule content varies, but phosphates are always present. Uppermost in the formation, the Van Keulenfjorden Member contains strongly cemented fine-grained sandstones. The unit is clearly identified at Treskelen, and quite similar beds uppermost in the formation also in the other localities clearly correlate with this unit, although based on the present data we cannot decide if these should be included in the member. The development in this area shows a basal pronounced transgression, bringing the seabed below normal wave base. The basin was then gradually filled as indicated by the regressive deposits.

Along the western margin of the Hornsund–Sørkapp High the cross-bedded sandstones of the Karentoppen Member are interpreted as representing deltaic input into the basin. Similar exposures also occur at Liedfjellet, further northwest in Sørkapp Land. Elsewhere along western Spitsbergen the gradation from dark shale to silt and sandstone shows a regressive trend where a deltaic system may have existed further west of the present land area. When the basin was filled, the Van Keulenfjorden Member developed in local lagoons or restricted areas.

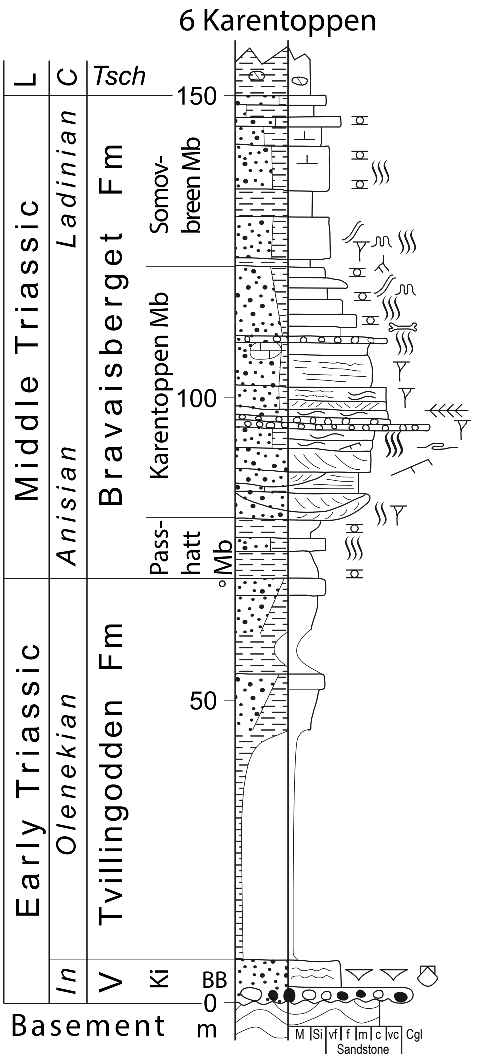


Figure 31a. Section 6 Karentoppen – Sassendalen Group.
The section was measured by A. Mørk on the southwestern coast of Sørkapp Land.
The Vardebukta Formation is represented by the Kistefjellet Member, which rests directly on folded metamorphic basement. At base a polymictic conglomerate is assigned to the Brevassfjellet Bed and contains both brachiopods and bivalves.
The overlying succession is covered in scree, and is tentatively assigned to the Tvillingodden Formation. In the upper part, this unit has two slightly coarsening-upward units from shale to very fine-grained sandstone. No sedimentary structures were observed.
The Bravaisberget Formation has a very special development at this locality. At base a few metres of dark shale with phosphate nodules and muddy siltstone clearly belong to the Passhatten Member. Above this follows a 43 m thick succession of cross-bedded sandstones and conglomerates. The sandstones represent channel-fill deposits. Herringbone structures are also observed. In the upper part phosphate nodules are present in the upward-fining sandstones. This sandstone development is named the Karentoppen Member.
The upper part of this succession consists of alternating shale and muddy siltstones, with bioturbation typical of the Somovbreen Member. Above this succession there is grey shale with siderite nodules of the Tschermakfjellet Formation.

Figure 31b. Channel sandstones from the Karentoppen Member.

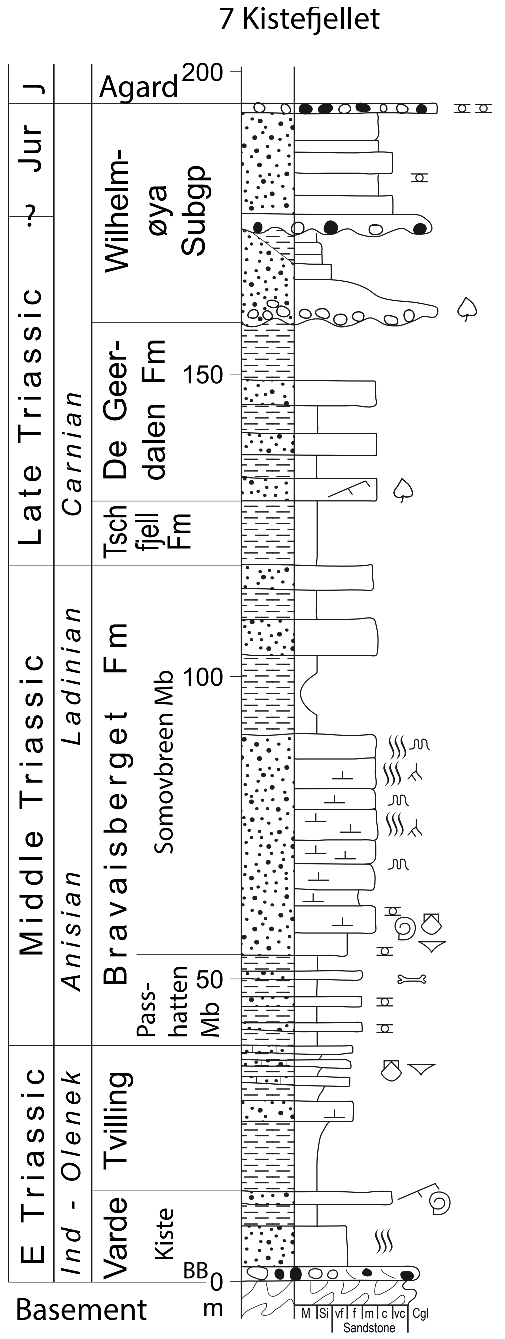


Figure 32. Section 7 Kistefjellet – Sassendalen and Kapp Toscana groups.
The section was measured by D. Worsley and A. Mørk. This section lies at Kistefjellet in southern Sørkapp Land on the Sørkapp-Hornsund High.
The Vardebukta Formation has very fine-grained sandstone in its lower part, while the base consists of a polymictic conglomerate (Brevassfjellet Bed) resting directly on folded basement rocks. The overlying Tvillingodden Formation has shale at its base and thin beds of very fine sandstone in the upper part, forming an overall coarsening upward succession. Both these formations show a thin development at this locality.
The lower parts of the Bravaisberget Formation consist of dark shale with thin fine-grained sandstone beds. Phosphate nodules are present and this lower unit represents the Passhatten Member. The middle parts of the formation consist of calcite-cemented strongly bioturbated sandstone of the Somovbreen Formation. The uppermost part is shale dominated, but with two thick beds of sandstone. From the present data it is not clear whether this represents the Van Keulenfjorden Member.
A thin overlying shale bed is included in the Tschermakfjellet Formation. The De Geerdalen Formation has its thinnest development at this locality and only consists of three thick sandstone beds with some shale in between and above.
The top of the mountain is formed by the 37 m thick Wilhelmøya Subgroup, here represented by the Smalegga Formation. The base of the unit is a series of conglomerates that may represent the Slottet Bed. On the neighbouring mountain Keilhaufjellet, facing Mathiasbreen, many beds of polymictic conglomerate with phosphatic boulders support this interpretation. Polymictic conglomerate also occurs in the middle part of the formation, and the sandstone of the Smalegga Formation is of medium to coarse grain-size. The top of the mountain is paved by a polymictic conglomerate with phosphate pebbles, clearly representing the Brentskardhaugen Bed.

Grey shales of the Tschermakfjellet Formation occur throughout the area. This unit's shales are organically lean compared with the underlying unit, demonstrating deposition in a well-ventilated basin, and the unit may be regarded as representing prodeltaic shales distal to the overlying De Geerdalen deltaic sediments. The De Geerdalen Formation has its thinnest development on Svalbard in this area, especially on the Hornsund–Sørkapp High. The cross-bedded development with mud clasts at Treskelen and Austjøkeltinden may indicate channel deposits and proximity to a delta, but the few fossils indicate marine influence, while desiccation cracks demonstrate occasional emergence.

The Wilhelmøya Subgroup is bounded by the phosphatic Slottet Bed at its base and the Brentskardhaugen Bed at its top. Both these beds can be followed over extensive areas of Svalbard and also into the northern Barents Sea. Coarse-grained sandstone with abundant high-energy trace fossils such as *Diplocraterion*, *Rhizocorallium* and *Skolithos* (Mørk and Bromley 2008) show that the unit represents high–energy, shallow-marine deposits. The unit has unfortunately not been internally dated and we do not know how much of the long time interval between the Slottet Bed (Norian) and the Brentskardhaugen Bed (Bathonian) is represented; however, its lithology resembles the Svenskøya Formation that overlies the Slottet Bed at Hopen, Kong Karls Land and Wilhelmøya.

Central to East Spitsbergen
(Sections 9–18, Figures 33–45)

This area follows the exposure belt of Triassic rocks that is found from Dickson Land through the Sassendalen area to the eastern coast of Spitsbergen. The entire succession is not exposed at any single locality but the sections overlap and thus give a representative understanding of the total development in the area.

The transition from the Permian Kapp Starostin to the Vikinghøgda Formation is exposed in the Sassendalen area, where basal sandstones may contain erosional debris from the underlying cherty and glauconitic Permian sandstones. There is no evidence of any substantial erosion at the boundary. Only a few metres above the lithostratigraphic boundary in Deltadalen (Mørk et al. 1999b), and also as reported by Korčinskaja (1986), the ammonoid *Otoceras boreale* occurs. The lowermost shales represent deposition in moderately deep shelf environments. Large areas of the slopes surrounding Sassendalen and most mountains in this area are formed by the shales and minor sandstones of the two upper members of the Vikinghøgda Formation. Abundant marine fossils, but few sedimentary structures, indicate deposition in relatively deep shelf conditions.

The abrupt transition into soft, dark shales at the base of the Botneheia Formation may represent a major transgression. The Botneheia Formation forms a dark cliff that can be followed throughout the area. The cliff reflects carbonate cementation from abundant thin-shelled bivalves (*Daonella*). The shales are very organic rich (Mørk and Bjorøy 1984) and also rich in phosphate nodules. These sediments represent deposition in deep-shelf environments, and alternating very organic-rich beds and beds that show thorough bioturbation (Mørk and Bromley 2008) indicate that short oxic episodes periodically ventilated a sea bottom that was mainly anoxic.

The transition from the Sassendalen Group to the Kapp Toscana Group is marked by the sudden influx of grey shales with siderite above the phosphatic dark shales. The ledge of carbonate-cemented siltstone at top Botneheia Formation may indicate a submarine hiatus before the transgression initiating Carnian sedimentation. The Tschermakfjellet shales are well oxygenated, and may represent prodeltaic environments to the approaching De Geerdalen Formation delta system.

The De Geerdalen Formation consists of a series of coarsening-upward sequences where the individual sandstones become thicker towards the east. This supports a model with delta domination in the east and more distal development towards the west, although marine conditions prevailed in all these localities. This model is also consistent with more sand being available in eastern localities. In its upper part, the Isfjorden Member, with its red- and green-coloured sediment, may represent restricted, possible lagoonal, depositional environments.

In this area the basal and uppermost part of the Wilhelmøya Subgroup is well exposed in Konusdalen, south of Sassenfjorden. The uppermost parts of the Kapp Toscana Group are eroded away in the central parts of Spitsbergen, but on the eastern coast, they are again preserved and can be studied at Klementievfjellet. While the group is strongly condensed at Konusdalen (15 m, Bjærke and Dypvik 1977), it thickens to 70 m on Klementievfjellet, on the east coast of Spitsbergen, where the unit has a lower shaly part (Flatsalen Member) and an upper, sandstone-dominated part (?Svenskøya and Kongsøya formations). These changes may well have taken place across the Billefjorden Fault Zone as suggested by Worsley et al. (1986) and Worsley (2008). The sandstones on the eastern coast show wave ripples and bioturbation indicating deposition in shallow-marine environments.

Figure 33. Section 9a Tschermakfjellet – Sassendalen Group. The section was measured by A. Mørk on the southern ridge of Drachedalen on the northwestern exposures of Tschermakfjellet. The boundary between the Kapp Starostin and Vikinghøgda formations is exposed a little further to the northeast and the regional dip suggests that the boundary occurs only a few metres below sea level in the measured section.
The Vikinghøgda Formation is well exposed except for the few basal metres below sea level. The lower Deltadalen Member is partly covered, except for some silty shale with thin sandstone beds in the sea-cliff and a sandstone bed with hummocky bedding forming the top of the member. The Lusitaniadalen and Vendomdalen members are well exposed on the ridge. They are very fossiliferous with abundant bivalves, ammonoids and reptile bones. Bioturbation is sparse.
The Botneheia Formation has its base on a small ledge where phosphate nodules start to be abundant. The lower Muen Member contains abundant phosphate pebbles and siltstone beds show abundant bioturbation. The upper Blanknuten Member forms a steep slope as abundant thin shelled Daonella *bivalves have contributed to cementing of the sediment. Phosphate nodules are abundant, and some beds are rich in faecal pellets. The top of the formation is a cliff with strongly burrowed and phosphatic siltstone. Phosphate nodules also occur in the lower part of the overlying formation, but they have a lighter grey colour and at the boundary the shales change colour from dark grey to grey.*

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Figure 34b. The Sassendalen Group at Drachedalen, Tschermakfjellet. The lower coarsening up (steeping up) successions are the Vikinghøgda Formation, while the upper dark cliff is the Botneheia Formation, with the basal part of the Kapp Toscana Group at top.

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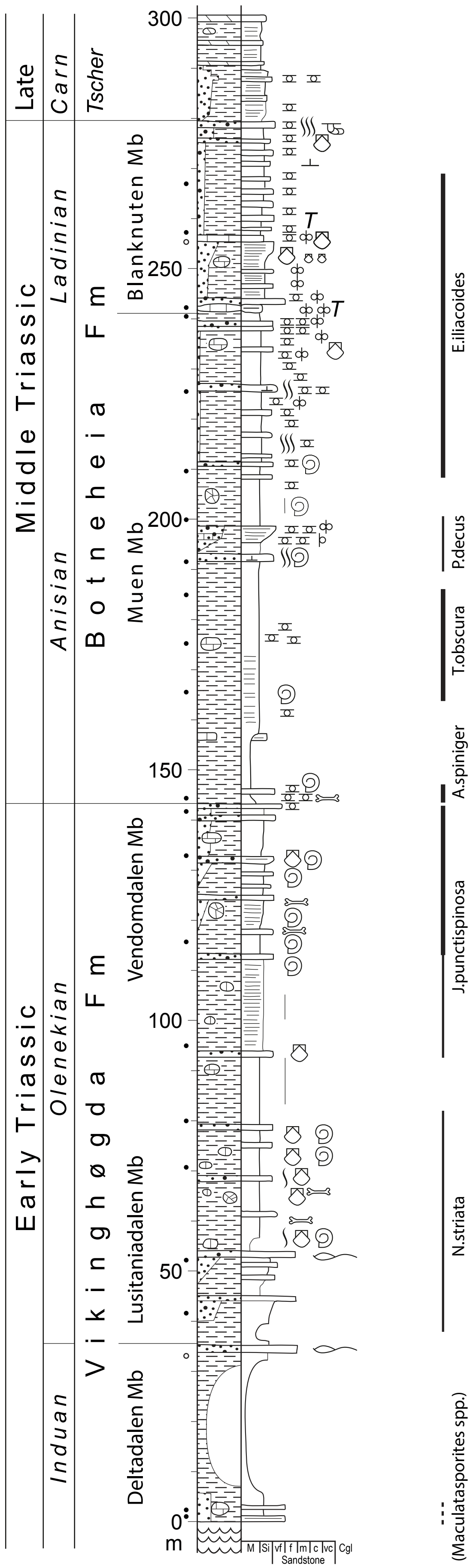
9 a Tschermakfjellet



9 b Tschermakfjellet

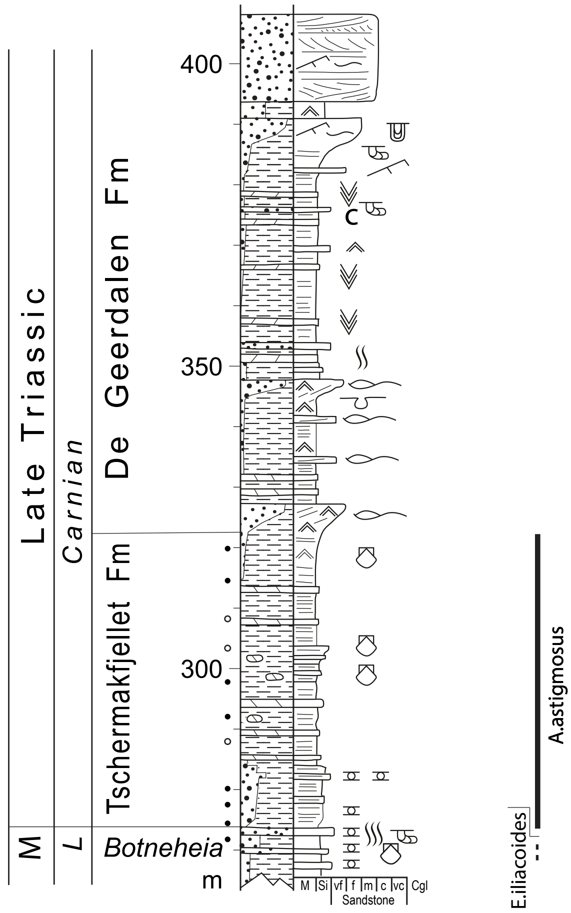


Figure 34a. Section 9b Tschermakfjellet – Kapp Toscana Group. The section was measured by R. Knarud and is a direct continuation of Section 9a. The Tschermakfjellet Formation is approximately 70 m thick and consists of silty grey shale. Red weathering siderite nodules and thin beds are common. There is no erosion at the base of the formation. The only fossils observed are bivalves. Only the lower part of the De Geerdalen Formation is preserved at this locality. The base is defined at the base of the first sandstone overlying the Tschermakfjellet Formation. Several small coarsening upward sequences are present and at the top of the exposure, and mountain, there is a 15 m thick cross-bedded sandstone. Hummocky cross-bedding is present in the lower sandstones of the formation, while high energy trace fossils such as Diplocraterion *occur just below the top sandstone.*

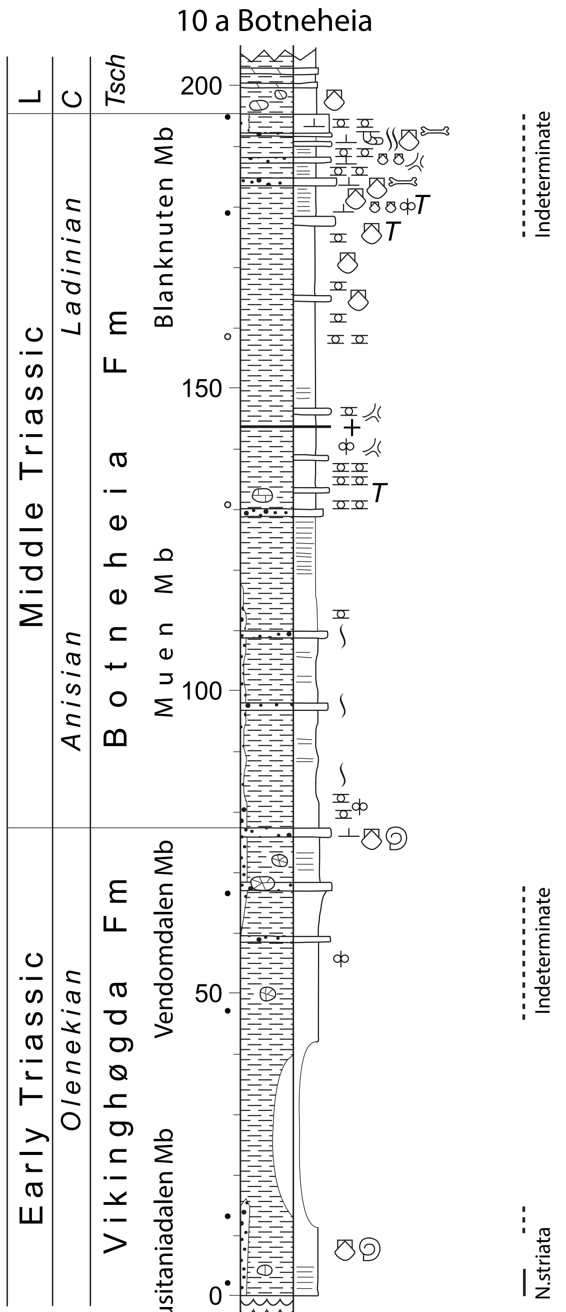


Figure 35a. Section 10a Botneheia – Sassendalen Group. The section was measured by A. Mørk. Botneheia (meaning mountain with cirques) is a mountain south of Sassenfjorden. One creek midway between Elveneset and Vindodden makes it possible to climb the coastal cliff. The section is measured on the west side of the ridge (Vikinghøgda Fm), on the accessible ridge in the small valley and on the one ridge where it is possible to climb up the steep part of the Botneheia Formation. The Kapp Toscana Group was measured higher on the same ridge. Ammonoid stratigraphy through the Sassendalen Group has been presented by Weitschat and Lehmann (1978, 1983).
Only the two upper members of the Vikinghøgda Formation are exposed, as the section continues downwards below sea level. The sea cliff consists of silty shale with limestone concretions contains Arctoceras blomstrandi *(Weitschat and Lehmann 1978), indicating that the base of the section is in the middle part of the Lusitaniadalen Member. Their fossil collection is from the mountainside between our measured creek and Vindodden, where the Vikinghøgda Formation is better exposed. The Vendomdalen Member contains large septarian nodules and abundant ammonoid imprints, and at top it has developed a calcite-cemented ledge.*
The Botneheia Formation's base is marked by finely laminated shales with phosphatic nodules that rest directly on the carbonate cemented siltstone bed forming the top of the Vikinghøgda Formation. The lowermost part is poorly exposed, but the upper part is excellently exposed in cliffs. One ridge can easily be climbed. The cliff is formed by calcite cementation from numerous bivalves (mostly Daonella*). Phosphate is very abundant at some levels. The ammonoid fauna from this locality was described by Weitschat and Lehmann (1983).*
The top of the Botneheia Formation forms a plateau with abundant phosphatic nodules. A few metres higher up the colour of the shale changes from dark grey to grey, and the phosphatic nodules are replaced by siderite nodules. This colour change marks the transition into the Tschermakfjellet Formation.

Figure 35b. The Botneheia Formation at Botneheia. The steep cliff is the Blanknuten Member.

Figure 35c. The transition from the Botneheia Formation to the Tschermakfjellet Formation. The lower person stands on the transgressive surface, the upper person points to the maximum flooding surface.

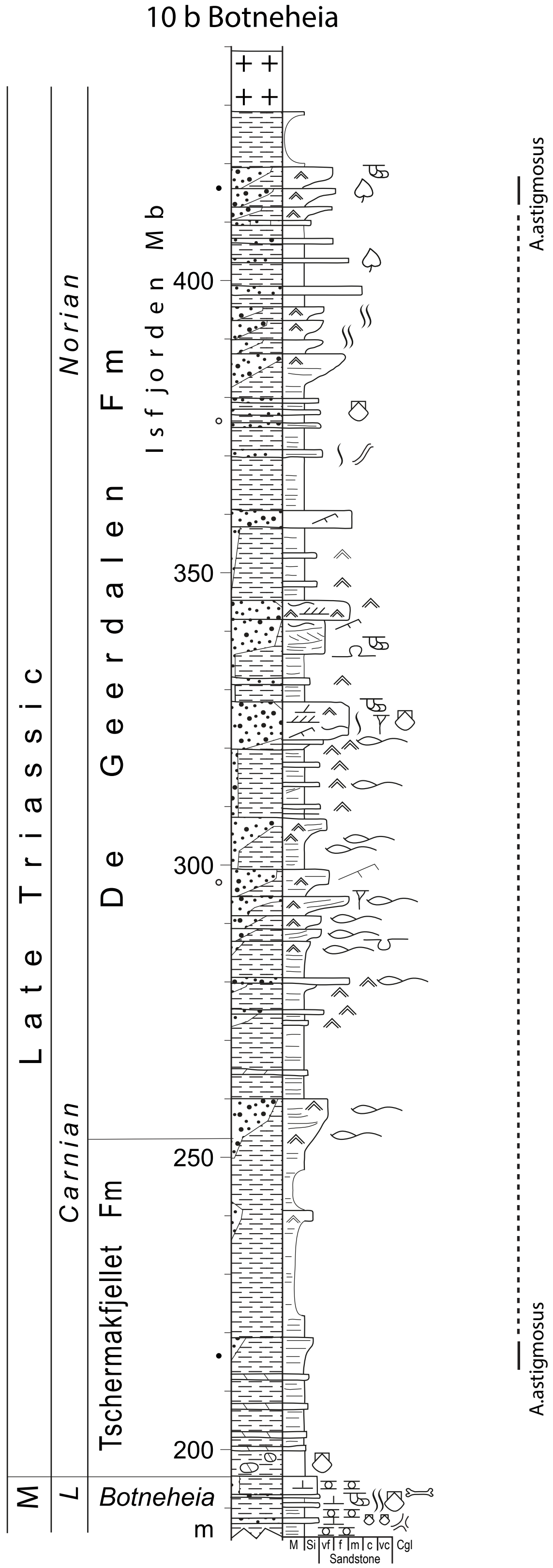


Figure 36a. Section 10b Botneheia – Kapp Toscana Group. The section was measured by R. Knarud. The lower 60 m is dominated by grey shales with purple-weathering siderite nodules and thin beds and constitutes the Tschermakfjellet Formation. The De Geerdalen Formation starts at the base of the first prominent sandstone. Upwards there is a series of coarsening upwards sandstones which in the lower part of the formation contain hummocky cross-lamination, but wave ripples are also present. The upper part of the formation only contains wave ripples with some bioturbation and is referred to the Isfjorden Member. Here plant debris also becomes abundant. The measured section terminates in a dolerite sill close to the top of the mountain.

Figure 36b. The cliff in the middle part is formed by the Blanknuten Member of the Botneheia Formation and is overlain by a series of coarsening upwards sandstones of the De Geerdalen Formation. The top of the mountain is capped by a dolerite sill. The photo is from Botneheia, east of the measured sections.

Figure 36c. Humocky cross bedding in sandstones from the De Geerdalen Formation (photo I.B. Hynne).

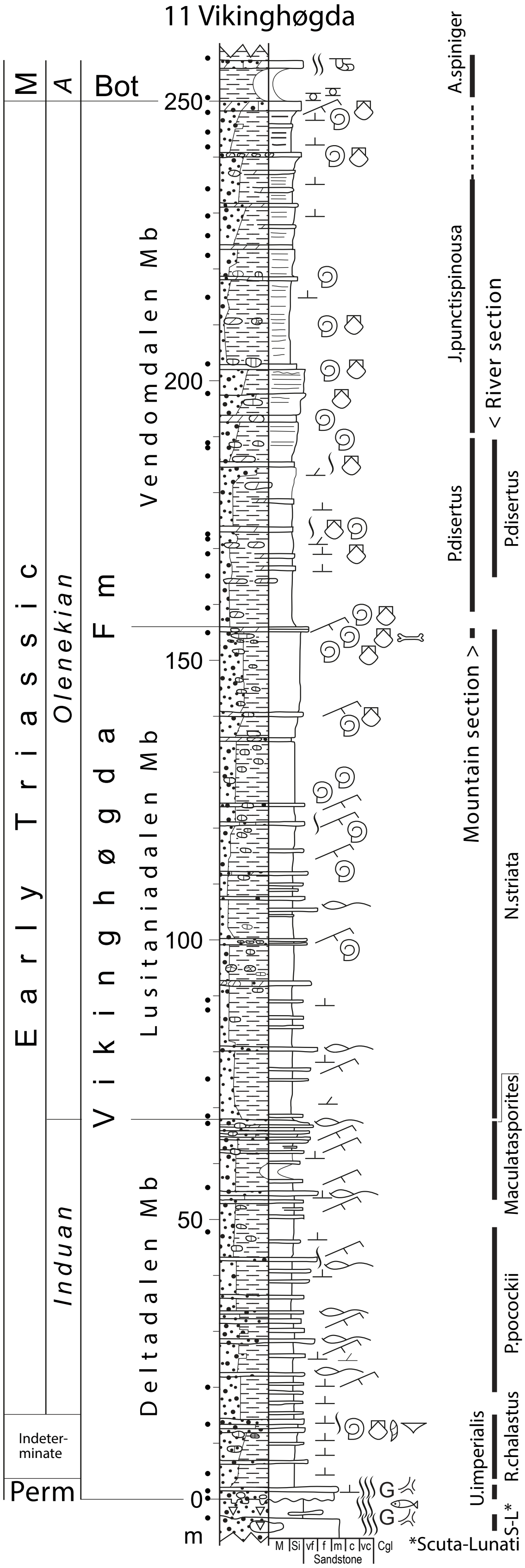


Figure 37a. Section 11 Vikinghøgda – Sassendalen Group. The section was measured in Deltadalen and a tributary which together circle the southern foot of Vikinghøgda. This section, which is the type section for the Vikinghøgda Formation, was described in detail by Mørk et al. (1999b). Their sedimentological section is supported by macrofossil, palynological and magneto-stratigraphical interpretations. The base is defined at top of the cherty Permian Kapp Starostin Formation, which is exposed in the river bank of Deltadalen. In the lower sandy parts some nodules contain a rich macrofossil fauna including the ammonoid Otoceras boreale. *The lower Deltadalen Member consists of alternating sandstone beds with hummocky and current ripples and silty shale beds. The Lusitaniadalen Member has only few sandstone beds and mainly consists of silty mudstone. This unit has abundant limestone nodules with a rich ammonoid fauna. Uppermost the Vendomdalen Member again has a higher sand content and a rich fauna of ammonoids and bivalves. The top of the formation is marked by a pronounced calcite-cemented siltstone bed. Above this the shale contains phosphate nodules. The overlying Botneheia Formation is well exposed around this location, but it is not included in this study as several low angle faults intersect the mountain and make it impossible to make reliable thickness estimates.*

Figure 37b. The boundary between the Permian Kapp Starostin Formation and the Vikinghøgda Formation is located where the person is pointing. Note that the greenish glauconitic cherty rocks below the boundary are overlain by less consolidated sandstones.

Figure 37c. The upper part of the Vikinghøgda Formation with dolomitic yellow coloured beds. This succession contains a rich ammonoid fauna.

Figure 38a. Section 12 Stensiöfjellet – Sassendalen Group. This section was measured by A.W. Forsberg as a composite in two major valleys on the southern side of Stensiöfjellet, facing Sassendalen. The Vikinghøgda Formation was measured in the eastern valley. The Botneheia Formation was measured and is best represented on the south-western side, and the formation is not completely represented as the top of the section is at the mountain top. The two sections can easily be correlated by following the orange weathering top siltstone bed of the Vikinghøgda Formation. The base of the Vikinghøgda Formation is located at the point where soft, laminated shales overlie green silica cemented glauconitic sandstones of the Permian Kapp Starostin Formation. The Deltadalen Member is very well exposed. Upward increase in sandstone content forms a coarsening upward trend with current and hummocky cross-bedding. In the upper part of the member siltstone beds become thinner and fewer. The overlying Lusitaniadalen Member is dominated by dark mudstones with septarian nodules and some siltstone beds. Bivalves, ammonoids and reptile bones are present. The Vendomdalen Member contains dark grey shales with carbonate nodules. Marine fossils such as ammonoids, bivalves and a few reptile (ichthyosaur) bones as well as belemnites are present. The top of the formation is a distinct dolomite-cemented siltstone bed with fossils.
The Botneheia Formation (except its top) is well exposed at Stensiöfjellet. The lower part consists of dark grey silty shales. A pronounced siltstone bed with abundant Rhizocorallium *trace fossils occurs here, as on the neighbouring mountains, 8 m above base. Phosphate nodules become very abundant upwards and the section is rich in fossils.* Daonella *shells, as well as minute micro-coquinal juvenile shells (Mørk and Bromley 2008, Vigran et al. 2008) occur in some beds. Reptile (ichthyosaur) bones are common towards the top of the exposure.*

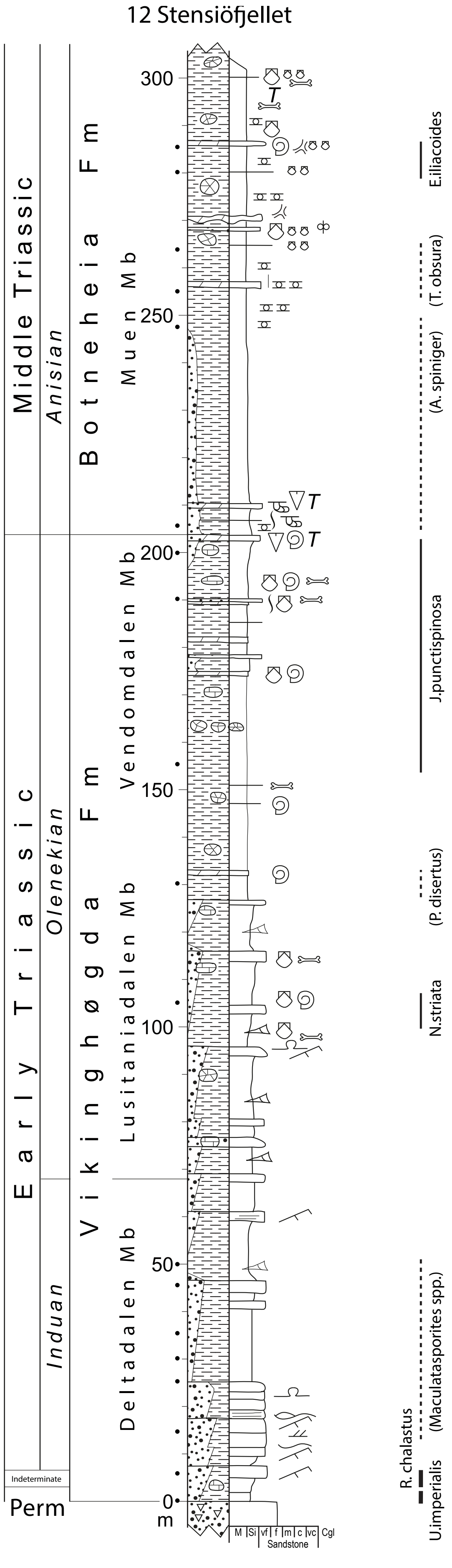


Figure 38b. The ammonoid Svalbardiceras spitzbergensis, *which is common in the upper part of the* Keyserlingites subrobustus *Zone in the Vendomdalen Member. The specimen is from Stensiöfjellet. Photo: W. Weitschat.*

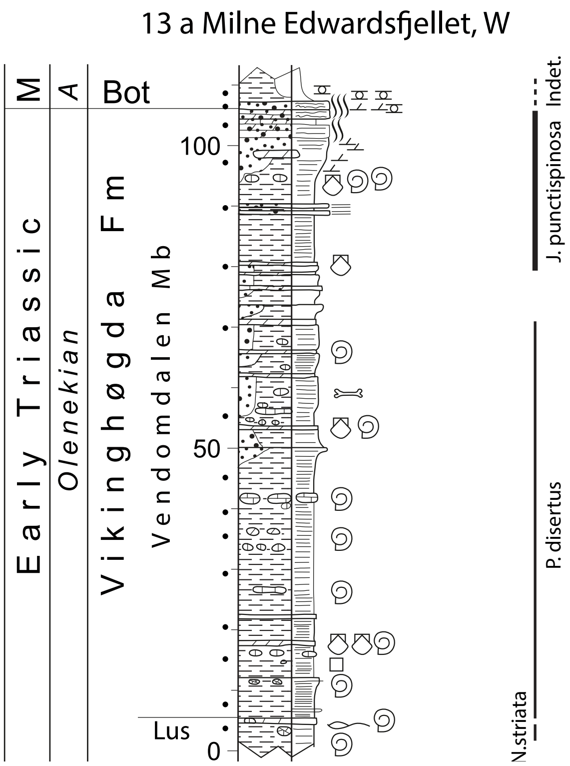


Figure 39a. Section 13a Milne Edwardsfjellet, W – Upper part of Vikinghøgda Formation.
The section was measured by A. Mørk on the western slopes of Milne Edwardsfjellet. A detailed description together with biostratigraphical dating by ammonoids, conodonts and palynology as well as magnetostratigraphy was presented by Hounslow et al. (2008). This upper part of the Vikinghøgda Formation, the Vendomdalen Member, has rich occurrences of ammonoids and gives a good documentation of the transition between the Middle and Late Triassic. The member is shale dominated and contains abundant limestone concretions that often contain fossils.

Figure 39b. The southeastern part of Milne Edwardsfjellet. The lower three steps of the mountain are the members of the Vikinghøgda Formation. The upper step passing up into the dark cliff is the Botneheia Formation. The top of the mountain is represented by the shales of the Tschermakfjellet Formation.

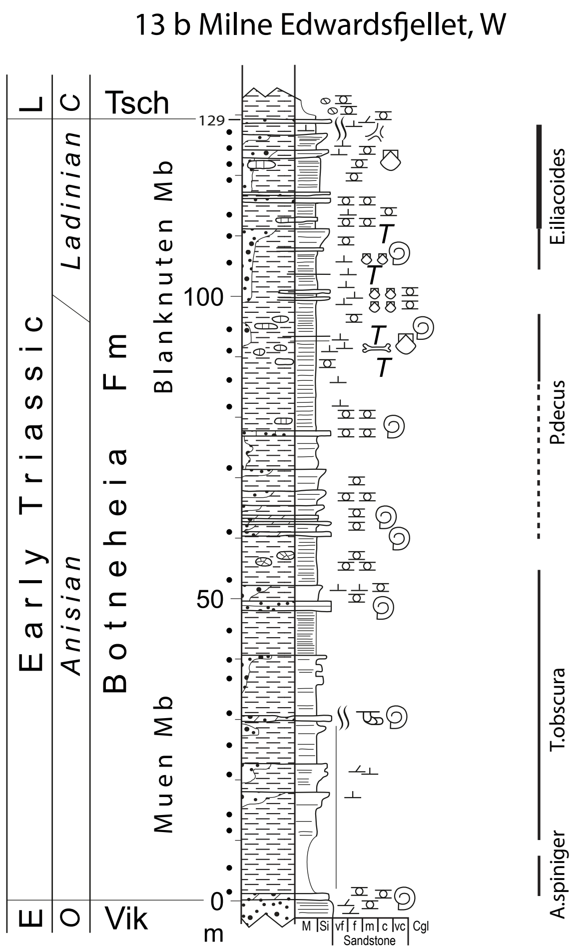


Figure 40. Section 13b Milne Edwardsfjellet, W – Botneheia Formation. The section was measured by A. Mørk on the western slopes of Milne Edwardsfjellet. A detailed description together with biostratigraphical dating by ammonoids, conodonts and palynology, as well as magnetostratigraphy, was presented by Hounslow et al. (2008). The formation is dominated by dark grey shale. The lower Muen Member does not show any bioturbation. Phosphate nodules are abundant from the middle parts of the formation to its top. Ammonoids occur throughout the unit, and in the upper part microcoquinal (Mørk and Bromley 2008, Vigran et al. 2008) beds are common. The transition from the underlying Vikinghøgda Formation (see Figure 39, Section 13a) and the transition to the overlying Tschermakfjellet Formation are both sharp.

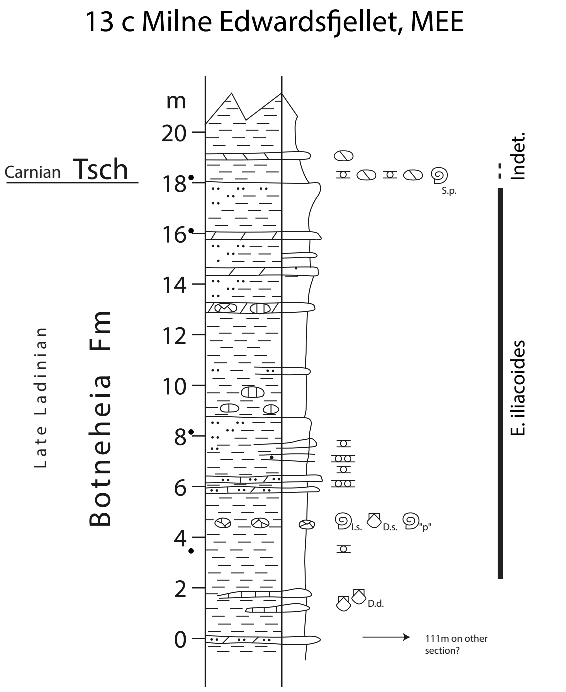


Figure 41. Section 13c Milne Edwardsfjellet, W – Botneheia/ Tschermakfjellet formational transition. The section was measured by A. Mørk on the western slopes of Milne Edwardsfjellet. The section, together with biostratigraphic and magnetostratigraphic subdivisions, was presented by Hounslow et al. (2007b). This short section was measured and sampled to make a detailed study of the transition from the dark grey shales of the Botneheia Formation to the grey shales of the Tschermakfjellet Formation. (S.p. = Stolleyites plana*, I.s. =* Indigirophyllites spitsbergensis*, D.s. =* Daonella subarctica*, "p" =* Protrachyceras*, D.d. =* Daonella degeeri*)*

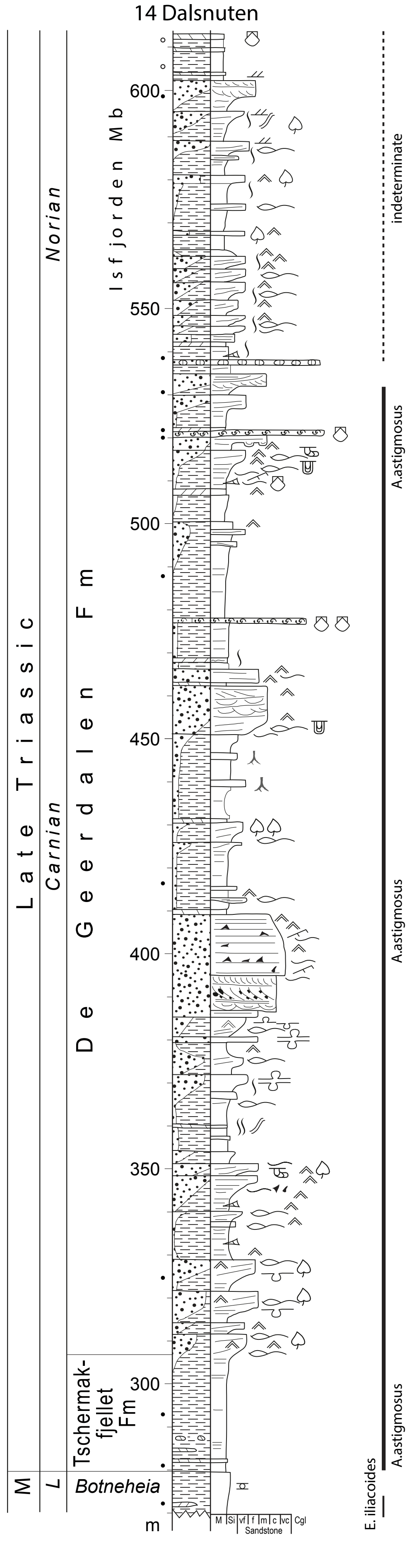


Figure 42a. Section 14 Dalsnuten - Kapp Toscana Group. The section was measured by R. Knarud and sampled in detail for biostratigraphy and magnetostratigraphy as presented by Hounslow et al. (2007a, b). The section was studied on the northern slopes of Dalsnuten and sampling of the upper parts was made on correlative beds on the northeastern slopes of the mountain. The Tschermakfjellet Formation consists of grey shales with purple weathering siderite nodules and thin beds, especially in its lower part. The transition to the De Geerdalen Formation is at the base of the first prominent sandstone. The lower part of this formation shows several coarsening upward units with hummocky cross-bedding. Around 100 m above the formational base a 25 m thick sandstone shows wave and current ripples as well as mudflake conglomerates. A similar sandstone also occurs higher up in the succession. Two root horizons are present between these pronounced sandstones. The upper part of the succession contains thinner sandstone beds, but shale and sandstones alternate. Several coquina beds with bivalves are present. Hummocky, wave and current ripples are present. This part of the formation is referred to the Isfjorden Member.

Figure 42b. The dark cliff is the Botneheia Formation at Dalsnuten which at this locality displays several thrust faults. The Kapp Toscana Group (Section 14) is measured on the left side of the photo.

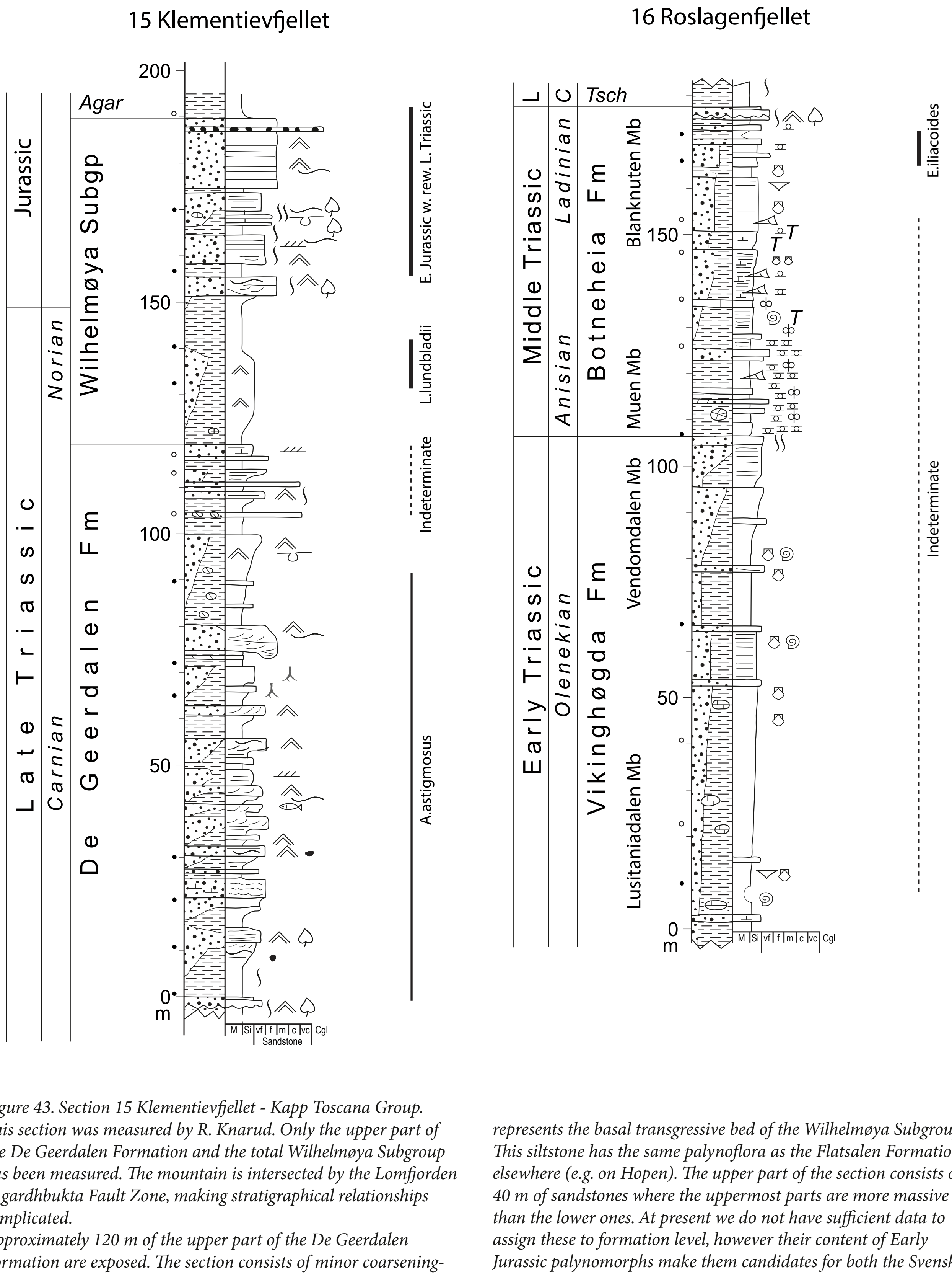


Figure 43. Section 15 Klementievfjellet - Kapp Toscana Group. This section was measured by R. Knarud. Only the upper part of the De Geerdalen Formation and the total Wilhelmøya Subgroup has been measured. The mountain is intersected by the Lomfjorden -Agardhbukta Fault Zone, making stratigraphical relationships complicated.

Approximately 120 m of the upper part of the De Geerdalen Formation are exposed. The section consists of minor coarsening-upward sandstones with abundant wave ripples. Roots are present in the middle part of the succession.

The whole Wilhelmøya Subgroup is exposed. The lower ca 30 m consist of shales with some siltstones. This we correlate with the Flatsalen Formation further to the east. The carbonate-cemented siltstone below this shale is here tentatively included in the De Geerdalen Formation, but may represent the Slottet Bed and if so represents the basal transgressive bed of the Wilhelmøya Subgroup. This siltstone has the same palynoflora as the Flatsalen Formation elsewhere (e.g. on Hopen). The upper part of the section consists of 40 m of sandstones where the uppermost parts are more massive than the lower ones. At present we do not have sufficient data to assign these to formation level, however their content of Early Jurassic palynomorphs make them candidates for both the Svensk-øya and Kongsøya formations. At top there is a plateau covered with phosphatic pebbles of the Brentskardhaugen Bed, which is again overlain by Agardhfjellet Formation shales.

Figure 44. Section 16 Roslagenfjellet - Sassendalen Group.
The section was measured by A. Mørk and A.W. Forsberg. The measured section is close to the Lomfjorden-Agardhbukta Fault Zone, which may be the reason for the very thin exposure of the Botneheia Formation at this locality. The lower part was measured in very bad weather, which may have hampered observations.
The Vikinghøgda Formation is represented by the Lusitaniadalen and Vendomdalen members. The section consists of silty shales with some bivalves and ammonoids. The top of the section is marked by a pronounced bioturbated siltstone.
The lower part of the Botneheia Formation, the Muen Member, consists of very dark grey shales that are very rich in phosphate nodules. The upper part, the Blanknuten Member, is dominated by carbonate cemented siltstones with abundant Daonella.
The transition to the Tschermakfjellet Formation is well exposed on the southeastern ridge of the mountain, where a rich fauna of gastropods and ammonoids was found. This fauna was described by Dagys et al. (1993) in their discussion of the Middle to Late Triassic transition.

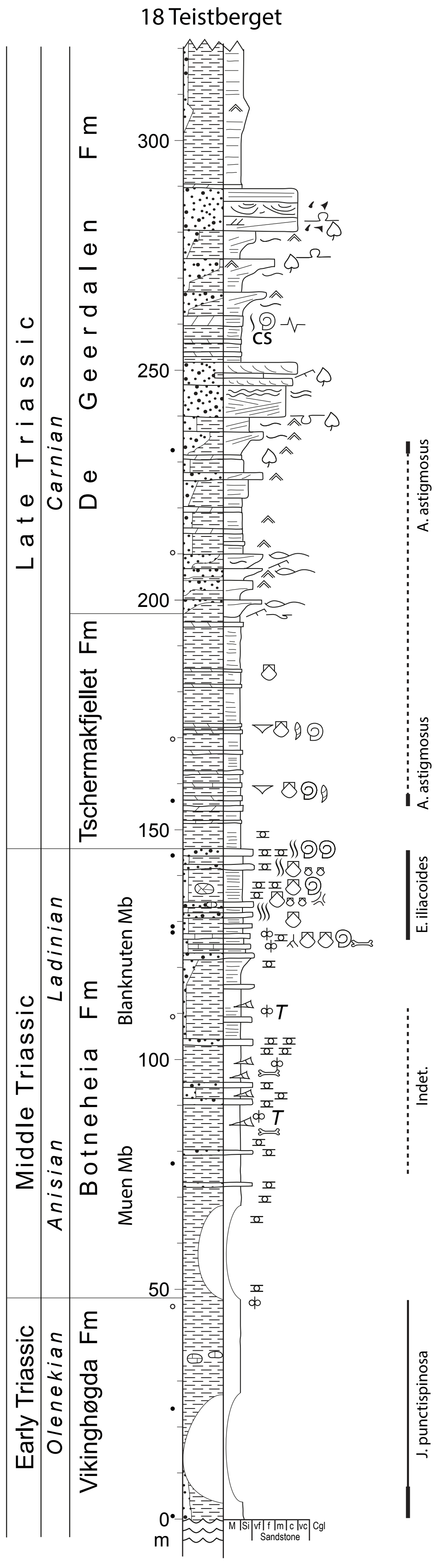


Figure 45. Section 18 Teistberget - Sassendalen and Kapp Toscana groups.
The section was measured by A. Mørk (Sassendalen Group), R. Knarud (Kapp Toscana Group) and D. Worsley.
The section starts at sea level with a small exposure of silty shale before it is covered and only displays a thin interval of grey shales with large carbonate nodules. This succession forms the upper part of the Vikinghøgda Formation.
*The lowermost part of the Botneheia Formation is covered by scree, but phosphate nodules on top of the Vikinghøgda exposure show the presence of the Botneheia Formation. Except for the lower 20 m, the Botneheia Formation is excellently exposed. Phosphate nodules are very common throughout. The upper Blanknuten Member is rich in bivalve (*Daonella*) shells and microcoquinal beds (Mørk and Bromley 2008, Vigran et al. 2008). The upper beds are exposed on large bedding surfaces. Abundant phosphate filled* Thalassinoides *tunnel systems occur on these surfaces.*
The overlying Tschermakfjellet Formation consists of grey shale with abundant small siderite nodules and common ammonoids in its lower parts. Only the lower 120 m of the De Geerdalen Formation were studied at this locality. These consist of coarsening and thickening upward sandstones. Hummocky cross-lamination is common in the lower part while the upper sandstones show wave and trough cross-bedding as well as mudflakes. The upper section is a 30 m thick shale, but the absolute top could not be measured because of time constraints.

Barentsøya and Edgeøya (Sections 19–28, Figures 46–56)

The present study includes localities on both Barentsøya and Edgeøya, where the base of the Vikinghøgda Formation rests directly on eroded upper Permian strata. Exposure of the Permian–Triassic contact has been reported from Kapp Ziehen at NE Barentsøya and from a Permian inlier in central Edgeøya (Lock et al. 1978, Winsnes 1981, Winsnes and Worsley 1981), but here we present data from the Veidebreen locality. On the cited maps the presence of the Vardebukta Formation is reported (Deltadalen Member in the present nomenclature), but our palynological data show no evidence of rocks older than early Olenekian (Smithian), and this age is confirmed by ammonoids from the central Edgeøya locality of Krokå (W. Weitschat pers. comm. 1997). We have visited all these localities and can see no evidence of the oldest (Deltadalen Member) succession, and conclude that these eastern localities were only transgressed in the early Olenekian, probably as a result of the base Olenekian transgression which is recognised in all our studied areas. This also implies that this eastern area was exposed during the Early Triassic (Induan).

The base of the unit is a transgressive conglomerate, but the overlying succession (Lusitaniadalen Member) is a silty shale with some thin siltstone and sandstone beds. Pelagic fossils such as ammonoids occur throughout the unit, demonstrating its marine nature. The lack of coarse-grained sediments, however, indicates distal environments. The upper part of the Vikinghøgda Formation, the Vendomdalen Member, shows a quite similar development to that seen in central Spitsbergen, and moderately deep shelf conditions developed all over the area.

The base Botneheia transgression, with soft shale overlying the silty shale of Vikinghøgda Formation, has a very similar development to that seen on Spitsbergen. Krajewski (2008) defined a lower Muen Member as non-phosphogenic in his type section at Muen on western Edgeøya, while our sections show varying content of phosphate also in this unit. Neither current structures nor bioturbation are observed and the fossil content is totally dominated by pelagic forms. We thus interpret the member as representing dominantly anoxic, deep-shelf environments.

The upper part of the formation, the Blanknuten Member, shows much more variation. It is dominated by *Daonella* shells and has abundant phosphate nodules as well as ammonoids. Beds very rich in faecal pellets are common. Ribs and vertebral discs of ichthyosaurs are common in the upper beds. Localities with well-exposed bedding surfaces at Muen and Skrukkefjellet show extensive burrow networks of *Thalassinoides* traces, often infilled by flattened phosphate nodules. The succession has a high organic content (Mørk and Bjorøy 1984). These combined features indicate fluctuating oxic to anoxic conditions. Conditions were ideal in the upper water masses for animals such as ammonoids and ichthyosaurs, while prolific microplankton blooms, especially of the algal-like *Tasmanites*, resulted in accumulation of very organic-rich mud on the sea bottom. As oxygen was used up in the upper water masses, the sea floor was mostly anoxic to dysoxic. However, occasional ventilation by heavy storms made it possible for a rich community of benthic

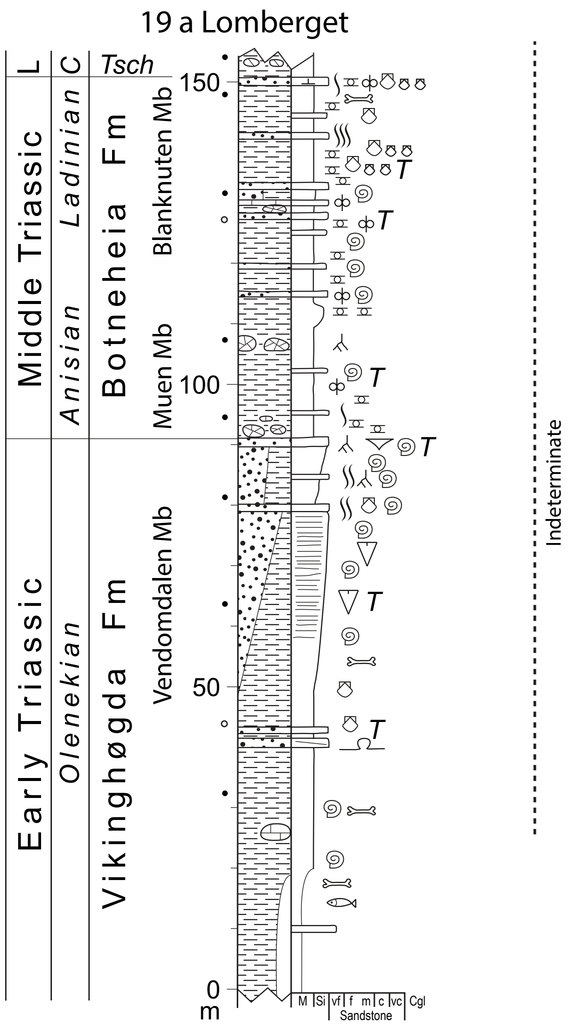


Figure 46. Section 19a Lomberget - Sassendalen Group.
This section was measured by A. Mørk on Lomberget south of Willybreen. The lower part is covered in scree, but the upper Vendomdalen Member of the Vikinghøgda Formation is well exposed. The upper part of this unit forms a coarsening upward section from shale to silt-/very fine-grained sandstone. The section shows a varied marine fauna including ammonoids, belemnites, bivalves, reptile bones (ichthyosaurs) and in the uppermost beds also a spiriferid brachiopod. The upper part of the succession is extensively bioturbated.
The Botneheia Formation is also well exposed and it is dominated by dark grey papery weathering shales. Phosphate nodules are abundant throughout the unit. Limestone nodules are abundant, most of them septarian. Ammonoids, bivalves and reptile bones are present. Siltstone beds in the upper parts are strongly bioturbated. The top of the formation is formed by a carbonate cemented siltstone bed with phosphate nodules, bivalves and abundant microcoquinas and faecal pellets. Grey shales with red siderite nodules rest directly on top of this bed and represent the basal Tschermakfjellet Formation.

epi- and even infauna to be established periodically. Partly restricted shelf conditions around storm-wave base are thus suggested as the depositional environment for these sediments.

The Tschermakfjellet Formation's grey shales with siderite nodules and thin beds that overlie the Botneheia Formation may represent a prodeltaic facies to the approaching De Geerdalen Formation's deltaic system. The abundant ammonoids at the base of this formation demonstrate its fully marine depositional environment. Lock et al. (1978) discussed the great variation in thickness of this formation, which we simply attribute to a delta-switch model with deltaic lobes and interdistributary bays.

The De Geerdalen Formation on these eastern islands is dominated by coarsening-upward sequences from shales to coarse sandstones. The sandstones often show trough cross-bedding and are interpreted as distributary channels of a major prograding delta system. Coal beds and root horizons interbedded with burrowed beds are indicative of delta-top sedimentation. The De Geerdalen Formation thus represents a prograding delta system with channels developed from the prodelta to delta top. No exposures show the uppermost parts of the formation.

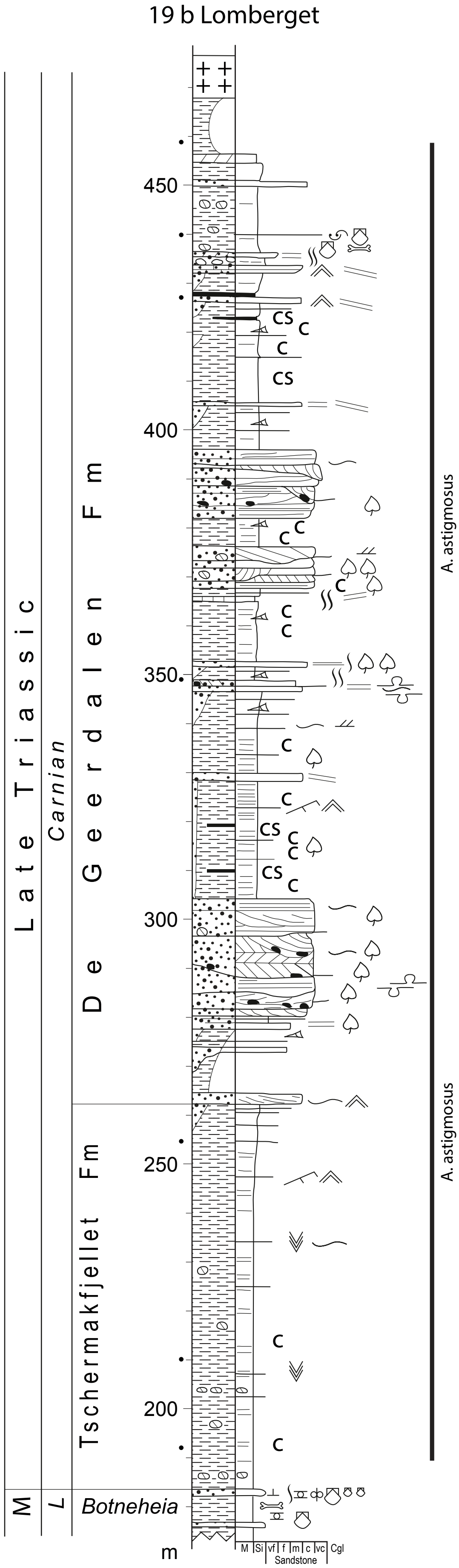


Figure 47a. Section 19b Lomberget - Kapp Toscana Group.
The section was measured by R. Knarud. The lower part is a nearly 80 m succession of grey shales with siderite nodules. Cone-in-cone structures occur at several levels. The upper parts form a faintly coarsening up succession with increased silt content and wave ripples are present.
Approximately 200 m of the De Geerdalen Formation are exposed below a thick dolerite sill. The formation contains several thick (up to 30 m) cross-bedded sandstone beds. Mudflakes are common in these beds. Coal shales and thin coal beds are present between the thick sandstone units. Plant debris is common throughout the section and represents the only identified fossils, except for a bed with bivalves and reptile bones in the uppermost part of the exposure.

Figure 47b. The purple coloured slopes are siderite rich shales of the Tschermakfjellet Formation on top of the cliff forming Botneheia Formation.

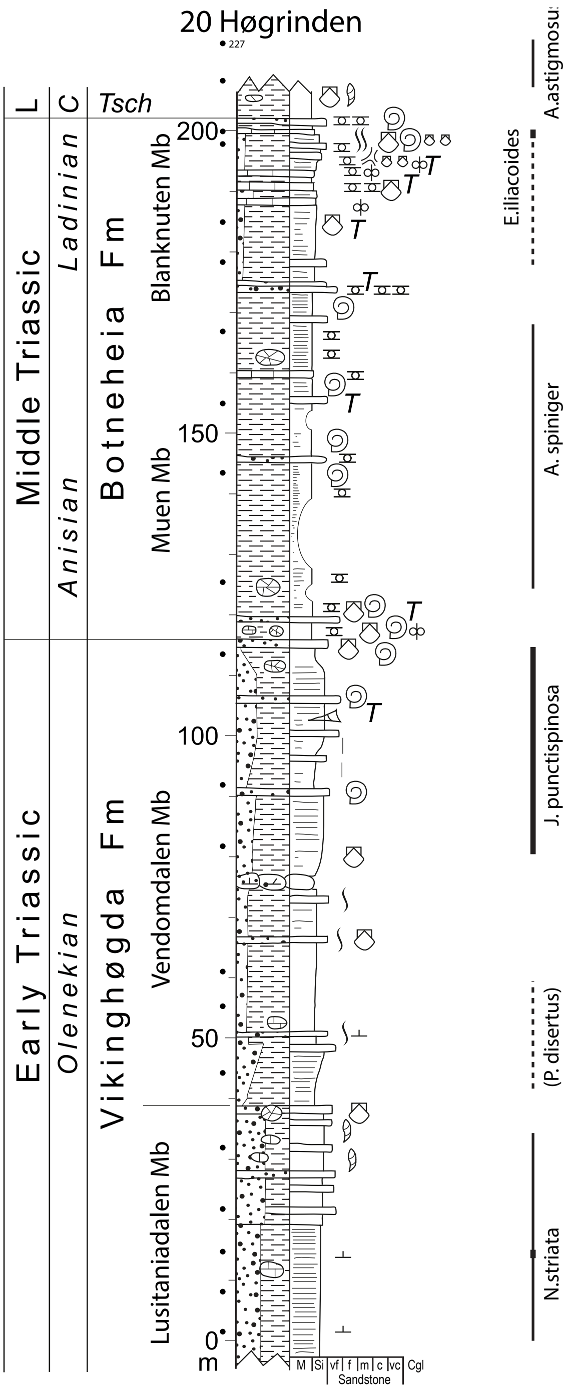


Figure 48a. Section 20 Høgrinden - Sassendalen Group. The section was measured by A. Mørk, and is exposed on the southeastern ridge of Høgrinden, a mountain on Barentsøya facing Freemansundet. The section is generally well exposed.
The Vikinghøgda Formation is represented by its two upper members. The formation has its thickest observed development in Barentsøya and Edgeøya at this locality. The base of the Lusitaniadalen Member is covered by scree and the member consists of silty mudstone without observed sedimentary structures. Upwards in the section some thin siltstone beds show a platy development. The member is devoid of bioturbation or fossils, except for some gastropods in the upper part and bivalves in the top bed. The Vendomdalen Member shows a clear reduction in silt content. Some sparse bioturbation is present, as well as some ammonoids and bivalves. The top of the member is marked by a 0.5 m thick yellow weathering carbonate rich siltstone bed with abundant ammonoids and bivalves.
The Botneheia Formation shows dark shales rich in phosphate and carbonate nodules, with bivalves and ammonoids in its lower part. The overlying section is dominated by papery dark shales with abundant phosphate nodules, some ammonoids and abundant bivalves (mostly Daonella*) and microcoquinal beds. The uppermost part is strongly bioturbated, including* Thalassinoides *and some vertebrate bones are also seen. Above this, grey shales with siderite nodules and bivalve and gastropods belong to the Tschermakfjellet Formation.*

Figure 48b. One of the most complete sections of the Sassendalen Group (Section 20) occurs at Høgrinden on the southern part of Barentsøya. The lower dark cliff is the Lusitaniadalen Member. From top of this lower cliff to the main cliff central in the photo the Vendomdalen Member is well exposed. The Botneheia Formation forms the flattened areas grading up into the dark cliff of the Blanknuten Member.

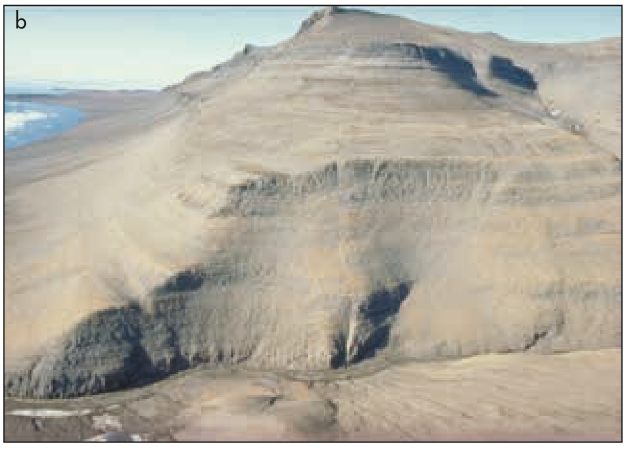


Figure 49a. Section 21 Skrukkefjellet - Sassendalen Group. The section was measured by A. Mørk on the northern slopes of Skrukkefjellet on Edgeøya. The section is very well exposed and several plateaux give a good mix of bedding surfaces and steep cliff exposures.
The Vikinghøgda Formation is represented by its two upper members, while the base of the formation is covered by scree. The Lusitaniadalen Member consists of silty shale with a sparse fauna of ammonoids and reptile bones. No bioturbation was observed. The Vendomdalen Member is fossiliferous (ammonoids and bivalves) and contains very large septarian nodules. The top of the member consists of carbonate cemented strongly bioturbated siltstones forming a cliff.
The Botneheia Formation consists of dark grey papery-weathering shales with abundant phosphate nodules. Thin beds of yellow weathering siltstone are common in the upper part. A black limestone bed, approximately 50 m above the base of the formation, mainly consists of faecal pellets, and this bed contains abundant phosphate nodules. The upper part of the formation weathers into paper shales with abundant Daonella*. The top of the formation is marked by a series of siltstones which are very rich in phosphate nodules. These beds are overlain by grey shales with lighter coloured phosphatic nodules and the section continues into the typical red weathering siderite nodules of the Tschermakfjellet Formation. This lower part of the Tschermakfjellet Formation forms a plateau that rises slowly inland, and ammonoids are common on this gentle slope.*

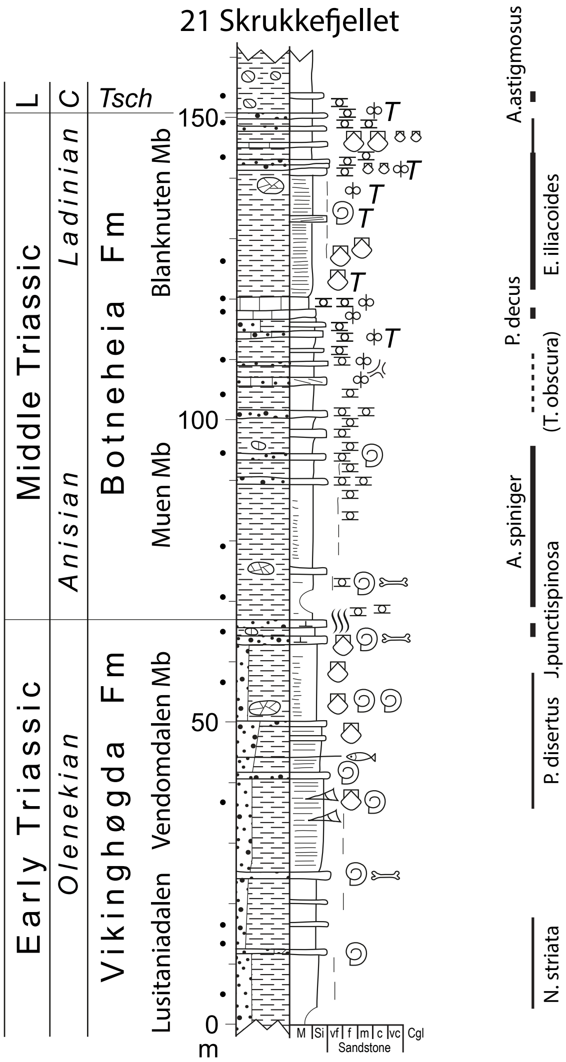
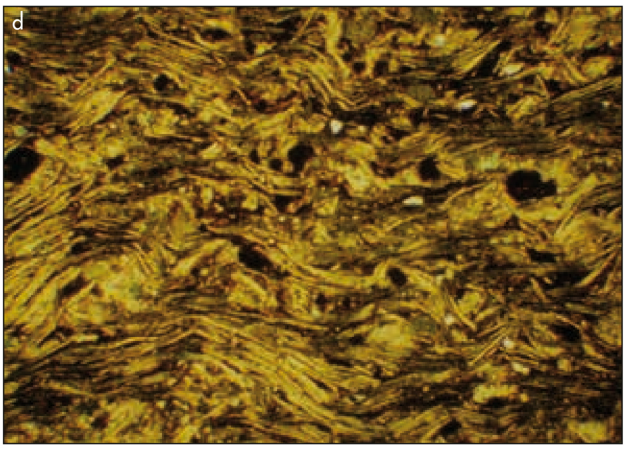


Figure 49b. Large concretions in the lower part of the Blanknuten Member at Skrukkefjellet. Note geologist as scale.

Figure 49c. The cliff of calcite cemented and phosphate rich shales forms the upper part of the Blanknuten Member at Skrukkefjellet.

Figure 49d. Numerous minute bivalves, 1 – 2 mm long, form grainstone beds, and are described as "microcoquina" by Mørk and Bromley (2008).



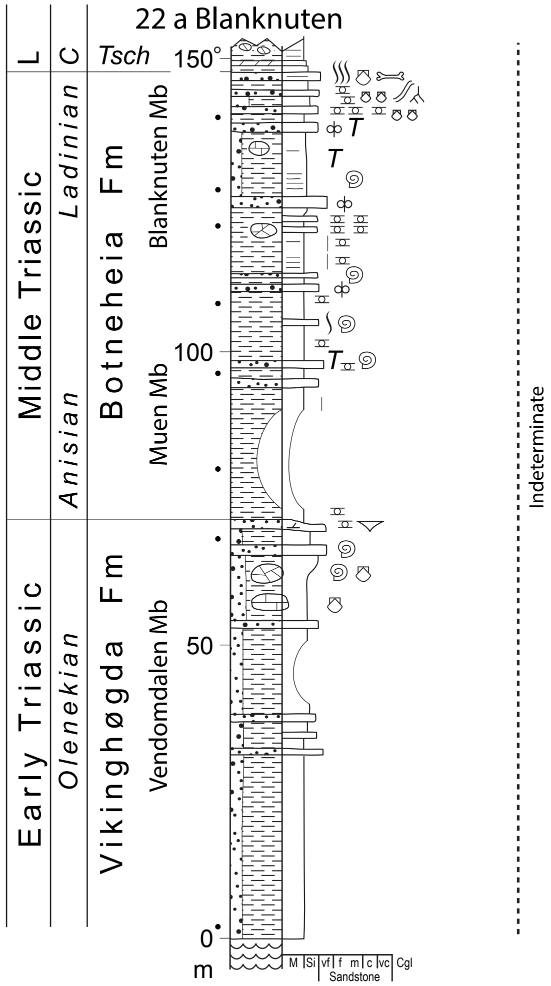


Figure 50a. Section 22a Blanknuten - Sassendalen Group. This section was measured by A. Mørk. The section starts at sea level close to Blankodden on the northwestern coast of Edgeøya (Figure 9). Only the upper part of the Vikinghøgda Formation is exposed above sea level and this consists of silty shales. The lowland behind the shore has exposures with large septarian nodules and also some fossils of bivalves and ammonoids. This part has only a few siltstone beds. The top of the formation is marked by a dolomite-cemented yellow-weathering siltstone bed which contains some phosphate nodules.
*The Botneheia Formation has been studied in the nearby cliff north of the river canyon. Here the lowermost part is covered by scree, while the upper part is cliff-forming. This cliff was defined as the type section for the Blanknuten Member (Mørk et al. 1982, 1999), while Krajewski (2008) has defined a hypostratotype in the northern cliffs of Blanknuten, where the entire formation is excellently exposed. The lowermost part of the formation occurs below the cliff and is partly covered. The cliff has excellent exposures dominated by dark shales with thin siltstone beds, some of them very rich in faecal pellets. Phosphate nodules are abundant in this part. The cliff-forming part of the formation is the type section of the Blanknuten Member. The uppermost bed is strongly bioturbated and has bivalves (*Daonella*) and ichthyosaur bones. On top of the cliff is a few metres thick bed partly eroded to form a plateau before the lithology changes to grey shale with red weathering siderite nodules. This section continues in Section 22c (Figure 52).*

Figure 50b. The top of the Vikinghøgda Formation consists of silty dark shales.

Figure 50c. The type locality of the Blanknuten Member at the southern foot of Blanknuten. This cliff, despite being a bird colony, is an excellent exposure of the dark shales and phosphates of the Blanknuten Member.

Figure 50d. Large vertebrae and ribs of an ichthyosaur at top of the Blanknuten Member at locality of Photo 50c.

Figure 51a. Section 22b Blanknuten, -Kapp Toscana Group. The section was measured by R. Knarud on one of the ridges south of the main valley central on Blanknuten (Figure 9). The Botneheia Formation here forms a pronounced cliff sharply overlain by grey shale with thin siderite beds of the Tschermakfjellet Formation. Most of the Tschermakfjellet Formation on this ridge is covered by scree but the uppermost part is exposed.
The base of the De Geerdalen Formation is defined at the first prominent sandstone. Upwards, many coarsening upwards sandstone units occur on top of each other, grading from shale to medium and occasionally coarse sandstones. Coal or coal-shale beds occur on top of several of these sandstones and some of them have root zones at their base. Marine trace fossils and a few beds with bivalves alternate. Desiccation cracks occurring in the upper part of the exposure are associated with gastropods. Above this level Diplocraterion *trace fossils are present.*

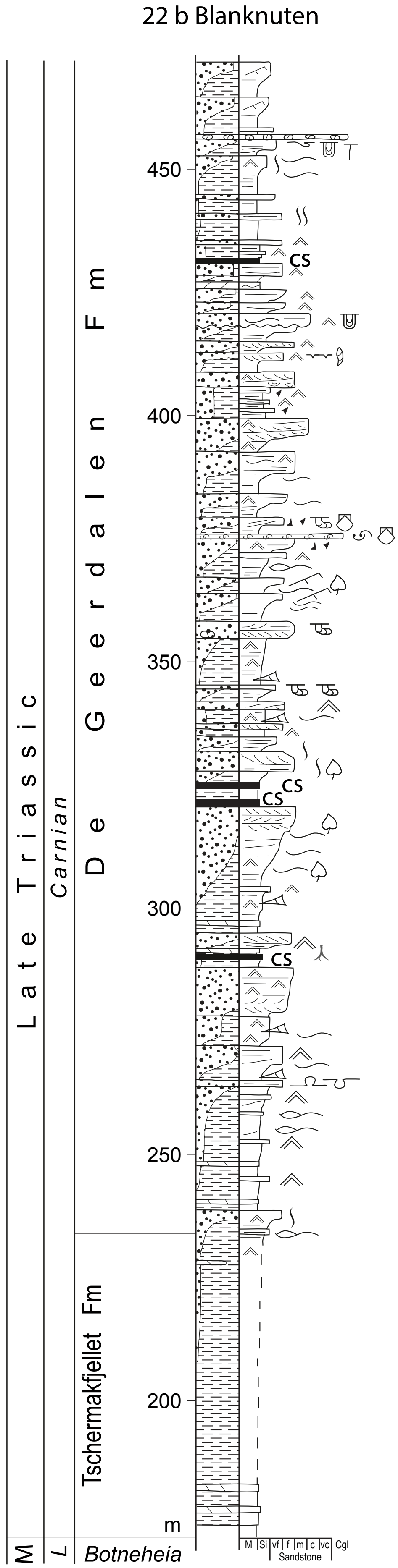


Figure 51b. Section 22b is measured from top of the cliff forming top of the Botneheia Member on the right hand side of this photo. Note the purple coloured Tschermakfjellet Formation grading into the De Geerdalen Formation with its deltaic sandstones.

Figure 51c. A typical sandstone from the upper part of Section 22b.

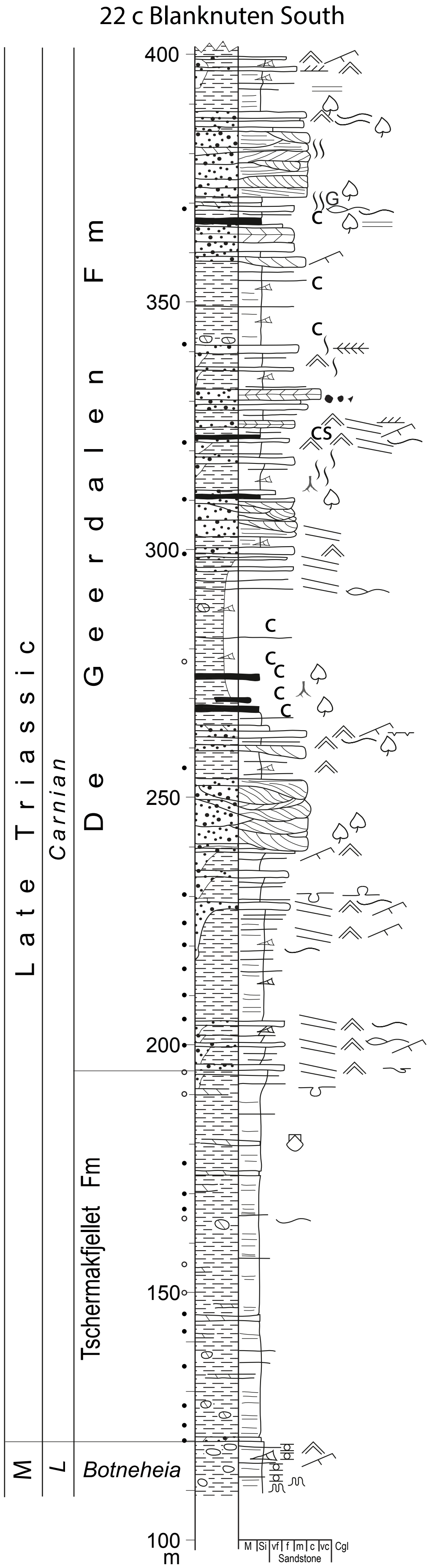


Figure 52a. Section 22c Blanknuten South, Kapp Toscana Group. This section was measured by R. Knarud and D. Worsley along the southern facing slopes of Blanknuten and the section is a direct continuation of Section 22a (Figure 9).
The grey shale of Tschermakfjellet Formation forms a small peak at this locality and many red weathering siltstone beds form small ledges on the slopes. Small ammonoids are common in the lower part of the unit.
In the lower part of the De Geerdalen Formation thin sandstone beds are less prominent than in Section 22b. These show both wave and hummocky cross-bedding. Upwards several thick sandstone units are up to 20 m thick. Between these there are several coal beds, some with root horizons. In the middle part of the formation fossilised large tree trunks (up to 40 cm in diameter) stand upright in living position. In the upper parts herringbone cross-bedding is observed at several levels.

Figure 52b. The purple colour of the Tschermakfjellet Formation is due to weathered siderite nodules.

Figure 52c. A tree trunk from the De Geerdalen Formation. Several similar trunks are present around 270 m of Section 22c.

Figure 53a. Section 23 Muen N, Kapp Toscana Group.
The section was measured by A. Mørk. The section starts above the large plateau close to the top of the Botneheia Formation at Muen in western Edgeøya (see Botneheia section in Krajewski 2008). The base is defined where dark Botneheia shales with phosphate nodules are overlain by grey shales with siderite nodules. At this level, as well as in the lower part of the formation, well preserved (often pyritic) small ammonoids are present. Several carbonate beds with cone-in-cone structures occur in the formation and in the lower part of the De Geerdalen Formation. The upper part of the formation is silty at this locality.
Only the lower parts of the De Geerdalen Formation are preserved at this locality. In the middle part sandstone beds with hummocky bedding are abundant. This locality is clearly less sandy than sections further north and south and it is thus included in this study. Soft sediment deformation is prolific in the upper part of the section.

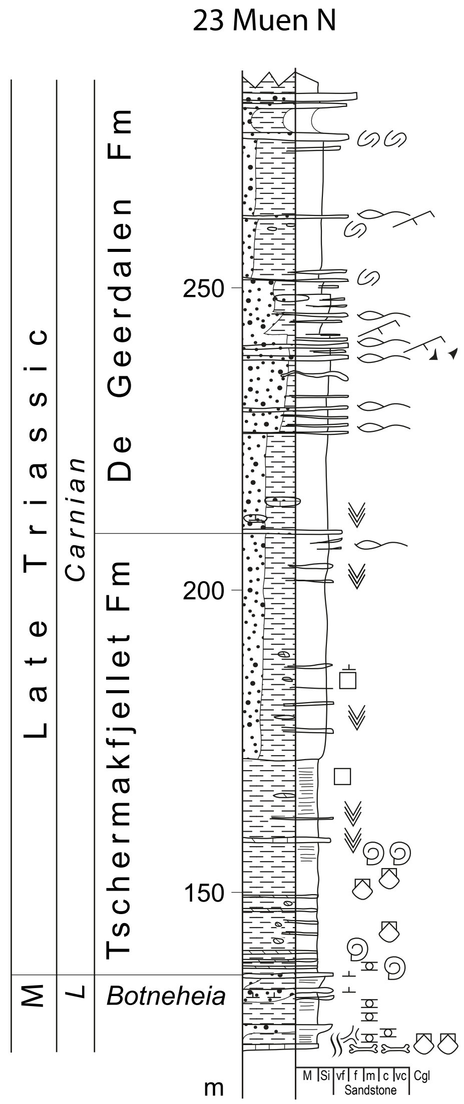
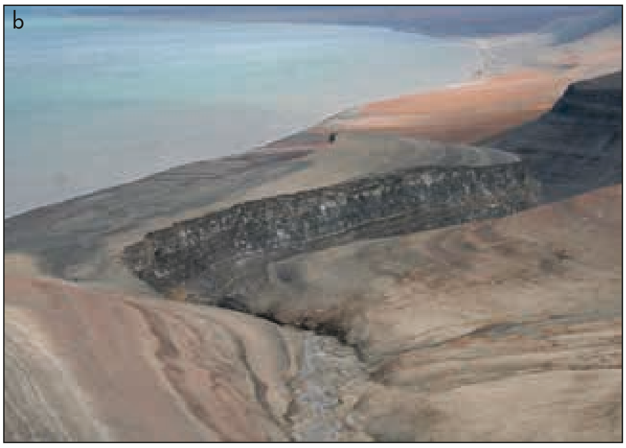


Figure 53b. The uppermost beds of the Botneheia Formation form a large plateau at Muen, and several ichthyosaurs (see photo 53c) are found on this plateau.

Figure 53c. A quite complete skeleton of an ichthyosaur from the Muen Plateau, described by Hurum et al. (in press).

Figure 53d. The transition from the Botneheia Formation (grey) to the Tschermakfjellet Formation (pink) at Muen.



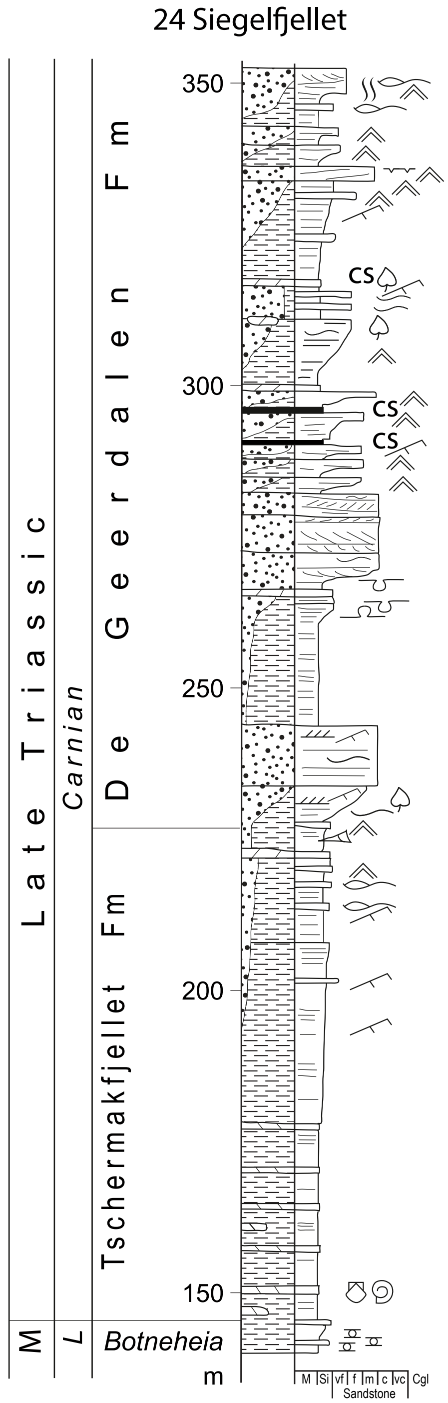


Figure 54a. Section 24 Siegelfjellet - Kapp Toscana Group. This section was measured by R. Knarud on the northern slope of the mountain. The Tschermakfjellet Formation consists of grey shales with thin siderite beds. The unit shows a faintly coarsening-upward trend.
The De Geerdalen Formation at this locality has several pronounced sandstone beds varying from 10 to 40 m in thickness. Coal shales occur between the thickest sandstone units. Wave ripples are abundant in the upper part of the succession.

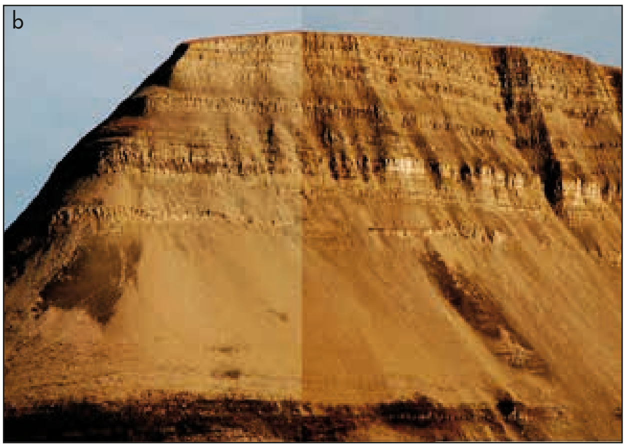


Figure 54b. Northern side of Siegelfjellet. The top of the Botneheia is exposed as the dark cliff close to the base of the section and is covered by shales of the Tschermakfjellet Formation. The sandstones forming the upper part of the mountain can be followed all along the mountain sides (Figure 54c). (Photo F. Riis)

Figure 54c. The section on Siegelfjellet shows the Botneheia Formation up to the dark cliff overlain by the shales of the Tschermakfjellet Formation. The sandstones in the upper part of the mountain can be followed for hundreds of meters. (Photo F. Riis)

Figure 54d. The top of the northern part of Siegelfjellet where Section 24 was measured. (Photo F. Riis)

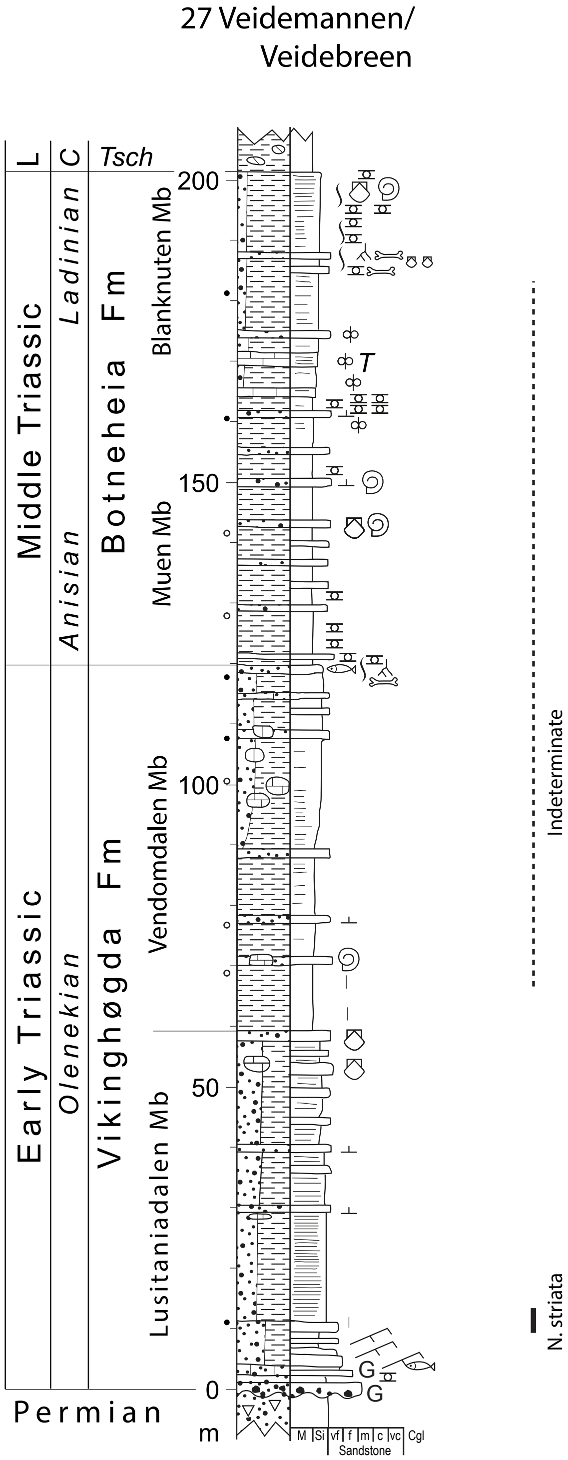


Figure 55a. Section 27 Veidemannen/Veidebreen - Sassendalen Group.
The section was measured by A. Mørk. The section is composite, with the Vikinghøgda Formation measured from the small window of Permian sediments in front of the Veidebreen glacier, approximately 50 m above sea level and following a small stream and up the hill to the base of the Botneheia Formation. The Botneheia Formation is measured on the slopes of Veidemannen mountain on the southern side of Veidebreen. Here the tops of the Vikinghøgda and the Botneheia formations are well exposed while the underlying section is covered by scree. The base of the unit is approximately 100 m above sea level.
The retreating glacier has exposed an excellent top surface of the Permian Kapp Starostin Formation. The surface is erosional, and is overlain by a meandering thin channel fill with clasts and fragments of Permian and Triassic lithologies forming local conglomerates. Glauconite as well as phosphate pebbles are present. Fish fragments are abundant in the sandstones of the lowermost Triassic beds. Above this basal unit, greenish-grey silty shales with silt-and sandstone beds dominate.
Above the basal beds there is a 50 m thick unit of green-grey silty shales with some very fine sandstone beds that are finely laminated and totally without any bioturbation. At top there are some bivalve fossils. This succession is regarded as belonging to the Lusitaniadalen Member. Above this there is a 60 m sequence dominated by shale, unbioturbated in its lower parts, and with limestone nodules in the upper more silty part. This succession is assigned to the Vendomdalen Member. At its top a carbonate bed contains fish fragments. This bed is overlain by soft shales with abundant phosphate nodules marking the base of the Botneheia Formation.
The characteristic top Vikinghøgda Formation siltstone bed is correlated from the Veidebreen section to the Veidemannen section. The Botneheia Formation has dark grey shales with phosphate nodules, often flattened, at its base. Upwards, thin siltstone beds may contain imprints of bivalves and ammonoids. In the upper part phosphate nodules become abundant and imprints of bivalves and ammonoids are present as well as ichthyosaur bones. Above a small depression in the mountainside, grey shales with siderite nodules can be referred to the Tschermakfjellet Formation.

Figure 55b. The top surface of the Permian Kapp Starostin Formation in front of Veidebreen. The white rocks are channels, in hyporelief, with both Permian and Triassic debris.

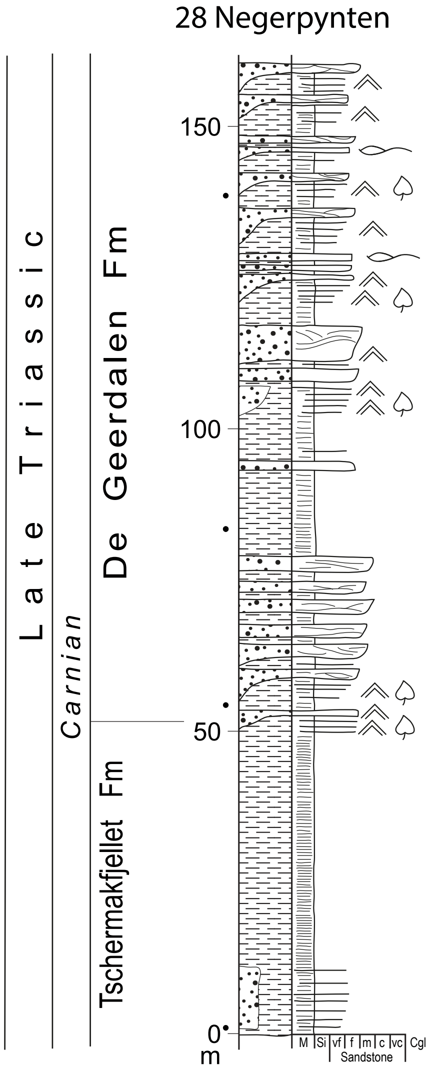


Figure 56a. Section 28 Negerpynten - Kapp Toscana Group. The section was measured by E. Glørstad-Clark on the southeastern side of Negerpynten, southeasternmost Edgeøya, while the samples analysed for palynology were sampled during earlier fieldwork.
The Tschermakfjellet Formation consists of dark shales, with some sandstone beds in its lowermost and uppermost parts. The De Geerdalen Formation consists of shales with thin sandstone units, mostly fining up. Wave ripples are abundant and some beds show hummocky cross-bedding.

Figure 56b. Sandstone benches of the De Geerdalen Formation outcrop in the cliff of Negerpynten.

Wilhelmøya (Section 30, Figure 57)

At Wilhelmøya, a thick De Geerdalen Formation is exposed, but unfortunately this section was not studied for the present work. The section through the Wilhelmøya Subgroup is reproduced from the Stratigraphical Lexicon (Mørk et al. 1999a) and was measured by E. Johannessen and S. Olaussen. At its base there is a polymictic conglomerate including phosphorite pebbles (Worsley 1973) below a strongly bioturbated fine-grained sandstone. This basal unit is the Slottet Bed, representing a transgressive episode. It is overlain by a shale unit displaying an upwards increasing number of thin sandstone beds with hummocky cross bedding, and is assigned to the Flatsalen Formation. Following the basal transgression these deposits represent a gradual shallowing from deep shelf up to above storm wave base.

On top of this, a white, poorly consolidated cross-bedded sandstone unit represents the Svenskøya Formation. Cross bedding and bioturbation in its upper parts indicate shallow-marine conditions. The uppermost ca. 20 m comprise a strongly bioturbated sandstone of clear marine origin, representing the Kongsøya Formation. The phosphatic polymictic conglomerate seen uppermost clearly represents the Brentskardhaugen Bed and it represents recurrent erosion, condensation and intermittent depositional episodes as seen elsewhere on Svalbard.

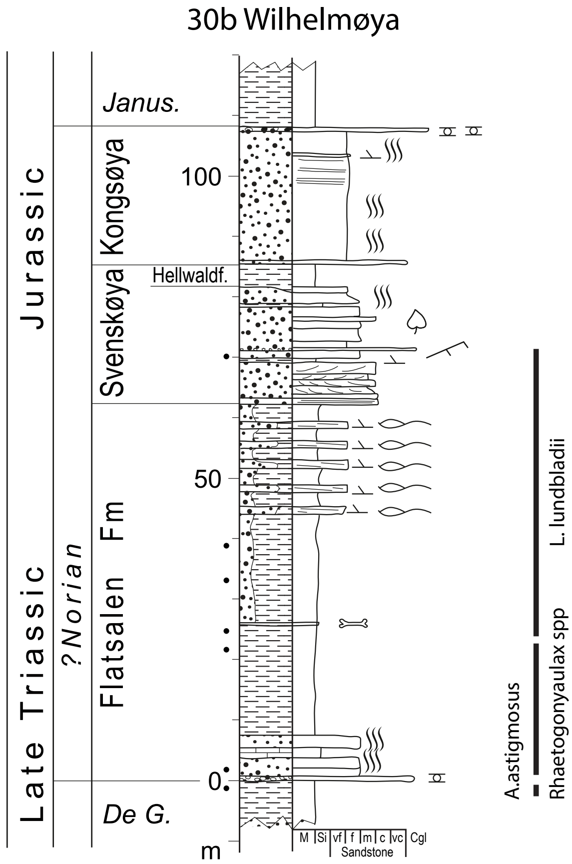


Figure 57a. Section 30b Wilhelmøya - Kapp Toscana Group. This section is reproduced from the Stratigraphic Lexicon of Svalbard (Mørk et al. 1999a), where the section, measured by E.P. Johannessen and S. Olaussen, was published. The samples analysed for palynology were sampled at another time. The Slottet Bed has a phosphatic conglomerate at its base, overlain by bioturbated sandstone including a thin limestone. The overlying shales form a coarsening upward succession with an increasing number of thin sandstones upwards and this unit is referred to the Flatsalen Formation. Above this lower part, mature white sandstones are referred to the Svenskøya Formation. Then follows a thin shale interval which is correlated to the Hellwaldfjellet Bed of the Sjøgrenfjellet Member of the Svenskøya Formation. Above this a bioturbated sandstone is included in the Kongsøya Formation. The top of the section is marked by a polymictic conglomerate with well-rounded phosphate pebbles representing the Brentskardhaugen Bed.

Figure 57b. Wilhelmøya mainly consists of the Kapp Toscana Group. The dark rock in the middle of the photo is a dolerite sill. The De Geerdalen Formation is mostly covered below the sill, but is well exposed upwards from the dolerite (Figure 57c).

Figure 57c. Grey sandstones of the De Geerdalen Formation overlain by yellow-brown shales and sandstones of the Wilhelmøya Subgroup.

Figure 57d. Poorly consolidated sandstone of the Svenskøya Formation.

Hopen
(Sections 32a, b, Figures 58, 59)

All of the Hopen succession is younger than the exposures on Barentsøya and Edgeøya (Riis et al. 2008) as seen from seismic data and from thickness data from deep exploration wells. The island mainly consists of the De Geerdalen Formation, with the lower units of the Wilhelmøya Subgroup on the highest mountain tops (Figure 15).

Well-developed channels, up to 36 m thick, can be seen in the coastal cliffs. The sediments between the channels display coarsening-upward sequences from shale to sandstone. Plant debris is common. Sandstone beds may show hummocky cross bedding but wave ripples dominate. Thin coal beds, commonly with underlying root horizons, occur in the lower and middle parts of the succession, while the upper parts are shale dominated with thin hummocky cross-bedded sandstones. The De Geerdalen Formation thus represents continuation of the same deltaic system as on Edgeøya, but the lower and middle exposures show a more proximal development. The upper part of the De Geerdalen Formation is dominated by dark marine mudstone and is now defined as the Hopen Member (Mørk et al. 2013).

Bioturbated siltstone of the Slottet Bed, with carbonate cement and fragments of bivalves and ammonoids, marks the transition between the De Geerdalen and Flatsalen formations. Occasional bivalves, ammonoids and ichthyosaur bones occur throughout the marine Flatsalen Formation, which represents a major coarsening-up succession. Increasing numbers of hummocky cross-bedded sandstones become thicker upwards and are then replaced by wave ripples uppermost. White sandstones of the Svenskøya Formation rest with an erosional contact on the Flatsalen Formation. These sandstones are trough cross bedded and the only fossils seen are plant remains. The formation may represent tidal- to coastal-plain deposits, possibly with a more marine development in its uppermost part.

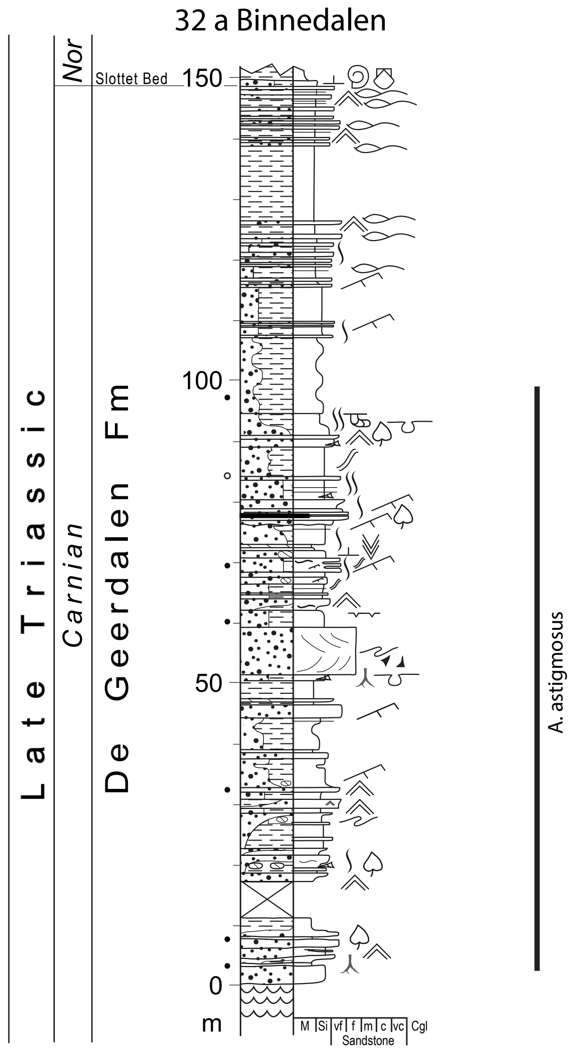


Figure 58a. Section 32a Binnedalen - De Geerdalen Formation. The section was measured in Binnedalen by I.B. Hynne (Figure 15).The section was measured in Binnedalen, which is a valley on the north-eastern side of Lyngefjellet on Hopen island, see photos in Mørk et al. (2013). The palynological samples were collected further south on the same mountain at an earlier expedition. The whole section consists of alternating shales and sandstones, often organised in coarsening up sequences. Thick cross-bedded sandstones in the lower to middle parts represent channel fill. The lower part of the succession has abundant wave ripples, while the upper part has both wave and hummocky lamination. Coal beds are common, except in the upper part. Several root zones are also present. At top a bioturbated fossiliferous sandstone represents the Slottet Bed of the overlying formation.

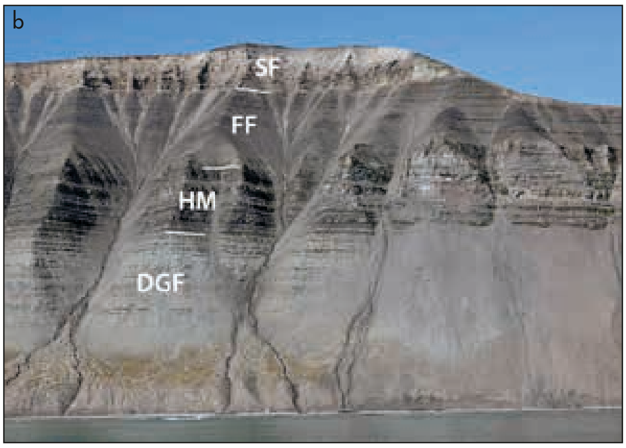


Figure 58b. Eastern side of Lyngefjellet, on the northern part of Hopen, displays the most complete succession of Upper Triassic rocks. DGF = De Geerdalen Formation with the dark Hopen Member (HM) at top. FF = Flatsalen Formation and at top, SF = the Svenskøya Formation (photo T. Hellem).

Figure 59d. Northward from the measured sections (see Figure 15) a channel in the De Geerdalen is 36 m thick and 1000 m wide in outcrop. Photo: T. Hellem, photomanipulation: K.O. Solvi. ❯

Figure 59a. Section 32b Lyngefjellet - Wilhelmøya Subgroup. The lower Flatsalen Formation was measured by A. Mørk, T. Hellem and E. Simonstad while the upper Svenskøya Formation was measured by G.S. Lord, except for the lowermost part of this unit which is taken from Mørk et al. (1999a), where it was measured by G.B. Larssen and others. The samples analysed for palynology were sampled during earlier fieldwork and are tentatively located in this present composite section. Figure 15 show the localisation of the individual measured sections.
The Slottet Bed can be followed along the eastern slopes of Lyngefjellet. It is easy accessible uppermost in Binnedalen, at the top of the Binnedalen section. The Flatsalen section is measured from the top of the Slottet Bed on the eastern slopes of Lyngefjellet. The Slottet Bed is strongly bioturbated and contains fragments of bivalves and ammonoids. Upward there are several siltstones to very fine-grained sandstone beds, often capping faint coarsening upward rhythms. Bivalves occur in many of these beds and midway in the formation ichthyosaur ribs and vertebrae are seen (including a vertebral disc 13 cm in diameter). Most of these very fine-grained beds show hummocky cross-bedding. The upper part of the formation shows increasing silt content upward and lenticular and thin sandstone beds are common.
The Svenskøya Formation has an erosional base. It consists of white coarse-grained large-scale cross-bedded sandstones. In the upper part mudflakes are common. Plant debris is abundant throughout. The uppermost part contains some shale and more brownish sandstone.

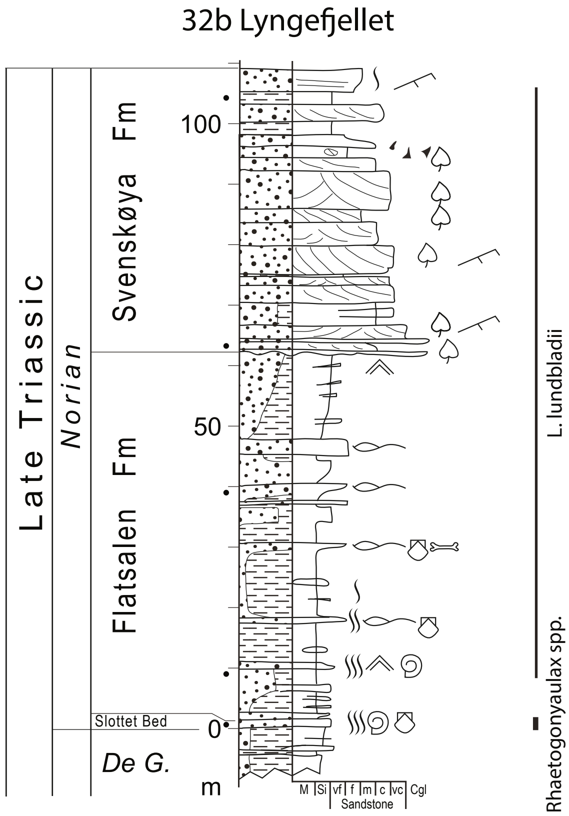


Figure 59b. The calcareous mudstone of the Slottet Bed rests on top of the De Geerdalen Formation and forms the basal unit of the Flatsalen Formation.

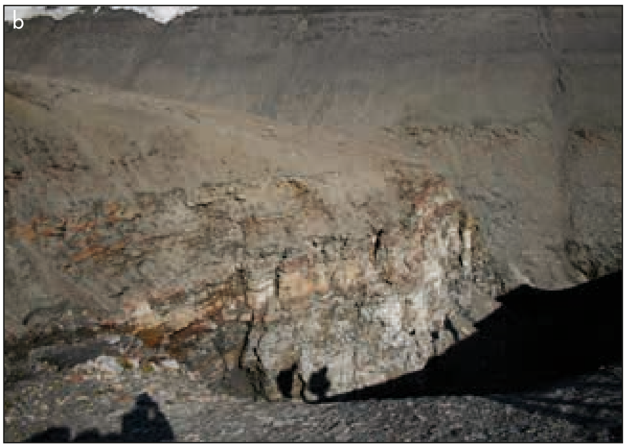


Figure 59c. The Svenskøya Formation is a 50 m thick sandstone at the top of Lyngefjellet.

Bjørnøya (Section 33, Figure 60)

Triassic rocks (Pčelina 1972a, Mørk et al. 1990) only occur on the highest mountain of the island (Figure 16). At base is a hiatus spanning the latest Permian and earliest Triassic, although no erosion is seen. The basal sandstone of the Urd Formation represents a transgression that reworked sediments of latest Permian and Triassic age. Above this sandstone, fossiliferous shales with thin siltstones of the Urd Formation represent shallow-marine environments. A condensed carbonate-cemented bed marks the top of the formation. The phosphate nodules of the overlying Verdande Bed may represent the remains of a thicker, Middle Triassic unit. The nodules are poorly dated as Anisian, and resemble those of the Bravaisberget and Botneheia formations on the islands further north. However, dating of the overlying sediments to the Ladinian supports the Anisian remanié origin of the nodules.

The coarsening-upward successions of the Skuld Formation, with siderite nodules and thin sandstone beds showing wave and hummocky cross lamination together with ammonoids and bivalves, indicate deposition in shallow-marine environments. The 3 m-long labyrinthodont amphibian found here most probably lived not too far from land. In upper exposures a thin mudstone with ammonoids and many gastropods may represent a lagoonal deposit. This mudstone is overlain by a cross-bedded sandstone, rich in plant remains and thick-shelled bivalves, which may represent bank or shoreline deposits.

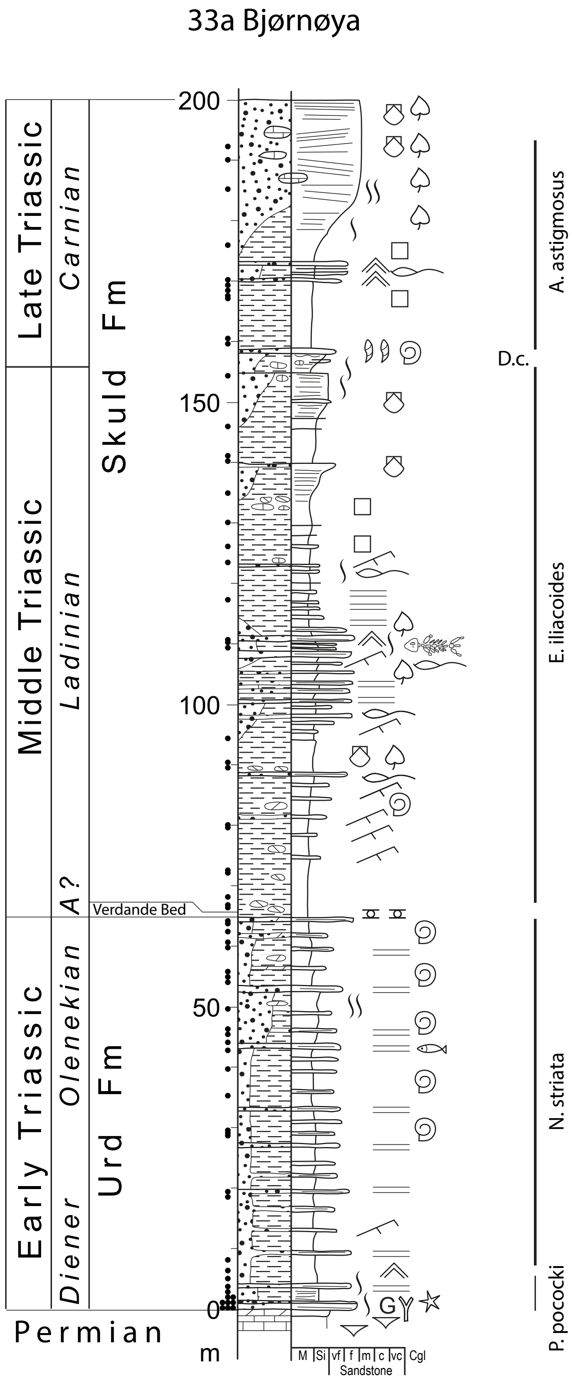


Figure 60. Section 33a Bjørnøya - Sassendalen and Kapp Toscana groups.
The section was measured by A. Mørk, and presented by Mørk et al. (1990). The section was measured along the southern ridge of Urd from the top Permian cliff to the top of the mountain (Figure 16). The base is a bed with mixed reworked Permian and Triassic fragments on top of the Miseryfjellet Formation, which is dolomitised uppermost. The lower Urd Formation consists of grey silty shale with thin sandstone beds and is 65 m thick. At top it has a carbonate cemented bed with voids indicating post sedimentational dissolution (Pchelina 1972a). On top of this bed there is a 20 cm thick conglomerate of phosphate nodules with fossil debris called the Verdande Bed.
Above the Verdande Bed 50 m of grey shales with siltstones and fine-grained sandstones form a faintly coarsening-upward succession. A 3 m long labyrinthodont amphibian skeleton was found between sandstone beds at top of this unit. Above this sandy interval there are several faintly coarsening-upward units. On top of the uppermost one, 40 m below the mountain top, ammonoids (among them the index fossil Daxatina canadensis *=D.c.) and abundant gastropods are present. The mountain is capped by a 25 m thick fine- to medium-grained sandstone with abundant bivalves and plant fragments.*

Figure 60b. The Triassic succession on Bjørnøya is only preserved on the island's highest mountain Miseryfjellet. The soft Triassic rocks form cones on top of the cliffs formed by Permian limestones.

Palynology of the Triassic succession

Introduction

The aim of this study is to establish a regional stratigraphical framework that can provide a solid correlative tool for the vast area of the Norwegian Arctic and document the results of all the studied sections. The palynostratigraphy presented herein (Figures 3a, b, 4, 5) is based on previously published records (Hochuli et al. 1989, Mørk et al. 1990, 1999b, Vigran et al. 1998), combined with hitherto unpublished data from onshore outcrops and from the offshore subsurface obtained through decades of palynological work. Most important are shallow stratigraphic cores providing continuous records through most of the Triassic succession. For the first time 15 Composite Assemblage Zones are formally defined (Figure 3), incorporating the stratigraphical schemes of Hochuli et al. (1989) and Vigran et al. (1998). An assemblage zone is a sequence (body of rock or strata) that is defined by a natural assemblage of three or more taxa without strict attention being paid to the distribution limits of each single taxon (Nystuen 1989). Not all the characteristic species of the assemblage need to occur in a defined order of a section to be assigned to an assemblage zone. In many cases the total range of the 'marker species' may extend beyond the boundaries of the zone. We consider the concept of Composite Assemblage Zone as most appropriate for the studied material, since the 'Last Appearance Datum (LAD) and First Appearance Datum (FAD) proved to be unreliable in a succession of changing environments, commonly biased by preservation. Environmental and preservational features also result in strong variations in the quantitative composition of the assemblages. Since the quantitative distribution of some species varies considerably throughout the vast study area, less weight is put on quantitative variations of specific taxa in the assemblages. We work with what we consider 'natural palynomorph assemblages' including all species comprising an assemblage. Palynomorph assemblages generally contain taxa of various biological origins (e.g., protists, fungi, bryophytes and vascular plants) and of various provenances (e.g. terrestrial and marine environments), implying that the assemblage zones can be defined on a combination of terrestrial and marine species of various biological affinities. The Triassic sequence in the Barents Sea is dominantly marine, but with major input of terrestrial material, resulting in a succession which is generally dominated by terrestrial sporomorphs, but it also contains numerous marine palynomorphs (e.g., dinoflagellate cysts and prasinophycean algae), including some important marine index fossils.

The main weakness of the present zonation reflects that it is based on many different studies with different aims that have been carried out over a long period of time. Over the decades taxonomic concepts and methods have changed (e.g., counting, reporting and preparation techniques). In this study, we have tried to homogenise taxonomy and to apply a consistent way of dealing with quantitative data. The abundances indicated in the range charts and the texts were originally based on semi-quantitative abundances and on various ways of counting. Another weakness of these data is related to the fact that quantitative data are commonly based on counts that include an entire assemblage (i.e., terrestrial and marine palynomorphs). Therefore, variations in spore/pollen abundances can be affected by the terrestrial/marine ratio.

On the other hand, the fact that a considerable part of our results is based on cores and outcrop section provides a high-quality reference for their stratigraphic occurrences. We therefore believe that the zonation is robust and provides a solid superregional biostratigraphic framework for the area. However, the present work reveals the need for more detailed investigations in order to refine local stratigraphy, ranges and areal distribution of taxa, and clearly shows the need for additional work on taxonomic issues.

The Tempelfjorden to Sassendalen Group contact

On Svalbard the contact between the Tempelfjorden and the Sassenfjorden groups (Kapp Starostin and Vardebukta/Vikinghøgda formations) has historically been regarded as representing the Permian to Triassic transition. The palynology of this succession has now been restudied and combined with previously published data (Mangerud and Konieczny 1993, Mangerud 1994,). However, a large number of the samples of this interval processed from Svalbard are barren of palynomorphs and in most sections the organic material is poorly preserved. Thus, identifications are difficult and particularly those of bisaccate pollen are problematic. For example, no palynomorphs with dating potential were recorded from exposures on Edgeøya. This contrasts with the core material from the Barents Sea, which generally shows good preservation (see below).

The transition between the two groups on Svalbard is documented in 19 sections, where sedimentation apparently continued across the Permian/Triassic boundary in the north-western and central areas. The Kapp Starostin Formation is characterised by the youngest occurrence of common *Lueckisporites virkkiae* and the presence of several species of *Vittatina*. However, palynologically productive samples are missing from a few metres (Selmaneset, Festningen, Bertilryggen, Reinodden) down to 80 m (Stensiöfjellet) below the top of the formation, making exact dating difficult. Several species, such as *Proprisporites pocockii*, *Lunatisporites* spp. and *Reduviasporonites chalastus*, have their first stratigraphic occurrence near the base of the Sassendalen Group.

Material from the Havert Formation in the Barents Sea is well preserved and palynological associations from the boundary between the Ørret and the Røye formations (Larssen et al. 2002) and the Havert Formation are characterised by abundant *Lunatisporites* spp. and microplankton, with a dominance of *Micrhystridium* spp. A marked shift from a dominance of pollen to dominance of spores is recorded at the transition. The presence of *R. chalastus*, *Lycospora imperialis*, *Maculatasporites* sp. and *P. pocockii* characterises the lowermost parts of the Havert Formation. Relatively consistent records of *Vittatina* spp. and *Lueckisporites virkkiae* are also typical features of this interval. These assemblages have been previously documented from shallow stratigraphic cores (Mangerud 1994; Hochuli et al. 2010 a) and represent one of the best documented end-Permian (Changhsingian) to earliest Triassic successions.

For a long time the rare but consistent records of Permian species such as *Vittatina* spp. and *Lueckisporites virkkiae* in the lowermost Sassendalen Group throughout the study area have been regarded as reworked. Based on preservation, consistent occurrence and gradual fading out of these taxa they are now regarded as *in situ*, indicating that their parent plants persisted through the end-Permian extinction event. This is consistent with interpretations based on records in the southern parts of the Barents Sea (Hochuli et al. 2010 b).

The ammonoid faunas of the lowermost Vardebukta and Vikinghøgda formations are assigned to the *Otoceras boreale* Zone and have previously been regarded as evidence for an early Griesbachian age. The redefinition of the Permian/Triassic boundary and the new Triassic timescale (Yin et al. 2001, Ogg et al. 2008, Ogg 2012) now assign the *O. boreale* Zone as spanning the Permian–Triassic boundary.

Palynostratigraphy of the Changhsingian and Lower Triassic succession

A major palynological turnover is reflected by the transition from typical Permian palynofloras dominated by gymnosperm pollen (including diverse and abundant *Vittatina*) in the Tempelfjorden Group to the spore-dominated palynofloras lowest in the Sassendalen Group. The latter assemblage probably represents a short-lived event, which is succeeded by a rapid recovery of the gymnosperms in the *Reduviasporonites chalastus* Composite Assemblage Zone (Hochuli, et al. 2010a, b). The overlying *Proprisporites pocockii*-, *Maculatasporites* spp. and *Naumovaspora striata* assemblage zones are strongly dominated by spores. A shift back to gymnosperm-dominated assemblages is first recorded at the Smithian–Spathian boundary (Vigran et al. 1998, Galfetti et al. 2007, Hochuli and Vigran 2010).

Only a few sections on Svalbard are sufficiently productive for palynological dating and correlation of the Vardebukta, Vikinghøgda and Urd formations. These are located at Bravaisberget (Table A.2), Festningen (Table A.1.1), Høgrinden (Table A.16), Stensiöfjellet (Table A.8), and Vikinghøgda, as well as at Miseryfjellet on Bjørnøya (Table A.24). The palynostratigraphy of the section at Vikinghøgda (Mørk et al. 1999b), has been slightly revised (Table A.7). Previously published, well-preserved palynological assemblages recovered in cores from the Svalis Dome (Vigran et al. 1998) have provided crucial palynological data for the Lower Triassic Havert and Klappmyss formations of the Barents Sea. The records from the Finnmark Platform (Mangerud 1994, Hochuli et al. 2010b) and from exploration wells (Hochuli et al. 1989) give valuable data confirming the regional occurrences of key species.

Altogether seven Composite Assemblage Zones are defined for the Changhsingian to Olenekian interval (for comparison with previously published schemes see Figure 3a).

Uvaesporites imperialis Composite Assemblage Zone

Definition: The zone is characterised by a total dominance of lycopod spores, with an acme of *Uvaesporites imperialis*. *Vittatina* spp. and *Lueckisporites* spp. occur consistently, but in low numbers.

Characteristics: The Changhsingian spore peak is well documented by Mangerud (1994) and Hochuli et al. (2010b), although it was then regarded as Triassic.

Biostratigraphic correlation: The *U. imperialis* Zone correlates with the acme for the *U. imperialis* morphon described by Mangerud (1994, figures 6 and 7) and with phase D and lower part of phase E of Hochuli et al. (2010a). The zone corresponds to the lower part of the *Lundbladispora obsoleta–Tympanicysta stoschiana* Assemblage Zone defined by Mangerud (1994) from the Finnmark Platform (*Tympanicysta* is synonymous with *Reduviasporonites*). The *U. imperialis* zone is now placed within the latest Permian based on the recent definition of the Permian–Triassic boundary. It probably corresponds to the spore spike observed by Stemmerik et al. (2001) and seems related to the end-Permian extinction event. So far it has been documented only from very few locations.

Age: Changhsingian. The distinct pattern of the $\delta^{13}C_{org}$ curve (Hermann et al. 2010, Hochuli et al. 2010b) suggests correlation with sections in Canada, China and Australia. The *Uvaesporites imperialis* zone almost coincides with the globally recognised negative $\delta^{13}C_{org}$ isotope spike (Wignall et al. 1998, Hermann et al. 2010, Hochuli et al. 2010b) marking the end-Permian event.

Reference section: The lowermost part of the Havert Formation is well developed in shallow stratigraphic cores 7129/10–U–1 (depth: 64.4–55.4 m) and 7128/12–U–1 (depth: 116.4–108 m) on the Finnmark Platform (Mangerud 1994). The lithological development of this area was described by Bugge et al. (1995).

Remarks: The major turnover from gymnosperm-dominated floras to those dominated by lycopods was documented by Hochuli et al. (2010b), suggesting a short duration of the distinct floral assemblages. The changes recorded for floral assemblages coeval with the $\delta^{13}C_{org}$ isotope records suggest that there is a coupling between the carbon cycle and the floral turnovers (Hochuli et al. 2010b).

Reduviasporonites chalastus Composite Assemblage Zone

Definition: The zone represents the interval between the First Appearance Datum (FAD) of *Lundbladispora obsoleta* and the last consistent occurrence of *Reduviasporonites chalastus* (synonymous to *T. stoschiana*). This zone is also characterised by a continued consistent occurrence of *Vittatina* spp. and *Lueckisporites* spp., as well as the FAD of *Aratrisporites* spp.

Characteristics: Diverse assemblages of bisaccate pollen, including the *Protohaploxypinus*, *Striatoabieites* and *Lunatisporites* groups, characterise this zone. There is a high diversity of spores, including the *Densoisporites*, *Lundbladispora* and *Kraeuselisporites* groups and the species *Proprisporites pocockii*. The relatively consistent presence of *R. chalastus*, *Vittatina* and *Lueckisporites* distinguishes the assemblage from the overlying zone. It is important to note that these palynomorphs are rare in most associations from Svalbard.

Biostratigraphic correlation: On Spitsbergen, this zone is recorded from below the level with ammonoids of the *Otoceras boreale* Zone. So far *Otoceras concavum* has not been recorded in the area. The *Reduviasporonites chalastus* Zone incorporates the upper part of the *L. obsoleta–T. stoschiana* Assemblage Zone defined from the Finnmark Platform by Mangerud (1994) (see Figure 3). The zone is equivalent to the assemblages recorded in the lower part of the succession of Assemblage P of Hochuli et al. (1989). A similar assemblage has been described from the Wordie Creek Formation in East Greenland (Piasecki 1984, Looy et al. 2001, Stemmerik et al. 2001).

Age: Changhsingian–Early Induan/Early Griesbachian (sensu Tozer 1994) spanning the Permian–Triassic boundary.

Reference section: On the Finnmark Platform, the Havert Formation of shallow stratigraphic core 7128/12–U–1 (depth: 108–62.5 m) was described by Mangerud (1994). The type section of the Vikinghøgda Formation in Deltadalen with corresponding assemblages is also a good reference section (Table A.7).

Remarks: Similar assemblages were documented by Mangerud and Konieczny (1993) and Mørk et al. (1999b) from the basal parts of the Vardebukta and Vikinghøgda formations in several sections on Svalbard, assigning them to an earliest Triassic age. The presence of 'Permian' taxa in these deposits has been discussed by several authors (e.g., Mangerud 1994, Utting et al. 2004, Hochuli et al. 2010a). Hochuli et al. (op. cit.) noted the consistent presence of taxa such as *Vittatina* spp. above the lithological contact and their gradual fading out, favouring the conclusion that they are *in situ* in early Griesbachian deposits. They also concluded that since most major Palaeozoic plant groups in the Barents Sea area range into the Mesozoic, the end-Permian extinction event had only a minor impact on plant communities.

Proprisporites pocockii Composite Assemblage Zone

Definition: The FAD of *Densoisporites nejburgii*, with presence of rare but consistent *Proprisporites pocockii* and *Maculatasporites* spp., as well as common *Aratrisporites* spp., *Pechorosporites* spp. and the Last Appearance Datum (LAD) of *Vittatina* spp., define this zone.

Characteristics: The assemblages are dominated by cavate and zonate spores of the *Densoisporites, Kraeuselisporites* and P*echorosporites* groups. Pollen include monosulcate pollen such as *Cycadopites*, and consistent but generally low abundances of bisaccate pollen. Acritarch acmes are seen in several of the successions.

Biostratigraphic correlation: The '*D. nejburgii–Proprisporites pocockii–Maculatasporites* sp. Concurrent Range Zone' or 'Svalis–1' of Vigran et al. (1998) is incorporated in the *Proprisporites pocockii* Zone. In core Dia–84–2 the zone is dated by the ammonoid Ophiceras sp. The zone is equivalent to the upper part of Assemblage P of Hochuli et al. (1989). In the present study, corresponding assemblages have been recorded from deposits of the *Ophiceras commune* Zone.

Age: Early Induan.

Reference section: Havert Formation, shallow stratigraphic core Dia–84–2, on the Svalis Dome (Table A.33), as described by Vigran et al. (1998).

Remarks: This assemblage is present in the section above the *Otoceras boreale* Zone of the Deltadalen Member at Vikinghøgda (Mørk et al. 1999b).

Maculatasporites spp. Composite Assemblage Zone

Definition: The zone is defined by the occurrence of *Punctatisporites fungosus*, consistent *Maculatasporites* as well as common *Cycadopites* and *Pretricolpipollenites*. From semi-quantitative data it is clear that the two latter occur in relatively higher abundance than in the overlying zone. This was also noted by Hochuli et al. (1989). The last consistent occurrence of *P. pocockii* is within this zone. The first occurrences of *Protodiploxypinus doubingeri* and *Circumstriatites* sp. are within this zone and rare fungal remains are commonly observed.

Characteristics: The associations of the *Maculatasporites* spp. Composite Assemblage Zone are mostly poorly diversified. Marine plankton, including *Tasmanites*, are common. The genus *Vittatina* does not extend into the zone. In areas where the samples contain only poorly preserved palynomorphs, the spore-dominated assemblages with rarely occurring fungal remains lack differentiating features. This may make it difficult to distinguish it from the stratigraphically underlying *P. pocockii* Zone and the overlying *N. striata* Zone.

Biostratigraphic correlation: This assemblage zone was recovered from the Urd Formation on Bjørnøya, where the strata are dated by ammonoids of the *Vavilovites sverdrupi* Zone (Mørk et al. 1990, Figure 3 and Table A.24). Assemblage O of Hochuli et al. (1989) is incorporated within this zone. It should be noted that no cores from the late Induan (Dienerian) have yet been retrieved from the Barents Shelf.

Age: Late Induan/Dienerian.

Reference section: The type section of the Vikinghøgda Formation in Deltadalen, Svalbard (Table A.7).

Remarks: Assemblages assigned to this zone include those from the Vardebukta Formation at Bravaisberget and from the upper Deltadalen Member at Tschermakfjellet, Vikinghøgda and Stensiöfjellet (Table A.8), as well as those from the lower part of Urd Formation on Bjørnøya (Mørk et al. 1990 and Table A.24).

Naumovaspora striata Composite Assemblage Zone

Definition: The first common to abundant occurrence of *Punctatisporites fungosus* and *Densoisporites playfordi*, together with the last consistent occurrence of *Naumovaspora striata* define this zone. Occasional *Proprisporites pocockii* are recorded at some localities.

Characteristics: The assemblages vary in diversity, but are generally dominated by spores. Acmes of fungal remains occur repeatedly. There is a distinct spore peak in the upper part of the zone. Similar spore spikes have been observed worldwide in middle Smithian deposits of Pakistan and Tibet (Hermann et al. 2011a, b, Hermann, pers. comm. 2012). Being associated with a distinct shift in the $\delta^{13}C_{org}$ record, this feature resembles the spore acme and coeval changes in the carbon cycle near the Permian–Triassic boundary, reflecting a major environmental event (Galfetti et al. 2007).

Biostratigraphic correlation: The *Punctatisporites fungosus – Naumovaspora striata – Densoisporites playfordi* (maximum) – *Grebespora concentrica* Concurrent Range Zone ('Svalis–2' of Vigran et al. 1998) and Assemblage N (Hochuli et al. 1989) are incorporated within this zone. The 'Svalis–2' zone was recorded in beds with the ammonoid *Wasatchites tardus*. On Bjørnøya, assemblages of this type occur in the Urd Formation, in beds with ammonoids of the *Euflemingites romunderi* Zone (Mørk et al. 1990) and these are dated as Smithian.

Age: Early Olenekian/Smithian.

Reference section: The reference section for this assemblage zone is on the Svalis Dome, in the Klappmyss Formation of shallow stratigraphic cores 7323/7–U–8 and –6 (Table A.33).

Remarks: Assemblages which have been assigned to this zone were described from the Vikinghøgda Formation by Mørk et al. (1999b). The zone is recorded in the Tvillingodden Formation at Bravaisberget (Table A.2), and in the Lusitaniadalen Member of the Vikinghøgda Formation at Tschermakfjellet (Table A.5.1), Vikinghøgda (Table A.7), Stensiöfjellet (Table A.8), Milne Edwardsfjellet (Table A.9), Høgrinden (Table A.16) and Skrukkefjellet (Table A.17). On Bjørnøya (Table A.24), assemblages representing this zone occur in the Urd Formation (Mørk et al. 1990).

Pechorosporites disertus Composite Assemblage Zone

Definition: The first occurrence of *Cordaitina gunyalensis* and the consistent occurrence of *Pechorosporites disertus* characterise this zone.

Characteristics: Although characterised by diverse cavate spores, the abundance of bisaccate pollen characteristic of many assemblages contrasts with the Smithian spore-dominated palynofloras. The transition from spore-dominated Smithian assemblages to the gymnosperm-dominated Spathian ones has also been documented by Galfetti et al. (2007). On the Svalis Dome, the consistent occurrence of *Pechorosporites disertus* is a distinctive feature and it has its highest record at the top of the 'Svalis–3' zone of Vigran et al. (1998). Its regional records suggest a longer and wider range of this species.

Biostratigraphic correlation: The *Pechorosporites disertus–Rewanispora foveolata* (maximum)–*Reticulatisporites bunteri–Verrucosisporites remyanus* Concurrent Range Zone ('Svalis–3') of Vigran et al. (1998) from the uppermost part of the Klappmyss Formation on the Svalis Dome (Figures 3, 4, Table A.33) and Assemblage M of Hochuli et al. (1989) are incorporated in the *Pechorosporites disertus* zone. The sparse fauna, including a pseudosageceratid ammonoid recorded from core 7323/7–U–3, gives evidence for an Early Triassic age (Vigran et al. 1998).

The significant global faunal turnover in ammonoids (Brayard et al. 2005) and conodonts (Orchard 2007) may also be reflected in the floral record of the Boreal Realm. Based on geochemical correlations, Galfetti et al. (2007) related this faunal turnover and the floral event, as recorded at the Svalis Dome, to a global climatic change at this time.

Age: Late Olenekian/early Spathian.

Reference section: The upper Klappmyss Formation, in the shallow stratigraphic core 7323/7–U–3 from the Svalis Dome (Table A.33 and Figure 4).

Remarks: Assemblages assigned to the *P. disertus* Composite Assemblage Zone occur in the Vikinghøgda Formation, Vendomdalen Member at Vikinghøgda (Figure 3 and Table A.7), Stensiöfjellet (Table A.8), Milne Edwardsfjellet (Table A.9), Høgrinden (Table A.16), and Skrukkefjellet (Table A.17). Similar assemblages of low diversity are also recorded in exploration wells penetrating the Klappmyss Formation.

On Svalbard, most assemblages of the *Pechorosporites disertus* Composite Assemblage Zone are of low diversity. Unless the characteristic elements of the *Naumovaspora striata* Composite Assemblage Zone are recorded, this zone is difficult to distinguish from the *Maculatasporites* spp. Composite Assemblage Zone (Figure 3). This was also pointed out by Hochuli et al. (1989) for their assemblages O, N and M, giving implications for the stratigraphic resolution in this part of the successions.

Jerseyiaspora punctispinosa Composite Assemblage Zone

Definition: The FADs of a number of spores such as *Jerseyiaspora punctispinosa*, *Cyclotriletes oligogranifer*, *C. pustulatus*, *Striatella seebergensis*, and first occurrences of the pollen *Illinites chitonoides*, *Protodiploxypinus* spp., *Angustisulcites grandis*, *Triadispora* spp., occur within this zone. Some of these taxa appear only sporadically.

Characteristics: Marine palynomorphs, including *Tasmanites* spp., dominate the assemblages in many localities. Taeniate bisaccate pollen, including consistent to abundant *Lunatisporites* and *Striatoabieites*, are also characteristic. Relatively diverse associations of cavate spores, such as *Densoisporites nejburgii*, are consistently present in this interval and are common in parts of the section.

Biostratigraphic correlation: The *Jerseyiaspora punctispinosa – Cyclotriletes pustulatus – oligogranifer – Verrucosisporites jenensis – Densoisporites nejburgii* Concurrent Range Zone ('Svalis–4', Vigran et al. 1998) from the Svalis Dome is incorporated in this zone (Table A.33). The zone has been recorded in the lower, but not lowermost part of the Steinkobbe Formation. Ammonoids of the *Keyserlingites subrobustus* Zone date the interval of 'Svalis–4' as late Spathian (Vigran et al. op. cit.). The assemblages resemble those recorded in the upper part of zone M of Hochuli et al. (1989) (Figure 3).

Age: Late Olenekian/late Spathian.

Reference section: The Steinkobbe Formation, lower part of the shallow stratigraphic core 7323/7–U–4 from the Svalis Dome (Table A.33).

Remarks: Assemblages assigned to this zone have been recorded from the Vikinghøgda Formation at Bravaisberget and the upper Vendomdalen Member in sections at Bravaisberget (Table A.2), Tschermakfjellet (Table A.5.1), Vikinghøgda (Table A.7), Stensiöfjellet (A.8), Milne Edwardsfjellet (Table A.9), Teistberget (Table A.14), Høgrinden (Table A.16) and Skrukkefjellet (Table A.17). They are also found in the upper Klappmyss Formation of the shallow stratigraphic cores 7532/2–U–1 (Table A.36) and 7534/6–U–1 (Table A.37), and are present in the same formation in the exploration wells 7121/1–1R (Table A.46), 7124/3–1 (Table A.47), and 7324/10–1 (Table A.49) in the Barents Sea (Figures 4, 5).

The last occurrence of *Densoisporites nejburgii* was reported to correspond to the top of this zone on the Svalis Dome by Vigran et al. (1998). This range has been revised based on records of this species in the overlying Middle Triassic succession (see below).

Palynostratigraphy of the Middle Triassic succession

The transition between the Early and Middle Triassic corresponds to the transitions between the Tvillingodden and Bravaisberget formations and the Vikinghøgda and Botneheia formations on Svalbard, and to the boundary between the Klappmyss and Kobbe formations in the southern Barents Sea, while it occurs within the lower part of the Steinkobbe Formation in the central Barents Sea (e.g., Svalis Dome, Figure 4).

Palynofloras of the Middle Triassic are dominated by bisaccate pollen, and in particular by the incoming of the non-taeniate pollen of the *Protodiploxypinus* group. Diverse associations of *Aratrisporites* characterise Middle Triassic successions throughout, but a drop in their numbers seems to occur near the Anisian–Ladinian transition (Hochuli and Vigran 2010).

Few Middle Triassic sections on Svalbard are sufficiently productive for palynological dating and correlation. These sections are located at Bravaisberget (Table A.2), Tschermakfjellet (Table A.5.1), Milne Edwardsfjellet (Table A.9), Høgrinden (Table A.16) and Skrukkefjellet (Table A.17), and in the Skuld Formation on Bjørnøya (Table A.24).

Assemblages from shallow stratigraphic cores through the Middle Triassic Steinkobbe/Kobbe and Snadd formations on the Svalis Dome, being independently dated by ammonoids (Vigran et al. 1998), provide crucial palynological reference material for the Barents Sea.

In addition, there are data from shallow stratigraphic cores drilled in the Nordkapp Basin: 7228/3–U–1 (Table A.28) and 7230/5–U–4, –5 and –6 (Tables A.30, 29, 27), the Hopendjupet area: 7532/2–1 (Table A.36), and 7427/3–U–1(Table A.34), and the Sentralbanken High: 7534/6–U–1 (Table A.37).The exploration well 7228/7–1A contains rich palynofloras (Hochuli and Vigran 2010) providing valuable data for the Middle Triassic succession.

Anapiculatisporites spiniger Composite Assemblage Zone

Definition: Consistent records of *Illinites chitonoides*, *Anapiculatisporites spiniger*, and *Podosporites amicus*, as well as the last consistent occurrence of *D. nejburgii*, define this zone. *Jerseyiaspora punctispinosa* occurs regularly and there are common occurrences of *Triadispora* spp.

Characteristics: Common to abundant occurrences of *Aratrisporites* spp. are typical of this zone. The assemblages are further characterised by common taeniate bisaccate pollen.

Biostratigraphic correlation: The *Striatella seebergensis*–*Accinctisporites circumdatus* – *Anapiculatisporites spiniger* – *Pretricolpipollenites* spp. Concurrent Range Zone or ‘Svalis–5’ of Vigran et al. (1998), (Figures 3, 4), as defined from the Steinkobbe Formation on the Svalis Dome, is incorporated within this zone. ‘Svalis–5’ was dated by ammonoids assigned to the *Karangatites evolutus* Zone to be of early Anisian age (Weitschat and Dagys 1989). Assemblage L of Hochuli et al. (1989) is incorporated within the *A. spiniger* Composite Assemblage Zone.

In the shallow stratigraphic core 7534/6–U–1 (Table A.37), drilled on the Sentralbanken High, the lower Kobbe Formation is dated by ammonoids belonging to the *Lenotropites caurus* Zone. This core provides an important data point across the Lower to Middle Triassic transition particularly by the regular presence of *A. spiniger* in the *Jerseyiaspora punctispinosa* Composite Assemblage Zone of the Klappmyss Formation.

Age: Early Anisian.

Reference section: The Kobbe Formation in shallow stratigraphic core 7534/6–U–1 from the Sentralbanken High (Table A.37).

Remarks: Assemblages recorded from the lowermost Botneheia Formation and the equivalent Bravaisberget Formation in sections at Bravaisberget (Table A.2) and Festningen (Table A.1) and Vikinghøgda (Table A.7) are assigned to this zone (Figure 3). In the section at Skrukkefjellet on Edgeøya (Table A.17), the presence of ammonoids of the *Karangites evolutus* Zone (at 97 m) dates these deposits to the early Anisian. The zone is also identified in well-preserved, diverse assemblages in the Kobbe Formation of shallow stratigraphic core 7532/2–U–1 (Table A.36) from the Sentralbanken High, and in exploration wells 7228/7–1A (Hochuli and Vigran 2010), 7228/2–1 (see Appendix) and 7324/10–1 (Table A.49).

Triadispora obscura Composite Assemblage Zone

Definition: The last consistent occurrence of *Jerseyiaspora punctispinosa*, consistent presence of *Podosporites amicus* and increased diversity of the *Triadispora* group define this zone, the last occurrence of D*ensoisporites nejburgii* is observed in its lower part. Although recorded in very low numbers, monosaccate pollen, e.g., *Dyupetalum* cf. *vicentinense*, are typical elements of this zone.

Characteristics: Diverse assemblages with the common appearance of *Aratrisporites* spp. and *Triadispora* spp., together with members of the *Illinites, Angustisulcites* and *Striatoabieites genera*, characterise this zone (Mangerud and Rømuld 1991).

Biostratigraphic correlation: The *Aratrisporites macrocavatus – Triadispora plicata – Jerseyiaspora punctispinosa – Kraeuselisporites punctatus* Concurrent Range Zone ('Svalis–6' of Vigran et al. 1998) recorded in strata dated by ammonoids of the *Anagymnotoceras varium* Zone, is incorporated within this zone. Assemblage K of Hochuli et al. (1989) is in its lower range equivalent to the *Triadispora obscura* Composite Assemblage Zone. Note that the upper part of assemblage K is incorporated within the succeeding *Protodiploxypinus decus* Composite Assemblage Zone, which is defined below (Figure 3).

Age: Middle Anisian.

Reference section: The Steinkobbe Formation in the shallow stratigraphic core 7323/7–U–1 from the Svalis Dome (Table A.33, Figure 4).

Remarks: Sections through the lower Bravaisberget/Botneheia Formation on Svalbard, at Tschermakfjellet (Table A.5.1), Stensiöfjellet (Table A.8), and Milne Edwardsfjellet (Table A.9), contain assemblages that have been assigned with variable confidence to the *T. obscur*a Composite Assemblage Zone. The palynoflora from the section at Skrukkefjellet is of low diversity and poor preservation (Table A.17). In the Barents Sea, the zone can be recognised in shallow stratigraphic cores, besides those from the Svalis Dome, in 7534/6–U–1 (Table A.37) from Sentralbanken and in several exploration wells, including 7228/7–1A (Hochuli and Vigran 2010), 7324/10–1 (Table A.49) and 7228/2–1. The highly variable productivity of the samples seems to be a typical feature for this zone in exploration wells. According to Hochuli and Vigran (2010), *Aratrisporites* spp. has the top of its abundance phase within the zone.

Protodiploxypinus decus Composite Assemblage Zone

Definition: The first common occurrence of *Chasmatosporites* spp. and *Illinites chitonoides*, as well as the last occurrences of *Protodiploxypinus decus* and *P. ornatus*, define this zone. *Kraeuselisporites apiculatus* and *Jerseyiaspora punctispinosa* have their last occurrences within the zone.

Characteristics: Abundant striate pollen, including the genera *Striatoabieites* and *Lunatisporites*, as well as common *Illinites chitonoides*, are typical of this zone. Members of *Aratrisporites* are common to abundant. Marine palynomorphs occur in relatively high proportions. In some areas, the coenobial alga *Plaesiodictyon mosellanum* has common appearances.

Biostratigraphic correlation: The *Protodiploxypinus decus – P. gracilis – Chasmatosporites* sp. A – *Kraeuselisporites apiculatus* Concurrent Range Zone ('Svalis–7' of Vigran et al. 1998), recorded in strata dated by ammonoids of the *Frechites laqueatus* Zone (Figures 3, 4), is incorporated within the *Protodiploxypinus decus* Composite Assemblage Zone. Assemblage K of Hochuli et al. (1989) includes both the *Triadispora obscura* and *Protodiploxypinus decus* zones.

Age: Late Anisian. Samples from the top of the shallow stratigraphic core 7323/7–U–9 (sample interval: 95.30–94.07 m) gave a Re–Os age of 239.3 ± 2.7 Ma (Xu et al. 2009), which is consistent with dating of the Anisian–Ladinian boundary (GSSP) at about 241 Ma (Brack et al. 2005).

Reference section: The Steinkobbe Formation in shallow stratigraphic cores 7323/7–U–7 and –U–9 from the Svalis Dome (Table A.33, Figure 4).

Remarks: Sections through the lower part of Bravaisberget/Botneheia formations from Svalbard mostly contain poorly preserved organic matter and low-diversity assemblages. Confident correlation or dating is based on palynological associations from sections at Stensiöfjellet (Table A.8), Høgrinden (Table A.16) and Skrukkefjellet (Table A.17). Well-preserved associations assigned to this zone are also recorded from the shallow stratigraphic core 7228/3–U–1 from the northern flank of the Sentralbanken High (Table A.28) and from several exploration wells (e.g., 7228/7–1A, Hochuli and Vigran 2010). It should be noted that in core 7228/3–U–1 the oldest record of *Aulisporites astigmosus* is in the *P. decus* Zone, which is stratigraphically lower than expected. Normally this species has its first occurrence in the Carnian.

Echinitosporites iliacoides Composite Assemblage Zone

Definition: The FAD of *Echinitosporites iliacoides* defines this zone. The following species have their first occurrences in the lower part of this zone: *Schizaeoisporites worsleyi*, *Staurosaccites quadrifidus*, *Triadispora verrucata* and *Ovalipollis pseudoalatus*. *Protodiploxypinus ornatus* appears consistently. *Monosaccoid* pollen, among them *Cordaitina gunyalensis*, appear as a typical feature. Characteristic is also the regular occurrence of the algal phycoma *Cymatiosphaera* sp.1 (sensu Hochuli et al. 1989).

Characteristics: Diverse assemblages dominated by bisaccate pollen, including common non-taeniate pollen, characterise this zone (see also Hochuli and Vigran 2010). Abundant and diverse *Aratrisporites* spp. and other spores occur in most sections.

Biostratigraphic correlation: The zone has been recognised in the Snadd Formation of the three youngest cores from the Svalis Dome (7323/7–U–10, –U–5 and –U–2). However, the youngest parts of Snadd Formation have not been recovered from this locality. The *Ovalipollis pseudoalatus–Echinitosporites iliacoides–Cordaitina gunyalensis* Concurrent Range Zone ('Svalis–8', defined by Vigran et al. 1998), is equivalent to, and incorporated in the *E. iliacoides* Composite Assemblage Zone (Figures 3, 4). The *E. iliacoides* Composite Assemblage Zone embraces assemblages I and H of Hochuli et al. (1989). Since *E. iliacoides* seems sparsely represented in sections from Svalbard, the zone has there been recognised mainly based on *O. pseudoalatus*, *Schizaeoisporites worsleyi* and *Staurosaccites quadrifidus*.

Age: Ladinian.

Reference section: The Snadd Formation in shallow stratigraphic cores 7323/7–U–2, –5 and –10 from the Svalis Dome (Table A.33).

Remarks: The sections from Svalbard generally contain low-diversity associations of poorly preserved palynomorphs that are difficult to identify to species level. Correspondingly, the assemblage-composition (relative abundance characters) distinguishing assemblages I, and H of Hochuli et al. (1989) are difficult to trace (Figures 3, 4). Studied sections containing the *E. iliacoides* Composite Assemblage Zone include the upper Bravaisberget Formation at Festningen (Table A.1), the Botneheia Formation at Drachedalen (Table A.5.1), Milne Edwardsfjellet (Table A.9), Dalsnuten/Jinnbreen (Table A.10), Høgrinden (Table A.16) and Skrukkefjellet (Table A.17). The assemblage zone, as recorded in the Skuld Formation on Bjørnøya, includes *E. iliacoides*, *Triadispora verrucata*, *Podosporites amicus* and *Staurosaccites quadrifidus* (Mørk et al. 1990, Table A.24). In the Barents Sea area, the *E. iliacoides* Composite Assemblage Zone has been identified in shallow stratigraphic cores 7831/2–U–2 east of Kong Karls Land (Table A.42), 7427/3–U–1 (A.34) from the southeastern flank of the Gardarbanken High, from the shallow stratigraphic cores 7230/5–U–4 and 7230/5–U–5 of the Nordkapp Basin, and from the cores 7323/7–U-2, –U–5 and –U–10 from the Svalis Dome (Table A.33 and Figure 4). It has also been recognised in several exploration wells, including 7228/7–1A (Hochuli and Vigran 2010), 7324/10–1 (Table A.49), and 7228/2–1.

Echinitosporites iliacoides is a very distinct and important marker that has generally been regarded as restricted to the Ladinian. On Bjørnøya, it occurs regularly also above strata dated by *Daxatina* cf. *canadensis*. This ammonoid previously defined a late Ladinian age, but now is accepted as representing the base Carnian (e.g., Mietto et al. 2008, Ogg et al. 2008). See further discussion below.

Palynostratigraphy of the Upper Triassic succession

The Middle to Upper Triassic boundary on Svalbard (except Bjørnøya) corresponds to the contact between the Sassendalen and Kapp Toscana groups, usually recognised as a gradual shift in palynological associations. The organic remains, including the palynomorphs, from Upper Triassic units are generally better preserved than those from the underlying Middle Triassic succession. However, there are only a few independently dated sections and the palynostratigraphic resolution is not as good as in the Lower and Middle Triassic.

Compared to Ladinian assemblages, Carnian palynofloras are characterised by a relative decrease in taeniate bisaccate pollen. Other gymnosperm pollen, such as *Aulisporites astigmosus*, and the *Araucariacites*, *Chasmatosporites*, *Ovalipollis* and *Protodiploxypinus* groups, show increased abundance and diversity. The different development, with a significant decline in diversity of pollen, as documented from central and northwestern Europe (Kürschner and Herngreen 2010), is considered a possible consequence of different climate conditions.

Carnian deposits from the Barents Sea area also show an increased abundance of trilete and monolete spores. Occasionally, the assemblages are characterised by abundance peaks of monolete spores such as *Leschikisporis aduncus* and of smooth trilete spores such as *Calamospora*, *Deltoidospora* and *Dictyophyllidites*. From the late Carnian onwards, spores become dominant and more diverse (see Hochuli et al. 1989 and Hochuli and Vigran 2010). Norian and Rhaetian assemblages are characterised by the common occurrence of some distinct groups such as *Kyrtomisporis* spp. in the Norian as well as *Ricciisporites* spp. and *Limbosporites* spp. in the Rhaetian. Cavate trilete spores are rare in Middle and early Late Triassic assemblages but show a marked increase in the Rhaetian. Compared to the Early and Middle Triassic the occurrence of marine palynomorphs seems to be more episodic.

The four Composite Assemblage Zones outlined below are based on previously published and new data from sections on Svalbard and from shallow cores in the Barents Sea, notably from the Nordkapp Basin (shallow stratigraphic cores 7227/8–U–1 and 7230/5–U–3, Tables A.31 and A.32), Hopendjupet (shallow stratigraphic core 7430/7–U–1, Table A.35), Sentralbanken (shallow stratigraphic cores 7533/2–U–1, 7533/2–U–2, and 7533/3–U–7, Tables A.38, 39, 41) and off Kong Karls Land (shallow stratigraphic cores 7830/3–U–1 and 5–U–1, Table A.42). Additionally, exploration wells such as 7228/7–1A (Hochuli and Vigran 2010) and wells from the Hammerfest Basin (7120/12–1 and –2, 7124/3–1, Tables A.43, 44, 47) and the Bjarmeland Platform (7224/7–1, Table A.48, 7228/2–1S, and 7324/10–1, Table A.49) provide excellent data for the Upper Triassic succession.

Aulisporites astigmosus Composite Assemblage Zone

Definition: The zone is defined by the first occurrence or, in some locations, abundance of *Aulisporites astigmosus* together with the FADs of *Ricciisporites tuberculatus*, *Camarozonosporites rudis* and rare *Uvaesporites argentaeformis*. The definition of this zone is also dependent on the taxa *Illinites chitonoides*, *Angustisulcites klausii*, *Echinitosporites iliacoides* and *Triadispora verrucata*, which have their last occurrences within this zone, although the latter might occasionally range higher. The first occurrences of *Enzonalasporites vigens* and *Camerosporites secatus* are often recorded within this zone. Like *A. astigmosus* they occasionally have a rare representation, but provide additional stratigraphic evidence.

Characteristics: The genus *Kyrtomisporis* becomes diverse within the zone. The most distinct species, *K. gracilis*, may occur rather sporadically in the lower part but becomes consistent up section. The *Chasmatosporites* group is commonly recorded and is regarded as typical for Carnian successions. The *Aratrisporites* group shows a high diversity, but is less abundant than in the under- and overlying zones. Smooth trilete spores, including *Deltoidospora* and *Calamospora*, become common to abundant (see also Hochuli and Vigran 2010). Common to abundant *Leschikisporis aduncus* often characterise intervals within this assemblage zone, particularly in the lower part, as seen in the diverse associations from shallow stratigraphic cores in the Barents Sea (Tables A.37, A38 and A.40). These acmes of monolete spores, such as *L. aduncus*, are a typical feature of this succession and were also documented by Hochuli and Vigran (2010) in their zones E/F. A maximum of *Ovalipollis pseudoalatus* together with common bisaccate pollen is sometimes observed in the upper part of this zone, also with an abundance peak of *Protodiploxypinus* spp. (see also Hochuli and Vigran 2010). The presence and sporadic abundance of the acritarchs *Veryhachium* spp. or *Micrhystridium* spp. in several locations document a marine influence within the interval (for example on Festningen, Tschermakfjellet, Eistraryggen, Bjørnøya and shallow stratigraphic cores 7534/4–U–1 and 7533/2–U–2).

Biostratigraphic correlation: This zone correlates with assemblages G, F, E and D of Hochuli et al. (1989). The presence of ammonites of the *Stollenites tenuis* Zone, at the base of the Tschermakfjellet Formation (Wolfgang Weitschat, written communication 1987) and the record of *Daxatina canadensis* in the Skuld Formation at Bjørnøya (Mørk et al. 1990), confirm an early Carnian age (Mietto et al. 2012).

Age: Early to mid Carnian.

Reference section: Snadd Formation in shallow stratigraphic core 7533/3–U–7 (Table A.39). The De Geerdalen Formation at Festningen (Table A.1) is an additional good reference profile.

Remarks: This zone has been confidently recognised in samples from the Tschermakfjellet Formation at Blanknuten, Dalsnuten, Eistraryggen, Høgrinden, Negerpynten, Skrukkefjellet, Tschermakfjellet, Teistberget, Tumlingodden and Vogelfjellet. It is also recorded in the De Geerdalen Formation at Blanknuten, Dalsnuten, Eistraryggen, Klementievfjellet, Negerfjellet, Teistberget, Tumlingodden, Vogelfjellet and Årdalsknuten, as well as on Iversenfjellet and Lyngefjellet on Hopen. *Corollina* has been found within this assemblage at Klementievfjellet, but is here interpreted as contamination.

On Bjørnøya, the ammonoid *Daxatina canadensis* occurs in beds about 40 m from the top of the Skuld Formation (Böhm 1903, Tozer and Parker 1968). Based on the opinion that *D. canadensis* was of late Ladinian age and co-occurred with *E. iliacoides*, Mørk et al. (1990) proposed the top of the Ladinian slightly above this point. According to the revised timescale of Ogg et al. (2008) and work by Mietto et al. (2008, 2012), the D. canadensis Zone represents the basal Carnian.

Accordingly, the base of the Carnian on Bjørnøya should be placed lower, at the lowest occurrence of *D. canadensis*, at about 55 m from the top of Skuld Formation and approximately 150 m above top Permian (Table A.24). This implies that *E. iliacoides* occurs in confidently dated basal Carnian deposits.

In the Barents Sea at Hopendjupet (shallow stratigraphic core 7534/4–U–1, Table A.40) *E. iliacoides* co-occurs with an association of *Aratrisporites laevigatus*, *Aulisporites astigmosus* and *Enzonalasporites vigens* that is considered to be of early Carnian age. Co-occurrence of *E. vigens* and *E. iliacoides* was for example described by Orlowska-Zwolinska (1983) from the lower Gipskeuper in Poland. *E. iliacoides* has also been mentioned from the middle and lower Keuper by Döring et al. (1966) and Heunisch (1986), respectively. No evidence of reworking has been found in the studied interval, and we regard *E. iliacoides* as being *in situ*. This concurs with the record in the Carnian on Bjørnøya (Table A.24). Furthermore the Russian late Ladinian to early Carnian association '3' of Mørk et al. (1993) shows a similar composition, also with *E. iliacoides* showing peak abundance in the Carnian. However, peak abundance of *E. iliacoides* has never been recorded in the Norwegian part of the Barents Sea.

In exploration wells from the Barents shelf (e.g. 7228/7–1A) Hochuli and Vigran (2010) recognised this zone in the middle part of the Snadd Formation.

We have considered the possibility of defining an earliest Carnian assemblage zone based on co-occurrence of *E. iliacoides* and *A. astigmosus*. This seems to be a valid solution in some parts of the region. However, *E. iliacoides* is very rare on Spitsbergen and due to its relatively small size is difficult to detect. In addition, the preservation of these assemblages varies considerably.

Rhaetogonyaulax spp. Composite Assemblage Zone

Definition: The zone is defined by the FADs of dinoflagellate cysts, including *Rhaetogonyaulax rhaetica*, *R. arctica*, *Shublikodinium arcticum* and *Sverdrupiella mutabilis*; the last occurrences of *Podosporites amicus*, *Protodiploxypinus gracilis* and *Staurosaccites quadrifidus* occur within this zone.

Characteristics: The zone is characterised by common to abundant *Rhaetogonyaulax rhaetica* and bisaccate pollen, including *Ovalipollis pseudoalatus* and *Protodiploxypinus* spp. associated with abundant spores. Representatives of the *Aratrisporites* group are still present, but in low numbers.

Biostratigraphic correlation: Assemblage C of Hochuli et al. (1989) is incorporated in this zone.

Age:?Late Carnian–early Norian.

Reference section: The De Geerdalen Formation at Festningen, Spitsbergen (Table A.1).

Remarks: This zone is recorded from the marine succession of the Isfjorden Member of the De Geerdalen Formation at Festningen, Spitsbergen (Table A.1, Enclosure). It has also been recognised in the lowermost Flatsalen Formation on Wilhelmøya and Hopen (Tables A.22, A.23). Bjærke and Manum (1977) also described a similar association of unspecified cysts from the lower part of the Flatsalen Formation on Hopen and Kong Karls Land. Korčinskaja (1980) reported early Norian ammonoids from the lower part of the Flatsalen Formation on Hopen, as further discussed by Smith (1982).

Compared to the outcrop sections, the generally better preserved assemblages recorded from wells and shallow stratigraphic cores on the Barents Shelf allow more precise correlations (Figure 4). There are records from cored material of the Flatsalen Formation on Sentralbanken (Table A.41) and numerous records are reported from the Snadd and lowermost Fruholmen formations in exploration wells (e.g., 7120/12–1 and –2, 7228/7–1A, Hochuli and Vigran 2010), (Tables A.43, A.44).

Limbosporites lundbladii Composite Assemblage Zone

Definition: This zone is defined by the FADs of *Limbosporites lundbladii* and *Rogalskaisporites barentzii*, as well as by regular occurrences of *Cingulizonates rhaeticus*, *Granuloperculatipollis rudis*, *Ricciisporites umbonatus*, and occurrences of *Quadraeculina anellaeformis*. Regular occurrences of the dinoflagellate cysts *Heibergella asymmetrica* and *H. salebrosacea* spp. are additional characteristics of this zone. The first occurrence of pollen assigned to *Corollina* spp. can be used as an additional feature of this zone although this group is generally rare in this part of the succession. *Leschikisporis aduncus*, *Striatoabieites* spp., *S. aytugii*, *R. barentzii*, and *Schizaeoisporites worsleyi* have their last occurrences within this zone. Furthermore, *Triadispora* spp. and the green alga *Plaesiodictyon mosellanum* are rare components.

Characteristics: In contrast to underlying assemblages, the assemblages of this zone are dominated by spores, with acmes of e.g., *Annulispora* spp., *Camarozonosporites laevigatus*, *C. rudis*, *Concavisporites* spp., *Deltoidospora* spp. and several species of *Kyrtomisporis* spp. Pollen assigned to *Ovalipollis*, *Araucariacites*, *Chasmatosporites* and *Protodiploxypinus* have common appearances. The zone is also characterised by the presence of a number of dinoflagellate cysts such as *Heibergella* spp., *H. asymmetrica*, *H. salebrosacea*, *Rhaetogonyaulax rhaetica* and *Sverdrupiella* spp.

Biostratigraphic correlation: The two sub-assemblages 'B–1' and 'B–2' of Hochuli et al. (1989) are incorporated within this zone (Figure 3). The acme of dinoflagellate cysts is the main feature distinguishing assemblage B2 from B1. On Svalbard, this maximum frequency of dinoflagellate cysts has been observed in strata dated by ammonoids of the *Pterosirenites kerry* Zone of latest Carnian to early Norian age (Smith 1974, 1982, Korčinskaja 1980, Mørk et al. 1993). Our work suggests that sub-assemblage B–2 represents a facies controlled association of B–1.

Similar dinoflagellate cyst assemblages have been described from Alaska and the Canadian Arctic (Wiggins 1973, Fisher and Bujak 1975, Bujak and Fisher 1976, Staplin 1978, Fisher and van Helden 1979). When summarising the records of dinoflagellate cyst assemblages, Hochuli (in Hardenbol et al. (1998), chart 8, and appendix p. 781), concluded that they have a circumpolar distribution and in some areas fall into the *Monotis scutiformis* ammonoid Zone.

Age: Norian.

Reference section: The Flatsalen and Svenskøya formations on Wilhelmøya (Tumlingodden, Table A.22). In shallow stratigraphic core 7533/2–U–2, the same formations contain diverse associations of the *Limbosporites lundbladii* Composite Assemblage Zone (Table A.41).

Remarks: On Spitsbergen, the *L. lundbladii* Composite Assemblage Zone is recognised by low-diversity assemblages in the Tverrbekken Member, representing the lowermost Knorringfjellet Formation at Festningen (Table A.1.2, Section 1d). The deposits from the Flatsalen Formation on Wilhelmøya contain diverse associations with acmes for numerous dinoflagellate cyst taxa, while the Svenskøya Formation shows reduced diversity (Table A.22). At Hopen, the Flatsalen Formation of Lyngefjellet West and the Svenskøya Formation (LYN and LY, Table A.23) contain similar assemblages. Only deposits from the lowermost part of the Flatsalen Formation contain an association with a dinoflagellate cyst acme.

Bjærke and Manum (1977) and Smith (1982) described associations from the upper Flatsalen Formation with a sporadic occurrence of the dinoflagellate cysts *Rhaetogonyaulax rhaetica* and *Shublikodinium* sp., presence of *Quadraeculina anellaeformis* as well as abundance and high diversity of the *Kyrtomisporis* and *Protodiploxypinus* groups.

A similar assemblage, recorded by Bjærke and Dypvik (1977) from sections at Knorringfjellet and Marhøgda on Spitsbergen, also contains *Corollina* spp. In their study of foraminifera from the Knorringfjellet Formation on Spitsbergen, Nagy and Berge (2008) place Jurassic beds directly above the Norian succession, implying a hiatus. Their conclusion that the hiatus between Triassic and Jurassic strata encompasses less time eastwards from Festningen (see A.1) is supported by our palynological records. The *L. lundbladii* assemblage occurring in the Teistberget Member of the Knorringfjellet Formation at Festningen has been recycled into the Lower Jurassic deposits of the Tverrbekken Member (Table A.1.2).

The *L. lundbladii* Composite Assemblage Zone is recognised in the Flatsalen (above the Slottet Bed) and Svenskøya formations in the Barents Sea in the shallow stratigraphic core 7533/2–U–2 from Sentralbanken (Table A.41). It is also recorded in the Fruholmen Formation of exploration well 7224/7–1B (Table A.48). Furthermore, palynomorphs typical of this zone occur as reworked in the Lower Jurassic deposits of shallow stratigraphic core 7230/5–U–3 (Table A.32).

An assemblage with abundant *Annulispora folliculosa* has been recorded from Franz Josef Land, and assigned a Norian age (Dypvik et al. 1998). Bakken (1990) reported a 'first down-hole appearance' of the spore *Rogalskaisporites barentzii* from the transition between the Reke and Akkar members, corresponding to a late Norian LAD. He concluded that this spore probably ranges throughout the Norian. Thus, the species appears to be an important stratigraphic marker restricted to Norian deposits.

Most other spores, pollen, and dinoflagellate cysts of the *L. lundbladii* Composite Assemblage Zone are considered to range throughout the Norian. The characteristic dinoflagellate cyst assemblage is restricted to marine depositional conditions; however, it has widespread records throughout Norian successions.

Ricciisporites tuberculatus Composite Assemblage Zone

Definition: This zone is defined by the common to abundant occurrence of *Limbosporites lundbladii* and *Cingulizonates rhaeticus*, the common occurrence of *Chasmatosporites* spp. and *Ricciisporites tuberculatus* (see also Hochuli and Vigran 2010) and the presence of *Quadraeculina anellaeformis*. The LADs of a number of spores, such as *Aratrisporites fimbriatus*, *A. laevigatus*, *A. macrocavatus*, *L. lundbladii*, *Camarozonosporites laevigatus*, *Cingulizonates rhaeticus*, and the pollen *Ricciisporites tuberculatus* and *R. umbonatus*, as well as taeniate bisaccates and *Ovalipollis pseudoalatus* are additional criteria defining this zone. The dinoflagellate cysts *Rhaetogonyaulax rhaetica*, *Suessia swabiana* and *S. mutabilis* have their LADs also within the zone.

Characteristics: Compared to underlying Late Triassic units, the assemblage generally shows an increase of non-taeniate bisaccate pollen, and *Chasmatosporites*. The common to abundant occurrence of *Limbosporites lundbladii* and *Ricciisporites tuberculatus* is the most typical feature.

Biostratigraphic correlation: This zone is equivalent to assemblage A of Hochuli et al. (1989). The Rhaetian age is based on correlation with East Greenland (Pedersen and Lund 1980), see also Hochuli in Hardenbol et al. (1998, chart 8, and appendix).

Age: Rhaetian.

Reference section: Exploration well 7120/12–3 (Table A.45).

Remarks: So far confidently correlated Rhaetian assemblages have only been recovered from exploration wells drilled in the southern Barents Sea. There is no confident record of this zone from Svalbard.

Generally, the thick Upper Triassic succession contains well-preserved palynological associations. The *Ricciisporites tuberculatus* Zone is defined based on material from exploration wells penetrating the Fruholmen Formation (in e.g., wells 7120/12– 2 at 2142 m, 7129/9–1 at 2063 to 1995.5 m, and, according to Hochuli and Vigran (2010), in 7228/7–1A). In the present study it has been recognised in exploration wells 7120/12–2 and –3 (Tables A.44 and A.45) and in 7124/3–1 (Table A.47).

In East Greenland, an assemblage from classic plant macrofossil localities was assigned to the Rhaetian by Pedersen and Lund (1980) and Mander et al. (2010, 2013). These assemblages contain *Apiculatisporis parvispinosus*, *L. lundbladii*, *Ovalipollis ovalis*, *Rhaetipollis germanicus*, and frequent *Ricciisporites tuberculatus*.

Palynostratigraphical conclusions

A stratigraphic succession of 15 palynological Composite Assemblage Zones for the Barents Sea area (Figures 3, 4) has been defined based on data from outcrop sections on Svalbard (Plates 1-10), shallow stratigraphic cores and exploration wells. These new, formally defined zones form a palynostratigraphic framework that will serve as a solid correlative tool for the vast area of the Norwegian Arctic. Previously published zonations are incorporated into this new framework.

Ammonoids recovered from Lower and Middle Triassic deposits cored on the Svalis Dome, the Bjarmeland Platform, in Finnmark East and in the Nordkapp Basin (Figure 4) permit confident correlation with the ammonoid-dated sections at Festningen and Vikinghøgda on Svalbard and calibration of the co-occurring palynological assemblages (Figures 3a, 7 and Enclosure). Thus, the cores from the Svalis Dome with well-preserved and independently dated Lower and Middle Triassic palynomorphs represent the major source of our palynological database (Plates 11–18).

Results from the shallow cores from Sentralbanken and off Kong Karls Land add valuable knowledge of the Late Triassic and the variable depositional environments and breaks in deposition during the Carnian and Norian. The cores of Middle to Upper Triassic strata on Sentralbanken contain similarly well-preserved material (Plates 19–28). Important data have been compiled from exploration wells, particularly from side-wall and conventional cores from the Hammerfest Basin, the Bjarmeland Platform and the Maud Basin (Plates 29–33).

The Triassic–Jurassic boundary is often difficult to recognise. As in the sections at Festningen and Klementievfjellet on Svalbard, where Lower Jurassic deposits directly overlie Norian beds, the Jurassic beds contain abundant reworked, Late Triassic palynomorphs. In exploration wells further to the southeast, well-preserved palynological material from the uppermost Triassic units includes Norian and Rhaetian palynological assemblages and allows confident correlation and recognition of Rhaetian units, representing the youngest Triassic deposits in the area. These deposits are overlain by Lower or Middle Jurassic deposits.

Seven zones have been defined for the Lower Triassic. These include the *Uvaesporites imperialis*, *Reduviasporonites chalastus*, *Proprisporites pocockii*, *Maculatasporites* spp., *Naumovaspora striata*, *Pechorosporites disertus* and *Jerseyiaspora punctispinosa* Composite Assemblage Zones. These zones appear to have a variable presence as displayed by the west–east review. The two lowermost assemblages are recorded at Festningen, Vikinghøgda and Stensiöfjellet, in the very thin, oldest deposits of the Sassendalen Group. The overlying Lower Triassic units thicken eastwards. Thus, the easily recognisable *Naumovaspora striata* and *Jerseyiaspora punctispinosa* assemblage zones are well represented in the sections shown on the W–E panel (Figure 8).

Four zones have been defined for the Middle Triassic, including the *Anapiculatisporites spiniger*, *Triadispora obscura*, *Protodiploxypinus* decus and the *Echinitosporites iliacoides* Composite Assemblage Zones. These zones are present in most of the measured sections on Spitsbergen (Enclosure). On Bjørnøya, there is a major stratigraphic break above the Smithian beds, represented by the *Naumovaspora striata* Assemblage

Zone and the overlying Middle Triassic beds represented by the Ladinian *Echinitosporites iliacoides* Assemblage Zone. Anisian deposits are apparently missing or may be represented in the distinctive conglomeratic Verdande Bed.

Four zones have been defined for the Late Triassic, including the *Aulisporites astigmosus*, *Rhaetogonyaulax* spp., *Limbosporites lundbladii* and *Ricciisporites tuberculatus* Composite Assemblage Zones. However, in most localities on Svalbard only the Carnian *Aulisporites astigmosus* Zone is recognisable. On Bjørnøya, the lower part of this assemblage, containing *E. iliacoides*, is confidently dated as early Carnian by ammonoids. A similar, very diverse assemblage of this zone occurs in the stratigraphic cores drilled off Kong Karls Land (7534/4–U–1). The dinoflagellate cysts of the *Rhaetogonyaulax* spp. Zone reflect a widespread transgressive episode that is recorded at Festningen, through the eastern islands of Svalbard (Enclosure), in the Nordkapp Basin (Figure 4) and in several exploration wells (Figure 5).

It is worth noting that the only localities on Spitsbergen where both the *Rhaetogonyaulax* and the *Limbosporites lundbladii* Composite Assemblage Zones are recorded are at Festningen, Klementievfjellet and in the islands of Hopen and Wilhelmøya, as Late Triassic beds are eroded elsewhere on Svalbard (Enclosure). These two zones are also present in the Nordkapp Basin (Enclosure and Figure 4, 7230/5–U–3). It needs to be stressed that in exploration wells 7120/12–2 and –3, 7124/3–1 and 7324/10–1 there are variably thick units representing the three Late Triassic zones (*Rhaetogonyaulax* spp., *Limbosporites lundbladii* and *Ricciisporites tuberculatus*). Generally, these units seem to thin east- and northwards (Figure 5). The irregular record of the palynological zones and the evidence of stratigraphic gaps show that the Late Triassic was a time of major sea-level changes, inducing breaks in sedimentation.

On Spitsbergen, reworked Norian palynomorphs dominate the assemblages recorded from Lower Jurassic strata as shown in the Festningen and Klementievfjellet sections (Enclosure). Although the present study did not focus on the Jurassic, we note, based on dinoflagellate cysts, that significant stratigraphic gaps punctuated also the Early to Middle Jurassic successions.

The Enclosure, together with the lithological sections, presents the data of the above-described palynological zones and the level of confidence for the correlations over the various areas of Svalbard (Sections 0–38 a) and the Barents Sea (Figures 3, 4, 5). The composite tables (Enclosure and Figures 4, 5, 7, 8, 9) present the studied material from outcrops, stratigraphic cores and well samples and place them in a regional stratigraphic frame.

The relative quantitative distribution of various spores and pollen varies through the Triassic, as discussed by Hochuli and Vigran (2012) and reflects both the actual evolution of the plant groups as well as a response of the flora to changing climates through time. The recorded palynofloras include material originating from several local communities of land plants. The variable temperatures and precipitation over this vast study area, as well as locally variable groundwater levels, controlled the relative composition of the floras. The transported, sorted and degraded dead plant remains were finally deposited in varying marine to non-marine environments.

The present study represents the first comprehensive compilation of palynological data from the Triassic succession of the Norwegian Arctic. The authors believe that there is still a huge potential for further detailed palynological investigations and their application in palaeoclimatic, palaeoenvironmental as well as stratigraphic interpretations and reconstructions.

Appendix – Palynological data

Numerous palynological investigations of the Triassic succession of Svalbard and the Barents Sea area have been carried out during the last 25 years. The data are presented in range charts (Tables A.1–A.49) and photographic plates (Plates 1–33), and there are brief comments on the acid-resistant organic residues and palynomorph preservation from the localities studied. A review of the localities with references to the studied intervals, the range charts and the plates is included (Figure A.1).

Palynomorphs recorded from the Triassic succession on Spitsbergen generally show only mediocre preservation. They offer few characters for identification, which in some cases hampers precise dating and high-resolution stratigraphy. Especially palynomorphs recorded from the Sassendalen Group have wall structures which seem to have been destroyed by diagenetic minerals, in particular pyrite. In some cases the wall material is recovered as a thin organic film with adhering compact granules. Palynomorphs recorded from the Kapp Toscana Group show relatively better preservation, particularly those from the eastern islands of Svalbard where the Cenozoic orogeny had little impact.

The far better preservation of palynomorphs from cores and wells drilled in the Barents Sea makes these locations important reference sections for the interpretation of palynological data from Svalbard.

A. Material from Svalbard

Spores, pollen and algal remains from localities on Spitsbergen (Figure A.1) have been pictured in Plates 1–2 and in parts on Plates 3–8. Material from the eastern islands and Hopen is found on Plates 3–9 and from Bjørnøya on Plate 10.

A.1 Western Spitsbergen

Palynology has been studied in sections from one locality close to the mouth of Isfjorden and in two localities in van Keulenfjorden (Tables A.1–3).

A.1.1 Festningen

Festningen (Locality 1a–d) is situated along the southern shore in the outermost Isfjorden area (Figure 17). Samples were collected from parts of the Sassendalen Group (Vardebukta and Bravaisberget formations, Table A.1.1, Sections 1a and 1c) and the Kapp Toscana Group (Table A.1.2, Section 1d, Plates 7–8).

Sassendalen Group

The contact between the Kapp Starostin and Vardebukta formations

Samples from uppermost in the Kapp Starostin Formation yielded poorly preserved palynomorphs including *Lueckisporites virkkiae*, *Vittatina* spp., 'Fungal remain type 1' (sensu Hochuli et al. 1989) and the supposedly marine plankton form *Unellium* spp. This plankton group seems to be confined to the uppermost beds (Table A.1.1). Mangerud and Konieczny (1993) referred to this association as '*Kraeuselisporites* spp. Assemblage' of a general Late Permian age.

Vardebukta Formation

The samples from the lowermost part of the Vardebukta Formation at Festningen contain assemblages with mostly thin-walled, poorly preserved palynomorphs (see Plate 1). Common *Vittatina* (0.05–0.2 m) together with *Densoisporites nejburgii*, *Proprisporites pocockii*, *Uvaesporites imperialis* and the plankton form *Unellium* spp. allow correlation with the *Uvaesporites imperialis* Composite Assemblage Zone. The overlying interval (1.2–8.3 m; Table A.1.1) with *Reduviasporonites chalastus* and regular to common *Micrhystridium* spp. and *Veryhachium* spp. is correlated with the *Reduviasporonites chalastus* Composite Assemblage Zone. The palynofacies is dominated by dark, woody material. The presence of acritarchs, in the absence of planktonic green algae such as *Tasmanites*, has been interpreted as reflecting deposition in a more restricted marine environment.

Tvillingodden Formation

No samples have been studied from this formation at the Festningen locality.

Bravaisberget Formation

The palynomorphs recorded from the 21 samples from the Bravaisberget Formation at Festningen are poorly preserved and confident determination of taxa is therefore difficult. Still a sufficient number of species allows identification of the *Anapiculatisporites spiniger* and *Echinitosporites iliacoides* Composite Assemblage zones and an association tentatively assigned to the *Protodiploxypinus decus* Composite Assemblage Zone (513.5–547.0 m, Table A.1.1 and Enclosure). Marine

PALYNOLOGICAL DISTRIBUTION CHARTS - Tables A.1.1-A.49.2.2 APPENDIX	
SVALBARD	
Western Spitsbergen	
A.1.1	Festningen, Localities 1a and 1c, Tempelfjorden and Sassendalen groups
A.1.2.1-A.1.2.2	Festningen, Locality 1d, Kapp Toscana Group
A.2	Bravaisberget, Localities 2a, b and c, Tempelfjorden and Sassendalen groups
A.3	Reinodden, Locality 3, Tempelfjorden and Sassendalen groups
Southern Spitsbergen (no diagrams)	
Isfjorden area	
A.4	Selmaneset, Locality 8, Tempelfjorden and Sassendalen groups
Eastern Spitsbergen	
A.5.1	Tschermakfjellet, Locality 9a, Sassendalen Group
A.5.2	Tschermakfjellet, Locality 9b, Kapp Toscana Group
A.6	Botneheia, localities 10a and b, Sassendalen and Kapp Toscana groups
Central Spitsbergen	
A.7.1	Vikinghøgda, Deltadalen river locality No. 11, Sassendalen Group
A.7.2	Vikinghøgda, Mountain locality No. 11, Sassendalen Group
A.8	Stensiöfjellet, Locality 12a, top Permian and Sassendalen Group
A.9.1	Milne Edwardsfjellet, Locality 13a, Sassendalen Group
A.9.2	Milne Edwardsfjellet, localities 13b and c, Sassendalen Group
A.10	Dalsnuten, Locality 14, Sassendalen and Kapp Toscana groups
Eastern Spitsbergen	
A.11	Klementievfjellet, Locality 15, Kapp Toscana Group
A.12	Roslagenfjellet, Locality 16, Sassendalen Group
A.13	Eistraryggen, Locality 17, Kapp Toscana Group
A.14	Teistberget, Locality 18, Sassendalen and Kapp Toscana groups
Barentsøya	
A.15.1	Lomberget, Locality 19a, Sassendalen Group
A.15.2	Lomberget/Willybreen, Locality 19b, Kapp Toscana Group
A.16	Høgrinden, Locality 20, Sassendalen and Kapp Toscana groups
Edgeøya	
A.17	Skrukkefjellet, Locality 21, Sassendalen and Kapp Toscana groups
A.18.1	Blanknuten, Locality 22a, Sassendalen Group
A.18.2	Blanknuten South, Locality 22c, Kapp Toscana Group
A.19	Årdalsknuten, Locality 25, Kapp Toscana Group
A.20	Vogelfjellet, Locality 26, Sassendalen and Kapp Toscana groups
A.21	Negerfjellet, Locality 28, Kapp Toscana Group
Wilhelmøya	
A.22.1	Tumlingodden, localities 30a and b, Kapp Toscana Group
A.22.2	Tumlingodden, localities 30a and b, Kapp Toscana Group
Hopen	
A.23.1- A.23.2	Iversenfjellet, Lyngefjellet South and West and Binnedalen, Localities 31, 32c, a, d and b, Kapp Toscana Group
Bjørnøya	
A.24	Urd Mountain, Locality 33a, Sassendalen and Kapp Toscana groups
A.25	Miseryfjellet North, Locality 33b, Sassendalen Group

STRATIGRAPHIC BOREHOLES THE BARENTS SEA	
Finnmark Platform	
A.26.1.1-A.26.1.3	Core 7128/12-U-1, Tempelfjorden and Sassendalen groups, modified tables from Mangerud (1994).
A.26.2	Core 7128/9-U-1, Havert Formation, Sassendalen Group
Nordkapp Basin	
A.27	Core 7230/5-U-6, Sassendalen Group
A.28	Core 7228/3-U-1, Sassendalen Group
A.29	Core 7230/5-U-5, Kapp Toscana Group
A.30	Core 7230/5-U-4, Kapp Toscana Group
A.31	Core 7227/8-U-1, Kapp Toscana Group
A.32	Core 7230/5-U-3, Kapp Toscana Group
Svalis Dome	
A.33.1-A.33.3	Cores Dia-84-2, 7323/7-U-8, -6, -3, -4, -1, -7, -9, -10, -5, and -2, Sassendalen Group, Tables compiled based on Vigran et al. (1998) by including the herein composite assemblage zones
Hopendjupet	
A.34	Core 7427/3-U-1, Sassendalen Group
A.35	Core 7430/7-U-1, Kapp Toscana Group
Sentralbanken	
A.36	Core 7532/2-U-1, Sassendalen Group
A.37	Core 7534/6-U-1, Sassendalen Group
A.38	Core 7533/2-U-1, Kapp Toscana Group
A.39	Core 7533/3-U-7, Kapp Toscana Group
A.40.1-A.40.2	Core 7534/4-U-1, Kapp Toscana Group
A.41	Core 7533/2-U-2, Kapp Toscana Group
Kong Karls Land	
A.42.1-A.42.3	Core 7831/2-U-2, Sassendalen Group, and cores 7831/2-U-1, 7830/6-U-1, 7830/3-U-1 and 7830/5-U-1, Kapp Toscana Group

EXPLORATION WELLS FROM THE NORWEGIAN BARENTS SEA	
Hammerfest Basin	
A.43.1-A43.2	Well 7120/12-1, Kapp Toscana Group
A.44.1.1-A.44.1.2	Well 7120/12-2, Sassendalen and Kapp Toscana groups, bases
A.44.2.1-A.44.2.2	Well 7120/12-2, Sassendalen and Kapp Toscana groups, tops
A.45.1-A.45.2	Well 7120/12-3, Kapp Toscana Group
A.46.1.1-A.46.1.2	Well 7121/1-1R, Sassendalen and Kapp Toscana groups
A.46.2.1-A.46.2.2	Well 7121/1-1R, Sassendalen and Kapp Toscana groups
A.47.1-A.47.2	Well 7124/3-1, Sassendalen and Kapp Toscana groups
A.48.1.1-A.48.1.2	Well 7224/7-1B, Kapp Toscana Group
A.48.2.1-A.48.2.2	Well 7224/7-1B, Kapp Toscana Group
A.49.1.1-A.49.1.2	Well 7324/10-1, Sassendalen and Kapp Toscana groups
A.49.2.1-A.49.2.2	Well 7324/10-1, Sassendalen and Kapp Toscana groups

Figure A.1: List of studied sections, cores and exploration wells with reference to appendix text, palynological distribution charts and photographic plates.

WESTERN SPITSBERGEN

FESTNINGEN	T. Gr.					SASSENDALEN GROUP																												
Locality	Loc. 1a													Loc. 1c																				
Lithostratigraphy	K.Star.			Vardebukta Formation										Bravaisberget Formation																				
Age	L.Permian					P/T boundary								Triassic																				
	Changhsing.					Induan (Griesbach)								Spathian-Anisian							Anisian					Ladinian								
Pollen / Height in metres	360,4	364,0	378,3	0,05	0,2	1,2	2,25	3,1	4,0	4,7	5,0	6,5	8,3	513,5	517,0	522,0	528,0	531,0	537,0	547,0	557,0	566,0	571,0	626,0	643,0	655,0	662,0	675,0	705,0	710,0	711,0	721,0	721,5	725,5
Vittatina spp.	x	x	x	C	C		x			x		x																						
Bisaccate pollen (indeterminate)		x			x									x	x	x	x		x		x	x	x	x	x	x	x	A	x			x	x	A
Lunatisporites noviaulensis		x			x	C	x					x	x													x		x	x			x	x	x
Protohaploxypinus spp.		x			x		x					x	x										x					x						
Cycadopites spp.		x			x	x		x				x	x	x						x			x			x								
Lueckisporites virkkiae		x	x		x		x			x	x	x	x																					
Vittatina striata		x		x																														
Vittatina saccata		x																																
Falcisporites zapfei			x	x	x	x						x																						
Striatoabieites spp.					x	x	x			x	x	x	x	x			x		x	x	x	x	x			x	x	x	x		x	x	x	x
Lunatisporites spp.					x	C			x	x																							x	x
Ephedripites spp.					x		x		x	x		C											x			x								
Klausipollenites schaubergeri					x		x					x	x																					
Lunatisporites pellucidus					x																													
Vitreisporites spp.												x	x																					
Weylandites striata												x																						
Protodiploxypinus gracilis														x									x			x				x		x	x	x
Protodiploxypinus spp.														x							x	x	x			x							x	x
Triadispora spp.														x	x	x			x	x	x	x	x					x	x				x	x
Illinites chitonoides														x															x					
Pretricolpipollenites spp.														x		x	x																	
Striatoabieites multistriatus																	x						x					x	x			x		x
Bharadwajispora labichensis																	x			x														
Podosporites spp.																				x						x								
Protodiploxypinus decus																							x			x				x				
Accinctisporites circumdatus																							x											
Vitreisporites pallidus																										x		x	x			x	x	
Ovalipollis pseudoalatus																										x			x			x		
Staurosaccites quadrifidus																										x			x					
Protodiploxypinus minor																										x								
Illinites spp.																												x	x					
Schizaeoisporites worsleyi																													x		x			
Protodiploxypinus ornatus																																x	x	x
Triadispora verrucata																																x		x
Spores																																		
Kraeuselisporites spp.		C	x	x	x	x	x	x	x		x	x	x										x									x		x
Trilete smooth spores		x			x	x			x		x	x		x						x				x										
Cavate indeterminate spores		x			x																													
Uvaesporites imperialis				x	x	x						x																						
Densoisporites spp.					x	x	x	x	x	x	x	x	x				x	x	x	x														
Densoisporites nejburgii					x	x											x																	
Proprisporites pococki					x																													
Lundbladispora spp.						x		x	x		x																							
Laevigatosporites spp.							x					x	x																					
Kraeuselisporites apiculatus												x											x									x		
Aratrisporites spp.														x		x			x	x	x	x	x					x	x					
Anapiculatisporites spiniger														x					x															
Gordonispora fossulata														x																				
Lycopodiacidites spp.														x																				
Retusotriletes spp.														x																				
Striatella seebergensis																x																		
Leschikisporis aduncus																								x		x								
Perotrilites spp.																												x	x					
Semiretisporis "barentzii"																													x					
Plankton and varia																																		
Unellium spp.	C	C	x	x	x																													
Micrhystridium spp.	x	x	x	x	x	C	x	x	x	x	C	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	A	A	A	A	C	x
Veryhachium spp.		x			x	C						x		x	x	x			x						x			x	x	C		C	A	C
Fungal remain type 1		C	C	x	x	x	x		x	x	x	x										x												
Micrhystridium sp. (small specimen)		x			x			x				x				x																		
Reduviasporonites chalastus						x					x	C	x																					
Cymatiosphaera spp.												x	x													x						x		x
Plaesiodictyon spp.														x																				
Small sphaerical bodies																x		x	x	x					x				x					x
Tasmanites spp.																											x		x					x
Solisphaeridium spp.																													x					
Composite Assemblage Zone	Kraeu.*			U.im		Reduviasporon. chalastus								Anapiculat. spiniger							(P.dec.)			indet.		Echinitosporites iliacoides								

LEGEND
D dominant
A abundant
C common
x present

Kraeu.* Permian ass. Described by Mangerud (1994)
(P.dec)= An assemblage zone, or age, in bracketshas a low level of confidence

A.1.1 Festningen, Localities 1a and 1c, Tempelfjorden and Sassendalen groups.

plankton (*Micrhystridium* spp. and *Veryhachium* spp.) are present throughout, becoming abundant and co-occurring with *Tasmanites* in the upper part (from sample 705.0 m).

Kapp Toscana Group

Section 1d (Table A.1.2, Plates 7–8) covers an approximately 350 m thick succession of the Kapp Toscana Group, overlying deposits of the Bravaisberget Formation.

De Geerdalen Formation

Thirteen productive palynological samples were studied from the De Geerdalen Formation at Festningen (42.0–324.0 m). Well-preserved palynomorphs occur in many samples. The variably dark palynomorphs are mixed with tracheidal woody material. Levels with dominant *Leschikisporis aduncus*, smooth trilete spores (*Calamospora* spp., *Concavisporites* spp.), *Aratrisporites* spp., and alete bisaccate pollen represent monotonous vegetation, probably growing on a tidal flat and attributed to the *Aulisporites astigmosus* Composite Assemblage Zone (35.2–252.0 m). Acritarchs are rare and of low diversity; however, it is worth noting that *Micrhystridium* spp. and *Veryhachium* spp. are abundant at 167.6 and 283.3 m. The latter level corresponds to the lowermost part of the Isfjorden Member. The overlying interval (287.2–305.8 m) is almost barren of palynomorphs. At 323.5–324.0 m, the first dinocysts appear together with abundant acritarchs and allow identification of the *Rhaetogonyaulax* spp. Composite Assemblage Zone (see Plate 7).

The Wilhelmøya Subgroup

The Knorringfjellet Formation at Festningen (325.3–341.5 m, Table A.1.2) is about 20 m thick and contains well-preserved, diverse palynomorph assemblages rich in dinoflagellate cysts. This cyst assemblage probably correlates to the important marine horizon described by Bujak and Fisher (1976) from Arctic Canada. A similar assemblage was also recorded by Bjærke (1977) and Bjærke and Manum (1977) from above the Slottet Bed on Hopen. Fauna described by Korčinskaja (1980) dates the *Rhaetogonyaulax* spp. Composite Assemblage Zone to an early to middle Norian age. The cyst assemblage (acme zone) may reflect a circumpolar correlative event that also occurs at Wilhelmøya (see Section A.7 below).

The overlying interval (331.0–338.0 m in this section) contains assemblages dominated by Triassic palynomorphs. However, the records of the dinoflagellate cysts *Cleistosphaeridium* sp. and the pollen *Cerebropollenites thiergartii* (Table A.1.2.2) are considered evidence for a Jurassic age as also interpreted for material from East Greenland (Lund 1977).

A.1.2 Bravaisberget

The mountain Bravaisberget is situated at the entrance to van Keulenfjorden in Bellsund (Locality 2a–c, Figure 17). The 25 samples from the three sections investigated show rather low palynological diversity (Table A.2, Plate 1).

The contact of Vardebukta with the Kapp Starostin Formation

The Kapp Starostin/Vardebukta Formation transition shows no sign of erosive structures. The palynofacies across the contact is characterised by dark, woody material and the samples yield mostly low-diversity associations of poorly preserved specimens with a dominance of acritarchs.

The Sassendalen Group

The Vardebukta Formation

The assemblages are characterised by poorly preserved palynomorphs dominated by spores and by dark, woody material. Fungal hyphae and 'Fungal remain type 1', as well as abundant *Micrhystridium* spp. and *Veryhachium* spp. occur throughout the section (0.02–190.0 m).

The poor preservation prevents confident recognition of the *Uvaesporites imperialis* Composite Assemblage Zone at this locality. Based on the presence of *Reduviasporonites chalastus* and *Vittatina* spp. the associations up to 1.5 m are assigned to the *Reduviasporonites chalastus* Composite Assemblage Zone. Higher in the formation, poorly preserved palynomorphs form monotonous palynological associations of low stratigraphical significance. Cavate spores, *Punctatisporites* spp. and relatively common 'Fungal remain type 1' of Hochuli et al. (1989), are associated with the *Maculatasporites* spp. Composite Assemblage Zone.

The Tvillingodden Formation

The assemblages are characterised by poorly to moderately well-preserved palynomorphs. Low-diversity associations (210.0–230.0 m) include common 'Fungal remain type 1', acritarchs and fungal hyphae. They are assigned to the *Naumovaspora striata* Composite Assemblage Zone. The single specimen of *Reduviasporonites chalastus* (210.0 m) is considered recycled from older deposits. The middle part of the formation (247.0–326.0 m), where fungal remains become more sporadic, provides little conclusive evidence. The record of the bisaccate pollen *Triadispora* spp. (366.0–395.0 m) supports correlation with the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

WESTERN SPITSBERGEN

FESTNINGEN	S. Gp		KAPP TOSCANA GROUP																																		
Locality number	Loc. 1c		Loc. 1d																																		
Lithostratigraphy																				Wilhelmøya Subgroup																	
	Bot. Fm.		De Geerdalen Formation																	Knorringfjellet Formation																	
											Isfjorden Member									Tverrbekken Mb							Teistberget Member										
Age	Ladin		Carnian															Ca/No			Norian							Early Jurassic								MJ		
Pollen / Height in metres	0-721.5	725.5	35.3	42.0	143.0	167.8	169.2	203.0	245.8	252.0	283.3	287.2	289.9	305.8	310.0	320.0	322.0	323.5	324.0	324.3	325.3	326.7	328.0	328.0	329.0	329.3	330.0	331.0	331.5	333.5	335.0	336.0	337.5	337.7	338.0	339.3	340.3	341.5
Bisaccate pollen (alete)	x	x		x	A	C	x	C	x		A			x	A	A	A	A	x		C	C	C	x	A	x	C	C	A	A	A	C	A	C	C	A	x	x
Chasmatosporites spp.	x			x		C	x	x			x				x		x		x		x	x	x	x	x	x	x	x	C	C	A	C	x	C	C		x	x
Lunatisporites spp.	x	x				x					x				x			x			x		x					R	R	R		R		R	R			
Ovalipollis pseudoalatus	x	x			x	C		C			C				C	C	C	x			x	x	C	x	C	x	x	R	R	R	R	R	R	R	R			
Protodiploxypinus spp.	x	x				x			x		C				x		x	x	x			x		x	x	x	x	R	R	R	R	R	R	R				
Triadispora spp.	x	x			x	x	x	x	x		C				x	x		x			x		x	x	x	x	x	R	R	R	R	R	R	R				
Striatoabieites spp.	x	x			x	C	x	x	x		x							x				x		x				R	R				R					
Vitreisporites pallidus	x	x							x		x												x							x		x						
Staurosaccites quadrifidus	cf.					x	x		x		x				x		x											R										
Accinctisporites circumdatus	x										x				x																							
Illinites chitonoides	x					x	x	x			x																											
Cycadopites spp.						x		x	x		x				x	x		x			x		x	x		x	x	x	x	x	x	x	x		x		x	
Duplicisporites spp.						x					x																							R				
Podosporites sp. B						x																				x		R										
Cordaitina spp.						x										x																						
Striatoabieites multistriatus						C																																
Angustisulcites spp.							x				x				x								x									R						
Patinasporites densus							x								x		x																					
Araucariacites spp.								x			x				x				x				x	x	x	x		x		x	x	x	x	x	x			x
Porcellispora longdonensis											x				x										x				R	R	R							
Partitisporites spp.											x																											
Enzonalasporites vigens																		x											R	R	R			R	R			
Protodiploxypinus gracilis																			x			x				x				R	R	x	R	R				
Protodiploxypinus minor																			x							x		R			R	R		R				
Granuloperculatipollis rudis																					x						x		R				R	R				
Retisulcites spp.																						x	x					R				R		R				
Ricciisporites spp.																						x					x	R	R									
Vallasporites ignacii																						x																
Quadraeculina anellaeformis																												x						x				
Corollina spp.																													x					x		C	x	x
Cerebropollenites thiergartii																													x	x								x
Callialasporites dampieri																																						x
Cerebropollenites macroverrucosus																																						x
Concentrisporites hallei																																						x
Exesipollenites scabratus																																						x
Perinopollenites elatoides																																						x
Spores			b							b		b																										
Calamospora spp.	x			x	x	x	x	C	x		A			x	C	C	C	x			x	x	x	x		C	x	x	C	C	C	C	C	C	x			x
Leschikisporis aduncus	x					A	x	A	x		x			x	C	C	C	C		x	C		x	C				R							R			
Aratrisporites spp.	x				C	x	x	C	x		C			x	C	C	C	x			x	x	x	x	x	x	x	R	R	R	R	R	R	R				
Kraeuselisporites spp.	x	x			x	x	x	x	x		x				x	x	x						x	x	x	x	x		x	x	x			x				
Striatella seebergensis	x				x	x	x	x			x				x		x	x			x		x		x	x	x	x	x	x	x	x	x	x				
Gordonispora fossulata	x				x	x	x				x				x								x															
Concavisporites spp.					x	x	x	C	x		A			x	C	C	C	C			C	x	C	C	A	C	C	C	A	A	A	C	A	C	C	C	x	x
Deltoidospora spp.					x	x	x	x	x		A			x	x	x		x	x		x	x	C	C	x	x	x	C	C	A	C	C	x	C	C			x
Todisporites spp.					x	x	x	x	x		C			x	x		x		x			x	x	x	x		x		x	x	x	x	x	x			x	
Anapiculatisporites spp.					x	x	x	x	x		C				x		x					x	x		x	x	x	x	x	x	x	x	x	x	x			
Annulispora folliculosa					x		x	x	x		x				x		x				C	x	C	x	x	x	C	C	x	x	C	C	C	C	C			
Lycopodiacidites spp.					x	x	x										x					x	x			x				x		x	x	x	x			
Camarozonosporites laevigatus					x												x					x	x	x	x	x		R	R	R	R	R	R	R				
Lycopodiumsporites spp.					x						x					x							x		x		x		x					x				
Baculatisporites spp.					x			x							x														x		x							
Cosmosporites elegans					x		x				x																											
Converrucosisporites spp.					x																																	
Apiculatisporis spp.						x	x	x	x		C				x	x	x	x					x	x	x		x	x	x	x	x	x	x	x	x			x
Camarozonosporites rudis						x			x								x					x	x		x	x	x	R	R	R	R	R			R			
Uvaesporites spp.						x	x				x			x	x								x							x	x	x		x				
Verrucosisporites spp.						x																						x	x									
Polypodiisporites spp.						x		x	x		x				x								x															
Punctatosporites spp.						x		x			x				x																							
Triplexisporites playfordii						x																																
Neoraistrickia spp.							x				x				x											x			x		x		x	x				
Conbaculatisporites spp.							x	x			x				x		x	x							x			x	x		x	x						
Nevesisporites vallatus							x				x				x								x			x				x								
Retusotriletes spp.									x		x											x			x			x				x						
Kyrtomisporis laevigatus											x				x		x				C	C	C	C	C	C	x	R	R	R	R	R	R	R	R			
Gordonispora lubrica											x						x				x							x										
Thomsonisporites undulatus											x												x							x								
Kyrtomisporis speciosus															x		x				C	C	C	C	C	C	x	R	R	R	R	R	R	R	R			
Microreticulatisporites fuscus															x			x				x	x				x	x	x	x	C	x		x	x			
Velosporites spp.															x						x		x					R				R		R	R			
Stereisporites spp.															x																	x	x	x				
Tigrisporites spp.															x								x										R					
Densosporites spp.															x							x									x							
Leptolepidites spp.																x																		x				
Aratrisporites laevigatus																	x										x	R	R	R	R			R	R			
Zebrasporites interscriptus																	x				x		x	x	C	x	x	x	x	x	C	C	x	x	x			
Semiretisporis gothae																		x								x	x	R	R	R	R			R	R			
Cingulizonates rhaeticus																					x		x			x	x	R	R		R	R	R		R			
Polycingulatisporites spp.																					x	x	x	x	x	x	C	x	x	x	x	x	C	x	x			
Zebrasporites laevigatus																					C	x	x	x	x	x		R	R		R	R	R	R	R			
Kyrtomisporis niger																						C	x		x	C		R			R	R	R	R	R			
Densosporites fissus																						x			x				x									
Rogalskaisporites barentzii																							x					R		R		R		R				
Selagosporis mesozoicus																							x											x				
Kyrtomisporis gracilis																									x	C		R	R	R	R	R	R	R	x			
Densoisporites spp.																											x											
Limbosporites lundbladii																												R	R			R			R			
Rogalskaisporites cicatricosus																												x				x		x	x			
Auritulinasporites triclavis																												x	x					x				
Kraeuselisporites reissingeri																														R	R							
Convolutispora spp.																																	R					
Composite assemblage zone	E.iliac.		Aulisporites astigmosus															Rhaetog			Limbosp. lundbladii							(Cerebropoll. zone)								E-M J		

LEGEND
- D dominant
- A abundant
- C common
- x present
- R reworked
- b barren sample

A.1.2.1 Festningen, Locality 1d, Kapp Toscana Group.

WESTERN SPITSBERGEN

FESTNINGEN																																						
Lithostratigraphy	S. Gp		KAPP TOSCANA GROUP																																			
Locality number	Loc. 1c		Loc. 1d																																			
																			Wilhelmøya Subgroup																			
	Bot. Fm.		De Geerdalen Formation																Knorringfjellet Formation																			
											Isfjorden Member								Tverrbekken Mb							Teistberget Member											
Age	Ladin		Carnian														Ca/No			Norian							Early Jurassic								MJ		
Plankton and varia / Height in metres	0-721.5	725.5	35.3	42.0	143.0	167.8	169.2	203.0	245.8	252.0	283.3	287.2	289.9	305.8	310.0	320.0	322.0	323.5	324.0	324.3	325.3	326.7	328.0	328.1	329.0	329.3	330.0	331.0	331.5	333.5	335.0	336.0	337.5	337.7	338.0	339.3	340.3	341.5
Micrhystridium spp.	x	x				C	x				A				x		x	A	C	x	x		x	x	x	x	C	x		x	x	x	x					
Veryhachium spp.		x				C					A					x	x	A	C	x	C	C	A	A	A	A	C	A	A	A	A	A	A	A	A	C		
Cymatiosphaera spp.		x																A	x	x			x	x							x	x	x					
Tasmanites spp.		x									x							x																				
Plaesiodictyon spp.											x				x		x	x																R				
Baltisphaeridium spp.											x					x													x		x							
Dictyotidium spp.											x							x			x																	
Rhaetogonyaulax rhaetica																		x	x		x	x	C	A	x	x		R				R	R		R			
Rhaetogonyaulax sp. A																		C	A		A	A	C	C				R			R	R	R		R			
Pterospermella spp.																		x					x	x	x			C	x	C	C	C		x				
Shublikodinium arcticum																		x	x	x						x		R				R						
Foram linings																			x			x	x	x	x			x	x	x				x	x			
Fungal remain																			x																			
Noricysta spp.																					x	x	A	x	x	x	x	R		R	R	R		R	R			
Sverdrupiella spp.																					x	A	C	C	A	C	x	R	R	R	R	R			R			
Heibergella spp.																					C	A	C		A	C	x	R	R		R	R		R				
Heibergella aculeata																					x	A	A						R									
Heibergella asymmetrica																					x																	
Hebecysta spp.																							C		x	x		R			R	R		R				
Noricysta fimbriata																							A															
Noricysta varivallata																							x															
Valvaeodinium spp.																												R	R	R	R			R	R			
Cleistosphaeridium sp.																												x	x	x	x	x		x				
Chlamydophorella sp.			b							b			b																									x
Chytroeisphaeridia chytroeides																																						x
Ctenidodinium ornatum																																						x
Gonyaulacysta jurassica																																						x
Kalyptea diceras																																						x
Lacrynodinium warrenii																																						x
cf. *Lacrynodinium* sp.																																						x
Nannoceratopsis pellucida																																						x
Rhynchodiniopsis chladophora																																						x
Composite assemblage zone	E.iliac.		Aulisporites astigmosus														Rhaetog			Limbosp. lundbladii							(Cerebropoll. zone)								E-M J		
Sample identifications				F.78	F-62	FES-1	FES-1	F-47	F-39	FES-2	FES-2	FES-2	FES-2	FES-2	SAB77F-31	SAB77F-27	SAB77F-25	77F24sab78-3	F-23A	SAB78-5	SAB78-5	SAB78-8	SAB78-15a	SAB77F22	SAB78F20	SAB78F21	SAB78F30	SAB77F-21	SAB78F27	SAB78F31	SAB78F55	SAB77F-19	SAB78F43	SAB78F37	SAB77F-15	SAB78F44	SAB78F46	SAB78F50

LEGEND
D dominant
A abundant
C common
x present
R reworked
b barren sample

(Cerebropoll. Zone) marks an informal assemblage zone with *Cerebropollenites macroverrucosus* recorded in Sinemurian and Pliensbachian deposits (Lund 1979)

A.1.2.2 Festningen, Locality 1d, Kapp Toscana Group.

Bravaisberget Formation
The samples (Locality 2c) from the lowest part of the Bravaisberget Formation at Bravaisberget contain a relatively rich and distinct association of pollen that is assigned to the *Anapiculatisporites spiniger* Composite Assemblage Zone. The acritarchs comprise *Micrhystridium* spp. and abundant *Veryhachium* spp. Dark, terrestrially derived material dominates the organic residues. The record of *Vittatina* spp. suggests that oldest Triassic or Permian deposits were redeposited at this level. Two samples from the highest part of the formation were palynologically barren and added no stratigraphic information.

A.1.3 Reinodden

The Reinodden Peninsula (Locality 3) is located 10 km across van Keulenfjorden from the Bravaisberget section (Figure 17). Table A.3 covers the Reinodden locality, where eight samples from the Tempelfjorden and Sassendalen groups were investigated to study the palynology of the Permian–Triassic boundary. There is no lithological log of this particular section.

The contact between the Kapp Starostin and Vardebukta formations
The samples from the Kapp Starostin Formation are dominated by plankton and diverse pollen of the *Vittatina* group. Referring to the papers by Mangerud and Konieczny (1993) and Mangerud (1994) the two lower samples (-35.0 and -26.0 m) with abundant *Micrhystridium* and plankton recorded as *Reinoddenium* sp., *Starostinia* sp. and *Unellium* sp. are assigned to the *Kraeuselisporites* assemblage. The two uppermost samples (-6.7 and -4.0 m) represent the *Scutasporites–Lunatisporites* assemblage, where acritarchs also dominate the plankton.

The Sassendalen Group

Vardebukta Formation
Strongly degraded, thin-walled palynomorphs characterise the deposits (sample levels 0.0–15.0 m). Most groups show a different relative abundance from their records in the Kapp Starostin Formation and most of the palynomorphs present in the underlying interval are missing. The reduction of marine plankton suggests a distinct change in depositional conditions. The association is identified as the *Reduviasporonites chalastus* Composite Assemblage Zone.

A.2 Southern Spitsbergen

In southern Spitsbergen, the palynology of a few samples has been studied from each of four localities: Treskelen, Austjøkeltinden, Karentoppen and Kistefjellet (localities 4a–b, 5a–b, 6 and 7), all in the western fold belt (Figure 17).

The organic matter has been strongly affected by thermal alteration. In the deposits of the Sassendalen and Kapp Toscana groups, the particulate organic matter is extremely poorly preserved and darkly coloured, causing severe problems for recognition and identification of the palynomorphs. No biostratigraphic or palaeoenvironmental information has been gained from palynology and the sections were excluded from further studies. No distribution diagrams have been produced for these localities.

The Sassendalen Group
The Vardebukta Formation
A complete Triassic succession is present at Treskelen. The six samples processed for palynology contain poorly preserved organic remains. The material is dark or opaque, reflecting a high thermal maturity. At 22.5 m, possible acritarchs are recorded, represented by small spherical bodies covered by agglutinated degraded matter.

From Austjøkeltinden, three sample levels (2.7, 6.0 and 16.0 m) were investigated from the Induan section. Two of them contain strongly fragmented, degraded organic material as granular aggregates and the sample from the 16.0 m level contains coherent sheet-like, probably degraded algal, amorphous organic matter (AOM).

WESTERN SPITSBERGEN

BRAVAISBERGET	TEMPEL FJORDEN	SASSENDALEN GROUP																						
Locality numbers		Loc. 2a														Loc. 2b								2c
Lithostratigraphy	K.Staros	Vardebukta Formation														Tvillingodden								Brav
Age	Permian	P/T boundary				Triassic										Triassic								Tr.
Age		Induan														Olenekian								Anis
Age	Changhsing	Griesbach				(Dienerian)										Smith.		Spathian				I.Sp.		e.An.
Pollen / Height in section	-3.0	0.0	0.02	0.5	1.5	3.0	10.0	30.0	40.0	60.0	80.0	90.0	110.0	141.0	190.0	210.0	230.0	247.0	249.0	301.0	326.0	366.0	395.0	475.0	478.0
Bisaccate pollen (indeterminate)	x		x											x			x	x	x	x		x	x	x	x
Bisaccate pollen (taeniate)	x	x		x	x		x		x								x	x	x		x	x	x	x	x
Vittatina spp.	C	x	x		x																			R	R
Vitreisporites pallidus				x		x							x				x					x		x	x
Lunatisporites noviaulensis					x				x					x					x			x	x	x	x
Cycadopites spp.									x		x			x			x		x		x	x	x	x	x
Pretricolpipollenites spp.											x														x
Triadispora spp.																						x	x	x	x
Accinctisporites circumdatus																								x	x
Illinites spp.																								x	x
Staurosaccites quadrifidus																								x	x
Protodiploxypinus spp.																								x	x
Cordaitina gunyalensis																								x	x
Ephedripites spp.																									x
Spores								b		b		b													
Calamospora spp.	x	x			x																			x	x
Kraeuselisporites spp.	x	x	x	x	x				x					x	x		x		x	x				x	x
Cavate spores (indeterminate)	x	x		x	A	x	x		x		x			x	x	x	x		x	x		x	x		
Densoisporites nejburgii		x		x	A		x		x						x	x	x		x			x	x		
Baculatisporites spp.		x		x	C																				
Deltoidospora spp.				x	x																				
Punctatisporites spp.			x	x	x	x					x						x					x		x	x
Verrucosisporites spp.			x	x	x						x														
Densoisporites playfordi					x		x																		
Proprisporites pocockii					x																	R			
Densosporites spp.					x	x	x																		
Alete spores					x																				
Endosporites papillatus					x																				
Lapposisporites spp. (tetrads)					C																				
Lundbladispora spp.					x																				
Kraeuselisporites apiculatus											x													x	x
Apiculatisporis spp.													x	x											
Perotrilites spp.														x											
Rewanispora spp.															x		x	x	x		x	x			
Punctatisporites fungosus																x	x								
Dictyophyllidites spp.																								x	x
Striatella seebergensis																								x	C
Stereisporites spp.																								x	x
Plankton and varia																									
Micrhystridium spp.	A	A	x	x	A	C	C		A		A		A	A	C	x	A		x		x	x	C	x	x
Veryhachium spp.		x			x						x			C	C	x	C							A	x
Fungal remain type 1		x	x	x	C	C	C		x		x			x	x	C	C	x	x	x		x			
Fungal remain (hyphae)		x							x					x	x	x	x					x			
Reduviasporonites chalastus		x														R									
Unellium spp.		x																							
Smooth folded bodies					x																	x			
Cymatiosphaera spp.											x					x									
Composite Assemblage Zone		R. chalastus				Maculatasporites spp.										N.stri		indeterm				J.pu.		A.spi	

LEGEND
D dominant
A abundant
C common
x present
R reworked
(dotted pattern) barren s. b

(Dienerian)= When in brackets the age has a low level of confidence

A.2 Bravaisberget, Localities 2a, b and c, Tempelfjorden and Sassendalen groups.

Bravaisberget Formation
Samples from the Bravaisberget Formation at Treskelen and Karentoppen were investigated in a preliminary study. The organic material left after standard palynological processing comprises poorly preserved, dominantly terrestrial, strongly fragmented remains and coaly debris. Dark-coloured indeterminate bisaccate pollen and spores represent the main constituents of the organic residues. The uppermost sample from the Bravaisberget Formation at Treskelen is marked by the presence of dark-brown remains, possibly of degraded algae (AOM).

At Karentoppen (Locality 6), the silty sandstone at 79.5 m yielded a residue dominated by coherent sheet-like material that seems of brighter colour than the material in the two lower samples (at 60.5 and 74.3 m). Comparison with better preserved material recovered from stratigraphically equivalent parts of the Bravaisberget/Botneheia formations on Svalbard and the Barents Shelf, suggests that these remains may be derived from green algae (i.e. mainly *Tasmanites* spp.) and represent AOM. In our experience, samples enriched in *Tasmanites* tend to be rich in sheet-like remains, which are more brightly coloured than spores and pollen from the same deposits, as also described by Pocock (1982).

A.3 Isfjorden area

The following localities belong to the Isfjorden area of western to central Spitsbergen: Festningen (Locality number 1), Selmaneset, Tschermakfjellet and Botneheia (Figure 17). In contrast to western Spitsbergen, where Triassic beds are strongly folded within the Cenozoic fold belt, the more flatlying successions eastwards form gentle domes and monoclines. NNW–SSE-oriented lineaments have partly controlled thickness variations. Facies distributions have also influenced the palynological assemblages and palynofacies.

WESTERN SPITSBERGEN

REINODDEN Locality 3 Lithostratigraphy	TEMPELFJORDEN				SASSENDALEN Gp			
	K.Star. Fm				Vardeb. Fm			
Age	L.Permian				P/T boundary			
	Changhsing.				Ind.(Griesb)			
Pollen / Height in section	-35,0	-26,0	-15,0	-7,0	0.00	5.00	10.00	15.00
Protohaploxypinus limpidus	x	x	x	C				
Vittatina spp.	C	C	x	x				
Vittatina striata	A	C	x	C				
Lueckisporites virkkiae	x	x		x	x	x		
Protohaploxypinus spp.	x	x	x	x		x		
Vittatina simplex	x	x		x				
Alisporites spp.	C	C						
Klausipollenites schaubergeri	x			x				
Vittatina saccata	x		x	x				
Vittatina minima	x		x	x				
Protohaploxypinus chaloneri	x		x					
Vittatina costabilis	x		x					
Vittatina subsaccata	x		x					
Falcisporites zapfei	x							
Platysaccus papilionis	x							
Florinites luberae		x						
Lunatisporites pellucidus			x	x	x	x		
Lunatisporites spp.			x	x	x	x		
Lunatisporites noviaulensis			x	x	x	x		
Bisaccate pollen (taeniate)					x	x		
Cycadopites spp.						x		x
Spores								
Kraeuselisporites spp.	x	x	x					
Punctatisporites spp.						x	x	x
Apiculatisporis spp.		x	x	x				
Kraeuselisporites apiculatus			x	x				
Leiotriletes spp.	C	x		x				
Acanthotriletes spp.								
Calamospora breviradiata		x						
Kraeuselisporites punctatus	x	x						
Verrucosisporites spp.				x				
Densoisporites nejburgii					x	x	x	x
Cavate spores (indeterminate)					x	x	x	x
Endosporites papillatus						x		x
Plankton and varia								
Micrhystridium spp.	A	A	A	A		x	x	x
Reinoddenium spp.	x	x		x				
Starostinia spp.	x	C	x	x				
Unellium spp.	A	C	x	x				
Veryhachium spp.	A	x	x	C				
Fungal remain type 1					x	x		
Reduviasporonites chalastus					x	x	x	
Composite Assemblage Zone	Kraeus		Scu-Lun		R. chalastus			

LEGEND
D dominant
A abundant
C common
x present

A.3 Reinodden, Locality 3, Tempelfjorden and Sassendalen groups.

A.3.1 Selmaneset

The Selmaneset Peninsula (Locality 8) is located at the northern entrance of Isfjorden, directly across the fjord from Festningen (Figure 17). Steeply dipping rocks at Selmaneset probably span the Permian–Triassic boundary. Table A.4 covers the palynology of a short section, with 15 samples from the Tempelfjorden and Sassendalen groups.

The Sassendalen Group
The Vardebukta Formation
Poorly preserved palynomorphs dominated by spores occur together with black, woody material. Preservation is slightly better than in sections from the southern parts of the Cenozoic fold belt. Only the assemblage from the highest samples (9.0–12.0 m) can be confidently assigned to the *Reduviasporonites chalastus* Composite Assemblage Zone.

A.3.2 Tschermakfjellet

Drachedalen is a valley northwest of the mountain of Tschermakfjellet (Locality 9a) that is located at the entrance to Nordfjorden, on the southwestern shores of Dickson Land (Figure 17). Selected material is depicted in plates 1–7.

Sassendalen Group
Vikinghøgda Formation, including the Deltadalen, Lusitaniadalen and Vendomdalen members
The lowermost part of the Deltadalen Member at

SPITSBERGEN - ISFJORDEN

SELMANESET Locality 8	TEMPELFJ.						SASSEND.								
Lithostratigraphy	K. Starostin						Vardebukta Fm								
							Deltadalen Member								
Age of deposits	Permian												P/T		
	Changhsingian												Ind.		
Pollen / Height in section	(-) 49.00	(-)26.50	(-)13.50	(-)10.50	(-)6.70	(-)4.00	0.00	0.05	0.90	2.15	2.25	6.00	9.00	11.00	12.00
Lunatisporites spp.		x							x			x	x	x	x
Cycadopites spp.		x				x	x		x	x			x		
Vittatina spp.		x			x	x	x	x	x			x			
Falcisporites sp.		x				x			x						
Vesicaspora spp.		x	x	x											
Vittatina striata		x													
Platysaccus spp.		x													
Protohaploxypinus spp.			x			x	x		x				x	x	
Alisporites spp.							x		x			x	x		
Pretricolpipollenites spp.												x		x	
Spores	b														
Kraeuselisporites spp.		x				x		x	x		x	x	x		
Lundbladispora spp.		x			x						x		x		
Baculatisporites spp.		x				x		x							
Deltoidospora minor		x			x	x		x							
Perotrilites spp.					x		x								
Rugulatisporites spp.								x							
Acanthotriletes spp.									x						
Densoisporites nejburgii									x						
Endosporites papillatus									x						
Proprisporites pocockii										x			x		
Maculatasporites spp.											x		x		
Concavisporites spp.											x				
Aratrisporites spp.													x		
Lapposisporites spp.													x		
Plankton and varia	b														
Micrhystridium spp.		x				x	x	x	x	x	x		x		
Veryhachium spp.		x			x	x	x	x	x	x	x				
Unellium spp.		x			x	x	x	x							
Scolecodont						x									
Tasmanites spp.								x							
Reduviasporonites chalastus													x		
Cymatiosphaera spp.													x		
Composite Assemblage Zone	indeterminate								(U. imp)				R.chal		

(U. imp) = An assemblage zone in brackets has a low level of confidence
b = barren sample

A.4 Selmaneset, Locality 8, Tempelfjorden and Sassendalen groups.

Drachedalen (0.5–1.5 m, Table A.5.1) yielded a palynological association of dark palynomorphs including *Densoisporites* spp., *Kraeuselisporites* spp. and *Pechorosporites* spp., but this is too poorly preserved for confident association with the *Maculatasporites* spp. Composite Assemblage Zone. The higher part of Deltadalen Member is covered by scree. The association from the Lusitaniadalen Member (43.0–80.0 m), containing 'Fungal remain type 1' of Hochuli et al. (1989), *Densoisporites nejburgii* and abundant plankton, is assigned to the *N. striata* Composite Assemblage Zone. The Vendomdalen Member (95.0–142.0 m), above the 95.0 m level, contains abundant bisaccate pollen, including *Illinites chitonoides* and representatives of the *Triadispora* group, as well as indeterminate cavate spores. The *Tasmanites* group is common to abundant in this uppermost part, indicating marine depositional conditions. The association is assigned to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Botneheia Formation

The upper part of the Drachedalen section at Tschermakfjellet (144.0–266.0 m, Table A.5.1), contains organic material that is better preserved than that in the underlying Vikinghøgda Formation. The material allows identification of the *Anapiculatisporites spiniger*, the *Triadispora obscura* and the *Protodiploxypinus decus* Composite Assemblage zones in the lower part (144.0–200.0 m) of the Botneheia Formation. The regular presence of acritarchs, *Tasmanites* and other green algae indicates marine depositional conditions. Specimens of *Ovalipollis pseudoalatus* and *Camerosporites secatus* at 166.0 m are considered to result from contamination of the samples in the field as they were collected below layers of scree material.

The dark shale appearing at 209 m coincides with poor preservation and reduced diversity of the palynoflora, but also with some first appearances (FADs) of sporomorphs. The association is identified as belonging to the *Echinitosporites iliacoides* Composite Assemblage Zone. The base of the Blanknuten Member, situated between 240.5 and 242.5 m, and the overlying interval is associated with reduced palynological diversity.

Kapp Toscana Group

Tschermakfjellet Formation

The single sample collected from above the Sassendalen Group at Tschermakfjellet (Locality 9a, 372 m, Table A.5.1, Plate 6) has a low palynological productivity, with an association dominated by acritarchs, mostly *Veryhachium*.

The 10 samples representing the Tschermakfjellet Formation towards the top of the Tschermakfjellet section (Locality 9b) contain fairly well-preserved organic remains. Bisaccate pollen dominate together with *Leschikisporis aduncus* and a number of other smooth spores. Microplankton include *Cymatiosphaera* sp., *Dictyotidium* spp., *Micrhystridium* sp., *Veryhachium* sp. and *Tasmanites*. Samples from the 303 m and 308 m levels being palynologically barren, comprise dense aggregates of amorphous material (AOM), probably reflecting a marine environment with stagnant bottom conditions. The overlying interval is characterised by dominant structured woody material and common *Micrhystridium* sp. and *Veryhachium*, seeming to reflect more oxygenated depositional conditions (Table A.5.2). The association from the Tschermakfjellet Formation at this locality is regarded as belonging to the *Aulisporites astigmosus* Composite Assemblage Zone.

A.3.3 Botneheia

The mountain of Botneheia is located in the inner parts of Isfjorden on the southern shores of Sassenfjorden, between Elveneset and Vindodden (Locality 10a–b, Figure 17).

Sassendalen Group

Eight samples from this ammonoid-dated section were analysed (Table A.6). They contain only poorly preserved organic remains and are of minor value for palynological dating and correlation. This section

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TSCHERMAKFJELLET /DRACHEDALEN Locality 9a, lower part of mountain	SASSENDALEN GROUP																								KAP TOSC
Lithostratigraphy	Vikinghøgda Formation											Botneheia Formation													De Gee
	Deltadalen			Lusitaniad. Mb				Vendomd. Mb													Blanknuten Mb				
Age	Induan			Olenekian								Anisian						Ladinian							
	(Dienerian)			Smithian				Sp.	I.Spathian			e-m Anisian				I. Anis									Car.
Pollen / Height in section	0,5	1,5	32,5	43,0	52,5	71,0	80,0	95,0	116,0	132,0	142,0	144,0	166,0	175,0	185,0	192,0	200,0	209,0	225,0	240,5	242,5	255,0	258,0	266,0	372,0
Cycadopites spp.	x	x						x	x			x	x	x		x		x	x	x				x	x
Vitreisporites pallidus		x				x							x				x	x							
Bisaccate pollen (indeterminate)					x	x	C	x	A	A	C	A	A	x	C	x	A	A	C	A	x		x	C	x
Bisaccate pollen (striated)	x				x		x	x	x			x		x		x									
Lunatisporites noviaulensis							x	x	C			x	x	x	x	x									
Triadispora spp.									x	x		x	x	x	x		x	x	x		x			x	C
Illinites chitonoides									x			x	x	x		x		x						x	
Striatoabieites aytugii											x		x		x	x	x	x							x
Striatoabieites multistriatus												x	x	x	x	x	x	x	x				x	x	x
Protodiploxypinus spp.													x					x						x	x
Brachysaccus spp.													x								x				
Pretricolpipollenites spp.													x	x	x	x					x				
Duplicisporites granulatus													x	x			x								
Cordaitina spp.													x	x	x	x									
Bharadwajiispora labichensis													x		x										
Lunatisporites acutus													x		x										
Podosporites amicus													x	x	x										
Lueckisporites junior													x	x											
Infernopollenites spp.													x	x											
Protodiploxypinus gracilis														x	x			x	x	x				x	x
Triadispora obscura																x									
Praecirculina granifer																		x							x
Staurosaccites quadrifidus																		x	x					x	x
Ovalipollis pseudoalatus													ctd.					x						x	C
Angustisulcites spp.																		x							
Camerosporites secatus													ctd.												
Schizaeoisporites worsleyi																		x							
Eucommiidites sp.																					x				x
Protodiploxypinus ornatus																								x	x
Aulisporites astigmosus																									x
Spores			b																			b			
Kraeuselisporites spp.	x													x				x							
Densoisporites spp.	x	x						A	C	C	C				x	x									
Pechorosporites spp.	x																								
Punctatisporites spp.				x	x									x	x										
Densoisporites nejburgii				x				x	x	x	x														
Calamospora spp.				x																					
Aratrisporites spp.					x		x		x	x	x	x	x	x	x	x				x	x		x	x	x
Uvaesporites spp.										x			x		x										
Gordonispora fossulata												x	x	x				x							
Semiretisporis sp.												x	x	x		x									
Perotrilites minor												x		x											
Rewanispora spp.												x		x											
Lundbladispora spp.												x													
Eresinia spinellata													x	x	x			x							
Kraeuselisporites apiculatus													x		x	x	x	x							
Lapposisporites spp. tetrads													x	x	x	x									
Apiculiretusispora spp.													x		x										
Anapiculatisporites spiniger													x												
Discisporites niger													x												
Striatella seebergensis													x												
Ischyosporites spp.														x											
Lycopodiacidites spp.															x										
Leschikisporis aduncus																									x
Plankton and varia (sample numbers)			b																			b			
Micrhystridium spp.	x	x		x	x	x	x			x		x	x	x	x	x	x	x	x	x	x		x	x	x
Veryhachium spp.	x	x		x	A	x	x			x		C	x		x		C								C
Veryhachium sp. S	C	x		C	C	x	x			C		A	x	C	x	C	C				x			x	x
Tasmanites spp.				x	C				x	A	C		x	x		x	x	x	x	C			x	x	
Fungal remain type 1				x	A	C	x					x			x										
Cymatiosphaera spp.												C		x										x	
Solisphaeridium spp.												x		x			x				x				
Domasia sp.												x													
Micrhystridium sp. F													x	x	x		x							x	x
Veryhachium sp. L													x	x	x	C	C							x	
Pterospermella spp.														x		x								x	
Composite Assemblage Zone	(Maculatasp.)			Naumov. striata				ind	J. punctisp.			A.s.	T. obscura			P. decus		Echinitosporites iliacoides							A.a

LEGEND
D dominant
A abundant
C common
x present
R reworked
ctd. "contaminated"
barren sample b

(Maculatasp.)=When in brackets the assemblage zone, or age, has a low level of confidence

A.5.1 Tschermakfjellet, Locality 9a, Sassendalen Group.

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TSCHERMAKFJELLET Locality 9b, top of mountain	S.	K. TOSCANA GP									
Lithostratigraphy	Bo.	Tschermakfj. Fm									
Age	La.	Carnian									
Pollen / Sample numbers*	1	2	3	4	5	6	7	8	9	10	11
Bisaccate pollen (alete)	x	A	A	x	A	A	C			A	C
Striatoabieites spp.	x	x	C		C	C	x			x	x
Triadispora spp.	x	C	C		C	x	C			x	x
Angustisulcites spp.	x						x				
Triadispora verrucata	x	x	x		x		x				
Araucariacites spp.		x	x		x	x	x			x	x
Bisaccate pollen (indeterminate)		x									x
Camerosporites secatus		x									x
Cycadopites spp.		x	x				x				x
Illinites chitonoides		x	x		x		x			x	x
Partitisporites spp.		x	x		x	x	x			x	x
Patinasporites densus		x		x			x			x	x
Podosporites sp. B		x				x				x	x
Porcellispora longdonensis		x									x
Protodiploxypinus spp.		x	x							x	x
Vitreisporites pallidus		x	x		x	x					x
Lunatisporites spp.		C	C		C	x	x			x	
Ovalipollis pseudoalatus		x	x		x	x	x			x	
Staurosaccites quadrifidus		x	x			x	x			x	
Enzonalasporites vigens		x			x		x				
Bisaccate taeniate pollen		x	x		x						
Retisulcites spp.		x	x								
Verrucatosporites scabratus		x	x								
Eucommiidites sp.		x									
Lueckisporites junior		x									
Ricciisporites tuberculatus						x					x
Cordaitina spp.						x					
Spores								b			
Anapiculatisporites spp.	x	x			x	x	x			C	C
Kraeuselisporites spp.	x	x	x		x	x	x			x	x
Lycopodiacidites spp.	x	x	x		x	x	x			x	x
Nevesisporites vallatus	x	x	x		x		x			x	x
Uvaesporites spp.	x	x	x		x	x	x			x	x
Retitriletes spp.	x	x	x				x				
Schizaeoisporites worsleyi	x	x				x					
Velosporites spp.	x	x	x								
Leschikisporis aduncus		C	C		C	C	C			x	x
Calamospora spp.		x	x		A	C	C			C	x
Aratrisporites spp.		C	x			x	C			C	x
Striatella seebergensis		x	x		x	x	C			C	x
Annulispora folliculosa		x	x		x		x			x	x
Apiculatisporis spp.		x	x		x	x	C			x	x
Camarozonosporites rudis		x	x			x					x
Concavisporites spp.		C	C	x	A	A	C			A	C
Deltoidospora spp.		x	C		x	x	x			x	x
Leptolepidites spp.		x	x		x	x	x				x
Todisporites spp.		x			x						x
Retusotriletes spp.		x								x	
Gordonispora lubrica		x	x								
Zebrasporites interscriptus		x	x								
Conbaculatisporites spp.		x									
Aratrisporites laevigatus			x		x						x
Neoraistrickia spp.			x				x				x
Punctatosporites spp.			x								x
Polypodiisporites spp.			x				x				x
Semiretisporis sp. A *(barentzii)*			x				x			x	
Camarozonosporites laevigatus			x								
Verrucosisporites spp.						x	x				
Baculatisporites spp.						x					
Thomsonisporites undulatus							x				x
Converrucosisporites spp.											x
Plankton and varia	1	2	3	4	5	6	7	8	9	10	11
Micrhystridium spp.	C	C	x	x	C	A	x			C	x
Veryhachium spp.	x	x	x	x	C	C	x			C	
Cymatiosphaera spp.	x		x		x	x					
Dictyotidium spp.	x					x					
Foram linings		x			x	x				x	
Plaesiodictyon spp.			x				x				
Tasmanites spp.						x					
Fungal remain (hyphae)											x
Composite Assemblage Zone	E.i.	Aulisporites astigmosus									
Extrapolated heights for samples 1-11	272	274	277	280	288	292	298	303	308	314	320

LEGEND
A abundant
C common
x present
barren sample b

A.5.2 Tschermakfjellet, Locality 9b, Kapp Toscana Group.

is well dated by ammonoids from the Vikinghøgda Formation (Weitschat and Lehmann 1978) and the Botneheia Formation (Weitschat and Lehmann 1983).

Vikinghøgda Formation
The four samples (3.0–65.0 m) contain sparse and poorly preserved palynomorphs. The lowest sample contains an association that is assigned to the *Naumovaspora striata* Composite Assemblage Zone based on the dominant 'Fungal remain type 1' of Hochuli et al. (1989).

Botneheia Formation
The four samples (132.0–195.0 m) comprise strongly degraded organic material as firm aggregates and indeterminate bisaccate pollen in the uppermost samples recorded, together with common *Micrhystridium* and *Veryhachium* reflecting marine depositional conditions.

Kapp Toscana Group
The samples from this section (Locality 10b) generally show a larger input of woody organic matter and palynomorphs are somewhat better preserved than those of the underlying Sassendalen Group.

Tschermakfjellet Formation
Mostly bisaccate pollen and some spores of poor to moderate preservation occur in the single productive sample from the stratotype of the Tschermakfjellet Formation (Table A.6, 216.0 m).

De Geerdalen Formation
A palynologically barren interval separates this interval from the underlying formation. A low-diversity assemblage from the uppermost sample in the section (417.5 m) is dominated by spores. For both formations the assignment to the *Aulisporites astigmosus* Composite Assemblage Zone is based on sparse evidence.

A.4 Central Spitsbergen

A.4.1 Vikinghøgda/Deltadalen

The mountain of Vikinghøgda (Locality 11, Figure 17) is located in southern Sassendalen.

The Sassendalen Group was sampled in the Deltadalen valley and its tributary (0.2–173.6 m, 44 samples, A.7.1) and in a continuous mountain section (155.5–257.5 m, 21 samples, A.7.2) at Vikinghøgda. The section, which is dated by ammonoids, was described by Mørk et al. (1999b). Here, we discuss the succession based on the slightly revised range chart, including the assignment to the composite assemblage zones described in this study.

The samples generally contain poorly to moderately well-preserved organic remains (Plates 1–2). The palynodebris, particularly those of the Vendomdalen Member, appear as sheet-like AOM.

Sassendalen Group

Vikinghøgda Formation, Deltadalen Member

The 16 samples (0.2–67.8 m, Table A.7.1) contain diverse associations of poor to moderate preservation. Particularly samples from the middle part of the member (20.3–48.0 m) comprise palynomorphs with walls damaged by pyrite growth. The ammonoid *Otoceras boreale* occurs at 12 m above base of the section and dates the succession to the *O. boreale* Zone (Mørk et al. 1999b).

The material allows identification of three zones: the *Uvaesporites imperialis*, *Reduviasporonites chalastus* and *Proprisporites pocockii* Composite Assemblage Zones. *Micrhystridium* spp. is dominant throughout the formation. *Veryhachium ellesmerense* is present and becomes a dominant taxon in the uppermost beds of the Deltadalen Member, where the association is identified as the *Maculatasporites* spp. Composite Assemblage Zone, probably of Dienerian age. The isolated specimen of *Reduviasporonites chalastus* at 67 m is interpreted as reworked.

Vikinghøgda Formation, Lusitaniadalen Member

The diverse associations from 23 samples (68.6–156.8 m, Table A.7.1) show poor to moderate preservation. Plankton up to 92.6 m co-occur with dominant 'Fungal remain type 1'. *Veryhachium ellesmerense* dominates throughout the member. Diversity, in particular of pollen, decreases upwards. The interval between 100.0 and 156.8 m includes the so-called 'Fish Niveau', described by Stensiö (1921, 1925). The palynological associations throughout this section are assigned to the *Naumovaspora striata* Composite Assemblage Zone. The section is dated by ammonoids of the *Euflemingites romunderi* Zone (Mørk et al. 1999b).

Vikinghøgda Formation, Vendomdalen Member

Four samples from the river section (Table A.7.1) and 18 samples from the mountain section (Table A.7.2) comprise palynomorphs embedded in dense aggregates of amorphous organic matter. *Micrhystridium* spp. dominates while 'Fungal remain type 1' and *Veryhachium ellesmerense* occur in low proportions. Pollen diversity seems to increase gradually up-section, distinguishing the associations in the lower part of Vendomdalen (159.0–188.5 m) from those of the Lusitaniadalen Member. The association is identified as the *Pechorosporites disertus* Composite Assemblage Zone.

Pollen and spore diversity varies and is generally reduced in the higher part of the member (190.3–249.3 m) in the mountain section. The record of stratigraphically significant palynomorphs allows identification of the *Jerseyiaspora punctispinosa* Composite Assemblage Zone. *Micrhystridium* and degraded, smooth and thin-walled plankton related to the *Tasmanites* group dominate samples between 188.5 and 233.8 m. The highest samples (242.3–249.3 m) have reduced diversity of *Tasmanites* and spores, but *Densoisporites nejburgii* is occasionally dominant.

Ammonoids date this member to the Spathian, the lower part to the *Bajarunia euomphala* Zone, above this to the *Keyserlingites subrobustus* Zone and the upper part to the *Parasibirites grambergi* Zone (Mørk et al. 1999b).

Botneheia Formation

The palynological assemblage of the two samples (250.3–257.5 m) from the lowest part of the formation shows some increase in diversity and abundance of pollen and spores. Presence of *Angustisulcites klausii* together with the *Protodiploxypinus*, *Striatoabieites* and *Triadispora* groups, as well as incoming of *Anapiculatisporites spiniger* and *Eresinia spinellata*, allows identification of the *Anapiculatisporites spiniger* Composite Assemblage Zone. The plankton association present in most of the upper part of the Vendomdalen Member also continues in the lower parts of the Botneheia Formation.

SPITSBERGEN - ISFJORDEN

BOTNEHEIA	SASSENDALEN GROUP								K.TOSC GROUP			
Localities	Loc. 10a								Loc. 10b			
Lithostratigraphy	Vikingh.Fm.				Botneh.Fm.				Tsch	DeGeer.		
		Vendo.										
Age	S.	Spath							Carn			
Pollen / Height in meter	3.01	12.01	48.01	65.01	132.01	159.01	179.01	195.01	216.01	(298.01)	(375.01)	(417.5)
Bisaccate pollen (indeterminate)		x	x	x	x	C	C	C	x			
Cycadopites spp.									x			
Podosporites amicus									x			
Podosporites spp.									x			
Protodiploxypinus gracilis									x			
Protodiploxypinus spp.									x			
Protohaploxypinus spp.									x			
Striatoabieites spp.									x			
Triadispora spp.									x			
Araucariacites spp.												x
Chasmatosporites magnolioides												x
Spores / Height in meter	3.01	12.01	48.01	65.01	132.01	159.01	179.01	195.01	216.01	(298.01)	(375.01)	(417.5)
Densoisporites spp.	x	x	x	x					x			
Punctatisporites sp. cf. *P. fungosus*	x											
Gleicheniidites senonicus									x			x
*Dictyophyllidites*spp.									x			x
Lycopodiacidites spp.									x			
Striatella seebergensis									x			
Kyrtomisporis spp.												x
Leptolepidites spp.												x
Calamospora spp.												x
Deltoidospora minor												x
Todisporites spp.												x
Plankton and varia										b		
Fungal remain type 1	C											
Micrhystridium spp.							C					
Veryhachium spp.								C				
Composite Assemblage Zone	N.s.	Indeterminate							A. astigmos.			

LEGEND
C common
x present
barren s.- b

(298.01)=The section hight when in brackets has an uncertain stratigraphic position

A.6 Botneheia, localities 10a and b, Sassendalen and Kapp Toscana groups.

CENTRAL SPITSBERGEN

VIKINGHØGDA, DELTADALEN River locality, Number 11		SASSENDALEN GROUP																																									
Lithostratigraphy		Vikinghøgda Formation																																									
		Deltadalen Member															Lusitaniadalen Member																							Vend.Mb.			
Age	L.Perm			P/T bound.					Early Triassic																																		
		Induan															Olenekian																										
		Griesbachian											Dienerian					Smithian																							Spath.ely			
Pollen / Interpreted height in section	-5	0,2	1,2	4,7	7,6	11,2	13,8	14,0	20,3	27,5	37,0	48,0	56,6	62,2	65,8	67,0	67,8	68,6	70,8	75,8	79,5	84,0	87,0	89,0	92,6	95,9	101,0	102,3	122,3	128,2	132,2	137,5	141,2	143,2	144,2	146,7	150,5	153,8	155,8	156,8	165,9	169,0	172,0	173,6
Bisaccates (indeterminate, fragmented)	x	x	D	x	x	x	x	D	D	D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	D	x	D	
Protohaploxypinus spp.	x	x	x					x	x	x	x	x	x	x		x			x	x	x	x	x									x	x						x		x	x	x	
Lueckisporites virkkiae	x	x				x	x	x	x	x																																		
Vittatina spp.	x	x	x	x		x		x	x																																			
Protohaploxypinus perfectus	x																																											
Protohaploxypinus samoilovichii	x																																											
Vesicaspora spp.	x																																											
Cycadopites spp.		x		x	x	x	D	D	D	D	x	x	x	x	x	x	D	D	x	D	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	D	D	x	x	x	
Lunatisporites spp.		x	x	D	D	D	D	D	D	D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											x			
Inaperturopollenites nebulosus		x						x																																				
Klausipollenites schaubergeri		x																																										
Lunatisporites noviaulensis			x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											x	x	x	x			x		x	
Lunatisporites pellucidus			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x			x	x		x				x			x	x	
Lunatisporites transversundatus				x	x	x		x	x	x	x	x		x																												x		
Protohaploxypinus microcorpus				x		x																																						
Pretricolpipollenites spp.					x	x	x	x	x	x	x	x	x	x		x	D	D	x	D	D	x	x	x	x	x	x	x	x	x		x	x	x					x		x	x	x	
Ephedripites steevesii						x	x	x	x					x		x		x	x	x	x	x	x	x		x																		
Crustaesporites globosus						x	x	x																																				
Cordaitina minor										x					x	x																											x	
Bharadwajispora labichensis											x								x	x	x	x	x	x																				
Protodiploxypinus doubingeri															x	x																											x	
Circumstriatites sp.															x	x																												
Lunatisporites acutus																																											x	
Striatoabieites balmei																																											x	
Lueckisporites junior																																											x	
Vitreisporites pallidus																																												
Striatoabieites spp.																																												
Illinites chitonoides																																												
Podosporites amicus																																												
Striatoabieites multistriatus																																												
Triadispora spp.																																												
Angustisulcites klausii																																												
Protodiploxypinus gracilis																																												
Protodiploxypinus spp.																																												
Spores																																												b
Retusotriletes spp.	x											x																												x				
Trilete smooth spores	x	x	x							x	x	x	x			x	x		x	x	x	x	x	x					x	x					x					x				
Kraeuselisporites apiculatus	x	x					x	x		x	x	x	x				x	x	x	x	x	x	x	x											x									
Kraeuselisporites spinosus	x	x																																	x									
Neoraistrickia spp.	x	x	x																																									
Apiculatisporis lanjouwii	x	x																																										
Granulatisporites spp.	x	x																																										
Densoisporites nejburgii		x		x	x	x	x	x	x	x	x	x		x	x	x	x	D	D	D	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Densoisporites spp.		x			x		x	x		D	x	x	x	x	x	x	x	D	D	D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	D	x	D	x	x	x	
Aratrisporites tenuispinosus		x	x	x					x			x																																
Maculatasporites spp.		x		x		x	x																																					
Densoisporites playfordi				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										x	x	x	x			x	x			
Proprisporites pocockii				x	x	x	x	x			x										x		x	x																x				
Uvaesporites imperialis				x		x	x	x																																				
Pechorosporites disertus						x	x			x	x	x			x	x		x					x		x							x		x	x	x								
Lundbladispora spp.						x		x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Rewanispora foveolata						x																																					x	
Lundbladispora obsoleta						x	x	x						x		x																												
Pilasporites spp.						x	x																																					
Kraeuselisporites spp.							x		x	x	x				x	x	x			x	x	x	x	x									x	x					x	x	x	x	x	
Aratrisporites spp.							x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x			x	x			
Aratrisporites scabratus							x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x																				
Kraeuselisporites hoofddijkensis										x		x			x	x				x		x	x																					
Pechorosporites intermedius										x																																		
Densoisporites complicatus											x	x							x	x	x	x	x	x											x									
Endosporites papillatus											x										x	x	x																					
Pechorosporites coronatus											x			x																														
Gordonispora fossulata															x																												x	
Punctatisporites fungosus																			x		x	x								x	x	x	x	x	x		x	x	x			x	x	
Kraeuselisporites spp. (coarse sculpture)																																											x	
Cyclotriletes pustulatus																																												
Jerseyiaspora punctispinosa																																												
Cycloverrutriletes presselensis																																												
Lycopodiacidites spp.																																												
Uvaesporites argentaeformis																																												
Striatella seebergensis																																												
Eresinia spinellata																																												
Anapiculatisporites spiniger																																												
Cyclotriletes oligogranifer																																												
Polycingulatisporites spp.																																												
Retusotriletes hercynicus																																												
Staplinisporites caminus																																												
Plankton and varia / Sample number	1	2	3	5	6	7	9	10	11	13a	14	16	19	20	21	22	23	24	25	26	29	32	33	34	35	36	37	38	40	52	51	49	47	46	45	44	43	42	41b	53	56	57	59	60
Cymatiosphaera spp.	x	x	D															x	x	x	x		x													x							x	
Fungal remain type 1	x						x	x	x	x	x	x	x	x	x	x	D	D	x	D	D	D	D	D	D	x	x	x			x	x	x	x	x	x	x	D	x	x	x	x	x	
Micrhystridium spp.	x	x	x	D	D	D	D	D	D	x	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	x	x	x	x	x	x	x	x	x	x	x	x	D	D		D	
Grebespora concentrica	x		x	x											x			x	x	x			x												x									
Foraminiferal lining	x											x																					x											
Filisphaeridium setasessitante	x	x	x	x	x	x	x	x	D	x	D	D	D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	D	D	x	x	x	x	x	x		x	
Unellium spp.	x	x		x																																								
Fungal remain sp. B	x																																											
Leiospheres		x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	D	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		
Dictyotidium spp.				x																																								
Leech cocoon						x																																						
Veryhachium spp.								x	x		x		x	x	D	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x		x			x	x	
Tasmanites sp.								x										x	x										x	x					x									
Veryhachium ellesmerense								x	x	x	x	x	D	D	D	D	D	x	x	D	D	D	D	D	D	D	D	D	D	D	x	x	D	D	x	x	x	D	x	D	x	x	x	
Reduviasporonites chalastus								x								R																												
Botryococcus sp.													x			x																												
Pterospermella spp.																																												
Composite Assemblage Zone	SL	U.imp		R. chalastus					P.pocockii				Maculatasporites					Naumovaspora striata																							P.disertus			

LEGEND
D dominant
A abundant
C common
x present
R reworked
(stippled) barren s. b

A.7.1 Vikinghøgda, Deltadalen river locality No. 11, Sassendalen Group.

CENTRAL SPITSBERGEN

VIKINGHØGDA Mountain locality, Number 11	SASSENDALEN GROUP																				
Lithostratigraphy	Vikinghøgda Formation																			Bot	
	Lus.	Vendomdalen Member																			
Age	Early Triassic																			Mtr	
	Olenekian																			Anis.	
	Smit	Spathian early							Spathian late											An.e.	
Pollen / Height in section	155,5	159,0	164,5	168,0	175,0	177,7	184,0	188,5	190,3	197,4	200,4	213,0	221,8	226,0	229,8	233,8	242,3	246,7	249,3	250,3	257,5
Bisaccates (indeterminate, fragmented)	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	D	D	D
Protohaploxypinus spp.				x	x	x	x	x	x			x	x	x		x	x		x	x	x
Lueckisporites virkkiae																					
Vittatina spp.																					
Protohaploxypinus perfectus																					
Protohaploxypinus samoilovichii																					
Vesicaspora spp.																					
Cycadopites spp.	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x
Lunatisporites spp.		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x
Inaperturopollenites nebulosus																					
Klausipollenites schaubergeri																					
Lunatisporites noviaulensis				x	x	x	x	x	x	x										x	x
Lunatisporites pellucidus				x	x		x	x	x											x	x
Lunatisporites transversundatus																					
Protohaploxypinus microcorpus																					
Pretricolpipollenites spp.	x	x	x	x	x	x	x	x	x							x				x	
Ephedripites steevesii									x				x								x
Crustaesporites globosus																					
Cordaitina minor																				x	x
Bharadwajispora labichensis				x																	x
Protodiploxypinus doubingeri						x										x					x
Circumstriatites sp.					x	x	x	x	x												
Lunatisporites acutus				x	x		x	x	x												x
Striatoabieites balmei				x	x											x	x	x	x	x	D
Lueckisporites junior				x	x																
Vitreisporites pallidus									x							x					x
Striatoabieites spp.													x	x	x	x					
Illinites chitonoides														x							x
Podosporites amicus																x	x	x	x	x	x
Striatoabieites multistriatus																x	x	x	x	x	D
Triadispora spp.																x				x	x
Angustisulcites klausii																					x
Protodiploxypinus gracilis																					x
Protodiploxypinus spp.																					x
Spores											b										
Retusotriletes spp.																					x
Trilete smooth spores				x	x									x	x					x	x
Kraeuselisporites apiculatus																					
Kraeuselisporites spinosus																					
Neoraistrickia spp.																					
Apiculatisporis lanjouwii																					
Granulatisporites spp.																					
Densoisporites nejburgii	x	x		x	x	x	x	x	x	x		x	x			x		D		x	x
Densoisporites spp.	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x
Aratrisporites tenuispinosus																					
Maculatasporites spp.																					
Densoisporites playfordi												x	x			x					
Proprisporites pocockii																					
Uvaesporites imperialis																					
Pechorosporites disertus					x			x	x	x											
Lundbladispora spp.	x	x	x	x	x	x	x	x	x												
Rewanispora foveolata				x	x	x			x												
Lundbladispora obsoleta																					
Pilasporites spp.																					
Kraeuselisporites spp.		x		x	x	x	x	x	x									x		x	x
Aratrisporites spp.		x	x									x	x			x			x	x	x
Aratrisporites scabratus													x			x					
Kraeuselisporites hoofddijkensis																					
Pechorosporites intermedius																					
Densoisporites complicatus				x												x					
Endosporites papillatus																					
Pechorosporites coronatus																					
Gordonispora fossulata				x	x		x	x	x											x	
Punctatisporites fungosus				x	x																
Kraeuselisporites spp. (coarse sculpture)													x		x						
Cyclotriletes pustulatus									x	x						x					
Jerseyiaspora punctispinosa									x												x
Cycloverrutriletes presselensis									x												
Lycopodiacidites spp.														x							x
Uvaesporites argentaeformis																x					x
Striatella seebergensis																x					
Eresinia spinellata																					x
Anapiculatisporites spiniger																					x
Cyclotriletes oligogranifer																					x
Polycingulatisporites spp.																					x
Retusotriletes hercynicus																					x
Staplinisporites caminus																					x
Plankton and varia / Sample numbers	100	101	102	103	105	106	109	112	113	115	116	119	120	122	123	125	126	130	127	129	128
Cymatiosphaera spp.				x	x		x	x	x	x		x	x	x	x	x				x	x
Fungal remain type 1	x	x	x	x	x	x		x	x			x	x	x	x	x	x		x		x
Micrhystridium spp.	D	x	x	D	D	x	D	D	x	D		D	D	D	D	D	D	D	D	D	D
Grebespora concentrica									x							x					
Foram lining										x				x							
Filisphaeridium setasessitante	x			x	x	x	x														
Unellium spp.																					
Fungal remain sp. B																x					
Leiospheres	x		x	x	x	x	x	D	x			x	x	x	x	x		x		x	x
Dictyotidium spp.									x	x			x							x	x
Leech cocoon																					
Veryhachium spp.				x	x	x				x		x	x	x	x	D			x	x	x
Tasmanites sp.				x	x	x		D	D	x		D	D	D	D	D	x	x	x	D	D
Veryhachium ellesmerense	D			x	x	x															
Reduviasporonites chalastus																					
Botryococcus sp.																					
Pterospermella spp.																x					x
Composite Assemblage Zone	N.str	Pechorosp. disertus							Jerseyiaspora punctispinosa											A.spin	

LEGEND

D	dominant
A	abundant
C	common
x	present
R	reworked
(dotted)	barren s. b

A.7.2 Vikinghøgda, Mountain locality No. 11, Sassendalen Group.

A.4.2 Stensiöfjellet

The mountain of Stensiöfjellet is located in the Sassendalen area (Locality 12, Figure 17). The 21 samples representing a section through the Vikinghøgda and Botneheia formations have been collected at highly variable intervals (Table 8).

The 'top-Permian' is confidently recognised from a low diversity association of *Lueckisporites virkkiae*, *Protohaploxypinus* spp. and *Vittatina* spp. together with the marine plankton *Micrhystridium*, *Tasmanites* and *Unellium* spp. The palynology of the Kapp Starostin Formation at this locality was studied by Mangerud and Konieczny (1993) who assigned the upper part to a *Kraeuselisporites* spp. assemblage.

Sassendalen Group

Vikinghøgda Formation, Deltadalen Member

Poor to moderately well-preserved palynomorphs and dominant amorphous organic material (AOM) characterise the lowest samples (0.0–50.0 m) of this section. Small specimens of *Micrhystridium* are common to dominant.

At the lowest level, the presence of *Densoisporites nejburgii*, *Lueckisporites virkkiae* and *Lunatisporites* spp. allows identification of the *U. imperialis* Composite Assemblage Zone. 'Fungal remain type 1' (of Hochuli et al. 1989) and *Reduviasporonites chalastus* occur above (0.5–15.0 m) and are associated with the *Reduviasporonites chalastus* Composite Assemblage Zone. In the absence of these characteristic forms, the highest part of the member is tentatively associated with the *Maculatasporites* spp. Composite Assemblage Zone.

Vikinghøgda Formation, the Lusitaniadalen and Vendomdalen members

Impoverished palynological associations were obtained from samples in the interval 105.0–200.0 m. Abundance of *Densoisporites nejburgii* and 'Fungal remain type 1' of Hochuli et al. (1989) allow assignment of the lowest level to the *Naumovaspora striata* Composite Assemblage Zone. The 130.0 m sample level provided no stratigraphically significant information. For the highest samples, the presence of *Kraeuselisporites apiculatus* and *Podosporites amicus* allows assignment to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone. The marine plankton in this assemblage include *Cymatiosphaera*, *Tasmanites* and abundant *Micrhystridium*, indicating an environmental change from the lower levels of this section.

The coarse sampling grid prevents precise location of the boundary between the Lusitaniadalen and Vendomdalen members (Table A.8).

Botneheia Formation

In the lower part of the section (206.0–263.0 m), aggregates of AOM only occasionally allow distinction of some specimens of *Ephedripites* sp., *Leschikisporis aduncus*, *Podosporites amicus* and *Triadispora* spp., preventing confident correlation with a specific zone. The association from 280.0–283.0 m (Table A.8) is assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone. *Micrhystridium* and *Tasmanites* represent a marine environment similar to that of the Botneheia Formation in other localities on Svalbard.

A.4.3 Milne Edwardsfjellet

Forty-eight investigated samples represent three sections of the Sassendalen Group from three localities on the western side of the mountain of Milne Edwardsfjellet (Locality 13a–c, sections MES, ME and MEE, Figure 17). A composite diagram (Table A.9) presents the results from these sections. The palynology has previously been discussed by Hounslow et al. (2007a, b, 2008a, b). The complete record is compiled in the present paper, including the discrimination of the composite assemblage zones defined herein.

Sassendalen Group

The 107 m thick Section 13a (Table A.9.1) covers the Vikinghøgda Formation and the basal beds of the Botneheia Formation.

Vikinghøgda Formation, Lusitaniadalen Member

The single sample from the uppermost part of this member contains a monotonous association of dominantly cavate spores and *Punctatisporites* spp. (including *P. fungosus*); pollen grains (*Cycadopites* spp. and bisaccates) are subordinate. 'Fungal remain type 1' of Hochuli et al. (1989) is common. Marine plankton include rare leiospheres and tasmanitids. The association is identified as the *Naumovaspora striata* Composite Assemblage Zone. The late Smithian range of this zone is in agreement with the ammonoids dating these deposits to the late Smithian *Anawasatchites tardus* Zone (Dagys and Weitschat 1993, Hounslow et al. 2008c).

Vikinghøgda Formation, Vendomdalen Member

The monotonous, but relatively rich associations recorded in the lower part of the Vendomdalen Member (8.0–70.2 m, Table A.9.1) contain common to dominant bisaccate pollen, *Cycadopites*, *Pretricolpipollenites* spp. and abundant cavate spores. Finely dispersed organic residues of predominantly indeterminate terrestrial origin dominate. The walls of the palynomorphs are damaged by traces of pyrite framboids. The marine plankton in this part of the member include dominant *Micrhystridium*, tasmanitids and leiospheres. 'Fungal remain type 1' of Hochuli et al. (1989) is regularly present. The association is correlated with the *Pechorosporites disertus* Composite Assemblage

CENTRAL SPITSBERGEN

STENSIÖFJELLET Locality 12a (STE)	T.Gp			SASSENDALEN GROUP																			
Lithostratigraphy	K.Star.			Vikinghøgda Formation															Botneheia				
				Deltadalen Member										Lusit/Vendom									
Age	Permian				EarlyTriassic														Mid Triassic				
	Changh.			Induan										Olenekian									
	Loping.			Griesbach					Dienerian					S	Sp	l.Spath.			Anisian				Lad
Pollen / Height in section	115.00	117.00	165.0	0.00	0.50	1.00	5.00	15.0	25.0	30.0	35.0	45.0	50.0	105.0	130.0	155.0	190.0	200.0	206.0	248.0	255.0	263.0	280.0	285.0
Cycadopites spp.	x			x	x	x				x	x	x	A		x				x				x	x
Protohaploxypinus spp.	x	C	x	C	x																			
Vittatina spp.	x	x	x	x	x																			
Platysaccus spp.	x		x																					
Vittatina striata	x	x																						
Vittatina simplex	x																							
Lueckisporites virkkiae		x	x	x	x		x			R														
Bisaccate pollen (indeterminate)				x		x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lunatisporites noviaulensis				x	x	C		x			x		x			x	x						x	x
Ephedripites spp.				x	x	x																	x	
Lunatisporites pellucidus				x	x	x	x	x			x	x	x											
Lunatisporites spp.				x	x	x	x	x		x														
Alisporites spp.				x	x		x																	
Striatoabieites spp.				x	x	x																		
Klausipollenites schaubergeri				x	x	x																		
Florinites luberae				x																				
Triadispora spp.					x																x		x	x
Vitreisporites pallidus					x						x	x	x											
Bharadwajispora labichensis					x																			
Podosporites amicus																x		x		x				
Podosporites sp. B																							x	x
Striatoabieites multistriatus																							x	x
Pretricolpipollenites spp.																							x	
Spores																								
Lophotriletes spp.	x	x																						
Kraeuselisporites spp.		x				x			x			x	C	x		x								
Aratrisporites spp.				C									x			x					x			
Densoisporites nejburgii				x	x	x	x	x	x	x	x		C	C										
Densoisporites spp.				x	x	x	x	x	x	x	x	x	x	C										
Cyclogranisporites				x						x														
Lapposisporites spp.				x																				
Proprisporites pocockii					x									x										
Endosporites papillatus					x																			
Calamospora spp.								x	x															
Leiotriletes spp.									x	x	x	x	x											
Punctatasporites spp.											x	x	x	x										
Kraeuselisporites apiculatus													x	x	x									
Perotrilites spp.														x										
Leschikisporis aduncus																			x				x	
Striatella seebergensis																								x
Plankton and varia																								
Micrhystridium spp.	x		x	A	A	x	C	C	C	A	C	C	C	x		A	A	A		x	x	x	x	x
Tasmanites spp.	x		x	x	x	x									x	x	x	x	x	x	x	x	x	x
Veryhachium spp.	x	A		x	x				x	x														
Unellium spp.	x	x	x																					
Reinoddenium spp.		x																						
Scolecodont			x																					
Cymatiosphaera spp.				x											x	x	x	x	x		x			
Veryhachium sp. (large specimens, Staplin, 1978 pl. 3)				x	x				x	x	x	x	x							x				
Fungal remain type 1				x		x	x				x	x	A	A										
Reduviasporonites chalastus					x	x	x	x																
Tasmanites sp. (eroded thin wall)																x								
Composite Assemblage Zone	Kraeuseli			U.i	R. chalast.				(Maculatasp.)					Ns	(Pd)	J. punct			(A.sp)		(T.ob)		E.iliac	

LEGEND	
A	abundant
C	common
x	present
R	reworked

(Maculatasp.) = A composite assemblage zone in brackets has a low level of confidence

A.8 Stensiöfjellet, Locality 12a, top Permian and Sassendalen Group.

Zone. In this section it ranges through lower Spathian deposits (8.0–12.8 and 26.0 to ca. 78 m), dated by the ammonoids of the *Bajarunia euomphala* and *Parasibirites grambergi* zones (Hounslow et al. 2008c).

The uppermost samples from the Vendomdalen Member (80.2–103.6 m) are characterised by *Filisphaeridium setasessitante* and large specimens of *Tasmanites*. The recognition of the *Jerseyiaspora punctispinosa* Composite Assemblage Zone, assigned to the late Spathian, agrees well with the presence of ammonoids known from the Siberian *Olenikites spiniplicatus* Subzone as described from the youngest Olenekian by Dagys and Weitschat (1993) and Dagys and Sobolev (1995).

Botneheia Formation
The lowest part of the Botneheia Formation, Locality 13a (106.5–108.0 m, Table A.9.1, MES), contains an association resembling that of the highest part of the Vendomdalen Member. However, the presence of material reworked from deposits of latest Permian to earliest Triassic age leaves the association with no stratigraphic value.

The approximately 130 m thick section of Locality 13b (Table A.9.2, Section ME) is well dated by ammonoids and contains palynological assemblages of fairly good, but strongly variable, preservation. In this locality, three-dimensionally preserved specimens show that mineralisation took place at an early diagenetic stage. The plankton allow a threefold subdivision of this interval that is based on environmental variation.

The lowest interval (1.7–53.0 m, Table A.9.2) is dominated by *Filisphaeridium* spp., *Micrhystridium* spp., *Cymatiosphaera* spp., *Tasmanites* spp. and *Veryhachium* spp.

Palynology of the interval between 1.7–5.0 m allows assignment to the *Anapiculatisporites spiniger* Composite Assemblage Zone and for the interval 11.5–53.0 m to the *Triadispora obscura* Composite Assemblage Zone. The latter comprises the stratigraphically highest record of *J. punctispinosa*. The ammonoids *Grambergia*, recorded in Locality 13b (1.7–30.0 m) and *Karangatites evolutus* in a nearby section at Wallenbergfjellet date these deposits to the early Anisian (*Grambergia taimyrensis* Zone) (Dagys and Weitschat 1993, Hounslow et al. 2008b).

The middle interval (61.0–94.5 m) contains *Micrhystridium*, *Tasmanites* and large specimens of *Veryhachium*, the latter replacing the *Filisphaeridium* group. There is no palynostratigraphic evidence for the lower part of this interval (61.0–81.5 m); however, the deposits are dated by ammonoids (about 48.0–78.0 m) to the middle Anisian *Anagymnotoceras varium* Zone. The palynological assemblage of the interval from 85.5–94.5 m is assigned to the late Anisian *Protodiploxypinus decus* Composite Assemblage Zone. It is dated by the co-occurring ammonoids of the *Frechites laqueatus* Zone at about 92.0 m. The interval between 85.5 and 94.5 m is characterised by fragmented, degraded and mostly indeterminate organic remains that may appear as coherent sheets.

The lower part (110.0.5–112.7 m) of the highest interval of the Botneheia Formation in Section ME (105.5–127.6 m) contains particularly abundant large tasmanitids. The overlying deposits contain a palynological association representing the *Echinitosporites iliacoides* Composite Assemblage Zone. An *Acristoptychites euglypheus* fauna dates the interval from 105.5 to 110.0 m to the Ladinian (Hounslow et al. 2007b).

The transition from the Sassendalen to Kapp Toscana groups in Locality 13c
Three sample levels represent the top of the Botneheia Formation (3.2, 8.0 and 16.0 m, Table A.9.2). The association is dominated by bisaccate pollen and identified as belonging to the *Echinitosporites iliacoides* Composite Assemblage Zone. The single sample (18.0 m) representing the Tschermakfjellet Formation contains only rare age-diagnostic palynomorphs. It is completely dominated by pollen and has a plankton association resembling that of the Botneheia Formation, but with less common large sized *Tasmanites*.

A.4.4 Dalsnuten

The mountain of Dalsnuten is located on the southwestern side of Vendomdalen (Locality 14, Figure 17). Ten samples from deposits of the Kapp Toscana Group were studied (Table A.10). The magnetostratigraphy and biostratigraphy of this section were discussed by Hounslow et al. (2007a), who concluded that the upper Ladinian was missing below thick lower Carnian deposits.

Sassendalen Group
Botneheia Formation
The only investigated sample (level 273.0 m) from the upper part of the formation contains a poorly preserved assemblage of predominantly indeterminate bisaccate pollen and spores. Of note is the abundance of smooth trilete spores, and common *Leschikisporis aduncus* that also are encountered in the assemblages of the overlying formation. The association is assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Kapp Toscana Group
Tschermakfjellet Formation
Samples from the Tschermakfjellet Formation (Table A.10, 280.7–292.4 m) at Dalsnuten contain predominantly degraded, finely dispersed organic

CENTRAL SPITSBERGEN

MILNE EDWARDSFJELLET	SASSENDALEN GROUP Locality 13a (MES)																
Lithostratigraphy	Vikinghøgda Formation															Bot	
	Lus.	Vendomdalen Member															
Age	E.Triassic															M.Tr.	
	Ind.	Olenekian														Anis.	
	Smi.	Spathian										lt Spathian				e.An.	
Pollen / Height in section	3,0	8,0	12,8	20,5	29,0	35,0	39,0	45,0	55,0	63,0	70,2	80,2	88,9	97,0	103,6	106,5	108,0
Bisaccate pollen (indeterminate)	x	x	D	D	A	A	x	D	D	D	D	A	A	A	x	x	A
Cycadopites spp.	x	x	D	A	A	A	A	C	x	x		C	C	x			x
Lunatisporites spp.	x	x	x	A	x	C	A	D	D	x	C	A	C	A			C
Pretricolpipollenites spp.		C	x	A	A		C		C			x		x			
Striatoabieites spp.											x					x	x
Lueckisporites junior												x					x
Voltziaceaesporites heteromorpha														C			x
Nuskoisporites spp.																	R
Vittatina spp.																	R
Araucariacites spp.																	x
Lunatisporites noviaulensis																	
Striatoabieites multistriatus																	
Protohaploxypinus spp.																	
Bharadwajispora labichensis																	
Lunatisporites acutus																	
Angustisulcites klausii																	
Triadispora spp.																	
Angustisulcites grandis																	
Illinites chitonoides																	
Accinctisporites circumdatus																	
Cordaitina minor																	
Cordaitina gunyalensis																	
Striatoabieites balmei																	
Duplicisporites granulatus																	
Eucommiidites major																	
Araucariacites australis																	
Podosporites spp.																	
Protodiploxypinus spp.																	
Alisporites spp. (large specimen)																	
Schizaeoisporites worsleyi																	
Protodiploxypinus doubingeri																	
Triadispora obscura																	
Kuglerina meieri																	
Ephedripites spp.																	
Vitreisporites pallidus																	
Chasmatosporites sp. A																	
Triadispora verrucata																	
Protodiploxypinus decus																	
Ovalipollis pseudoalatus																	
Staurosaccites quadrifidus																	
Protodiploxypinus gracilis																	
Podosporites amicus																	
Protodiploxypinus minor																	
Protodiploxypinus ornatus																	
Retisulcites perforatus																	
Eucommiidites microgranulatus																	
Chasmatosporites apertus																	
Eucommiidites minor																	
Protodiploxypinus macroverrucosus																	
Spores																	
Densoisporites nejburgii	A	A	A	x	C	C	C	C	A	A	C	A	A				x
Cavate spores (indeterminate)	A	A	A	A	A	A	D	A	A	A	C	A	C				x
Lundbladispora spp	x	x	x	x	C												x
Punctatisporites spp.	A	C	x	x													
Kraeuselisporites spp.	x	x	x														
Punctatisporites fungosus	x	x															
Kraeuselisporites punctatus			x														
Gordonispora fossulata				x	x	x	x		x	x		C		C			x
Kraeuselisporites apiculatus						x	x										
Aratrisporites spp.							x										
Retusotriletes spp.												x					
Jerseyiaspora punctispinosa												x					
Verrucosisporites spp.														x			
Cyclotriletes spp.														x			x
Deltoidospora australis																	x
Cyclotriletes pustulatus																	x
Eresinia spinellata																	
Nevesisporites limulatus																	
Anapiculatisporites spp.																	
Todisporites spp.																	
Rewanispora foveolata																	
Conbaculatisporites hopensis																	
Semiretisporis sp. A *(barentzii)*																	
Striatella seebergensis																	
Camarozonosporites laevigatus																	
Deltoidospora minor																	
Aratrisporites paenulatus																	
Kyrtomisporis spp.																	
Annulispora folliculosa																	
Staplinisporites caminus																	
Plankton and varia																	
Tasmanitid	x	x	C	x	C	A	A	D	D	A	D	x		x			
Fungal remain type 1	C	x	x	x	x	x	x	x	C	C	x	x		x			
Leiosphere	x	x	C	x	C	A	A	A	A	A	A						
Micrhystridium spp.			C	D	D	D	D	D	D	D	D	D	D	D	C	D	D
Tasmanites spp.			x									A	A	A	C	C	
Cymatiosphaera spp.						x		x									C
Filisphaeridium setasessitante												C	x	C			
Tasmanites sp. (large specimen)												C		C			
Pterospermella spp.													x				x
Veryhachium spp.																	A
Cymatiosphaera sp. (large specimen)																	C
Veryhachium ellesmerense																	x
Micrhystridium spp. (thickwalled spherical)																	
Tyttodiscus spp.																	
Micrhystridium spp. (large specimen)																	
Dictyotidium tenuiornatum																	
Veryhachium sp. (large specimen)																	
Pterospermella sp. (large specimen)																	
Composite Assemblage Zone	N.st	Pechorosporites disertus										J.punctispin.				(A.sp.)	

LEGEND
D dominant
A abundant
C common
x present
R reworked

(A.sp.) = A composite assemblage zone in brackets has a low level of confidence

A.9.1 Milne Edwardsfjellet, Locality 13a, Sassendalen Group.

CENTRAL SPITSBERGEN

M. EDWARDSFJELLET	SASSENDALEN GROUP Locality 13b (ME)																										SASS Loc.13c (MEE)			KT
Lithostratigraphy	Botneheia Formation																										Botne.			Tsch
Age	Anisian																		Ladinian								Ladin			C
	early		middle									late								early		Ladinian									
Pollen / Height in section	1.7	5.0	11.5	15.3	21.5	26.8	31.0	37.0	40.0	44.0	53.0	61.0	65.5	71.2	77.2	81.5	85.5	91.0	94.5	105.5	110.0	112.7	114.0	118.6	122.3	124.5	127.6	3.2	8.0	16.0	18.0
Bisaccate pollen (indeterminate)	A	D	D	D	A	D	A	D	D	D	C	D	D	D	D	D	D	D	D	D	D	A	A	D	D	D	x	D	D	D	D
Cycadopites spp.	x		x	o	x	x		x	x	x	A			x	x		x	x	x		C			x				x	x	x	x
Lunatisporites spp.	D	D	A	A	A	D	D	A	A	A	A				x			x	x					x			x				x
Pretricolpipollenites spp.				x	x							x					x						x	x			x				
Striatoabieites spp.									A	D	D	x		C	x		A		x	x	x		x	x	x	x					
Lueckisporites junior									x		x																				
Voltziaceaesporites heteromorpha	x			A		x				x	x	x	x	x	C							x	C	x		x			x		C
Nuskoisporites spp.																															
Vittatina spp.																															
Araucariacites spp.							x	x	x	x																		x		x	x
Lunatisporites noviaulensis	x									x																		x	x		x
Striatoabieites multistriatus	A	A	x	C	A					x		x		x	x		A	x		x	x		x	x				C	x	x	C
Protohaploxypinus spp.	x			x	x			x																							
Bharadwajispora labichensis	x			C	x																										
Lunatisporites acutus	x																														
Angustisulcites klausii			x	x				x			x												x	x			x		x		
Triadispora spp.			A					C	A	x	D				x												x				
Angustisulcites grandis			x																		x		x	x		x					
Illinites chitonoides				C	C			A	A	A	D	C	C	x	C				x		x		x	x	x	x					
Accinctisporites circumdatus				x	C																	x	x	x							
Cordaitina minor				x	x	x			x		A												x								
Cordaitina gunyalensis						x	x	x																							
Striatoabieites balmei								x																				x	x		C
Duplicisporites granulatus									x	x	A													x							x
Eucommiidites major									x	x	x			x	x															x	x
Araucariacites australis									x	x																					
Podosporites spp.										x	D											x		x							
Protodiploxypinus spp.										x	x							x													
Alisporites spp. (large specimen)										x	A																				
Schizaeoisporites worsleyi										x																					x
Protodiploxypinus doubingeri											x	x		x					x	x	x		x	x							
Triadispora obscura											x	x			x		x				x	x	x	x							
Kuglerina meieri											x																				
Ephedripites spp.											x																				
Vitreisporites pallidus												x	x	x	x								x	x							
Chasmatosporites sp. A																	x													x	x
Triadispora verrucata																	x							x				x	x		x
Protodiploxypinus decus																						x					x				
Ovalipollis pseudoalatus																							C	x				x	x	C	C
Staurosaccites quadrifidus																							x	x			x	x		x	
Protodiploxypinus gracilis																							x								
Podosporites amicus																												x	x	x	x
Protodiploxypinus minor																												x			x
Protodiploxypinus ornatus																												x			x
Retisulcites perforatus																												x			
Eucommiidites microgranulatus																														x	x
Chasmatosporites apertus																															x
Eucommiidites minor																															x
Protodiploxypinus macroverrucosus																															x
Spores																															
Densoisporites nejburgii	x		x	x								R	R	R																	
Cavate spores (indeterminate)	x	x	x	x								R																			
Lundbladispora spp																															
Punctatisporites spp.																															
Kraeuselisporites spp.																															
Punctatisporites fungosus																															
Kraeuselisporites punctatus				x														x													
Gordonispora fossulata				C	C	x	x	x	x	x																					
Kraeuselisporites apiculatus	x	x							x	x								x													
Aratrisporites spp.				x	x							x		x	x	x		A	x	C	C		x	x		x					
Retusotriletes spp.															x	x															
Jerseyiaspora punctispinosa											x																				
Verrucosisporites spp.							x	x																							
Cyclotriletes spp.																															
Deltoidospora australis										x																		x			
Cyclotriletes pustulatus				x				x			x																				
Eresinia spinellata			x	x				x	x	x																					
Nevesisporites limulatus				x	x	x				x																					
Anapiculatisporites spp.				x	x																										
Todisporites spp.				x	x																										
Rewanispora foveolata						x																									
Conbaculatisporites hopensis							x																								
Semiretisporis sp. A *(barentzii)*								x	C	x	x							x													
Striatella seebergensis									x	x	x																				
Camarozonosporites laevigatus									x	x																					
Deltoidospora minor										x	x																	x	x		
Aratrisporites paenulatus											x																				
Kyrtomisporis spp.																								x							
Annulispora folliculosa																												x			x
Staplinisporites caminus																														x	C
Plankton and varia																															
Tasmanitid	x	x		C	A	C	A	C									C			D	D	A	x	x	x	x	A				
Fungal remain type 1																															
Leiosphere																															
Micrhystridium spp.	x	x	x	x								D	A	A	D	D	D	D	D	D	D	D	D	A	A	C	D	A	A		x
Tasmanites spp.	C		C		x	x	A	x	A		D	x	C	C	D	A	x	x	A	x		x						A	A	A	C
Cymatiosphaera spp.	x	C	x	x	x	x	x	x			x	x			C			x			x		x	x			C				
Filisphaeridium setasessitante	x	A	x	x	A	D	A	D	A	D	C			x	x		A											x	x		x
Tasmanites sp. (large specimen)																					x	A						C	C		x
Pterospermella spp.								x		x																					
Veryhachium spp.	x								x	D	A																			x	x
Cymatiosphaera sp. (large specimen)															x			x			x										
Veryhachium ellesmerense	x				A													A													
Micrhystridium spp. (thickw. spherical)	D	A	A	A	D	D	D	D	D	D	D					x		x													
Tyttodiscus spp.						x				x	C																				
Micrhystridium spp. (large specimen)								A																							
Dictyotidium tenuiornatum											x																				
Veryhachium sp. (large specimen)												x	x	x		x		x	x				x	x	x	x	D				
Pterospermella sp. (large specimen)																		x			x										
Composite Assemblage Zone	A. sp.		Triadispora obscura									(P. decus)					P. decus			(E.il)		Echinitosp. iliacoides						E.iliac.			indet.

LEGEND
- D dominant
- A abundant
- C common
- x present
- R reworked

(P. decus) = A composite assemblage zone in brackets has a low level of confidence remains, as well as some fragmented cuticles and wood remains. Pollen and spores show modest to good preservation. Up-section there is an increase in diversity of pollen and spore taxa. The assemblage is identified as the *Aulisporites astigmosus* Composite Assemblage Zone. The plankton include *Micrhystridium* spp. (dominant), *Veryhachium* spp., *Cymatiosphaera* spp. and tasmanitids.

De Geerdalen Formation

The palynofloras from lower parts of the formation (Table A.10, 326.2–489.1 m) show a high diversity of spores and pollen. Bisaccates, particularly *Protodiploxypinus* spp. seem of reduced diversity and acritarchs are subordinate. The association of abundant *A. astigmosus*, *L. aduncus* and predominantly smooth trilete spores (Table A.22.2) is characteristic for the *Aulisporites astigmosus* Composite Assemblage Zone and is connected with Carnian samples from, or neighbouring, coal beds.

The lower part (520.5–530.6 m) of the Isfjorden Member contains assemblages reflecting *Aulisporites* vegetation. Plankton are well represented and include marine acritarchs (*Micrhystridium* spp., *Veryhachium* spp.) and green algae (*Cymatiosphaera* sp., *Dictyotidium tenuiornatum* and *Psophosphaera*) as well as fresh and brackish water forms (*Plaesiodictyon mosellanum* and *Botryococcus* spp.). The presence of a coal bed at about 521 m confirms changing marine and terrestrial conditions for this part of the succession. The highest sample contains a single specimen of *Echinitosporites iliacoides*, which has no record below in this section and is very rare on Spitsbergen.

Assemblages from the uppermost part of the Isfjorden Member (538.2–599.0 m) are of extremely low diversity and have little stratigraphic value. It should be noted that marine plankton are rare, in contrast to the association from the De Geerdalen Formation at Festningen, where dinoflagellate cysts appear commonly in the uppermost parts of the Isfjorden Member. At some sample levels, pollen and spores have grooves and holes in their walls, reflecting precipitation of pyrite and formation of crystals.

Wilhelmøya Subgroup

Flatsalen Formation

The uppermost samples in this section (605.1–613.0 m, Table A.10) represent the lowest part of the Wilhelmøya Subgroup. The organic residues are palynologically barren, apart from the content of brightly coloured small *Botryococcus* colonies (4–8 cells) and fungal spores, both considered as representing contaminants in the sampled sediments.

CENTRAL SPITSBERGEN

DALSNUTEN Locality 14 (DA)	SA.	KAPP TOSCANA GP											Wil.	
Lithostratigraphy	Bot.	Tsch.		De Geerdalen Fm									Flats	
							Isfjord. Mb							
Age	Lad	Carnian									Carn/Nor			
Pollen / Height in section	273,0	280,7	292,4	326,2	417,0	489,1	520,5	©	521,5	530,6	538,2	599,0	605,1	613,0
Bisaccate pollen (indeterminate)	D	x	x	A	A	A	A		x		x	C		
Chasmatosporites magnolioides	x	x	x	x	x	x	x		x	D		x		
Aulisporites astigmosus	x	D		x	x	A			x	x				
Cycadopites spp.	x	x	x	x	x	x	C		C	x				
Illinites chitonoides	x	x	x	x	x	x	x		x	x				
Ovalipollis pseudoalatus	A	A	C	x	x		C		D	x				
Alisporites spp. (large specimens)	x	x	x	x			x		x					
Lunatisporites noviaulensis	C	x	x	x	x		x		x					
Podosporites amicus	x	x	x		x				x					
Protodiploxypinus microsaccus	x	x	x		x	x	x		x					
Striatoabieites multistriatus	C	x	x		x	x	C		x					
Triadispora spp.	A	A	x		x	x	A		A					
Voltziaceaesporites heteromorpha	x	x	x	x	x				A					
Chasmatosporites apertus	x	x					x							
Bharadwajispora labichensis	x													
Araucariacites australis		x		x	x	A	x		x	x				
Brachysaccus spp.		x	x	x	x		x			x				
Concentrisporites hallei		x	x		x	x	x		C	x				
Eucommiidites microgranulatus		x	x						A	x				
Eucommiidites minor		x		x	x				x	x				
Protodiploxypinus ornatus		x	x		x				x	C				
Triadispora obscura		x	x		x		x		x	x				
Angustisulcites klausii		x	x				x		x					
Podosporites spp.		x	x	x	x		x		x					
Protodiploxypinus gracilis		x	A		x	x			x					
Protodiploxypinus macroverrucosus		x	x						C					
Protodiploxypinus minor		x					x		C					
Retisulcites spp.		x					x		x					
Triadispora verrucata		C	x						x					
Concentrisporites pseudosulcatus		x				x	x							
Prepollen (indeterminate)		x	x											
Protodiploxypinus decus		x	x											
Staurosaccites quadrifidus		x	x											
Concentrisporites spp.		x												
Instisporites crispus		x												
Vitreisporites pallidus			x			A			x					
Cordaitina minor			C			x	x							
Schizaeoisporites worsleyi				x	x	x	x		x		x			
Infernopollenites spp.				x	x		x		x					
Kuglerina meieri							x							
Vallasporites spp.									x					
Echinitosporites iliacoides										x				
Spores								©					b	
Deltoidospora australis	x	C	A	x	x		x			x	x	x		
Deltoidospora minor	C	A	D	A	A	x	C		C	A	x	x		
Dictyophyllidites mortoni	C	A	x	C	C	C	C		A	A	x	D		
Aratrisporites macrocavatus	x	x	x	x			x		A	x	C			
Aratrisporites paenulatus	x	C	x								C			
Camarozonosporites laevigatus	x			x	x		x		x	x				
Dictyophyllidites harrisii	C	C	x	x	x		x		x	D				
Kyrtomisporis laevigatus	x	x	x	x					x	x				
Leschikisporis aduncus	C	A	A	x	C	x	C		C	D				
Striatella seebergensis	x	x	x	x	x	x	x		C	x				
Punctatisporites spp.	x	x		x										
Verrucosisporites spp.	x													
Anapiculatisporites spiniger		x	x	x	x		x		x	x				
Aratrisporites spp.		x	x	x	x	x	x			x				
Camarozonosporites rudis		x		x	x	x			x	A				
Gleicheniidites senonicus		x	x	x	x	x				x				
Kyrtomisporis spp.		x		x	C	x				x				
Calamospora spp.			C	x	x	x	x		x	x	x			
Polypodiisporites ipsviciensis			C	x	x	x	x		C	A	x			
Cingulizonates rhaeticus			x	x			x		x	x				
Uvaesporites argentaeformis			x	x		x				x				
Gordonispora fossulata			x	x	x		x		x					
Thomsonisporites undulatus			x		x									
Gordonispora lubrica			C											
Kraeuselisporites dentatus			x											
Baculatisporites comaumensis				x			x		x	x				
Annulispora folliculosa					x					x				
Kraeuselisporites spinosus					x	x	x			x				
Zebrasporites interscriptus					x					x				
Retusotriletes spp.					x				x					
Conbaculatisporites hopensis					x									
Kraeuselisporites cooksonae					x									
Neoraistrickia spp.						x								
Kraeuselisporites spp.							x		x	C	x			
Cyclotriletes pustulatus							x		x	x				
Todisporites minor							x		x	x				
Sellaspora foveorugulata							x		x					
Sellaspora rugoverrucata							x		x					
Perotrilites spp.									x	x				
Zebrasporites laevigatus									x					
Plankton and varia								©						
Micrhystridium spp.	A	D			x		A		A			x		
Cymatiosphaera spp.	C						x		D					
Veryhachium spp.	A	x		x	x		x		x					
Dictyotidium spp.		x	x	x										
Botryococcus spp.			x		x	x	x		A	x	x	x		
Tasmanitids			x				x							
Megaspore				x										
Plaesiodictyon mosellanum					x		x		D	x				
Psophosphaera spp.							x		x	C				
Dictyotidium tenuiornatum							x		A					
Fungal spores												C	C	C
Botryococcus spp. (contaminant)												C		D
Composite Assemblage Zone	E.i	Aulisporites astigmosus									indeterm.			

LEGEND
A abundant
C common
x present
R reworked
coal layer ©
barren sample b

◀ A.9.2 Milne Edwardsfjellet, localities 13b and c, Sassendalen Group.

A.10 Dalsnuten, Locality 14, Sassendalen and Kapp Toscana groups.

A.5 Eastern Spitsbergen

The study includes sections from the following four localities on eastern Spitsbergen: Klementievfjellet, Roslagenfjellet, Eistraryggen and Teistberget (Figure 17).

A.5.1 Klementievfjellet

The mountain of Klementievfjellet is located in eastern central Spitsbergen, on the southwestern side of Agardhdalen (Locality 15, Figure 17). Six samples were collected from this locality, representing the De Geerdalen Formation and the Wilhelmøya Subgroup (Table A.11).

Kapp Toscana Group
De Geerdalen Formation
Relatively rich and diverse palynofloras are recorded in samples from the lower part of the formation (0.0–92.0 m). The samples are characterised by alete bisaccate pollen, *Illinites chitonoides*, *Staurosaccites quadrifidus* and *Triadispora* spp., as well as diverse smooth spores, including abundant to dominant *Leschikisporis aduncus*. The latter taxon has its latest appearance within this part of the succession. *Corollina* spp. and *Microreticulatisporites fuscus* are recorded at 64.0 m. The green alga *Plaesiodictyon* spp., reflecting freshwater influence, co-occurs with sporadic acritarchs indicating marginal marine conditions.

The association is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.
The uppermost part of the De Geerdalen Formation (106.0–118.0 m) at this locality comprises samples that are almost barren of palynomorphs.

Wilhelmøya Subgroup, Flatsalen Formation
A diverse palynoflora of pollen and dominant spores characterises the lowest interval (133.0–140.0 m) that has been identified as the *Limbosporites lundbladii* Composite Assemblage Zone and assigned a Norian age. The freshwater green alga *Plaesiodictyon* spp. occurs in abundance.

At 157.0 m, the presence of species such as *Callialasporites dampieri* and *Uvaesporites argentaeformis* represent Jurassic evidence in deposits dominated by reworked Late Triassic pollen and spores (Table A.11). The interval of 170.0–173.9 m has no stratigraphic evidence. Similar mixed palynological assemblages have been recorded in the Tverrbekken Member at Festningen (Table A.1.2).

Agardhfjellet Formation
Upper Triassic reworked palynomorphs also dominate at 189.0 m, lowermost in the Agardhfjellet Formation. However, *Cerebropollenites thiergartii*, *Perinopollenites elatoides* and the dinocysts *Facetodinium faustum* represent evidence of late Early to Middle Jurassic age.

EASTERN SPITSBERGEN

KLEMENTIEVFJELLET Locality 15	KAPP TOSCANA GROUP															
											Wilh. Sgp					
Lithostratigraphy	De Geerdalen Fm										Flatsalen					Ag
Age	Carnian							Indet			Nor		Jurassic			
Heights above sea level	128.0	140.0	152.0	160.0	192.0	202.5	220.0	234.0	240.0	246.0	261.0	268.0	285.0	298.0	301.9	317.0
Pollen / Sample height in section	0.0 (x2)	12.0	14.0	32.0 (x2)	64.0	74.5	92.0	106.0	112.0	118.0	133.0	140.0	157.0	170.0	173.9	189.0
Bisaccate pollen (alete)	A	C	x	x	x	C	A			x	A	x	C	C		x
Protodiploxypinus spp.	x												R			R
Striatoabieites aytugii	x					x							R			R
Striatoabieites spp.	x				x	x						A	R			R
Protodiploxypinus spp.	x												R			R
Araucariacites spp.	x	x				x					C	x	x	x		
Ovalipollis pseudoalatus	x	x			x	x	x				x	x	R			
Protodiploxypinus ornatus	x						x						R			
Triadispora spp.	x	x	x		x	x	A				x	x				
Cordaitina / Heliosaccus	x				x	x				x		x				
Angustisulcites klausii	x						x									
Vallasporites ignacii	x															
Vitreisporites pallidus		x			x		x				x	x	x			x
Chasmatosporites spp.		C			x	x	x				x	x	x			x
Illinites chitonoides		x				x	x									
Cycadopites spp.					x		x				x	x	x			x
Corollina spp.					x							x	x			
Ricciisporites tuberculatus					x							x				
Schizaeoisporites worsleyi						x						x				
Podosporites amicus						x										
Angustisulcites grandis							x				x	x				
Lunatisporites spp.							x					x				
Staurosaccites quadrifidus							x									
Chasmatosporites magnolioides												x	x			x
Eucommiidites troedsonii													x			
Ricciisporites umbonatus												x				
Spores								b							b	
Aratrisporites spp.	x	C	x	x	x	x	x				x	x	R	R		R
Calamospora spp.	x	x	x	C	x	C	C				x	C	C			x
Concavisporites spp.	x	C	x	x	x	C	C				A	C	A			x
Punctatosporites spp.	x						x									x
Anapiculatisporites spp.	x	x					C				x			x		
Anapiculatisporites spiniger	x	x			x											
Kraeuselisporites spp.	x					x	x				x	x	x			
Uvaesporites gadensis	x											x				
Leschikisporis aduncus	C	C	x	D	D	x	A									
Apiculatisporis spp.		x			x	x	C				C	C	x			x
Deltoidospora spp.		x		x	x	x	C			x	C	C	A			x
Todisporites spp.		x		x	x	A	x				x	C	C			x
Conbaculatisporites spp.		x			x						x	x	x			
Striatella seebergensis		x		x		x	x				x	x	x			
Camarozonosporites rudis		x					x									
Microreticulatisporites fuscus					x								x			x
Velosporites spp.					x								R			
Leptolepidites spp.					x	x						x				
Aratrisporites laevigatus						x					x					R
Annulispora folliculosa						x	x					x	x			
Converrucosisporites spp.						x						x	x			
Uvaesporites spp.						x	x					x	x			
Lycopodiacidites spp.						x	x					x				
Nevesisporites vallatus						x	x				x	x				
Kyrtomisporis laevigatus						x	x									
Zebrasporites interscriptus						x										
Lycopodiumsporites spp.							x					x	x			
Polycingulatisporites spp.							x						x			
Conbaculatisporites mesozoicus							x				x					
Kraeuselisporites cooksonae							x									
Osmundacidites spp.							x									
Polypodiisporites spp.							x									
Kyrtomisporis speciosus											x		R			
Zebrasporites laevigatus											x		x			
Limbosporites lundbladii												x	R			
Gordonispora fossulata												x				
Densoisporites spp.												x				
Semiretisporis spp.												x				
Aratrisporites minimus													R			
Cingulizonates sp.													R			
Plankton and varia																
Plaesiodictyon spp	x				x	x						A	R			R
Micrhystridium spp.		x									x	x	C	x		A
Veryhachium spp.		x										x	C	x		
Cymatiosphaera spp.																x
Pterospermella spp.																x
Restricted Jurassic evidence																
Callialasporites dampieri													x			
Uvaesporites argentaeformis													x			
Dinocysts (indet. simple forms)														x		
Cerebropollenites thiergartii																x
Facetodinium faustum																x
Perinopollenites elatoides																x
Composite Assemblage Zone	A. astigmosus							Indet.			L.lu.		Jurassic			

LEGEND
D dominant
A abundant
C common
x present
R reworked
b barren sample

A.11 Klementievfjellet, Locality 15, Kapp Toscana Group.

A.5.2 Roslagenfjellet

The mountain of Roslagenfjellet is located in eastern central Spitsbergen, on the northeastern side of Agardhdalen (Locality 16, Figure 17).

Sassendalen Group
Vikinghøgda Formation
Strongly degraded material is recorded from four samples at Roslagenfjellet. Only sporadic fungal remains and a few long ranging and non-diagnostic acritarchs were recovered (10.0–67.0 m, Table A.12).

Botneheia Formation
The seven samples from the Botneheia Formation at Roslagenfjellet are dominated by poorly preserved amorphous organic material, mainly algal remains. The two assemblages from the Blanknuten Member (166.0–172.0 m, Table A.12) are better preserved and contain *Camerosporites secatus*, *Ovalipollis pseudoalatus*, *Nevesisporites vallatus* and *Triadispora verrucata*, together with abundant *Micrhystridium* spp., *Veryhachium* spp. and smooth indeterminate cysts. The listed taxa are recognised as evidence for the *Echinitosporites iliacoides* Composite Assemblage Zone and represent deposits of Ladinian to earliest Carnian age.

A.5.3 Eistraryggen

Eistraryggen is a mountain just southeast of Roslagenfjellet (Locality 17, Figure 17). Eleven samples (Table A.13, Plates 7–8) from the Tschermakfjellet and lower parts of the De Geerdalen formations have been collected by Wolfgang Weitschat.

EASTERN SPITSBERGEN

ROSLAGENFJELLET Locality 16	SASSENDALEN GROUP										
Lithostratigraphy	Vikingh				Botneheia Fm						
Age					Anis-Ladin					Lad	
Pollen / Height in metres	10.0	22.0	41.0	67.0	107.0	126,5	136.0	147.0	153.0	166.0	172.0
Bisaccate pollen (alete)										x	x
Camerosporites secatus										x	x
Ovalipollis pseudoalatus										x	x
Striatoabieites aytugii										x	x
Vitreisporites pallidus										x	x
Lunatisporites noviaulensis										x	
Triadispora verrucata										x	
Spores		b					b				
Trilete smooth spores					x					x	x
Nevesisporites vallatus										x	
Protohaploxypinus spp.										x	
Triadispora verrucata										x	
Concavisporites spp.											x
Plankton and varia		b					b				
Micrhystridium spp.	x			x						A	A
Smooth cysts (indeterminate)	x			x							x
Fungal remain (hyphae)	x									x	
Spherical cysts										x	x
Veryhachium spp.										x	
Composite Assemblage Zone	indeterminate									E.ili.	

LEGEND: D dominant; A abundant; C common; x present; (dotted) barren s. b

A.12 *Roslagenfjellet, Locality 16, Sassendalen Group.*

Kapp Toscana Group
Tschermakfjellet Formation
The finely dispersed organic residues are distinctly different from the dense aggregates recorded in samples from the Sassendalen Group in this area (localities 16 and 18). Samples 1–3 contain an association dominated by alete and taeniate bisaccate pollen and smooth spores. Plankton include *Cymatiosphaera* spp. and occasionally abundant *Micrhystridium* spp.

EASTERN SPITSBERGEN

EISTRARYGGEN	KAPP TOSCANA Gp										
Lithostratigraphy				Wilhelm. Sgp							
Locality 17 (*)	Tschermak			De Geer.Fm							
Age	Carn. ely			Carnian							
Pollen / sample numbers	1	2	3	4	5	6	7	8	9	10	11
Alete pollen (bisaccate)		A	C	C	C	x				A	
Angustisulcites spp.		x	x			x				x	
Araucariacites spp.		x	x	x	x	x				x	
Cycadopites spp.		x	x	x		x				x	
Illinites chitonoides		x	x							x	
Lunatisporites spp.		x	x	x						x	
Ovalipollis pseudoalatus		x	x			x				x	
Partitisporites spp.		C								x	
Podosporites spp.		x	x							x	
Porcellispora longdonensis		x								x	
Protodiploxypinus spp.		x	x							x	
Staurosaccites quadrifidus		x								x	
Striatoabieites spp.		x				x				C	
Triadispora spp.		C	x	C		x				x	
Triadispora verrucata		x	x	x						x	
Vitreisporites pallidus		x		x	x					x	
Enzonalasporites vigens			x	x		x				x	
Cordaitina spp.				x						x	
Ricciisporites spp.				x						x	
Vallasporites ignacii				x						x	
Ephedripites spp.										x	
Schizaeoisporites worsleyi										x	
Spores	b							b			b
Annulispora folliculosa		x	x	x		x				x	
Calamospora spp.		x	x	x	x	C				C	
Concavisporites spp.		C	A	C	C	A				C	
Deltoidospora spp.		C	C	C		x				x	
Leschikisporis aduncus		x	C	x						x	
Patinasporites densus		x								x	
Todisporites spp.		x	x	x		x				x	
Uvaesporites spp.		x	x		x	x				x	
Thymospora spp.		x	x		x	x					
Aratrisporites laevigatus		x									
Anapiculatisporites spp.			C	x	C	C				x	
Apiculatisporis spp.			C	C	x	C				x	
Aratrisporites spp.			x	x		x				x	
Densosporites spp.			x	x						x	
Kraeuselisporites spp.			x	x		x				x	
Nevesisporites vallatus			x		x	x					
Striatella seebergensis			x	x	x	x					
Conbaculatisporites spp.			x	x							
Leptolepidites spp.				x						x	
Lycopodiacidites spp.				x		x				x	
Polycingulatisporites spp.				x						x	
Lycopodiumsporites spp.				x		x				x	
Retusotriletes spp.				x						x	
Gordonispora lubrica				x		x					
Camarozonosporites rudis				x							
Converrucosisporites spp.				x							
Convolutispora spp.				x							
Neoraistrickia spp.				x							
Concavisporites spp.					x	x				x	
Zebrasporites interscriptus					x	x					
Punctatosporites spp.						x				x	
Thomsonisporites undulatus				b						x	
Plankton and varia / Sample levels (interpreted 1986)	192	202.5	220	246	261	268				285	317
Cymatiosphaera spp.		x	x							x	
Fungal remain		x	x			x				x	
Micrhystridium spp.		A	x	C						A	
Veryhachium spp.		x	x	x	x					A	
Foram lining		x									
Dictyotidium tenuiornatum										x	
Composite Assemblage Zone	Aulisporites astigmosus										

LEGEND: D dominant; A abundant; C common; x present; (dotted) barren s. b

(*) Correct heights are not available for this section (52 m high), W.Weitschat pers. comm.

A.13 *Eistraryggen, Locality 17, Kapp Toscana Group.*

De Geerdalen Formation
Only four of the eight samples studied (samples 4–6 and 10) were palynologically productive, containing associations richer in spores than the underlying formation. Bisaccates and smooth spores dominate. *Ricciisporites* spp. occurs together with diverse ornamented spores such as *Camarozonosporites rudis*, *Leptolepidites* spp., *Retitriletes* spp. and *Zebrasporites interscriptus*. Plankton are of low diversity but include occasionally abundant *Micrhystridium* spp. and *Veryhachium* spp. as well as sporadic *Cymatiosphaera* spp. The associations from both formations are interpreted to represent the *Aulisporites astigmosus* Composite Assemblage Zone. The common occurrence of taeniate bisaccate pollen is a feature typical of the lower part of this zone.

A.5.4 Teistberget

The mountain of Teistberget (Locality 18, Figure 17) is situated on the coast of Sabine Land north of Agardhfjellet. Twelve widely scattered samples (Table A.14, Plate 6) represent the Sassendalen and the Kapp Toscana groups.

Sassendalen Group
Vikinghøgda Formation
The only productive samples from the Vikinghøgda Formation (samples 1.0 and 23.0 m) contain an association of *Illinites chitonoides*, *Pretricolpipollenites* spp., *Densoisporites nejburgii* and *Gordonispora fossulata* that is identified as belonging to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone. The diverse plankton association includes *Crassosphaera* spp., *Cymatiosphaera* spp., *Micrhystridium* spp., *Pterospermella* spp., *Tasmanites* spp. and *Veryhachium* spp., reflecting a marine depositional environment.

Botneheia Formation
The only productive sample (78.0 m) from the lower interval (78.0–109.0 m) is dominated by marine plankton. The poorly diversified pollen association has no diagnostic value. The association in the upper interval (128.0–146.0 m) contains moderately preserved palynomorphs, dominantly pollen such as *Duplicisporites* spp., *I. chitonoides* and *Triadispora plicata*, with records of *E. iliacoides*, *Podosporites amicus* and *Staurosaccites quadrifidus* at the highest level. The interval is assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Kapp Toscana Group
Finely dispersed aggregated material embeds the palynomorphs, a state of preservation also seen in organic-rich deposits elsewhere on Spitsbergen.

Tschermakfjellet Formation
The only productive sample (157.0 m, Table A.14) has a dominant pollen association comprising *Araucariacites australis*, *Chasmatosporites magnolioides*, *Ovalipollis*

EASTERN SPITSBERGEN

TEISTBERGET Locality 18	SASSENDALEN GP								K.TOSC.			
Lithostratigraphy	Vikingh.			Botneh.Fm					Tsch.		DG.	
Age	Spath.			Anis.		Ladin.			Carnian			
Pollen / Height in section	1,0	23,0	47,0	78,0	109,0	128,0	129,0	146,0	157,0	170,0	210,0	236,0
Bisaccate pollen (indeterminate)	x	x				x	x	x	x			x
Illinites chitonoides	x	x				x	x	x				
Striatoabieites spp.	x	x				x		x				
Triadispora spp.	x	x				x	x	x				
Cycadopites spp.	x			x			x					
Lunatisporites noviaulensis	x	x				x	x					
Pretricolpipollenites spp.	x						x					
Bisaccate pollen (taeniate)	x	x		x								
Duplicisporites spp.						x	x					
Triadispora plicata							x	x				
Echinitosporites iliacoides								x				
Podosporites amicus								x				
Podosporites sp. B								x				
Staurosaccites quadrifidus								x	x			
Araucariacites australis									x			x
Chasmatosporites magnolioides									x			x
Ovalipollis pseudoalatus									x			x
Eucommiidites minor									x			
Infernopollenites sp.									x			
Podosporites sp.									x			
Protodiploxypinus ornatus									x			
Retisulcites spp.									x			
Ricciisporites tuberculatus									x			
Schizaeoisporites worsleyi												x
Spores			b		b					b		
Gordonispora fossulata	x	x										
Deltoidospora australis		x					x					
Eresinia spinellata		x				x						
Annulispora spp.		x										
Cavate spores (indeterminate)		x										
Densoisporites nejburgii		x										
Tigrisporites spp.		x										
Auritulinasporites triclavis									x			
Leschikisporis aduncus									x			
Lycopodiacidites spp.									x			
Cingulizonates rhaeticus												x
Kraeuselisporites reissingeri												x
Limbosporites lundbladii					b							x
Plankton and varia												
Tasmanites spp.	x			x			x	x				
Veryhachium spp.	x	x		x		x	x	x				
Crassosphaera spp.	x	x					x					
Cymatiosphaera sp.	x	x		x			x					
Micrhystridium spp.	x	x		x		x	x					
Micrhystridium sp. F	x	x		x			x					
Micrhystridium sp. (large)	x	x				x	x					
Pterospermella spp.	x	x		x								
Sentusidinium spp.									x			
Composite Assemblage Zone	J. puncti.			Indet.		E. iliac.			A.astigmosus			

LEGEND
x present
barren s.

A.14 Teistberget, Locality 18, Sassendalen and Kapp Toscana groups.

pseudoalatus, *Eucommiidites minor*, *Infernopollenites* sp., *Protodiploxypinus ornatus*, *Retisulcites* spp. and *Ricciisporites tuberculatus*. Spores include *Auritulinasporites triclavis* and *Leschikisporis aduncus*. The assemblage is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. The only plankton form recorded is a dinoflagellate cyst, *Sentusidinium* sp., representing an exceptionally early record of this genus.

De Geerdalen Formation
Two unproductive samples separate the interval from the underlying formation. The samples contain dominantly poorly preserved organic matter. The low-diversity association from 236.0 m contains no plankton, only some pollen already present in the Tschermakfjellet Formation and the spores *Cingulizonates rhaeticus*,

Kraeuselisporites reissingeri and *Limbosporites lundbladii* (Table A.14). The two first-mentioned spores are known from the Tschermakfjellet and the De Geerdalen formations elsewhere on Svalbard. *L. lundbladii* normally has its earliest records in the upper part of the De Geerdalen Formation. The association is correlated with the *Aulisporites astigmosus* Composite Assemblage Zone.

A.6 Barentsøya and Edgeøya

Studied localities on Barentsøya

Barentsøya, one of the larger islands in the Svalbard archipelago, is situated between Edgeøya and Spitsbergen. Sections from two localities were studied, one at the mountain of Lomberget near Willybreen on the eastern side of the island (Locality 19a and b) and the other at the mountain of Høgrinden (Locality 20) situated in the southern part of the island (Figure 17).

A.6.1 Lomberget

Sassendalen Group

Vikinghøgda and Botneheia Formation

The 10 samples from Locality 19a show a very low productivity of palynomorphs (Table A.15.1). The lower levels (32.01–82.01 m) contain only some bisaccate pollen, spherical bodies and *Micrhystridium* spp. Samples from the highest interval (96.1–154.5 m), representing the Botneheia Formation, are dominated by degraded amorphous organic matter with adhering, poorly preserved bisaccates and smooth trilete spores. The material was considered unsuitable for further palynological studies.

Kapp Toscana Group

The seven analysed samples from Locality 19b (Table A.15.2) contain moderately well-preserved palynomorphs.

Tschermakfjellet Formation

The palynological assemblage (192.0–254.0 m) comprises abundant alete and taeniate bisaccate pollen as well as *Triadispora* spp., together with common to abundant *Leschikisporis aduncus* and smooth trilete spores. Most of the taxa range up into the De Geerdalen Formation. Plankton include abundant *Micrhystridium* spp., scattered *Baltisphaeridium* spp. and *Tasmanites* spp. Occasional megaspore fragments indicate that the marine depositional environment was located relatively close to vegetation. The association is correlated with the *Aulisporites astigmosus* Composite Assemblage Zone.

BARENTSØYA

LOMBERGET Locality 19a	SASSENDALEN GROUP									
Lithostratigraphy	Vikinghøgda				Botneheia Fm					
Age										
Pollen and spores / Height in section	32.01	46.01	65.01	82.01	96.01	107.5	127.01	135.01	148.01	154.01
Bisaccate pollen (alete)	x				x	x		x	x	
cf. *Chasmatosporites* spp.										x
Trilete smooth spores (indeterminate)					x	x				
Plankton and varia		b					b			
Micrhystridium spp.	x		x							
Minute spherical bodies	x		x	x						
Composite Assemblage Zone	Indeterminate									

A.15.1 Lomberget, Locality 19a, Sassendalen Group.

BARENTSØYA

LOMBERGET WILLYBREEN Locality 19b	KAPP TOSCANA GP						
Lithostratigraphy	Tscherm.			De Geer. Fm.			
Age	Carnian						
Pollen / Height in section	192,0	210,0	254,0	348,0	427,0	440,0	458,0
Angustisulcites spp.	x						x
Bisaccate pollen (alete)	A	C	C	C	C	x	C
Cycadopites spp.	C	x	x		x	x	x
Lunatisporites spp.	C	C			x		x
Ovalipollis pseudoalatus	x		x	x	x		x
Partitisporites spp.	x		x				x
Patinasporites densus	x						x
Protodiploxypinus spp.	x						x
Staurosaccites quadrifidus	x				x		x
Striatoabieites spp.	x	C	x	x			x
Triadispora spp.	C	C	C	x	x		x
Chasmatosporites spp.	x		x	x	x		
Cordaitina spp.	x			x	x		
Vitreisporites pallidus	x				x		
Podosporites spp.	x						
Araucariacites spp.			x	C	C		C
Ephedripites spp.			x				
Retisulcites spp.			x				
Eucommiidites spp.				x			
Camerosporites secatus							x
Spores							
Apiculatisporis spp.	x	x	C	C	x		x
Aratrisporites spp.	x	x	C	C	C		x
Calamospora spp.	x	x	C	A	C		C
Conbaculatisporites spp.	x				x		x
Concavisporites spp.	A	C	C	C	C		C
Cosmosporites elegans	x						x
Deltoidospora spp.	C		x	x			x
Kraeuselisporites spp.	x	x	x	C	x		C
Todisporites spp.	C		x	C	x	x	x
Leschikisporis aduncus		x	C	C	C	C	x
Gordonispora fossulata		x		x			
Aratrisporites laevigatus		x					
Anapiculatisporites spp.			x	x	x		x
Camarozonosporites rudis			x	x			x
Lycopodiacidites spp.			x	x			x
Polycingulatisporites spp.			x	x			
Thomsonisporites undulatus			x	x			
Verrucosisporites spp.			x	x			
Striatella seebergensis				C			x
Uvaesporites spp.				x			x
Camarozonosporites laevigatus				x			
Converrucosisporites spp.				x			
Nevesisporites vallatus				x			
Polypodiisporites spp.					x		x
Densosporites spp.					x		
Punctatosporites spp.							x
Zebrasporites interscriptus							x
Plankton and varia							
Micrhystridium spp.	A	C		x			x
Baltisphaeridium spp.	x			x			
Tasmanites spp.		x					
Megaspore			x				
Botryococcus spp.							x
Dictyotidium spp.							x
Composite Assemblage Zone	Aulisporites astigmosus						

LEGEND
D dominant
A abundant
C common
x present

A.15.2 Lomberget/Willybreen, Locality 19b, Kapp Toscana Group.

De Geerdalen Formation
The samples are richer in organic material than those of the Tschermakfjellet Formation. The associations, as those below, are interpreted to belong to the *Aulisporites astigmosus* Composite Assemblage Zone. Here, they are rich in *Aratrisporites* spp. The marine plankton occur only sporadically.

The assemblages from the De Geerdalen Formation at Lomberget, Dalsnuten (Table A.10) and Eistraryggen (Table A.13) are distinguished from those of Tschermakfjellet by their greater diversity of ornamented spores.

A.6.2 Høgrinden

The moutain of Høgrinden (Locality 20, Figure 17) is situated in southern Barentsøya. Eighteen samples were studied from the Sassendalen Group and two samples from the lowermost part of the Kapp Toscana Group (Table A.16, Plates 3–4, 6).

Sassendalen Group
Vikinghøgda Formation, Lusitaniadalen Member
The assemblages recorded are of low diversity. Bisaccate pollen and cavate spores dominate. At 15.0 m 'Fungal remain type 1' of Hochuli et al. (1989) has an abundance peak. At 8.0 m there are regular to abundant *Tasmanites* spp., *Micrhystridium* spp. and *Veryhachium* spp. The association is identified as belonging to the *Naumovaspora striata* Composite Assemblage Zone.

Vikinghøgda Formation, Vendomdalen Member
Assemblages with abundant bisaccate pollen and a dominance of plankton characterise this member. Marine plankton include *Cymatiosphaera* spp., *Micrhystridium* spp., *Pterospermella* spp., *Solisphaeridium* spp. and *Tasmanites* spp. The lower interval (Table A.16) is tentatively assigned to the *Pechorosporites disertus* Composite Assemblage Zone. The stratigraphically diagnostic pollen *Accinctisporites circumdatus* and *Illinites chitonoides* and the spores *J. punctispinosa* and *Striatella seebergensis* allow identification of the *Jerseyiaspora punctispinosa* Composite Assemblage Zone and support a late Spathian age for the interval 82.0–113.0 m.

Botneheia Formation
The samples from this formation (125.0–200.0 m) contain palynomorphs embedded in degraded AOM. Most dominant forms continue from the Vendomdalen Member up through the lower part of the Botneheia Formation (125.0–167.0 m). The interval is particularly rich in taeniate pollen. The age diagnostic pollen *Pretricolpipollenites* spp. and *Staurosaccites quadrifidus* and spores such as *Anapiculatisporites spiniger*, *Uvaesporites gadensis* and *Sellaspora rugoverrucata* allow recognition of the *Anapiculatisporites spiniger* Composite Assemblage Zone.

Samples from the upper beds (178.0–200.0 m) contain a low-diversity association of rare and poorly preserved bisaccate pollen and *Micrhystridium* spp. Only the uppermost sample (200.0 m) containing *E. iliacoides*, *Protodiploxypinus* minor and *P. ornatus* confirms the identification of the *Echinitosporites iliacoides* Composite Assemblage Zone.

Kapp Toscana Group
Tschermakfjellet Formation
Alete and taeniate bisaccate pollen and smooth spores dominate the residues from the lowermost Tschermakfjellet Formation (208.0 and 227.0 m) at Høgrinden (Table A.16). The diverse palynoflora is correlated with confidence to the *Aulisporites astigmosus* Composite Assemblage Zone. Diverse plankton include common *Micrhystridium* spp. and *Solisphaeridium* spp. and occasionally the dinocyst recorded as *Sentusidinium* sp. A. The freshwater plankton taxon *Plaesiodictyon* spp., recorded at 208.0 m, has regular records in the uppermost Botneheia Formation and the lowermost Kapp Toscana Group on Svalbard.

Studied localities on Edgeøya

Edgeøya is situated in the southeastern part of the Svalbard archipelago and is the third largest island. The five localities Skrukkefjellet, Blanknuten, Årdalsknuten, Vogelfjellet and Negerfjellet (Figure 17) were sampled for palynology and all were useful for palynological studies.

A.6.3 Skrukkefjellet

The mountain of Skrukkefjellet is located on the northern shores of Edgeøya facing Freemansundet (Locality 21, Figure 17). Seventeen samples were studied from the Sassendalen Group and one from the base of the Kapp Toscana Group (Table A.17, Plates 3–6).

Sassendalen Group
The organic material in the samples from the Sassendalen Group varies, but is generally poorly preserved.

Vikinghøgda Formation; Lusitaniadalen and Vendomdalen members
In this section through the Vikinghøgda Formation (5.0–66.0 m, Table A.17), assemblages are dominated by taeniate and alete bisaccate pollen as well as cavate spores. The plankton *Micrhystridium* spp., *Veryhachium* spp.and *Tasmanites* spp. occur in abundance, but 'Fungal remain type 1' of Hochuli et al. (1989) has only scattered appearances. The evidence for the lowest part (5.0–16.0 m) supports assignment to the *Naumovaspora striata* Composite Assemblage Zone and the middle part (37.0–57.0 m) to the *Pechorosporites disertus* Composite Assemblage Zone. The uppermost sample (66.0 m)

BARENTSØYA

HØGRINDEN Locality 20	SASSENDALEN GROUP																		K.TOS.	
Lithostratigraphy	Vikinghøgda Formation										Botneheia Fm								Tsch.	
	Lusitaniadalen					Vendomdalen									Blanknuten					
Age	Olenekian										Anisian				Ladinian				Carn.	
	Smithian					Spathian			L.Spath.											
Pollen / Height in section	2.0	8.0	15.0	22.0	32.0	44.0	55.0	61.0	82.0	92.0	113.0	125.0	143.0	155.0	167.0	178.0	185.0	200.0	208.0	227.0
Bisaccate pollen (indeterminate)	x	A	x	x	C	x	C	C	C	A	C	A	A	x	A	C	A	A	x	D
Vitreisporites pallidus	C	x	C									x							x	
Striatoabieites spp.	x	C	x	x	x	x	x	x	x	C	x	A	A	C	C					
Lunatisporites noviaulensis		x				x	C	C	C	x	x	x	x		x				C	x
Cycadopites spp.		x			x	x	x	C	C	x	x	x	x							x
Lunatisporites pellucidus						x	x	C	C			x	x							
Striatoabieites aytugii								x	x	C	x	C	x	x	x					C
Bharadwajispora labichensis								A		x			A							
Accinctisporites circumdatus									x											
Illinites chitonoides										x		x	x	x						
Platysaccus papilionis											x									
Triadispora aurea												x								
Podosporites amicus												x			x				x	
Staurosaccites quadrifidus													x						x	x
Pretricolpipollenites spp.													x	x	x					
Ephedripites spp.													x	x	x					
Perotrilites minor													C	x						
Falcisporites spp.													x							
Smooth pollen (alete)														x						
Protodiploxypinus minor																		x	A	
Protodiploxypinus ornatus																		x	A	
Echinitosporites iliacoides																		x		
Ovalipollis pseudoalatus																			x	x
Patinasporites densus																			C	x
Protodiploxypinus gracilis																			x	C
Pseudenzonalasporites summus																			x	x
Eucommiidites spp.																			x	
Protodiploxypinus macroverrucosus																			A	
Ricciisporites sp.																			x	
Schizaeoisporites worsleyi																			x	
Triadispora plicata																			x	
Triadispora verrucata																			C	
Camerosporites secatus																				x
Triadispora spp.																				C
Vallasporites ignacii																				x
Spores																				
Nevesisporites vallatus	C	x						x		x		x	x	C						
Densoisporites nejburgii	A	x	C		C	x				x	x		x	x						
Kraeuselisporites apiculatus	x											x	x							
Rewanispora spp.	x																			
Anapiculatisporites spp.		x												x	x				x	
Gordonispora fossulata		C				x	x	C	C	C		x		x						
Lundbladispora spp.		x				x						x								
Verrucosisporites spp.		x						x	x		x									
Polycingulatisporites spp.		x																		
Uvaesporites spp.		x																		
Aratrisporites spp.					x								x							x
Deltoidospora minor								x			x								x	C
Striatella seebergensis									x	x										
Baculatisporites spp.									x											
Jerseyiaspora punctispinosa									x											
Apiculatisporis spp.												x	x							
Anapiculatisporites spiniger												x							x	x
Uvaesporites gadensis													x		x					
Lycopodiacidites kokenii													x							
Sellasporites rugoverrucata													x							
Trilete spore (indeterminate)													x							
Triplexisporites playfordii													x							
Annulispora folliculosa																			x	x
Enzonalasporites spp.																			x	x
Kyrtomisporis laevigatus																			x	x
Aratrisporites scabratus																			x	
Todisporites minor																			x	
Concavispotites spp.																				C
Leschikisporis aduncus																				x
Plankton and varia																				
Micrhystridium sp. (small specimen)	A	A	x	x		C	C	C	A	A	C	A	A	C	A	x	x	A	x	A
Veryhachium sp. L (large specimen)	A	x	C	C	C															
Fungal remain type 1	x		C	x																
Tasmanites spp.		A	x	x	x	A	A	A	A	C	C	x	x						x	x
Domasia spp.		x						x	x	x			x		x					
Spherical bodies (strongly degraded)		x							x	x			x		C					
Micrhystridium sp. B		A				C	C	A	A	A	C	C	C	C						
Veryhachium spp.			x				x	x	x	x	x	C	C	C	C				x	
Micrhystridium sp. (bifurcated processes)			x			C	C	C	A	A					x					
Veryhachium sp. (small specimen)					x			x	x	C		C	x							
Cymatiosphaera spp.						x	x	x	x	x	x	x						x	x	x
Solisphaeridium spp.						x	x	C	C	C	x	C	x	C	A			A	A	
Cymatiosphaera sp. (well develloped flange)						C	C	x	C	C	x	C		x	x					
Pterospermella spp.									x	x	x				x				x	
Sentusidinium sp. A																	x		x	
Plaesiodictyon spp.																			x	
Composite Assemblage Zone	Naumovaspora striata					(P.disertus)			J. punctisp.			Anapiculati. spiniger				indet		E.i	A. astig.	

LEGEND
D dominant
A abundant
C common
x present

(P.disertus)= A composite assemblage zone in brackets has a low level of confidence

A.16 Høgrinden, Locality 20, Sassendalen and Kapp Toscana groups.

EDGEØYA

SKRUKKEFJELLET Locality 21	SASSENDALEN GROUP																K.T.
Lithostratigraphy	Vikinghøgda Fm.						Botneheia Formation										Tsch.
	Lusit.Mb			Vend.Mb.									Blanknuten Mb				
Age	Olenekian						Anisian						Ladinian				Carn
	Sm/Spat			Spathian			early-middle					late					
Pollen / Height in section	5,0	13,0	16,0	37,0	57,0	66,0	72,0	79,0	94,0	105,0	110,0	119,0	120,0	127,0	143,0	149,5	152,0
Cycadopites spp.	x	C		C		x	x	C	x			x			x	x	x
Lunatisporites noviaulensis	x	x		x	x	x	x	x	x			x			x		x
Lunatisporites spp.	C	A	C	C	x	C						x					
Lunatisporites acutus		x		x	x								x				x
Striatoabieites aytugii		cf.		cf.				x	x	x		C	C		x		x
Vitreisporites pallidus		x			x			x				x			x	x	x
Podosporites spp.		x		C								x					
Pretricolpipollenites spp.		C		x		x	x	x									
Lunatisporites pellucidus		C		x	x	x											
Podosporites amicus		x															
Bisaccate pollen (indeterminate)				C			C	A		C	C	C	x	x		C	
Striatoabieites spp.					x			x	C			C					x
Bharadwajispora labichensis					x	x	x	x									
Triadispora obscura						x		x	x			x	x		x		x
Protohaploxypinus spp.						x											
Illinites chitonoides							x			x							x
Circumstriatites spp.							x	x				x			x		
Ephedripites spp.								x									
Duplicisporites spp.									x								x
Striatoabieites multistriatus									x			C			x		x
Platysaccus spp.												x			x		x
Podosporites sp. B												x					x
Protodiploxypinus gracilis												x					x
Lueckisporites junior												x					
Paracirculina tenebrosa												x					
Striatoabieites balmei												x					
Enzonalasporites vigens													x				x
Schizaeoisporites worsleyi													x				
Spiritisporites sp.													x				x
Accinctisporites circumdatus																	x
Camerosporites secatus																	x
Haberkornia spp.																	x
Ovalipollis pseudoalatus																	x
Podosporites amicus																	x
Protodiploxypinus ornatus																	x
Protodiploxypinus spp.																	x
Staurosaccites quadrifidus																	x
Triadispora verrucata																	x
Spores																	
Kraeuselisporites spp.	x			x	x	x			x			x					
Densoisporites nejburgii	x	A	x	x	x	x	x		x								
Deltoidospora minor		C															x
Nevesisporites spp.		x				C							x				x
Aratrisporites sp.		C		x	x	x	x	x	x		x	x				x	
Densoisporites spp.		C	C	C	C	C	x	x	x			x					
Gordonispora fossulata		C		x	x	x			x								
Lundbladispora spp.		x		x		x	x		x								
Verrucosisporites spp.		x															
Verrucosisporites morulae		x															
Proprisporites pocockii		x															
Discisporites niger				x													x
Keuperisporites baculatus				x	x	x											
Calamospora spp.				x													
Jerseyiaspora punctispinosa						x											
Kraeuselisporites cuspidus									x								
Stereisporites spp.									x								
Densoisporites velatus												x					x
Eresinia spinellata												x					
Deltoidospora australis															x		x
Todisporites spp.															x		x
Anapiculatisporites spiniger																	x
Deltoidospora juncta																	x
Dictyophyllidites harrisii																	x
Plankton and varia																	
Micrhystridium spp.	A	A	C	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Tasmanites spp.	A	A	C	x	C	A	C	x	x	x	A	x	C	C	C	C	x
Veryhachium sp. (large specimen)	A			C	C	C	C	A		x		x	x				x
Cymatiosphaera sp. L	C				x		x	x			x	C					
Veryhachium spp.	C			C		x		C		C		x					
Fungal remain type 1	x	x		x			x	x									
Solisphaeridium spp.		x		x	x	x		C		x	x	A			C		C
Spherical bodies (degraded walls)				C						C		C		x	C		
Domasia spp.				C	x												
Cymatiosphaera sp. S					x	x	x	x			x	C					
Pterospermella spp.								x				C					
Plaesiodictyon spp.									x			x					x
Dictyotidium spp.									x			C					
Sentusidinium sp. A										x		C			x		
Leiosphere (split specimen)												C			C		
Smooth bodies (folded)												A			x		
Foraminiferal linings												x					
Tasmanites sp. (large specimen)															C		
Composite Assemblage Zone	N. striata			P. dis.		J.p.	A. spiniger			(T.obsc.)		P.d.	E. iliacoides				A. ast.

LEGEND
D dominant
A abundant
C common
x present

(T.obsc.)= A composite assemblage zone in brackets has a low level of confidence

A.17 Skrukkefjellet, Locality 21, Sassendalen and Kapp Toscana groups.

contains an association correlated to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Botneheia Formation
In the lower Botneheia Formation (72.0–94.0 m, Table A.17) there are relatively rich assemblages of bisaccate pollen. The samples from higher in the formation (105.0–110.0, 127.0 and 149.5 m) contain coherent granular aggregates of AOM adhering to the palynomorphs and reducing their diagnostic value. Marine plankton represent a diverse and characteristic group throughout. They are particularly well developed at the 119.0 and 143.0 m levels, where they include large, only slightly compressed specimens of *Tasmanites* spp. (Plate 6).

Four palynological zones are recognised in the Botneheia Formation at this locality.

The *Anapiculatisporites spiniger* Composite Assemblage Zone is identified in the interval 72.0–94.0 m. The assemblage from the interval 105.0–110 m, tentatively assigned to the *Triadispora obscura* Composite Assemblage Zone, is different from the diverse association at 119.0 m. The latter has a high diversity of pollen, including *Lueckisporites junior*, *Paracirculina tenebrosa*, *Protodiploxypinus gracilis*, *Striatoabieites* spp. (abundant) and the spore *Eresinia spinellata*. It has been assigned to the *Protodiploxypinus decus* Composite Assemblage Zone. The association recovered from the overlying Blanknuten Member (120.0–149.5 m) is of lower diversity, but is identified as belonging to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Kapp Toscana Group
Tschermakfjellet Formation
Better preserved morphological structures, more diverse pollen and a less diverse plankton group distinguish the single sample from lowest Tschermakfjellet Formation. The plankton mainly comprise abundant *Micrhystridium* spp. and common *Solisphaeridium* spp. besides the freshwater plankton form *Plaesiodictyon* spp. The association is identified as belonging to the *Aulisporites astigmosus* Composite Assemblage Zone (Table A.17).

A.6.4 Blanknuten

The mountain of Blanknuten is located on the western shores of Edgeøya facing Diskobukta in Storfjorden (Locality 22, Figure 17). Samples from the Sassendalen Group (Locality 22a) were collected along the shore and up the cliff in the bird mountain gorge, inland from the local hut. Samples from the Kapp Toscana Group (Locality 22c, Plates 7–8) were sampled along the southern ridge of the mountain. The measured section on the central part of the mountain Blanknuten (Locality 22b) has not been studied for palynology.

Sassendalen Group
The two samples from the Vikinghøgda Formation (samples 1.01 and 68.5 m, Table A.18.1) comprise an association of cavate spores, bisaccate pollen, acritarchs of the *Micrhystridium* group and *Tasmanites* spp. The six samples (78.0–141.5 m) from the Botneheia Formation contain coherent aggregates and granular AOM embedding alete and taeniate bisaccate pollen and plankton of the *Micrhystridium* group. The samples at this locality contain poorly preserved material and were excluded from further palynological analysis.

Kapp Toscana Group
Tschermakfjellet Formation
Nine of the 14 samples studied (Table 18.2, 120.0–193.0 m) are productive and comprise diverse associations dominated by alete bisaccate pollen, *Leschikisporis aduncus* and smooth trilete spores. A relative increase of ornamented spores is recorded in the upper part of the formation. Plankton include regular to abundant *Micrhystridium* and *Tasmanites*. The presence of *Plaesiodictyon* spp. (170.0 m) suggests a certain influx of freshwater. Palynologically barren samples occur in two intervals (150.0–165.0 and 190.0–193.0 m).

De Geerdalen Formation
The palynomorphs are strongly affected by biodegradation. As in the Tschermakfjellet Formation, *Leschikisporis aduncus* and smooth trilete spores dominate most samples throughout the section (200.0–369.0 m). The bisaccate pollen show low diversity in samples close to the coal beds. In the lower part of the formation, the plankton include *Micrhystridium* spp., *Tasmanites* spp., *Veryhachium* spp. and *Plaesiodictyon* spp. (215.0–230.0 m). The latter suggests freshwater influx. The sample at 278.0 m, above a coal bed, was palynologically barren. Increased diversity and dominant terrestrial debris associated with a stronger influx of marine plankton characterise the uppermost sample (369.0 m).

EDGEØYA

BLANKNUTEN Locality 22a	SASSENDAL.GP								
Lithostratigraphy	Viki.		Botneheia Fm						T
Age									
Pollen and spores/Height in section	1.01	68.5	78.01	93.01	111.01	131.01	135.01	141.5	150.01
Bisaccate indeterminate pollen	x	x	x	x	x	x	x	x	
Taeniate bisaccate pollen			x						
Triadispora spp.							x		
Triletes smooth spores	x	x	x	x					
Cavate spores	x								
Leschikisporis aduncus					x				
Plankton and varia									
Micrhystridium spp.	x	x	x	x	x	x	x	x	
Minute spherical bodies	x	x	x	x	x				
Tasmanites spp.		x							
Composite Assemblage Zone	Indeterminate								

A.18.1 Blanknuten, Locality 22a, Sassendalen Group.

EDGEØYA

BLANKNUTEN SOUTH Locality 22c	KAPP TOSCANA GROUP																												
Lithostratigraphy	Tschermakfjellet Formation														De Geerdalen Formation														
Age	Carnian																												
Pollen / Height in section	120,0	123,0	128,0	135,0	142,0	146,0	150,0	156,0	165,0	167,0	170,0	175,0	190,0	193,0	200,0	205,0	210,0	215,0	220,0	224,0	230,0	255,0	©	278,0	299,0	310,0	322,0	342,0	369,0
Araucariacites spp.	x									x	x					x	x			x	x				x		x	C	x
Bisaccate pollen (alete)	x	A	C	x	C	C				C	C	A			x	A	A	x	C	C	x	x			x	x	C	A	A
Cycadopites spp.	x	x	x		x					x		x				x	x	x	x	x	x					x	x	x	x
Lunatisporites spp.	x	C	C	x						x	x						x											x	x
Striatoabieites spp.	x	C	C		x					x	x	x							x	x	x	x			x	x	x	x	x
Camerosporites secatus	x	x																											x
Chasmatosporites apertus	x	x	x		x					x						x	x	x	x	x					x	x		x	x
Chasmatosporites spp.	x	C	C	x	x					C	x					x	C	C	C	C					x	C	x	C	C
Triadispora spp.	x	x	x	x	x	x				x	x	x			x	C	A	x	x	C	x				x			x	x
Angustisulcites spp.	x	x									x	x						x		x									
Chasmatosporites magnolioides		x																											x
Ovalipollis pseudoalatus		C	C	x	x					C	x	x			x		C	C	x	x	x	x			x		x	x	x
Protodiploxypinus spp.		C	C	x	x	x						x																	x
Staurosaccites quadrifidus		C			x					x						x												x	
Vitreisporites pallidus		x		x						x						x	x		x									x	
Enzonalasporites vigens		x								x																			x
Kuglerina meieri		x																											x
Podosporites sp. B		x				x					x	x				x	x											x	x
Ricciisporites spp.		x		x						x										x	x							x	
Vallasporites ignacii		x			x												x		x									x	
Porcellispora longdonensis		x	x																							x			
Schizaeoisporites worsleyi		x																	x							x			
Partitisporites spp.		x		x	x							x				x	x			x									
Patinasporites densus		C	x			x					x	x			x		x		x	x									
Triadispora verrucata		C	x	x	x	x					x	x																	
Cordaitina spp.					x					x		x																x	
Illinites chitonoides																x													
Accinctisporites circumdatus																	x												
Retisulcites spp.																												x	
Infernopollenites spp.																													x
Spores / Height in section								b					b										©	b					
Aratrisporites spp.	x	x	x		x	x				x	x	x			x	x	x	x	x	x	x	x			x	x	x	x	x
Calamospora spp.	x	x	x		x	x				C	x	x			C	C	A	C	x	C	x	C			A	C	C	A	C
Deltoidospora spp.	x	x	x		x	x				x		x				x	x		x	x	x					x		x	x
Lycopodiacidites spp.	x	x			x						x	x			x	x	x	x	x						x		x	x	
Striatella seebergensis	x	x								x	x	x				x	C	x	x	C	x	x			x		x	C	x
Anapiculatisporites spp.	x	x			x					x		x				x	x	x	C	x	x	C			C	C	C	C	x
Apiculatisporis spp.	x									x	x	x			x	x	x	C	C	x	x	C			C	C	C	C	x
Concavisporites spp.	x	C	C	x	C	C				C	C	C			x	C	C	C	x	C	C	C			C	A	C	C	A
Leschikisporis aduncus	x	x	x	x	C	C				x	C	C			x	x	x	C	x	C	x	x			C	C		x	C
Todisporites spp.	x	x		x	x	x				x	x	x			x	x	x	x	x	x	x	x			C	A	x	x	x
Annulispora folliculosa	x									x	x	x					C		x	x	x						x	x	
Convolutispora spp.	x																	x							x			x	
Thomsonisporites undulatus	x									x						x				x								x	
Conbaculatisporites spp.		x								x	x	x				x	x			x	x	x			x	x	x	x	x
Polypodiisporites spp.		x			x						x				x	x	A			x					x		x		
Uvaesporites spp.		x				x						x			x	x	x			x								x	
Aratrisporites laevigatus		x																		x									x
Retusotriletes spp.		x																	x						x	x			
Lycopodiumsporites spp.		x																				x			x				
Verrucosisporites spp.		x	x									x				x			x		x								
Gordonispora lubrica		x	x														x												
Osmundacidites spp.		x																											
Camarozonosporites rudis				x	x						x				x		x	x											x
Punctatosporites spp.						x				x							x	x	x	x	x	x				x			x
Gordonispora fossulata										x		x					x											x	
Neoraistrickia spp.										x																	x		
Kraeuselisporites spp.										C	C	C			x	x	C	x	x	C	x				x		C	x	x
Camarozonosporites laevigatus										x																	x		
Converrucosisporites spp.										x																			
Zebrasporites interscriptus											x																x		
Tigrisporites spp.															x		x			x	x							x	
Densoisporites spp.															x		x												
Nevesisporites vallatus																	x												x
Ischyosporites spp.																	x											x	
Triplexisporites playfordii																		x											
Leptolepidites spp.																													x
Dictyophyllidites mortoni																													x
Dictyophyllidites spp.							b																						x
Plankton and varia								b					b										©	b					
Tasmanites spp.	x		x	x		A				x	x							x									x	x	
Dictyotidium spp.	x	x				x																							x
Micrhystridium spp.		C	A		x	x				x	x	x			x					x	x				x				C
Veryhachium spp.		x			x	x				x		x			x		x								x			x	C
Cymatiosphaera spp.		x				x																							C
Plaesiodictyon spp.											x							x	x		x								
Botryococcus spp.																									x		x		
Baltisphaeridium spp.																									x				
Composite Assemblage Zone	Aulisporites astigmosus																												

LEGEND
A abundant
C common
x present
R reworked
© coal layer
barren sampl.

At this locality the associations of the entire Kapp Toscana Group were identified as belonging to the *Aulisporites astigmosus* Composite Assemblage Zone (Table A.18.2).

A.6.5 Årdalsknuten

The mountain of Årdalsknuten is situated in southwestern Edgeøya (Locality 25, Figure 17). No sedimentological log has been measured at this locality.

Kapp Toscana Group
Tschermakfjellet Formation
The palynomorphs in the lowest interval have extremely thin walls. Judged by the poor preservation, the damaged walls and the darker colour of the organic material, it seems that the embedding deposits might have been exposed to high temperatures causing degradation of the organic matter. Age-diagnostic palynomorphs allow identification of the *Aulisporites astigmosus* Composite Assemblage Zone (Table A.19). The absence of marine indicators, as well as the leech cocoons observed at 33.0 m, suggests deposition in a freshwater environment (Manum et al. 1991). The indeterminate organic material recorded at the top of the interval marks increased biodegradation.

De Geerdalen Formation
The samples from the De Geerdalen Formation (51.0–419.0 m, Table A.19) are variably rich in organic material, with decreasing diversity upwards. The productive sample levels (51.0–120.0, 198.0–340.0 and 419.0 m) are separated by almost barren sample intervals (Table A.19). Indeterminate bisaccate pollen and smooth trilete spores dominate throughout. Age-diagnostic palynomorphs become rare above 258.0 m. *Triadispora* spp., *Leschikisporis aduncus* and *Aulisporites astigmosus* occur in low numbers, but allow recognition of the *Aulisporites astigmosus* Composite Assemblage Zone.

A.6.6 Vogelfjellet

The mountain of Vogelfjellet (Locality 26, Figure 17) is situated at the entrance to Tjuvfjorden in southwestern Edgeøya. Table A.20 represents a few samples from three separate localities (VO–1, VO–2 and VO–3) representing the Sassendalen and Kapp Toscana groups, respectively. No sedimentological logs have been measured at this locality.

EDGEØYA

ÅRDALSKNUTEN Locality 25	KAPP TOSCANA GROUP														
	Sect. ÅR 11				Section ÅR 1										
Lithostratigraphy	Tsch.				De Geerdalen Fm										
Age	Carnian				Carnian										
Pollen / Height above base of section	2,0	13,0	25,0	33,0	51,0	80,0	120,0	139,5	198,0	219,0	258,0	339,0	340,0	377,0	419,0
Bisaccate pollen	A	A	A	A	A	A	C	D	A	A	A	A	A		A
Protodiploxypinus spp.	x	C		x	x	x	x		x			x	x		x
Cycadopites spp.	x	x		x		x	x		x	x	x	x	x		x
Vitreisporites pallidus	x														x
Podosporites spp.	x	x	x	x	x	x	x		x	x		x	x		
Protodiploxypinus minor	x	x			x				x			x	x		
Ovalipollis pseudoalatus	x	x	x	x	x	x	x		x	x		x			
Illinites chitonoides	x	x					x		x		x				
Striatoabieites spp.	x		x	C	x		x		x	x					
Lunatisporites noviaulensis	x	x	x	x	x	x	x								
Schizaeoisporites worsleyi	x					x									
Protodiploxypinus ornatus	x	x													
Schizoisporis spp.	x														
Alisporites spp.		x	x	x	x							x	x		x
Chasmatosporites magnolioides		x	x	x	x	x	x			x	x				x
Triadispora spp.		x			x		x		x						x
Araucariacites australis		x		x	x	x	x			x	x	x	x		
Concentrisporites pseudosulcatus		x	x	x	x	x	x		x	x	x	x			
Aulisporites astigmosus		x		x							x				
Camerosporites secatus		x								x					
Eucommiidites minor		x					x		x	x					
Accinctisporites circumdatus		x	x	x		x	x								
Protodiploxypinus decus		x		x											
Duplicisporites spp.		x													
Pinuspollenites sp. (large specimens)		x													
Triadispora obscura		x													
Partitisporites sp.			x	x											
Patinasporites sp.			x	x	x	x	x		x						
Voltziaceaesporites spp.			x												
Quadraeculina anellaeformis	cf.				x	x						x			
Triadispora verrucata					x										
Eucommiidites major						x	x								
Eucommiidites microgranulatus							x								
Retisulcites sp.									x						
Ephedripites sp. (polyplicate)										x					
Podosporites amicus										x					
Staurosaccites quadrifidus												x			
Spores / Heigth above sea level															
Deltoidospora minor	x	C	C	C	C	C	C		C	C	C	x	C	x	C
Dictyophyllidites spp.	x	x		x	x		x		x	x	x	x			x
Camarozonosporites rudis	x	x		x					x				x		
Kyrtomisporis spp	x														
Aratrisporites spp.		x		x	x		x				x	x	x		x
Stereisporites spp.		x	x						x		x		x		
Calamospora spp.		x	x	x	x	x	x			x	x				x
Conbaculatisporites spp.		x		x					x	x	x				x
Kraeuselisporites apiculatus		x	x	x					x	x	x	x	x		
Kraeuselisporites reissingeri		x										x	x		
Osmundacidites spp.		x	x	x	x	x	x		x	x			x		
Striatella seebergensis		x	x	x	x	x	x						x		
Aratrisporites fimbriatus		x			x		x			x	x	x			
Staplinisporites caminus		x			x		x			x		x			
Aratrisporites macrocavatus		x		x	x	x	x			x	x				
Kraeuselisporites spp.		x			x		x				x				
Leschikisporis aduncus		C	x							x	x				
Gordonispora fossulata		x	x	x					x	x					
Polycingulatisporites spp.		x		x	x	x	x								
Retusotriletes spp.		x		x											
Camarozonosporites laevigatus		x	x												
Punctatisporites spp.		x													
Uvaesporites argentaeformis		x													
Baculatisporites comaumensis			x	x		x	x			x	x				x
Lycopodiumsporites spp.			x	x	x				x	x					
Anapiculatisporites spiniger				x	x	x				x	x	x	x		
Polypodiisporites spp.					x					C	x				
Rogalskaisporites cicatricosus					x				x						
Gleicheniidites senonicus							x								
Zebrasporites interscriptus									x						
Zebrasporites laevigatus									x						
Kyrtomisporis laevigatus												x			
Densosporites sp.													x		x
Plankton & varia / Identification no.	297	301	302	303	266	270	273	276	278	279	283	288	289	291	296
Plaesiodictyon spp.			x		x										x
Leech cocoon				x											
Micrhystridium spp.					x				x						
Psophosphaera spp.													x		
Composite Assemblage Zone	A. astigm.				Aulisporites astigmosus										

LEGEND
D dominant
A abundant
C common
x present

A.19 Årdalsknuten, Locality 25, Kapp Toscana Group.

A.18.2 Blanknuten South, Locality 22c, Kapp Toscana Group.

Sassendalen Group
Botneheia Formation
Two samples (Locality VO–1) contain rather poorly preserved palynomorph associations that elsewhere are characteristic for samples from the uppermost Botneheia Formation. In spite of the low diversity, age-indicative taxa allow tentative recognition of the *Echinitosporites iliacoides* Composite Assemblage Zone.

Kapp Toscana Group
Tschermakfjellet and De Geerdalen formations
Palynological assemblages of variable diversity and from widely separated sample localities (VO–3 and VO–2) contain associations allowing assignment to the *Aulisporites astigmosus* Composite Assemblage Zone. The stratigraphically lowest sample from VO–3, (20.0 m, Table A.20) contains an association with common *Micrhystridium* spp., while acritarchs have a low representation in the samples below and above this level.

A.6.7 Veidemannen/Veidebreen

The mountain of Veidemannen is located on the southwestern shores of Edgeøya (Locality 27, Figure 17). The Veidebreen locality is located inland of the mountain section, above a small Permian outcrop. Two overlapping sections, each of them comprising five samples from the Sassendalen Group, were investigated in a pre-study.

Vikinghøgda Formation, the Lusitaniadalen and Vendomdalen members and Botneheia Formation
The small organic residues from Locality 27, Section VEB, contain only some dark woody material. The five larger organic residues from Section VEI, levels up to 182.0 m, comprise dense aggregates of amorphous organic matter embedding mainly pollen. Some spherical bodies, probably representing algae, may reflect a marine depositional environment. Samples from this locality were excluded from further palynological studies.

A.6.8 Negerpynten

The mountain of Negerfjellet is located on the southeastern corner of Edgeøya facing south (Locality 28, Figure 17). The samples from the Negerpynten peninsula (in the southeast) are widely scattered at Locality NP–1 and densely spaced at Locality NP–2. The sections were investigated as part of a project for the Norwegian Petroleum Directorate, but the log was measured during a later field season.

Kapp Toscana Group
Tschermakfjellet Formation
The palynofacies of samples from levels 1.0 and 54.0 m (Locality NP–1, Table A.21) shows a strong input of terrestrial, mainly degraded, woody material. The moderately well-preserved palynomorph association, including abundant and diverse bisaccate pollen and abundant smooth spores, is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. There is a low input of acritarchs. The regular presence of leech cocoons and freshwater plankton suggests proximity to freshwater bodies.

De Geerdalen Formation
The palynofacies of two samples (83.0 and 142.0 m, Table A.21, Locality NP–1) shows an increase of structured woody material. The moderately well-preserved palynomorph association includes abundant

EDGEØYA

VOGELFJELLET	SASS.		KAPP TOSC.GP			
Locality 26	Loc. VO1		Loc. VO3			VO2
Lithostratigraphy	Botne. Fm		Tschermak./ De Gee.Fm.			D.G. Fm.
Age	Ladin.		Carnian			Car.
Pollen / Height above sea level	0,2	45,0	20,0	50,0	100,0	158,0
Podosporites spp.	x		x		x	
Chasmatosporites magnolioides		x			x	x
Chasmatosporites apertus		x			x	
Staurosaccites quadrifidus		x	x	x	x	
Eucommiidites spp.			x	x	x	x
Ovalipollis pseudoalatus			C		x	x
Protodiploxypinus decus			x		x	x
Protodiploxypinus macroverrucosus			x		x	x
Striatoabieites spp.			x	x	x	x
Triadispora spp.			C	x	x	x
Triadispora verrucata			x	x	x	x
Illinites chitonoides			x		x	
Lunatisporites noviaulensis			x		x	
Lunatisporites pellucidus			x		x	
Patinasporites spp.			x	x	x	
Podosporites amicus			x		x	
Protodiploxypinus gracilis			x		x	
Protodiploxypinus minor			x		x	
Protohaploxypinus spp.			x		x	
Podocarpidites spp.			x			
Protodiploxypinus spp.			C			
Schizaeoisporites worsleyi				x	x	
Accinctisporites circumdatus					x	x
Cycadopites spp.					x	x
Alisporites spp.					x	x
Araucariacites australis					x	x
Protodiploxypinus minor					x	x
Pinuspollenite sp. (large specimens)					x	
Pinuspollenites minimus					x	
Triadispora obscura					x	
Camerosporites secatus						x
Retisulcites sp.						x
Spores						
Dictyophyllidites spp.		x	x		x	x
Kyrtomisporis spp.		x	x		x	
Aratrisporites spp.			x		x	x
Deltoidospora minor			C		x	x
Gordonispora fossulata			x			x
Striatella seebergensis			x		x	x
Lycopodiacidites rugulatus			x		x	
Polycingulatisporites spp.			x			
Auritulinasporites triclavis					x	x
Osmundacidites spp.					x	x
Anapiculatisporites spiniger						x
Conbaculatisporites hopensis						x
Densosporites sp. (Bjærke & Manum)						x
Plankton & varia						
Micrhystridium spp.			C			x
Veryhachium spp.			x	x		
Sample identifications	1-232	23-254	1-258	4-261	8-265	2-256
Composite Assemblage Zone	E.iliacoid.		A. astigmosus			A.ast.

LEGEND
- A abundant
- A abundant
- C common
- x present

A.20 Vogelfjellet, Locality 26, Sassendalen and Kapp Toscana groups.

EDGEØYA - NEGERFJELLET

NEGERPYNTEN	KAPP TOSCANA GROUP												
Locality 28	Loc. NP-1				Loc. NP-2								
Lithostratigraphy	Tsch.		D.Ge.		De Geerdalen Fm								
Age	Carnian				Carnian								
Sample number					1	8	14	16	19	21	25	26	28
Pollen / Height above sea level	1,0	54,0	83,0	142,2	196	203	210	212	215	217	221	222	224
Accinctisporites circumdatus	x			x				x		x			x
Bisaccate pollen (indeterminate)	A	A	A	A	A	C	x	A	C	A		C	C
Chasmatosporites magnolioides	x	x	x	x	x		x	x		x		x	x
Concentrisporites pseudosulcatus	x		x	x	C	x	x	x	x	x		x	x
Eucommiidites minor	x		x	x	x			x	x				x
Illinites chitonoides	x	x	x	x	x	x		x	x	x			x
Podosporites amicus	x			x									x
Protodiploxypinus ornatus	x				x	x						x	x
Alisporites spp.	C	x	x	x	x			x		x		x	
Araucariacites australis	x	x	x	x	x	x		x		x		x	
Aulisporites astigmosus	x			x	x	x	A	C		x	x	x	
Chasmatosporites apertus	x											x	
Ovalipollis pseudoalatus	x	x	x	x								x	
Pinuspollenites minimus	x	x			x	x						x	
Protodiploxypinus doubingeri	x		x	x								x	
Protodiploxypinus minor	x			x	x							x	
Striatoabieites spp.	x			x	x	x						x	
Vitreisporites pallidus	x	x	x		x			x	x			x	
Protodiploxypinus gracilis	x	x	x		x			x		x			
Podosporites sp. B	x		x					x					
Triadispora verrucata	x	x	x			x		x					
Schizosporis spp.	x				x	x							
Eucommiidites intrareticulatus	x	x		x	x								
Eucommiidites major	x			x	x								
Staurosaccites quadrifidus	x	x		x			x			x			
Camerosporites secatus	x												
Doubingerispora filamentosa	x												
Podocapidites sp.	x												
Protodiploxypinus decus	x												
Voltziaceaesporites heteromorpha		x	x		x								
Triadispora obscura			x	x				x				x	
Protohaploxypinus spp.			x							x			
Partitisporites sp.				x									
Retisulcites sp.					x	x							x
Cycadopites spp.					x	x	x	x	x				
Pinuspollenites spp.					x	x							
Ephedripites multistriatus						x	x	x		x		x	x
Lunatisporites noviaulensis						x		x	x				x
Triadispora spp.									x				
Schizaeoisporites worsleyi													x
Spores / field number NPD	1-1	1-54	1-83	1-142	2-1	2-8	2-14	2-16	2-19	2-21	2-25	2-26	2-27
Aratrisporites spp.	x	x	x	x		x	x	x					x
Deltoidospora minor	A	x	x	x	A	x	C	x	x	x	x	x	x
Dictyophyllidites spp.	x			x	x	x		x	x			x	x
Leschikisporis aduncus	x	x	x	x	x	C	x	x	x	x		C	C
Striatella seebergensis	x	x	x		x	x	x	x	x			x	x
Anapiculatisporites spiniger	x	x				x	x	x	x			x	
Aratrisporites palettae	x			x	x		x	x	x			x	
Gordonispora fossulata	x	x	x	x	x				:			x	
Kyrtomisporis laevigatus	x								x				
Kyrtomisporis spp.	x	x			x	x			x				
Kraeuselisporites spinosus	x		x	x	x	x		x	x				
Polypodiisporites spp.	x					x	C	C	x				
Polycingulatisporites spp.	x						x						
Camarozonosporites rudis	x	x	x		x	x							
Kraeuselisporites sp.	x												
Retusotriletes spp.	x												
Zebrasporites interscriptus	x												
Aratrisporites macrocavatus		x			x	x	x	x					x
Baculatisporites comaumensis		x	x		x	x				x		x	x
Calamospora spp.		x	x	x		x	x	x					x
Osmundacidites spp.		x	x			x		x					
Camarozonosporites laevigatus			x			x							x
Polypodiisporites ipsviciensis			x	x	x	x	x						
Rogalskaisporites cicatricosus			x	x									
Staplinisporites caminus				x	x	x	x	x					
Leptolepidites equatibossus					x								x
Auritulinasporites triclavis					x	x						x	
Foveosporis sp. A					x	C	x	x	x	x		x	
Microreticulatisporites fuscus					x	x		x	x				
Neoraistrickia taylorii					x								
Aratrisporites sp. large							x	x					
Gleicheniidites senonicus								x					
Conbaculatisporites hopensis												x	x
Conbaculatisporites spp.												x	x
Kraeuselisporites reissingeri													x
Punctatisporites spp.													x
Plankton & varia/NPD Sample ident.	168	173	177	186	196	203	210	212	215	217	221	222	224
Botryococcus spp.	x	x	x	x				x				x	
Algal bodies	x			x						C	C		
Leech cocoon	x	x	x	x							x		
Micrhystridium spp.	x		x	x	x	x			x				
Veryhachium spp.	x				x	x							
Fungal remain	x	x	x	x									
Dictyotidium tenuiornatum			x		x								x
Cymatiosphaera spp.			x										
Plaesiodictyon moesellanum					x								x
Tasmanites spp.									D	x	x		
Psophosphaera spp.										x	x		
Composite Assemblage Zone	A.astigmosus				Aulisporites astigmosus								

LEGEND
D dominant
A abundant
C common
x present

A.21 Negerfjellet, Locality 28, Kapp Toscana Group.

and diverse bisaccate pollen and diverse smooth spores. It is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. Acritarchs are rare. As in the Tschermakfjellet Formation, leech cocoons and freshwater plankton suggest proximity to freshwater bodies.

Samples from locality NP–2 (196.0–224.0 m) contain diverse palynological assemblages. There is a strong input of terrestrial remains, mainly degraded woody material. Diverse bisaccate pollen and smooth spores, including *Leschikisporis aduncus*, occur as dominant forms together with *Aulisporites astigmosus* (Table A.21). Variable depositional conditions are reflected by sample level 215.0 m, containing an association with dominant *Tasmanites* spp., and at the levels 217.0 and 221.0 m, where low diversity associations contain abundant bisaccate pollen, algal bodies and *Psophosphaera* sp. together with *Tasmanites* spp. The associations resemble those described by Bjærke and Manum (1977) from the lowermost part of the Flatsalen Formation on Kong Karls Land. The sampled sections from Negerpynten represent the *Aulisporites astigmosus* Composite Assemblage Zone.

A.7 Nordaustlandet

Nordaustlandet, an island located northeast of Spitsbergen (Locality 29, Figure 17), is the second largest of the Svalbard archipelago. The palynological study of float samples from screes at Torellneset includes two lithologies: grey silty shale where the slab surfaces occasionally are enriched in well-preserved large (500–600 µm) *Tasmanites* cells (Vigran et al. 2008) and a dark, organic-rich shale that contains abundant small, as well as degraded large, *Tasmanites*.

The samples of dark-grey shale contain *Paracirculina tenebrosa* and *Triadispora aurea*, the grey silty shale additionally contains *Fossapollenites moderatus*, *Infernopollenites* spp., *Vitreisporites* sp., *Ricciisporites* sp. and *R.* cf. *tuberculatus* and they were dated by palynology as late Ladinian to early Carnian. It should be noted that deposits enriched in similarly large sized *Tasmanites* occur in the cored Ladinian to Carnian strata of the Snadd Formation from east of Kong Karls Land (7831/2–U–2 and –U–1 and 7830/5–U–1 and 7830/3–U–1 (see Part B of the Appendix). Rocks with abundant large-sized *Tasmanites* have also been recovered in lowermost Ladinian outcrops along the Olenek River and in the lower Norian deposits of the Buur Basin, Siberia. It has been assumed that these rocks reflect deposition in areas where climatic conditions resembled those of the present-day Mediterranean (Vigran et al. 2008).

A.8 Wilhelmøya

The island of Wilhelmøya is located between Spitsbergen and Nordaustlandet in Hinlopenstretet (Figure 17).

The palynology of the Upper Triassic and the lowest Jurassic deposits of the Kapp Toscana Group on Wilhelmøya has been studied in two sections above Tumlingodden (Section WI, Locality 30a and WØ, Locality 30b, Figure 17, Table A.22). The analysed samples were collected previous to the sedimentological logging of the section.

A.8.1 Tumlingodden

The point of Tumlingodden is located on the eastern side of Wilhelmøya. The palynological samples from the Tschermakfjellet Formation are separated from the samples of De Geerdalen Formation by an interval of about 160 m, which includes the formational boundary in Locality WI (Table A.22). The Locality WØ covers the uppermost part of De Geerdalen Formation as well as the overlying Flatsalen and basal Svenskøya formations.

Kapp Toscana Group

Tschermakfjellet Formation

It is not clear whether the lowermost beds on Wilhelmøya belong to the Tschermakfjellet or the De Geerdalen formations, as different authors have assigned them to different lithostratigraphic units (Buchan et al. 1965, Smith et al. 1975, Edwards et al. 1979).

Rich assemblages with abundant *Leschikisporis aduncus* and smooth trilete spores and a high diversity of the *Protodiploxypinus* and *Triadispora* groups are recorded from the basal part of the section (Locality 30a, WI, 6.0–16.0 m, Table A.22.1). The diversity of pollen and spores increases upwards. Plankton occur regularly and include abundant *Micrhystridium* spp. The uppermost sample also includes *Botryococcus* spp., *Plaesiodictyon* spp. and *Psophosphaera* spp. derived from a fresh or brackish water environment. This association suggests a shallow-marine depositional environment. The association represents the *Aulisporites astigmosus* Composite Assemblage Zone.

De Geerdalen Formation

The assemblages recovered from the lower part of the formation (179.0–233.0 m, Table A.22) resemble those of the Tschermakfjellet Formation. The diversity increases upwards with presence of *Araucariacites australis*, *Concentrisporites pseudosulcatus*, *Foveosporites* spp., *Neoraistrickia taylorii*, *Porcellispora longdonensis* and *Ricciisporites* spp.

Associations of lower diversity characterise the higher part of the section (242.5–395.0 m); barren samples occur from 306.0–315.0 m. The highest interval (330.0–395.0 m), however, shows an increased diversity of *Kyrtomisporis* spp., *Kraeuselisporites* spp., *Pinuspollenites* spp. and *Protodiploxypinus* spp. Common *Botryococcus* spp. and the presence of leech cocoons in the uppermost sample indicate a freshwater environment. The associations, like those of the Tschermakfjellet Formation below, have been correlated with the *Aulisporites astigmosus* Composite Assemblage Zone.

The lowermost sample from Locality 30b, WØ at Tumlingodden, (430.0 m, Table A.22) represents the highest part of De Geerdalen Formation. Woody (tracheidal) matter dominates. The low diversity of pollen and spores corresponds to the observations in the top part of Section WI. Here, the lowest record of *Quadraeculina anellaeformis* is associated with dominant spores. The diversity of plankton, with acritarchs, green algae and the first incoming of dinocysts distinguish the samples in this interval from those of underlying deposits. The dinocysts, including *Hebecysta brevicornuta*, *Noricysta fimbriata* and *Sverdrupiella downii*, are typical for the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

The presence of *Psophosphaera* sp. corresponds to the finds at Negerpynten (Table A.21). Bjærke and Manum (1977) record this taxon lowermost in the Flatsalen Formation on Kong Karls Land.

Wilhelmøya Subgroup

Flatsalen Formation, including Slottet Bed

The Slottet Bed, the prominent basal marker horizon of the Flatsalen Formation at Locality WØ, is represented by a single conglomeratic sample that is palynologically barren (431.0 m, Table A.22).

The lower Flatsalen Formation contains a pollen/spore association of low diversity and a plankton/dinoflagellate cyst association of increasing diversity. The sample levels 432.0 and 450.0 m (Locality 30b, Table A.22) show an acme of the algae *Crassosphaera* spp., *Cymatiosphaera* spp. and *Tasmanites* spp. as well as *Micrhystridium* spp. The samples contain abundant amorphous organic matter and the partial and gradual degradation of the wall material in specimens of *Tasmanites* may be ascribed to biodegradation. The association is assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

The highest samples from the Flatsalen Formation at Locality WØ (455.0–503.0 m) contain abundant smooth spores. There is maximum diversity and abundance

A.22.1 Tumlingodden, localities 30a and b, Kapp Toscana Group. ❯

WILHELMØYA

TUMLINGODDEN Locality 30a (WI)	KAPP TOSCANA GROUP														K. TOSCANA GP								TUMLINGODDEN Locality 30b (WØ)
Lithostratigraphy	Tsch.			De Geerdalen Fm											DG	Flatsalen Fm						Sv	Lithostratigraphy
Age	Carnian														Ca	Norian							Age
Pollen / Sample height ab. sea level	6,0	10,5	16,0	179,0	201,0	233,0	242,5	262,0	306,0	315,0	330,0	372,0	384,0	395,0	430,0	431.0	432.0	450,0	455,0	462,0	470,0	503,0	Pollen / Sample height ab. sea level
Protodiploxypinus macroverrucosus	x	x	C	x	C	x		x			x	A	A	A									*Protodiploxypinus macroverrucosus*
Alisporites spp.	x	x	x	x	x	x		x			x	C	C		x		x	x		x	x	x	*Alisporites* spp.
Chasmatosporites sp. A	x	x	x	x	x	x		x			x	x	x		x			x				x	*Chasmatosporites* sp. A
Ovalipollis pseudoalatus	x	x	x	x	x	x		x			x	x	C						x	x	x		*Ovalipollis pseudoalatus*
Protodiploxypinus decus	x	x	x										x							x			*Protodiploxypinus decus*
Protodiploxypinus gracilis	x	x	x	x	C	C		x			x	x	C		x				x	x	x		*Protodiploxypinus gracilis*
Protodiploxypinus minor	x		x	x	C	C					x	x	C								x		*Protodiploxypinus minor*
Schizaeoisporites worsleyi	x				x						x	A	x		x								*Schizaeoisporites worsleyi*
Triadispora crassa	x		x								x	x											*Triadispora crassa*
Cycadopites spp.	x	x	x	x	x	x	x				x										x		*Cycadopites* spp.
Illinites chitonoides	x	x	x	x	x	x					x												*Illinites chitonoides*
Ovalipollis spp.	x			x	x	x					x												*Ovalipollis* spp.
Podosporites amicus	x		x	x	x	x					x									x			*Podosporites amicus*
Striatoabieites spp.	x	x	x	x	x	x		x			x				x		x			x		x	*Striatoabieites* spp.
Lunatisporites noviaulensis	x	x	x	x	x			x							x				x	x	x	x	*Lunatisporites noviaulensis*
Lunatisporites pellucidus	x	x	x	x	x			x													x		*Lunatisporites pellucidus*
Staurosaccites quadrifidus	x	x	x	x				x															*Staurosaccites quadrifidus*
Triadispora obscura	x		x		x			x															*Triadispora obscura*
Eucommiidites minor	x		x	x	x	x	x														x		*Eucommiidites minor*
Triadispora verrucata	x	x	x	x	x	x																	*Triadispora verrucata*
Enzonalasporites spp.	x		x	x	x																		*Enzonalasporites* spp.
Podosporites sp. B	x		x																				*Podosporites* sp. B
Cordaitina minor	x																						*Cordaitina minor*
Kuglerina meieri		x	x	x	x	x						x											*Kuglerina meieri*
Protodiploxypinus doubingeri		x	x	x	x	x	x				x	x										x	*Protodiploxypinus doubingeri*
Triadispora aurea		x	x		x						x												*Triadispora aurea*
Triadispora bölchii		x	x																				*Triadispora bölchii*
Accinctisporites circumdatus			x	x	x	x					x		x									x	*Accinctisporites circumdatus*
Chasmatosporites magnolioides			x		x			x					x		C		x		x	x	C	C	*Chasmatosporites magnolioides*
Pinuspollenites minimus			x	x				x			C	A	C					x		x	x		*Pinuspollenites minimus*
Vitreisporites pallidus			x	x	x			x			x									x			*Vitreisporites pallidus*
Camerosporites secatus			x										x						x				*Camerosporites secatus*
Doubingerispora filamentosa			x					x			x	x											*Doubingerispora filamentosa*
Voltziaceaesporites spp.			x								x												*Voltziaceaesporites* spp.
Duplicisporites spp.			x		x	x		x															*Duplicisporites* spp.
Protohaploxypinus spp.			x	x	x	x		x															*Protohaploxypinus* spp.
Haberkornia spp.			x		x	x																	*Haberkornia* spp.
Araucariacites australis				x	x	x	x	x			x	x	x	C	x		x		x	x	x	C	*Araucariacites australis*
Concentrisporites pseudosulcatus				x	x	x					x	x	C	x			x				x	x	*Concentrisporites pseudosulcatus*
Protodiploxypinus sivaki				x	x	x						x	C										*Protodiploxypinus sivaki*
Ricciisporites spp.				x							x												*Ricciisporites* spp.
Porcellispora longdonensis				x																			*Porcellispora longdonensis*
Podocarpidites spp.								x			x	x	x										*Podocarpidites* spp.
Eucommiidites major								x					x										*Eucommiidites major*
Retisulcites sp.								x															*Retisulcites* sp.
Aulisporites astigmosus											x												*Aulisporites astigmosus*
Pinuspollenites spp.															x		x	x	x	x	x	x	*Pinuspollenites* spp.
Protodiploxypinus ornatus															x			x	x	x	x	x	*Protodiploxypinus ornatus*
Protodiploxypinus spp.															C		x	x	C	C	A	C	*Protodiploxypinus* spp.
Quadraeculina anellaeformis															x				x	x	x		*Quadraeculina anellaeformis*
Concentrisporites spp.															x								*Concentrisporites* spp.
Chasmatosporites apertus																				x			*Chasmatosporites apertus*
Spores									b							b							Spores / NPD Sample identification
Calamospora spp.	x	x	x	x	C	x	x	x			x	C	x	C			x	x		x	x	x	*Calamospora* spp.
Deltoidospora minor	x	C	x	x	C	x	x	x			x	C	C	A	x		x	x	C	C	x	x	*Deltoidospora minor*
Dictyophyllidites spp.	x	x	C	x	A	x	x	x			x	x	x	A					C	x	x	x	*Dictyophyllidites* spp.
Kyrtomisporis spp.	x	x	x	x	x		x				x	x	C	x	x				C	x	x		*Kyrtomisporis* spp.
Leschikisporis aduncus	C	C	C	C	C	x	A	x			A	C	C	A	A			C			x	x	*Leschikisporis aduncus*
Anapiculatisporites spiniger	x			x	x						x	C	x				x					x	*Anapiculatisporites spiniger*
Aratrisporites spp.	x	x	x	x	x	x	x	x			x										x		*Aratrisporites* spp.
Rogalskaisporites cicatricosus	x	x	x								x	x						x	x	x	x		*Rogalskaisporites cicatricosus*
Polycingulatisporites spp.	x		x		x													x	x	x	x		*Polycingulatisporites* spp.
Concavisporites intrastriatus	x	x	x	x	x	x					x	x	x										*Concavisporites intrastriatus*
Staplinisporites caminus	x		x	x	x	x					x	x	x										*Staplinisporites caminus*
Discisporites spp.	x		x		x	x																	*Discisporites* spp.
Lycopodiumsporites spp.		x	x		x								x	x							x		*Lycopodiumsporites* spp.
Polypodiisporites ipsviciensis			x	x		x		x				C					x			x	x	x	*Polypodiisporites ipsviciensis*
Microreticulatisporites fuscus			x	x	x	x	x	x			x	x	x	x						x			*Microreticulatisporites fuscus*
Camarozonosporites laevigatus			x		x	x					x	x		x									*Camarozonosporites laevigatus*
Lycopodiacidites rugulatus			x	x	x	x					x	x		x									*Lycopodiacidites rugulatus*
Uvaesporites argentaeformis			x			x					x			x									*Uvaesporites argentaeformis*
Gordonispora fossulata			x		x	x					x	x	x										*Gordonispora fossulata*
Kraeuselisporites spinosus			x	x	x	x					x	x	x										*Kraeuselisporites spinosus*
Retusotriletes spp.			x	x		x		x															*Retusotriletes* spp.
Striatella seebergensis				x	x	x		x				x	x		x					x	x		*Striatella seebergensis*
Verrucosisporites spp.				x		x					x	x								x	x		*Verrucosisporites* spp.
Neoraistrickia taylorii				x	x	x					x	x									x		*Neoraistrickia taylorii*
Punctatisporites spp.				x	x	x		x					x	x									*Punctatisporites* spp.
Polypodiisporites sp. (smooth)				x		x							x										*Polypodiisporites* sp. (smooth)
Foveosporites spp.				x	x	x	x	x															*Foveosporites* spp.
Aratrisporites fimbriatus				x	x	x	x																*Aratrisporites fimbriatus*
Composite Assemblage Zone	Aulisporites astigmosus														Rhaetogon. spp.			L. lundbladii					Composite Assemblage Zone

LEGEND
D dominant
A abundant
C common
x present
barren sample b

The Tschermakfjellet Formation was used when logging and sampling the lower 16 metres of Section WI

WILHELMØYA

TUMLINGODDEN Locality 30a (WI)	KAPP TOSCANA GROUP														K. TOSCANA GP								TUMLINGODDEN Locality 30b (WØ)
Lithostratigraphy	Tsch.			De Geerdalen Fm											DG	Flatsalen Fm						Sv	Lithostratigraphy
Age	Carnian														Ca	Norian							Age
Spores (continued)	6,0	10,5	16,0	179,0	201,0	233,0	242,5	262,0	306,0	315,0	330,0	372,0	384,0	395,0	430,0	431,0	432,0	450,0	455,0	462,00	470,0	503,0	Spores (continued)
Zebrasporites interscriptus						x					x									x	x		*Zebrasporites interscriptus*
Ephedripites steevesii							C	x															*Ephedripites steevesii*
Aratrisporites sp. (large specimen)								x			x				x								*Aratrisporites* sp. large
Densoisporites sp. (large specimen)								x			x												*Densoisporites* sp. (large specimen)
Conbaculatisporites spp.											x	x	x		x		x	x	x	x	x	x	*Conbaculatisporites* spp.
Kyrtomisporis gracilis											x	x	x				x		x	x	x	x	*Kyrtomisporis gracilis*
Kraeuselisporites cooksonae											x	x											*Kraeuselisporites cooksonae*
Zebrasporites laevigatus												x							x	x		x	*Zebrasporites laevigatus*
Gleicheniidites senonicus													x						x	x			*Gleicheniidites senonicus*
Deltoidospora australis															x		x					x	*Deltoidospora australis*
Kraeuselisporites sp. (apiculate)															x		x			x		x	*Kraeuselisporites* sp. (apiculate)
Trilete ornamented spores															C			x	x	C	C	C	Trilete ornamented spores
Trilete smooth spores															A		x	x	D	D	A	A	Trilete smooth spores
Kraeuselisporites reissingeri															x				x				*Kraeuselisporites reissingeri*
Lycopodiacidites spp.																	x		x	x	x	x	*Lycopodiacidites* spp.
Densosporites spp. (Bj. & M. 1977, pl. 5)																		x	x				*Densosporites* spp.
Auritulinasporites triclavis																			x		x		*Auritulinasporites triclavis*
Kyrtomisporis laevigatus																			x	x			*Kyrtomisporis laevigatus*
Aratrisporites macrocavatus																					x		*Aratrisporites macrocavatus*
Kraeuselisporites spp. (lacunae)																					x		*Kraeuselisporites* spp. (lacunae)
Thomsonisporites undulatus																					x		*Thomsonisporites undulatus*
Discisporites spp.																					x		*Discisporites* spp.
Plankton & varia (Section WI number)	1	2	3	6	9	11	12	14	16	17	19	20a	20b	21		b							Plankton & varia
Veryhachium spp.	x				x										x				x	C	C	x	*Veryhachium* spp.
Micrhystridium spp.	C	A	x	x	x								x		x			C	x		x		*Micrhystridium* spp.
Dictyotidium tenuiornatum	x		x	x							x		x		x		x	x					*Dictyotidium tenuiornatum*
Psophosphaera spp.		x	x					x							x						x		*Psophosphaera* spp.
Botryococcus spp.			x	x							C	x	C		x		x				x	x	*Botryococcus* spp.
Plaesiodictyon spp.			x	x	x			x					x				x				x	x	*Plaesiodictyon* spp.
Fungal hyphae			x	x																			Fungal hyphae
Algal bodies					x	x	x	x			x				x		x			x	x		Algal bodies
Crassosphaera spp.											x		x		D		x	D	x		x	x	*Crassosphaera* spp.
Leech cocoon														x									Leech cocoon
Hebecysta brevicornuta															x					C		x	*Hebecysta brevicornuta*
Noricysta fimbriata															x					C		x	*Noricysta fimbriata*
Cymatiosphaera spp.															x			C	x		x		*Cymatiosphaera* spp.
Tasmanites spp.															x		x	A	x		x		*Tasmanites* spp.
Dinocysts (indeterminate)															x			x	D	D	x		Dinocysts (indeterminate)
Sverdrupiella downii															x				x	x			*Sverdrupiella downii*
Dictyotidium spp. (large specimens)															x								*Dictyotidium* spp. (large specimens)
Rhaetogonyaulax rhaetica																			x	x			*Rhaetogonyaulax rhaetica*
Sverdrupiella mutabilis																			C				*Sverdrupiella mutabilis*
Sverdrupiella spp.																			C				*Sverdrupiella* spp.
Heibergella asymmetrica																				C			*Heibergella asymmetrica*
Heibergella aculeata																				x			*Heibergella aculeata*
Sample identification	391	392	393	396	399	401	402	404	406	407	409	410	411	412	WØ-1	WØ-2	WØ-3	WØ-8	WØ-9	WØ-10	WØ-11	WØ-12	Sample identification
Composite Assemblage Zone	Aulisporites astigmosus														Rhaetogon. spp.				L. lundbladii				Composite Assemblage Zone

LEGEND
C common
D dominant
A abundant
x present
(dotted) barren sample b

A.22.2 Tumlingodden, localities 30a and b, Kapp Toscana Group.

of *Chasmatosporites* spp., *Kyrtomisporis* spp. and *Protodiploxypinus* spp. The dinocysts of *Sverdrupiella* spp. (including *S. mutabilis*) show a marked increase at 455.0 m and for *Hebecysta brevicornuta*, *Heibergella asymmetrica* and *Noricysta fimbriata* at 462.0 m. Corresponding levels of increasing abundance for this dinocyst group have been recorded in the Tverrbekken Member of Knorringfjellet Formation at Festningen (Table A.1.2, Locality 1d); they probably represent a circumpolar level of stratigraphic importance. The association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

A.9 Hopen

Hopen island, situated in the southeastern part of the Svalbard archipelago (Figure 17), has outcrops consisting entirely of Upper Triassic rocks. Table A.23 compiles the De Geerdalen Formation at Iversenfjellet (Locality 31, IVE) and sections of the De Geerdalen, Flatsalen and Svenskøya formations at Lyngefjellet South and West (Localities 32c, d) and south of Binnedalen (Localities 32a, b). The recent publication of Strullu-Derrien et al. (2012) gives detailed descriptions of benettitalean wood anatomy from this area; their material is most probably of Carnian age.

A.9.1 Iversenfjellet

Iversenfjellet is located in the southernmost part of Hopen (Locality 31, Figure 17, IVE).

Kapp Toscana Group
De Geerdalen Formation
Silty samples representing the lowermost strata at Iversenfjellet (Table A.23, 4.0–90.0 m) contain diverse palynological assemblages with abundant bisaccate pollen, abundant smooth spores including *Leschikisporis aduncus* and the presence of *Kyrtomisporis gracilis*, *K. niger* and *K. speciosus*. This content allows correlation with the *Aulisporites astigmosus* Composite Assemblage Zone.

Samples from overlying shales (90.0–203.0 m) contain diverse associations variably rich in pollen, spores and plankton. Coal-bearing strata (117.0–119.0 m) yield a monotonous association including *Aratrisporites* spp., *Calamospora* spp., *Deltoidospora* spp. and *Leschikisporis aduncus*. These features, considered as typical for a swamp flora, were reported by Bjærke and Manum (1977, table 1), from "above the coal layer of Kollerfjellet" as well as from "a coal from about 100 m at Iversenfjellet". The residue from the 119 m level contains strongly pyritised palynomorphs and abundant fungal remains. The freshwater alga *Plaesiodictyon* is common at 150.0 m and 198 m; leech cocoons are common at 203 m. The microflora is recognised as the *Aulisporites astigmosus* Composite Assemblage Zone.

The uppermost samples (213.0–229.0 m) contain low–diversity associations of poorly preserved palynomorphs. The *Aratrisporites*, *Baculatisporites* and *Deltoidospora* groups dominate together with *L. aduncus*. No plankton have been recorded. The interval is left undated in the absence of age-indicative taxa.

A.9.2 Lyngefjellet

The mountain of Lyngefjellet is located in the northern part of Hopen (Locality 32, Figure 17, Table A.23). Upper Triassic deposits have been studied at the localities LYS, LYN and LY (Plate 9). The De Geerdalen and Flatsalen formations were sampled at Lyngefjellet South (Locality 32c, LYS) and the Flatsalen Formation only at Lyngefjellet West (Locality 32d, LYN). The De Geerdalen and Svenskøya formations have been sampled on Lyngefjellet south of Binnedalen (Locality 32a, LY and Locality 32b, LY). Note that the sedimentological logs Binnedalen and Lyngefjellet have been measured in recent years, while the samples for this study were collected in 1995.

Kapp Toscana Group at Lyngefjellet South
The section (Locality 32c, LYS) represents deposits from the uppermost De Geerdalen and lower Flatsalen formations (Table A.23).

De Geerdalen Formation
The association of the interval 147.0–159.0 m shows a high diversity of ornamented spores, particularly of the *Kyrtomisporis* group and of smooth trilete spores. *Leschikisporis aduncus* has regular records. The plankton comprise algal bodies, *Micrhystridium* spp. and *Tasmanites*, but dinocysts or freshwater plankton have not been recorded. The association is attributed to the *Aulisporites astigmosus* Composite Assemblage Zone.

Flatsalen Formation, Slottet Bed
The association in samples from the thin Slottet Bed (Table A.23, Locality LYS; 212.0–214.0 m) includes pollen and spores mostly present in the De Geerdalen Formation, but showing lower diversity. *Protodiploxypinus* spp. has a sparse representation and the genera *Angustisulcites* and *Triadispora* have no record, while *Pinuspollenites minimus* is regularly represented. There is a diverse plankton association dominated by *Tasmanites*, *Micrhystridium* and *Veryhachium*. The microflora is tentatively assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

Flatsalen Formation
There is a single sample from the Flatsalen Formation immediately above the Slottet bed (Table A.23, the 215.0 m level). The palynological assemblage is of low-diversity pollen occurring in lower numbers than spores. The plankton, although of low diversity, include abundant indeterminate dinocysts (oldest record). The association is assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

The depositional conditions resemble those recorded at the same stratigraphic level at Tumlingodden (Locality WØ, Table 22, 432.0–450.0 m)

Wilhelmøya Subgroup at Lyngefjellet
Flatsalen Formation with Slottet Bed
The assemblage from the Slottet Bed in this section (Locality 32d, LYN 170.0 m, Table 23) contains poorly preserved spores and rare pollen. Algal remains include common, indeterminate dinoflagellate cysts together with *Botryococcus*, *Plaesiodictyon* spp., *Tasmanites* spp. and *Veryhachium* spp. The association corresponds to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

The positions of the samples from the Flatsalen Formation (apart from the 180.0 m level) are located only relative to each other at Locality LYN. The microflora comprises *Pinuspollenites* spp., *P. minimus* and *Zebrasporites interscriptus* as well as spores and pollen ranging up from the De Geerdalen Formation into the Flatsalen Formation. *Veryhachium* spp. and indeterminate dinoflagellate cysts dominate the plankton. There is a lowermost record of an association of *Heibergella assymmetrica*, *H. salebrosacea*, *Rhaetogonyaulax* spp., *R. rhaetica*, *Sverdrupiella* spp., *S. manicata* and *S. mutabilis* that includes the acme of these dinoflagellate cysts. This association from Locality LYN has also been recorded lowermost in the Knorringfjellet Formation (Tverrbekken Member) at

HOPEN - KAPP TOSCANA GROUP

LOCALITY	IVERSENFJELLET															LYNGEFJELLET SOUTH										
Lithostratigraphy	De Geerdalen Formation															De Geerdal Fm.					Flatsalen Fm. Slottet Bed					
	Locality 31 (IVE)															Locality 32c (LYS)										
	-5	IVE-1											-2	IVE-3		LYS-1								LYS-3		LYS-1
Age	Carnian						late Carnian						indet.			late Carnian					Norian					
* Sample identification Height above base of section	9	12	14	15	16	18	19	20	21	24	27	28	30	31	32	105	106	107	108	109	110	111	112	149	150	1-113
Pollen / **Height above sea level (NPD)	4	60	67	70	80	90	90	117	119	150	198	203	213	228	229	147	149	151	153	159	212	212	212	213	214	214+
Araucariacites australis	x				x	x				x	x		x			x	x	x	x		x	x				
Chasmatosporites magnolioides	x	x	x	x	x	x	x	x	x	C						x	x	x	x	x	x	x	x	x	x	x
Eucommiidites minor	x		x							C	C					x	C	x	x	x	x	x	x			x
Concentrisporites pseudosulcatus	x	x	x	x	x	x	C	A		A	C	x	x			x	x	x	x	x	x	x	x	x		x
Alisporites spp.	x						x			C	x	x				x	x			x						x
Ovalipollis pseudoalatus	x		x				x			x	x						x	x	x	x	x	x	x	x	x	x
Eucommiidites intrareticulatus	x		x			x				C	x	x	x				x	x	x		x	x				
Staurosaccites quadrifidus	x									x	x								x	x						
Pinuspollenite sp. (large specimens)	x	x	x		x																					
Bisaccate pollen (abundance)	A	A	A	C	A	x	A	x	x	x	C	x	x													
Triadispora obscura	x									x																
Triadispora spp.	x									x																
Triadispora verrucata	x									x																
Protodiploxypinus doubingeri	x		x				x			x																
Retisulcites sp.	x									x																
Retisulcites sp. A (large specimen)	x									x																
Camerosporites secatus	x		x																							
Triadispora bölchii	x																									
Cycadopites spp.		x	x							C	x						x	x	x	x	x	x	x	x		x
Aulisporites astigmosus		x	x																							x
Podosporites amicus		x								x								x		x						
Accinctisporites circumdatus		x	x	x	x					x																
Doubingerispora filamentosa		x								x																
Striatoabieites spp.		x	x		x		x																			
Protodiploxypinus minor			x		x		x			x	x															
Illinites chitonoides			x		x					x	x								x			x				
Porcellispora sp.			x				x			x	x								x							
Schizaeoisporites worsleyi			x	x				x																		
Protodiploxypinus spp.			x			x	x			x	x	x														
Podosporites sp. (large specimens)			x																							
Protodiploxypinus gracilis							x				x															
Protodiploxypinus macroverrucosus							x			x	x															
Protodiploxypinus decus							x																			
Ricciisporites sp.							x				x															
Vitreisporites pallidus										C							x		x	x		x	x	x		x
Ephedripites steevesii										x																
Parvisaccites radiatus										x	x															
Protodiploxypinus ornatus											x															
Lunatisporites noviaulensis																	x									
Brachysaccus spp.																			x	x	x	x				
Chasmatosporites apertus																			x		x					
Pinuspollenites minimus																						x	x	x		
Triadispora aurea																										
Angustisulcites klausii																										
Concentrisporites hallei																										
Duplicisporires sp.																										
Partitisporites spp.																										
Podocarpidites rousei																										
Lunatisporites spp.																										
Perinopollenites elatoides																										
Plankton & varia	9-5	12-1	14-1	15-1	16-1	18-1	19-1	19-1	21-1	24-1	27-1	28-1	30-2	31-3	32-3											
Micrhystridium spp.							A											x	x		C	x	C	A	x	
Tasmanites spp.							C				x								C		C	A	A	A	x	x
Veryhachium spp.							A														C	C	C	A	x	
Cymatiosphaera spp.							A														x	x	x	x	x	
Dictyotidium tenuiornatum							C				x										x	x	x	x	x	
Crassosphaera spp.							x																			
Foraminiferal lining							C																			
Fungal remain (hyphae)									C																	
Plaesiodictyon spp.										C	C													x		
Botryococcus spp.										x															x	
Leech cocoon												C								x						
Algal bodies																		x	x	x	x					
Mussel																					A	A	A			x
Foraminiferal lining																					x	x	x	x	x	
Solisphaeridium spp.																					x	x	x	x	x	
Dinocysts (indeterminate)																										A
Ammonoid																										x
Rhaetogonyaulax spp.																										
Heibergella salebrosacea																										
Ichtyosaur																										
Rhaetogonyaulax sp. (double horn)																										
Sverdrupiella manicata																										
Heibergella asymmetrica																										
Leiosphere (indeterminate)																										
Rhaetogonyaulax rhaetica																										
Sverdrupiella spp.							b							b												
Sverdupiella mutabilis							©	©	©																	
Composite Assemblage Zone	Aulisporites astigmosus												Indetermin.			A. astigmosus					****(Rhaetogonyaul.)					Rh.

LEGEND

- A abundant
- C common
- x present
- R reworked
- (stippled) barren sample
- (hatched) sample from coal laye

* Sample identifications refer to a NPD (Norwegian Petroleum Directorate) project 1995

** Sample heights are correct within each of the three localities from Lyngefjellet, but not between sections measured at different time

A.23.1 Iversenfjellet, Lyngefjellet South and West and Binnedalen, Localities 31, 32c, a, d and b, Kapp Toscana Group.

HOPEN - KAPP TOSCANA GROUP

LYNGEFJELLET, BINNEDALEN													LYNGEFJELLET W.							BINNEDALEN				LOCALITIES
De Geerdalen Formation													Flatsalen Fm						Fl	***Svenskøya				Lithostratigraphy
													Slot.											
Locality 32a (LY-1)													Locality 32d (LYN)							Loc. 32b (LY-1)				
1-1	1-2	1-5	1-6	1-23	1-7	1-27B	1-27	1-9	1-10	1-11	1-12	1-14								1-36B	1-36A	1-40B	1-40A	
Carnian								late Carnian					Norian							Norian				Age
60	61	64	65	123	66	127B	127	68	69	70	71	73	1-2	1-7	1-6	1-5	1-4	1-3		136B	136A	140B	140A	* Sample identification
0	5	36	63	75	83	98	98	107	117	132	141	153	?	?	?	?	?	?		206	206	245	245	Height above base of section
30	35	69	93	105	113	128	128	137	147	162	171	183	170	180	?	?	?	200		236	236	275	275	Pollen / **Height above sea level (NPD)
x		x	x			x	C				x				C		x			x			x	*Araucariacites australis*
x						x	x	x	x	x	x	x		x	C	x	x			x		x	x	*Chasmatosporites magnolioides*
x		x	x					x	x		x	x	x										x	*Eucommiidites minor*
C	x	C	x			x	x	C	C	C	x	x								x			x	*Concentrisporites pseudosulcatus*
								x		x	x			x	x		x			x			x	*Alisporites* spp.
			x				x	x	x	x	x	x								x			x	*Ovalipollis pseudoalatus*
			x					x	x		x													*Eucommiidites intrareticulatus*
								x	x	x	x						x			x			x	*Staurosaccites quadrifidus*
														x	x	x	x			x				*Pinuspollenite* sp. (large specimens)
A	x	C	C	x				A	A	A	A	A					x					C	C	Bisaccate pollen (abundance)
x											x													*Triadispora obscura*
								x	x															*Triadispora* spp.
								x	x															*Triadispora verrucata*
																								Protodiploxypinus doubingeri
																								Retisulcites sp.
																								Retisulcites sp. A (large specimen)
																								Camerosporites secatus
																								Triadispora bölchii
x								x			x	x				x	x			x		x	x	*Cycadopites* spp.
x	x	C	x																				x	*Aulisporites astigmosus*
								x	x	x	x													*Podosporites amicus*
																								Accinctisporites circumdatus
																								Doubingerispora filamentosa
															x								x	*Striatoabieites spp.*
		x						x	C	C	C	x			x	x	x			x			x	*Protodiploxypinus minor*
								x	x															*Illinites chitonoides*
x				x																				*Porcellispora* sp.
															x									*Schizaeoisporites worsleyi*
																								Protodiploxypinus spp.
																								Podosporites sp. (large specimens)
x		x						x	C	C	C	x		x	x	x	x			C			x	*Protodiploxypinus gracilis*
		x						x	C	C	C	x			x	x	x			x			x	*Protodiploxypinus macroverrucosus*
		x	x					x	x	x		x								x			x	*Protodiploxypinus decus*
								x	x	x	x	x								x		x	x	*Ricciisporites* sp.
x								x	x	x	x						x			x		x	x	*Vitreisporites pallidus*
																							x	*Ephedripites steevesii*
																								Parvisaccites radiatus
																								Protodiploxypinus ornatus
																				x			x	*Lunatisporites noviaulensis*
						x					x						x			x			x	*Brachysaccus* spp.
								x	x															*Chasmatosporites apertus*
														x	x	x	x			x				*Pinuspollenites minimus*
								x	x															*Triadispora aurea*
									x	x														*Angustisulcites klausii*
																				x			x	*Concentrisporites hallei*
																				x				*Duplicisporires* sp.
																				x				*Partitisporites* spp.
																				x				*Podocarpidites rousei*
																							x	*Lunatisporites* spp.
																							x	*Perinopollenites elatoides*
					b																b			Plankton & varia
										x	x						x						x	*Micrhystridium* spp.
												x	x											*Tasmanites* spp.
								x	C	x	x		x	x	x	C	C			x				*Veryhachium* spp.
																	x							*Cymatiosphaera* spp.
																								Dictyotidium tenuiornatum
																								Crassosphaera spp.
																								Foraminiferal lining
																								Fungal remain (hyphae)
								x	x	x	x	x	x		x									*Plaesiodictyon* spp.
x										x	x	x	x							x			x	*Botryococcus* spp.
																								Leech cocoon
										x														Algal bodies
													A				x	x						Mussel
																								Foraminiferal lining
																								Solisphaeridium spp.
								x			x	C	C	C	C	C	C	x						Dinocysts (indeterminate)
																								Ammonoid
		x	x	x							x					x	C							*Rhaetogonyaulax* spp.
															x									*Heibergella salebrosacea*
															x									Ichtyosaur
															x									*Rhaetogonyaulax* sp. (double horn)
															x									*Sverdrupiella manicata*
																x	C							*Heibergella asymmetrica*
																x	C							Leiosphere (indeterminate)
																x	C							*Rhaetogonyaulax rhaetica*
					b											x	x				b			*Sverdrupiella* spp.
																x	C							*Sverdupiella mutabilis*
Aulisporites astigmosus								Rhaetogonyaulax spp.					Rh.	L. lundbladii						L. lundbladii				Composite Assemblage Zone

*** Svenskøya: The sample heights from Svenskøya Formation in this section have been projected on to a neighbouring section in the valley Binnedalen

**** (Rhaetogonyaul): Composite assemblage zone, or age in brackets, shows a low level of confidence

HOPEN - KAPP TOSCANA GROUP

LOCALITIES	IVERSENFJELLET															LYNGEFJELLET SOUTH										
Lithostratigraphy	De Geerdalen Formation															De Geerdal Fm.					Flatsalen Fm. Slottet Bed					
	Locality 31 (IVE)															Locality 32c (LYS)										
	-5	IVE-1											-2	IVE-3		LYS-1								LYS-3		LYS-1
Age	Carnian						late Carnian						indet.			late Carnian					Norian					
*Sample identification Height above base of section	9	12	14	15	16	18	19	20	21	24	27	28	30	31	32	105	106	107	108	109	110	111	112	149	150	1-113
Spores / **Height above sea leve	4	60	67	70	80	90	90	117	119	150	198	203	213	228	229	147	149	151	153	159	212	212	212	213	214	214+
Anapiculatisporites spiniger	x	x	x				x			x	x	x				x										
Aratrisporites spp.	x	x		x	x		C	C	x	x	x	x	x			x										
Deltoidospora australis	x					x	x			x		x	x					x	x	x				x		x
Deltoidospora minor	x	x		x	x		x	x		A	C	x	x			x	x	x	x	x	x	x	x	x	x	x
Dictyophyllidites mortoni	x	x	x	x	x		x			x	x							x	x	x	x		x			
Leschikisporis aduncus	x	x	C	x	x	A	x	A	x	x	x	C	x			x	C	x	x	x				x		
Aratrisporites macrocavatus	x	x	x							x	x										x					x
Baculatisporites comaumensis	x	x	x	x	x					x			x													
Kraeuselisporites spinosus	x	x	x		x					x																
Kyrtomisporis speciosus	x						x										x		x	x				x		x
Microreticulatisporites fuscus	x	x	x	x	x		x	x									x	x	x	x						
Osmundacidites spp.	x	x		x	x																					
Polypodiisporites ipsviciensis	x									x									x	x	x			x	x	x
Rogalskaisporites cicatricosus	x																				x					x
Calamospora spp.	x						C	C		A	x							x	x							
Gleicheniidites senonicus	x					x	x				x						x	x	x	x					x	
Lycopodiacidites rugulatus	x									x																
Polycingulatisporites crenulatus	x	x			x																					
Camarozonosporites rudis	x		x				x			x																
Spores (abundance)	A	A	A	x	A	A	C	C	x	A	A	C	C													
Deltoidospora neddeni	x	x	x				A	A	C	A	x															
Foveasporis spp.	x	x								x																
Kyrtomisporis niger	x									x																
Kraeuselisporites sp.B	x	x								x																
Aratrisporites palettae	x	x	x	x	x																					
Lycopodiacidites kokenii	x		x																							
Lycopodiacidites spp.	x		x																							
Dictyophyllidites spp.		x					x			x	x						x	x	x		x		x			
Conbaculatisporites spp.		x								x	x					x		x	x	x				x		x
Striatella seebergensis		x	x		x		x			x	x							x		x		x				x
Stereisporites spp.		x	x																x	x	x			x	x	x
Aratrisporites sp. large		x	x				x			x	C	C														
Densosporites sp.		x					x																			
Zebrasporites kahleri		x																								
Zebrasporites laevigatus			x							x																
Leptolepidites spp.			x				x																			
Concavisporites intrastriatus				x	x		x																			
Polycingulatisporites spp.					x																					x
Kyrtomisporis gracilis							x											x	x	x	x	x		x		x
Conbaculatisporites hopensis							x			x	x							x	x	x						x
Staplinisporites caminus							x			x											x					
Retitriletes spp.							x																			
Aratrisporites laevigatus										x									x	x						
Polypodiisporites sp. (granulate)										x																x
Gordonispora fossulata										x	x							x	x	x						
Aratrisporites scabratus										x	x															
Concavisporites sp. (ornamented)										x	x															
Retusotriletes spp.										x	x															
Anapiculatisporites spp.										x																
Leptolepidites equatibossus										x								x						x		
Densoisporites sp. (large specimen)											x	x														
Polypodiisporites sp. (smooth specimen)												x														
Kraeuselisporites sp. A (equatorial flange)																x										x
Todisporites spp.																x	x	x	x	x	x					
Kyrtomisporis spp.																	x			x	x	x	x	x		x
Kraeuselisporites sp. (apiculate)																	x				x					x
Kyrtomisporis laevigatus																	x			x	x					x
Auritulinasporites triclavis																		x	x					x		x
Acanthotriletes spp.																		x	x		x					
Uvaesporites argentaeformis																						x		x		
Foveosporites spp.																							x			
Lycopodiumsporites austroclavatidites																								x		x
Camarozonosporites laevigatus																										x
Kraeuselisporites cooksonae																										x
Zebrasporites interscriptus																										
Verrucatosporites scabratus																										
Neoraistrickia taylorii																										
Annulispora folliculosa																										
Perotrilites spp.																										
Punctatisporites spp.																										
Acanthotriletes varius																										
Foveosporites sp.A																										
Ischyosporites spp.																										
Limbosporites lundbladii																										
Annulispora sp. A																										
Rogalskaisporites barentzii																										
Discisporites spp.							b							b												
Kraeuselisporites reissingeri							©	©	©																	
Composite Assemblage Zone	Aulisporites astigmosus												Indetermin.			A. astigmosus					****(Rhaetogonyaul.)					Rh.

LEGEND
A abundant
C common
x present
R reworked
(stippled) barren sample
(ruled) sample from coal layer

* Sample identifications refer to a NPD (Norwegian Petroleum Directorate) project 1995
** Sample heights are correct within each of the three localities from Lyngefjellet, but not between sections measured at different time

A.23.2 Iversenfjellet, Lyngefjellet South and West and Binnedalen, Localities 31, 32c, a, d and b, Kapp Toscana Group.

HOPEN - KAPP TOSCANA GROUP

LYNGEFJELLET, BINNEDALEN													LYNGEFJELLET W.						BINNEDALEN					LOCALITIES
De Geerdalen Formation													Flatsalen Fm						Fl	***Svenskøya				Lithostratigraphy
													Slot.											
Locality 32a (LY-1)													Locality 32d (LYN)							Loc. 32b (LY-1)				
1-1	1-2	1-5	1-6	1-23	1-7	1-27B	1-27	1-9	1-10	1-11	1-12	1-14								1-36B	1-36A	1-40B	1-40A	
Carnian								late Carnian					Norian							Norian				Age
60	61	64	65	123	66	127B	127	68	69	70	71	73	1-2	1-7	1-6	1-5	1-4	1-3		136B	136A	140B	140A	* Sample identification
0	5	36	63	75	83	98	98	107	117	132	141	153	?	?	?	?	?	?		206	206	245	245	Height above base of sectior
30	35	69	93	105	113	128	128	137	147	162	171	183	170	180	?	?	?	200		236	236	275	275	Spores / **Height above sea leve
x				C		x	x	x	x	x	x				x								x	*Anapiculatisporites spiniger*
x						x		x	x	x		C			x					x			C	*Aratrisporites* spp.
x		x				x					x	x			x	x	x			x		x	x	*Deltoidospora australis*
x	x	x	x			C	x	x	x	x	x	x		x	x	x	x			x		x	x	*Deltoidospora minor*
x			x	x				x	x	x	x	x		x			x			x			x	*Dictyophyllidites mortoni*
C	x	A	A			C	x																x	*Leschikisporis aduncus*
												x			x		x			x			x	*Aratrisporites macrocavatus*
						x					x	x					x			x			x	*Baculatisporites comaumensis*
											x	x											x	*Kraeuselisporites spinosus*
							x			x	x	x			x		x			x			x	*Kyrtomisporis speciosus*
x		x																					x	*Microreticulatisporites fuscus*
x												x								x			x	*Osmundacidites* spp.
			x									x			x		x						x	*Polypodiisporites ipsviciensis*
x												x								x			x	*Rogalskaisporites cicatricosus*
x		x	x			C	x	x	x	x	x									x				*Calamospora* spp.
								x	x		x	x				x	x			x				*Gleicheniidites senonicus*
											x									x				*Lycopodiacidites rugulatus*
												x												*Polycingulatisporites crenulatus*
								x																*Camarozonosporites rudis*
																								Spores (abundance)
																								Deltoidospora neddeni
																								Foveasporis spp.
																								Kyrtomisporis niger
																								Kraeuselisporites sp.B
																								Aratrisporites palettae
																								Lycopodiacidites kokenii
																								Lycopodiacidites spp.
x						x	x	x	x	x	x	x		x		x	x			x			x	*Dictyophyllidites* spp.
x		x	x			C	x	x	x	x	x	x											x	*Conbaculatisporites* spp.
			x				x	x	x	x		x								x			x	*Striatella seebergensis*
																								Stereisporites spp.
																								Aratrisporites sp. large
															x									*Densosporites* sp.
																								Zebrasporites kahleri
															x		x					x	x	*Zebrasporites laevigatus*
																		x						*Leptolepidites* spp.
																								Concavisporites intrastriatus
												x											x	*Polycingulatisporites* spp.
												x											x	*Kyrtomisporis gracilis*
x		x	x			x			x	x		x												*Conbaculatisporites hopensis*
x											x													*Staplinisporites caminus*
																								Retitriletes spp.
																							x	*Aratrisporites laevigatus*
																	x							*Polypodiisporites* sp. (granulate)
																								Gordonispora fossulata
																								Aratrisporites scabratus
																								Concavisporites sp. (ornamented)
																								Retusotriletes spp.
																								Anapiculatisporites spp.
																								Leptolepidites equatibossus
																							x	*Densoisporites* sp. (large specimen)
																							x	*Polypodiisporites* sp. (smooth specimen)
															x		x			x			x	*Kraeuselisporites* sp. A (equatorial flange)
x																								*Todisporites* spp.
x						x						x											x	*Kyrtomisporis* spp.
																								Kraeuselisporites sp. (apiculate)
																								Kyrtomisporis laevigatus
x				x													x			x			x	*Auritulinasporites triclavis*
																								Acanthotriletes spp.
										x		x												*Uvaesporites argentaeformis*
												x												*Foveosporites* spp.
																								Lycopodiumsporites austroclavatidites
								x	x	x		x											x	*Camarozonosporites laevigatus*
																								Kraeuselisporites cooksonae
															x								x	*Zebrasporites interscriptus*
		x						x	x	x	x						x			x		x		*Verrucatosporites scabratus*
				cf.		x		x	x	x		x								x				*Neoraistrickia taylorii*
				x											x	x	x							*Annulispora folliculosa*
												x								x			x	*Perotrilites* spp.
												x								x			x	*Punctatisporites* spp.
												x												*Acanthotriletes varius*
																				x			x	*Foveosporites* sp.A
																				x			x	*Ischyosporites* spp.
																				x		x	x	*Limbosporites lundbladii*
																				x				*Annulispora* sp. A
																						x	x	*Rogalskaisporites barentzii*
					b								b								b		x	*Discisporites spp.*
																							x	*Kraeuselisporites reissingeri*
Aulisporites astigmosus								Rhaetogonyaulax spp.					Rh.	L. lundbladii						L. lundbladii				Composite Assemblage Zone

*** Svenskøya: The sample heights from Svenskøya Formation in this section have been projected on to a neighbouring section in the valley Binnedalen

**** (Rhaetogonyaul): Composite assemblage zone, or age in brackets, shows a low level of confidence

Festningen (Table A.1.2) and in the Flatsalen Formation at Tumlingodden (Table A.22). On Hopen, it is so far only recorded from Section LYN. The association is attributed to the *Limbosporites lundbladii* Composite Assemblage Zone.

Kapp Toscana Group at Binnedalen, Lyngefjellet
There are two localities from Binnedalen, Lyngefjellet area. Locality 32a (LY–1) covers the De Geerdalen Formation and Locality 32b (LY–1) covers the Svenskøya Formation.

Section LYN (32d), exposing the Slottet Member and the Flatsalen Formation at Lyngefjellet West, has a stratigraphic position between the De Geerdalen Formation of section LY–1 (32a) and the Svenskøya Formation of section LY–1 (32d). This is also reflected by palynology.

De Geerdalen Formation
The lowest samples from this formation (Locality 32a, LY 30.0–93.0 m, Table A.23) are dominated by terrestrial particulate organic matter. The pollen shows low diversity: common *Aulisporites astigmosus*, bisaccate pollen and *Concentrisporites pseudosulcatu*s characterise the association. Spores show an acme of *Leschikisporis aduncus*. Sporadically occurring dinoflagellate cysts have been identified as *Rhaetogonyaulax* spp. An interval (105.0–128.0 m) with samples of very low productivity separates this part of the section from the richer interval above. The palynoflora of this interval is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

The interval from 137.0 to 183.0 m (Table A.23) shows an increased diversity of pollen, with *Protodiploxypinus* spp. (dominant), *C. pseudosulcatus* (common), *Angustisulcites klausii*, *Ricciisporites* spp. and *Triadispora* spp. The characteristic early Carnian forms *A. astigmosus* and *L. aduncus* seem to be rare or absent. Spores include *Uvaesporites argentaeformis*.

The richer plankton association of this sample interval comprises indeterminate dinocysts, rare *Rhaetogonyaulax* spp., the acritarchs *Veryhachium* and *Micrhystridium* and the fresh to brackish water algae *Botryococcus* and *Plaesiodictyon*. The association based on this evidence and the presence of *Triadispora* spp. as well as *Angustisulcites klausii*, suggests assignment to the *Rhaetogonyaulax* spp. Composite Assemblage Zone and is considered of late Carnian age.

Wilhelmøya Subgroup, Svenskøya Formation
Only two sample levels, 236.0 and 275 m from Locality 32d, have been investigated. Palynomorphs and variably degraded, woody material dominate. Pollen includes *Concentrisporites hallei*, *Perinopollenites elatoides*, *Pinuspollenites* spp. (large specimens), *P. minimus*, *Podocarpidites rousei* and a diverse *Protodiploxypinus* group. Spores include *Foveosporites* spp., *Ischyosporites* spp., *Limbosporites lundbladii*, *Rogalskaisporites barentzii*, *Zebrasporites interscriptu*s and *Z. laevigatus*. Plankton comprise rare *Veryhachium* spp. and *Botryococcus* spp. (Table A.23) bearing evidence of a marginal-marine depositional environment. The assemblage is identified as belonging to the *Limbosporites lundbladii* Composite Assemblage Zone.

The assemblages recovered from the Svenskøya Formation correspond to assemblages described previously from Hopen and then assigned to the Iversenfjellet Formation (Smith 1974) and the Flatsalen Formation (Smith et al. 1975, Bjærke and Manum 1977). The deposits were then considered as being of Rhaetian age. The age of the assemblage was later revised as Norian (Smith 1982), based upon the Norian ammonoids described by Pčelina (1972b) and Korčinskaja (1980) and the middle Norian age of similar assemblages from the Canadian Arctic Archipelago (Fisher 1979).

A.10 Bjørnøya

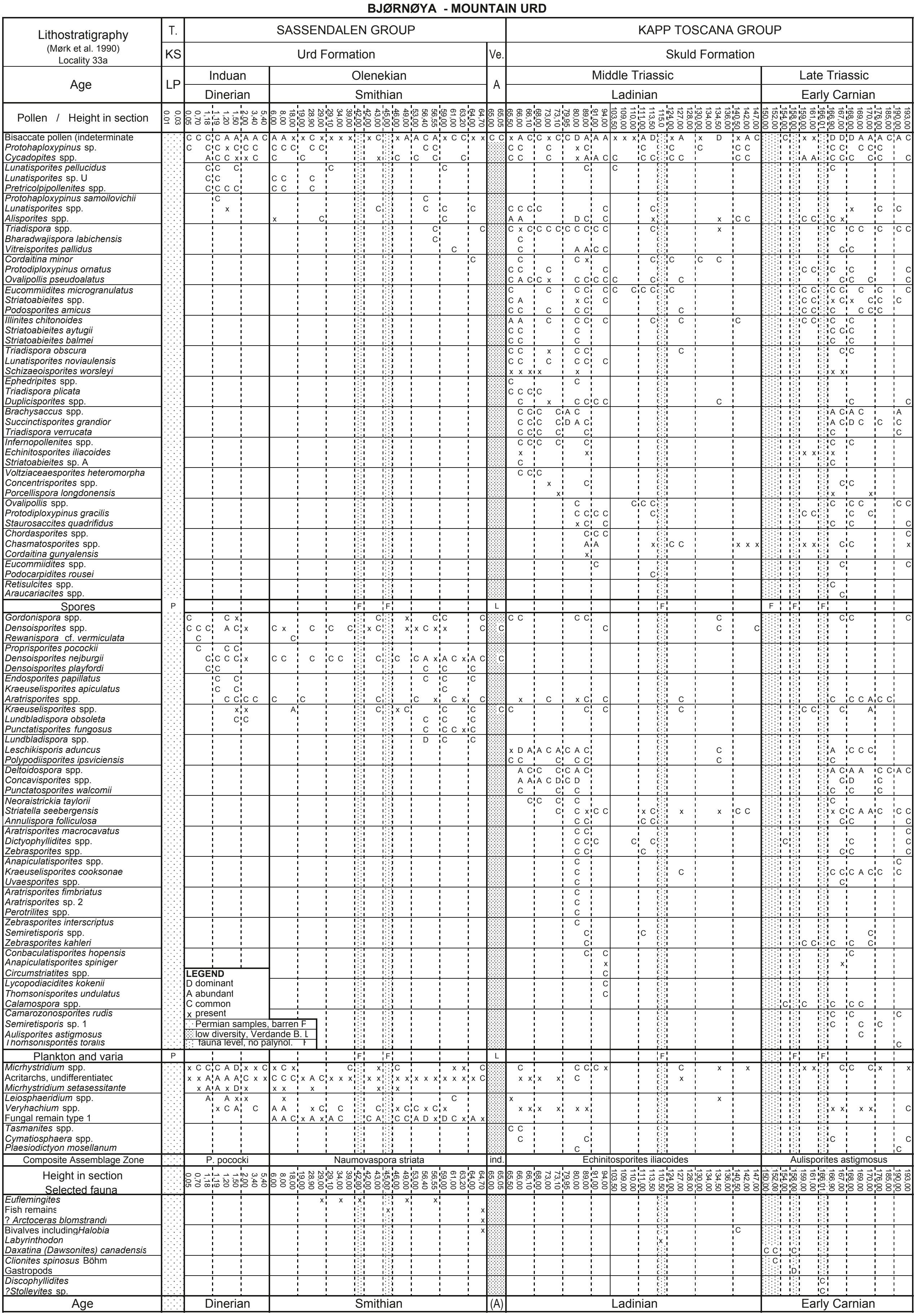
Bjørnøya is located on the Stappen High approximately halfway between Spitsbergen and northernmost Norway (Locality 33, Figure 17). It displays a Late Precambrian to Triassic succession. The Triassic strata rest on Upper Permian limestone and include the Lower Triassic Urd Formation (65 m) of the Sassendalen Group and the Middle to Upper Triassic Skuld Formation (135 m) of the Kapp Toscana Group.

The Triassic palynology of Bjørnøya was published by Mørk et al. (1990). That study involved about 140 palynological samples; about half of them were productive and have been included in the distribution chart. The age interpretation for parts of the Skuld Formation has been modified in the present paper. The revised distribution chart also includes the levels with stratigraphically important fauna (Table A.24, Plate 10).

A.10.1 The peak Urd at Miseryfjellet

Miseryfjellet is located in the southeastern part of the island. The peak Urd with the type section through the Triassic (Locality 33a,) represents its southernmost part. The Triassic deposits rest disconformably on the Upper Permian rocks of the Miseryfjellet Formation. The two samples representing the contact between the Miseryfjellet Formation and the Sassendalen Group contained no palynomorphs (Table A.24).

Sassendalen Group
Urd Formation
Poorly preserved organic material recovered from the lowermost interval (0.05–3.4 m), allows identification



A.24 Mountain Urd, Locality 33a, Sassendalen and Kapp Toscana groups.

of taeniate bisaccate pollen, *Cycadopites* spp. and *Pretricolpipollenites* spp. together with dominant cavate spores and *Proprisporites pocockii*. The abundant plankton includes *Micrhystridium setasessitante*. The association corresponds to the *Proprisporites pocockii* Composite Assemblage Zone. An interval with samples of reduced productivity separates this interval from the one above.

The upper part of the interval 6.0–64.7 m is dated by ammonoids. *Euflemingites* occurs at 29.0 m and cf. *Arctoceras blomstrandii* together with bivalves at 64.7 m (Pčelina 1972a). The preservation of the palynomorphs is moderately poor to poor. At 29.1–42.0 m, below the so called 'Fish beds', samples are palynologically almost barren. According to Pčelina (1972a) and Mørk et al. (1990) this interval is dated as Smithian (early Olenekian).

The palynological assemblages contain abundant 'Fungal remain type 1' (sensu Hochuli et al. 1989) and abundant and diverse plankton. *Punctatisporites fungosus* and cavate spores (*Densoisporites* spp. and *Lundbladispora* spp.) show increasing abundance. Above the 'Fish Beds', at 56.5 m, we note the presence of *Bharadwajispora labichensis* and *Triadispora* spp. The assemblage is correlated with the *Naumovaspora striata* Composite Assemblage Zone.

Verdande Bed
The 0.3 m-thick Verdande Bed, separating the Urd and Skuld formations, consists of reworked phosphate nodules that contain only rare palynomorphs. The stratigraphically significant *Densoisporites nejburgii* has been recovered from one nodule and indicates a youngest possible mid Anisian age. The abundant, densely aggregated granular organic material may reflect presence of degraded algal material (AOM).

Kapp Toscana Group
Skuld Formation
The lowermost parts of the formation (65.5–147.0 m, Table A.24) have poorly to moderately well-preserved, organic remains. Diverse palynological assemblages show marked turnovers at 65.5–66.0 m and at 80.0 m. Marine plankton include *Cymatiosphaera* and *Tasmanites*. The green algae *Plaesiodictyon mosellanum* (at 80.0 m) reflect freshwater influx. The other plankton groups show lower diversity than in the Urd Formation and 'Fungal remain type 1' has no record in this interval. The income of a stratigraphically significant group of pollen and spores allows confident correlation with the *Echinitosporites iliacoides* Composite Assemblage Zone.

The associations from 103.0–147.0 m are of low diversity, apparently with the last occurrence of pollen such as *Bharadwajispora labichensis*, *Cordaitina minor*, *Triadispora plicata* and *Voltziaceaesporites heteromorpha* and with the first record of *Podocarpidites rousei* at 113.5 m. The entire interval is included within the *Echinitosporites iliacoides* Composite Assemblage Zone. A labyrinthodont amphibian has been recovered from 120 m (Mørk et al. 1990).

The interval 150.0–193.0 m represents the uppermost beds of the Skuld Formation. Up to the 159.0 m level, these are palynologically nearly barren, but include a rich fauna marked by the presence of *Daxatina* cf. *canadensis*. The ammonoid *D. canadensis* was previously regarded as restricted to Ladinian deposits on Svalbard. Studies carried out by Mietto et al. (2008) in the Italian Dolomites show that this species has its range in the *canadensis* Subzone of the early Carnian Trachyceras Zone.

Palynological assemblages from the 159.0–193.0 m interval include *Araucariacites* spp., *Aulisporites*

BJØRNØYA - MISERYFJELLET

MISERYFJELLET NORTH Lithostratigraphy Locality 33b	SKREKKJUVET								OST		BRETTINGSDALEN												
	T.Gp		SASSENDALEN Gp								SASSENDALEN GROUP												
	K.Ha		Miseryfj. Fm								Miseryfjellet Formation												
Age	Carb		Permian						Trias		Permian												
Pollen / Height in section	-5.00	-1.00	2.00	5.00	11.00	15.00	20.00	31.00	-1.00	-0.10	11.00	12.00	15.00	20.00	25.60	32.00	34.00	36.00	43.00	54.00	67.00	78.00	112.00
Vittatina spp.					x						x	x											
Vittatina striata				x								x											
Vittatina simplex												x											
Cycadopites spp.	x		x				x								x		x		x				
Protohaploxypinus spp.																x							
Bisaccate indeterminate pollen		x								x								x					
Sulcatisporites nilssoni										x											x		
Spores																							
*Punctatisporites*spp.			x	x	x					x		x	x				x				x		
Verrucosisporites spp.										x			x	x									
Leiotriletes spp.			x			x		x					x			x			x			x	
Kraeuselisporites spp.		x		x						x				x									
Neoraistrickia spp.														x									
Trilete indeterminate spore	x		x												x			x				x	
Lophotriletetes spp.				cf.																			
Kraeuselisporites punctatus									x														
Plankton and varia																							
Micrhystridium spp.	x				x			x			x	x		x	x	x	x			x			x
Acritarchs, undifferentiated																							
Micrhystridium setasessitante																							

LEGEND
x present

A.25 *Miseryfjellet North, Locality 33b, Sassendalen Group.*

astigmosus, *Camarozonosporites rudis*, *Echinitosporites iliacoides*, *Retisulcites* spp., *Semiretisporis* sp. 1, *Staurosaccites quadrifidus*, *Thomsonisporites toralis* and *Triadispora verrucata*. The record of *E. iliacoides* above *Daxatina* cf. *canadensis* proves that this species continues into the early Carnian.

The *Aulisporites astigmosus* Composite Assemblage Zone is defined by the co-appearance of *A. astigmosus*, *Camarozonosporites* spp., *Camerosporites secatus*, *Echinitosporites iliacoides*, *Enzonalasporites vigens*, *Kyrtomisporis* spp. and *Ricciisporites tuberculatus*. So far the complete early Carnian association has not been recorded elsewhere on Svalbard, where *E. iliacoides* seems to be missing. However, *E. iliacoides* is regularly present in many of the stratigraphic cores drilled in the Barents Sea (see 7533/2–U–1, 7533/3–U–7, 7534/4–U–1, 7831/2–U–2 and –1 and 7830/3–U–1). The presence of *E. iliacoides* in the early Carnian agrees with the observations reported by Mørk et al. (1993) from the lower Carnian of Russia. In the latter area there is an acme for *E. iliacoides* in the early Carnian.

A.10.2 Miseryfjellet, central East

The palynology of the Permian–Triassic boundary strata has been studied at the locality Miseryfjellet, the central East part (Osten, Locality 33b, Table A.25). The organic remains are poorly preserved and the palynological results have no biostratigraphic significance.

B. Stratigraphic boreholes

In order to provide additional information on the Triassic succession of the Barents Sea area, shallow stratigraphic cores were drilled by IKU (now SINTEF Petroleum Research) between 1984 and 1990 and by the Norwegian Petroleum Directorate between 1990 and 2005. This study presents the results from 22 continuous cores representing localities where Triassic rocks subcrop beneath a relatively thin Quaternary cover (Figures 2 and 4, Tables A.26–46). Various aspects of the palynology and its integration with other disciplines have been published previously (Mangerud and Rømuld 1991, Mørk et al. 1993, Mangerud 1994, Bugge et al. 1995, 2002, Nilsson et al. 1996, Vigran et al. 1998, Galfetti et al. 2007, Hermann et al. 2010, Hochuli et al. 2010b and Hochuli and Vigran 2010) and are referred to in this paper. Detailed palynological work on some of the NPD cores is currently being carried out at the University of Bergen.

Nearly all of the shallow stratigraphic cores from the Barents Sea area penetrate strata containing well-preserved palynological assemblages that provide valuable stratigraphic data (Tables A.26–A.46, Figure A.1). These data also add to our knowledge of the palaeogeographic distribution of the floras in this area.

B.1 Cores from the Finnmark Platform

The shallow stratigraphic cores 7129/10–U–1 and 7128/12–U–1 drilled in 1986 and 1987 penetrated the latest Permian and earliest Triassic on the Finnmark Platform. Studies of these cores have been published by Mangerud (1994), Bugge et al. (1995) and Hochuli et al. (2010b). The cored material allows tracing of the terrestrial ecosystems across the Permian/Triassic transition with a time resolution on the order of 10 kyr, based on a high-resolution C_{org}-isotope stratigraphy (Hermann et al. 2010, Hochuli et al. 2010b). The two cores described by Mangerud (1994) are compiled as Tables A.26.1.1–3. They provide information about first appearances of taxa in the Barents Sea and are of crucial importance for our definition and dating of the Permian–Triassic transition: the *Uvaesporites imperialis* and *Reduviasporonites chalastus* Composite Assemblage zones (Figure 4). In addition, we include the range chart for Core 7128/9–U–1 (Table A.26.2).

B.1.1, Core 7128/9–U–1

This core was drilled in 1988 and represents 12.75 m of the lower part of the Sassendalen Group. The palynological assemblages are of very low productivity (Table A.26). Based on seismic correlations, the core is placed stratigraphically below a tentative Smithian reflector (T. Bugge pers. comm. 2012).

Havert Formation
The interval of 87.55–72.10 m comprises poorly preserved pollen, recorded as *Striatoabieites* spp. and *Ephedripites* spp., as well as spores such as *Calamospora* spp., *Concavisporites* spp., *Deltoidospora* spp. and *Gordonispora lubrica*. The assemblages have limited stratigraphic significance and an undifferentiated Early Triassic age is suggested for these deposits.

B.1.2, Core 7128/12–U–1 and 7129/10–U–1

The youngest Permian and the Havert Formation
The associations between 119.13–116.47 m of Core 7128/12–U–1 and between 74.47–65.51 m of Core 7129/10–U–1 represent the youngest palynologically productive Permian deposits, with associations defined as the *Scutasporites* sp. cf. *S. unicus*–*Lunatisporites* spp. Assemblage (Mangerud 1994). The overlying deposits contain associations defined as the *Tympanicysta stoschiana*–*Lundbladispora obsoleta* Assemblage (Mangerud 1994). This is now revised and comprises the *Uvaesporites imperialis* and the *Reduviasporonites chalastus* Composite Assemblage Zones of latest

FINNMARK PLATFORM

Core 7128/12-U-1	148.54	148.49	146.87	144.93	139.49	139.21	139.07	137.75	119.13	119.09	118.14	117.17	116.49	116.47	116.17	115.94	112.30	109.65	104.73	103.90	100.22	94.23	84.28	80.26	75.05	70.36	66.04	64.34
Lithostratigraphy	Tempelfjorden Group														Sassendalen Group													
	Late Permian																		P/T boundary									
Age	Changhsingian																		Griesbachian									
	Lopingian																		Induan									
Pollen / sample depth	148.54	148.49	146.87	144.93	139.49	139.21	139.07	137.75	119.13	119.09	118.14	117.17	116.49	116.47	116.17	115.94	112.30	109.65	104.73	103.90	100.22	94.23	84.28	80.26	75.05	70.36	66.04	64.34
Klausipollenites staplinii	x	x		x		x			x	x			x	x	x	x	x	x	x	x	x				x		x	x
Protohaploxypinus spp.	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Cycadopites spp.	x				x	x			x					x	x	x	x		x	x	x	x	x	x	x	x	x	x
Striatoabieites spp.	x		x	x		x	x		x	x					x	x	x	x	x	x	x	x	x	x			x	
Klausipollenites spp.	x	x	x	x	x	x	x			x	x			x	x	x	x	x	x	x	x	x	x	x	x	x		
Vesicaspora spp.	x			x	x	x																			x	x		
Falcisporites spp.	x		x	x	x	x	x							x	x		x	x	x	x	x		x					
Alisporites spp.	x	x	x	x	x	x			x	x				x		x	x											
Limitisporites spp.	x	x	x		x	x		x		x					x													
Vittatina spp.	x	x	x	x	x	x	x		x	x			x	x	x													
Piceapollenites spp.	x	x							x	x			x	x														
Protohaploxypinus perfectus	x		x	x		x			x	x																		
Florinites luberae	x	x	x	x	x	x			x	x																		
Vittatina striata	x	x	x	x	x	x			x	x																		
Vittatina simplex	x	x	x			x			x	x																		
Striatopodocarpidites cancellatus	x			x					x	x																		
Vittatina vittifera	x	x	x	x	x	x			x																			
Vittatina saccata	x	x	x	x	x	x																						
Vittatina minima	x	x	x	x	x																							
Protohaploxypinus amplus	x																											
Cordaitina spp.		x				x			x	x																		
Nuskoisporites spp.		x																										
Protohaploxypinus varius			x	x	x	x			x	x																		
Dyupetalum sp.			x	x	x	x																						
Florinites spp.			x	x	x	x																						
Lueckisporites spp.				x	x				x	x							x				x							
Striamonosaccites spp.				x					x																			
Vesicaspora schemelii				x																								
Lueckisporites sp. A					x				x	x																		
Vittatina costabilis					x	x			x	x																		
Protohaploxypinus minor				x																								
Striatoabieites multistriatus									x	x																		
Hamiapollenites bullaeformis						x																						
Platysaccus spp.						x			x	x							x											
Lueckisporites virkkiae						x			x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Vitreisporites signatus						x				x						x			x	x	x	x				x		x
Pallidosporites minimus																												
Protohaploxypinus globus									x	x																		
Scutasporites cf. *unicus*									x	x																		
Lunatisporites spp.									x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Falcisporites zapfei									x	x		x			x													
Jugasporites sp. A									x	x																		
Libumella sp.									x	x																		
Lueckisporites sp. B									x																			
Inaperturopollenites nebulosus										x			x	x	x	x	x						x			x		
Lunatisporites noviaulensis													x	x	x	x	x		x	x	x			x				
Ephedripites spp.														x	x	x	x		x	x	x	x	x	x	x		x	x
Protohaploxypinus samoilovichii																												
Scutasporites spp.																												
Striatoabieites richteri															x	x	x	x	x	x			x	x	x	x		x
Ephedripites steevesii															x	x	x	x	x	x	x							x
Crustaesporites globosus															x				x			x		x	x			x
Assemblages	Dyup.- H. bullae						indet		Scuta.- Lunati.						U.imp.				R.chalastus									

7129/10-U-1	83.03	82.05	81.56	79.81	78.91	77.98	77.28	74.47	72.27	70.97	69.39	67.19	65.51	64.36	63.56	63.10	62.20	59.15	58.95	57.25	56.78	56.43
Lithostratigraphy	Tempelfjorden Group													Sassendalen Gp								
	Late Permian																					
Age	Changhsingian																					
	Lopingian																					
Pollen / sample depth	83.03	82.05	81.56	79.81	78.91	77.98	77.28	74.47	72.27	70.97	69.39	67.19	65.51	64.36	63.56	63.10	62.20	59.15	58.95	57.25	56.78	56.43
Klausipollenites staplinii								x	x				x	x			x		x	x	x	x
Protohaploxypinus spp.		x	x	x		x			x				x	x		x		x	x	x	x	x
Cycadopites spp.						x		x					x	x								
Striatoabieites spp.				x				x	x				x			x	x	x	x	x	x	x
Klausipollenites spp.																						
Vesicaspora spp.													x									
Falcisporites spp.				x			x	x					x			x	x		x	x	x	x
Alisporites spp.		x		x		x		x					x									
Limitisporites spp.				x	x			x					x									
Vittatina spp.	x	x	x	x	x	x	x	x	x				x	x								
Piceapollenites spp.			x										x							x		
Protohaploxypinus perfectus			x	x			x	x	x				x								x	x
Florinites luberae			x	x	x	x		x	x				x									
Vittatina striata	x	x	x	x	x	x	x	x	x				x									
Vittatina simplex			x			x		x					x									
Striatopodocarpidites cancellatus																						
Vittatina vittifera			x	x			x						x									
Vittatina saccata				x		x	x		x				x									
Vittatina minima								x					x									
Protohaploxypinus amplus																						
Cordaitina spp.													x	x	x	x	x		x		x	x
Nuskoisporites spp.			x																			
Protohaploxypinus varius				x	x	x	x	x					x									
Dyupetalum sp.		x	x	x			x															
Florinites spp.				x				x					x									
Lueckisporites spp.								x					x						x		x	x
Striamonosaccites spp.				x	x																	
Vesicaspora schemelii								x					x	x					x	x	x	x
Lueckisporites sp. A													x									
Vittatina costabilis				x					x				x									
Protohaploxypinus minor			x	x				x														
Striatoabieites multistriatus			x	x				x					x									
Hamiapollenites bullaeformis		x	x	x	x	x																
Platysaccus spp.				x									x	x								
Lueckisporites virkkiae																			x		x	x
Vitreisporites signatus													x									
Pallidosporites minimus					x																	
Protohaploxypinus globus								x	x													
Scutasporites cf. *unicus*								x	x				x									
Lunatisporites spp.								x					x	x	x	x	x	x	x	x	x	x
Falcisporites zapfei																		x		x	x	
Jugasporites sp. A																						
Libumella sp.																						
Lueckisporites sp. B													x									
Inaperturopollenites nebulosus													x	x	x	x	x		x	x		x
Lunatisporites noviaulensis															x			x	x	x	x	x
Ephedripites spp.														x	x	x	x	x	x	x	x	x
Protohaploxypinus samoilovichii													x	x		x					x	
Scutasporites spp.													x									
Striatoabieites richteri															x		x		x	x		x
Ephedripites steevesii															x						x	x
Crustaesporites globosus																					x	x
Assemblages	Dyup.- H. bullae							Scuta.- Lunati.						Uvaesporites imperialis								

A.26.1.1 Core 7128/12-U-1, Tempelfjorden and Sassendalen groups, modified tables from Mangerud (1994).

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Core 7128/12-U-1 Lithostratigraphy	Tempelfjorden Group															Sassendalen Group													
Age	Late Permian																		P/T boundary									
	Changhsingian																		Griesbachian									
	Lopingian																		Induan									
Pollen continued / sample depth	148.54	148.49	146.87	144.93	139.49	139.21	139.07	137.75	119.13	119.09	118.14	117.17	116.49	116.47	116.17	115.94	112.30	109.65	104.73	103.90	100.22	94.23	84.28	80.26	75.05	70.36	66.04	64.34
Lunatisporites pellucidus																	x	x	x			x	x	x	x	x	x	x
Protohaploxypinus microcorpus																			x				x	x		x		
Lunatisporites transversundatus																				x				x				
Striatopodocarpidites pantii																								x	x	x		x
Klausipollenites schaubergeri																							x			x	x	x
Monosulcate pollen sp. A																												x
Lagenella delineatus																			x				x		x			
Piceapollenites sp. B																			x									
Spores																												
Calamospora spp.	x	x	x	x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Maculatasporites spp.	x	x	x	x	x	x						x	x	x	x	x	x	x	x	x		x	x		x	x	x	x
Kraeuselisporites spp.	x		x		x			x			x		x	x	x						x	x		x				x
Apiculatisporis spp.	x		x						x				x	x		x			x			x		x		x		
Leiotriletes spp.	x	x	x	x	x	x			x	x	x		x	x		x				x	x	x				x		
Punctatisporites spp.	x	x	x								x		x	x	x		x	x	x	x	x		x	x	x	x		
Neoraistrickia spp.	x	x	x		x	x			x	x						x												
Maculatasporites aff. *Reticulina*	x					x																					
Granulatisporites spp.		x	x						x									x	x	x						x		
Conbaculatisporites spp.		x	x	x						x																x		
Acanthotriletes spp.		x											x	x						x								
Lophotriletes spp.		x	x						x						x													
Baculatisporites spp.			x	x					x	x						x	x	x			x	x						
Verrucosporites spp.			x										x		x					x								
Convolutispora spp.			x		x				x																		
Gordonispora lubrica									x				x	x	x	x	x					x	x	x				
Indotriradites spp.													x	x														
Striatpodocarpidites spp.																								x	x			x
Cyclogranisporites spp.																x	x		x		x					x		
Striatpodocarpidites spp.																												
Klausipollenites spp.																												
Tiwariasporis spp.																												
Neoraistrickia cornutus						x																					
Leiotriletes sp. A						x			x	x			x	x	x	x	x	x	x	x	x		x	x		x	x	x
Laevigatosporites spp.						x								x													
Waltziaspora spp.						x																					
Gordonispora fossulata									x	x					x	x	x		x	x		x				x		
Punctatosporites spp.									x	x			x									x						
cf. *Dictyophyllidites mortonii*									x	x			x		x				x		x							
cf. *Rewanispora* sp.													x	x	x													
Triquitrites proratus													x	x	x							x				x		
Thymospora ipsviciensis													x	x	x	x			x	x								
Kraeuselisporites spinosus													x			x	x											
Kraeuselisporites apiculatus													x	x	x	x												
Ahrensisporites spp.													x															
Acanthotriletes tereteangulatus													x	x														
Polycingulatisporites spp.															x		x	x	x									
Rewanispora sp.																						x							
Simeonospora minuta														x	x		x			x							x	
Kraeuselisporites punctatus																												
Uvaesporites - morphon															x	x	x	x	x	x	x	x	x	x	x		x	x
Retusotriletes spp.															x		x						x	x				x
Assemblages	Dyup.- H. bullae						indet		Scuta.- Lunati						U.imp.				R.chalastus									

7129/10-U-1 Lithostratigraphy	Tempelfjorden Group													Sassendalen Gp								
Age	Late Permian																					
	Changhsingian																					
	Lopingian																					
Pollen continued / sample depth	83.03	82.05	81.56	79.81	78.91	77.98	77.28	74.47	72.27	70.97	69.39	67.19	65.51	64.36	63.56	63.10	62.20	59.15	58.95	57.25	56.78	56.43
Lunatisporites pellucidus														x					x			
Protohaploxypinus microcorpus																			x		x	x
Lunatisporites transversundatus																			x		x	
Striatopodocarpidites pantii																			x			x
Klausipollenites schaubergeri																						
Monosulcate pollen sp. A																					x	x
Lagenella delineatus																						
Piceapollenites sp. B																						
Spores																						
Calamospora spp.			x			x	x	x	x				x					x	x	x	x	x
Maculatasporites spp.				x	x			x							x	x	x	x	x	x	x	x
Kraeuselisporites spp.																						
Apiculatisporis spp.		x	x	x	x	x		x					x		x	x				x		x
Leiotriletes spp.			x	x			x	x					x	x	x	x	x	x	x	x	x	x
Punctatisporites spp.				x				x					x			x	x				x	x
Neoraistrickia spp.	x	x	x	x	x	x	x	x					x									
Maculatasporites aff. *Reticulina*	x		x	x																		
Granulatisporites spp.		x	x				x	x					x									x
Conbaculatisporites spp.			x		x																	
Acanthotriletes spp.				x										x						x		
Lophotriletes spp.			x	x										x								
Baculatisporites spp.																						
Verrucosporites spp.				x									x									
Convolutispora spp.			x	x			x	x						x								
Gordonispora lubrica				x	x									x	x						x	
Indotriradites spp.				x										x							x	
Striatpodocarpidites spp.		x		x	x			x					x		x			x	x	x	x	x
Cyclogranisporites spp.			x	x	x	x									x				x		x	x
Striatpodocarpidites spp.		x		x	x			x					x		x			x	x	x	x	x
Klausipollenites spp.				x		x	x								x	x			x	x	x	x
Tiwariasporis spp.							x		x													
Neoraistrickia cornutus			x																		
Leiotriletes sp. A														x	x	x	x	x	x	x	x	x
Laevigatosporites spp.																						
Waltziaspora spp.																						
Gordonispora fossulata																			x	x		
Punctatosporites spp.																			x	x	x	x
cf. *Dictyophyllidites mortonii*															x	x			x	x	x	x
cf. *Rewanispora* sp.																						
Triquitrites proratus														x			x			x		
Thymospora ipsviciensis														x						x	x	x
Kraeuselisporites spinosus													x								x	
Kraeuselisporites apiculatus																	x	x			x	x
Ahrensisporites spp.																						
Acanthotriletes tereteangulatus																				x	x	x
Polycingulatisporites spp.													x									
Rewanispora sp.													x	x	x	x		x	x	x	x	
Simeonospora minuta															x						x	
Kraeuselisporites punctatus														x							x	x
Uvaesporites - morphon														x	x	x	x	x	x	x	x	x
Retusotriletes spp.															x				x		x	x
Assemblages	Dyup.- H. bullae							Scuta.- Lunati						Uvaesporites imperialis								

A.26.1.2 Core 7128/12-U-1, Tempelfjorden and Sassendalen groups, modified tables from Mangerud (1994).

FINNMARK PLATFORM

Core 7128/12-U-1	Tempelfjorden Group														Sassendalen Group													
Lithostratigraphy	Late Permian																		P/T boundary									
	Changhsingian																		Griesbachian									
Age	Lopingian																		Induan									
Spores continued / sample depth	148.54	148.49	146.87	144.93	139.49	139.21	139.07	137.75	119.13	119.09	118.14	117.17	116.49	116.47	116.17	115.94	112.30	109.65	104.73	103.90	100.22	94.23	84.28	80.26	75.05	70.36	66.04	64.34
Polycingulatisporites densatus															x				x									x
Lundbladispora obsoleta															x	x	x	x	x	x	x	x	x	x	x	x	x	x
Endosporites papillatus															x													
Densoisporites spp.															x			x	x	x								
Densoisporites complicatus															x	x	x			x								
Anaplanisporites stipulatus															x				x	x					x		x	x
Laevigatosporites callosus																x										x	x	
Densoisporites playfordi																x	x		x									
Densoisporites nejburgii																x	x		x			x						x
Proprisporites pocockii																	x		x				x	x	x		x	x
Foveosporites spp.																	x		x									
Converrucosisporites spp.																	x											
Naumovaspora striata																			x	x				x				x
Lundbladispora spp.																			x		x	x						
Leptolepidites jonkeri																			x	x		x			x		x	x
Dictyotriletes spp.																			x									
Apiculatisporis lanjouwii																			x	x								x
Lycopodiacidites spp.																							x					x
Aratrisporites tenuispinosus																							x			x		
Concavisporites spp.																							x	x				
Dictyophyllidites spp.																										x		
Kraeuselisporites saeptatus																												x
Plankton and varia																												
Micrhystridium spp.	x	x	x	x	x	x		x	x	x			x	x	x	x		x	x		x	x	x			x		x
Cymatiosphaera spp.	x					x																			x			
Veryhachium spp.	x			x		x			x	x			x	x	x	x	x		x			x						
Scolecodont	x																					x						
Brazilea spp.					x	x																						
Tasmanites spp.					x																	x	x			x		
Unellium spp.									x	x																		
Pilasporites spp.													x	x	x		x				x				x			
Fungal remain															x		x	x	x	x		x	x	x	x	x	x	x
Fungal type B															x	x												
Reduviasporonites chalastus															x	x												
Circulisporites parvus															x													
Megaspore																	x					x			x			
Dictyotidium reticulatum																							x		x	x		
Grebespora concentrica																							x	x		x		
Foram inner lining																			x									
Assemblages	Dyup.- H. bullae						indet		Scuta.- Lunati						U.imp.				R. chalastus									

Tempelfjorden Group													Sassendalen Gp									7129/10-U-1
Late Permian																						Lithostratigraphy
Changhsingian																						
Lopingian																						Age
83.03	82.05	81.56	79.81	78.91	77.98	77.28	74.47	72.27	70.97	69.39	67.19	65.51	64.36	63.56	63.10	62.20	59.15	58.95	57.25	56.78	56.43	Spores continued
													x	x								*Polycingulatisporites densatus*
													x	x	x	x	x	x	x	x	x	*Lundbladispora obsoleta*
																			x	x	x	*Endosporites papillatus*
																						Densoisporites spp.
																				x	x	*Densoisporites complicatus*
														x				x	x	x	x	*Anaplanisporites stipulatus*
																				x	x	*Laevigatosporites callosus*
														x								*Densoisporites playfordi*
														x				x	x	x	x	*Densoisporites nejburgii*
																		x	x	x		*Proprisporites pocockii*
																		x			x	*Foveosporites* spp.
																						Converrucosisporites spp.
														x				x		x		*Naumovaspora striata*
													x	x	x	x	x	x	x	x	x	*Lundbladispora* spp.
														x						x	x	*Leptolepidites jonkeri*
													x	x						x		*Dictyotriletes* spp.
														x	x					x	x	*Apiculatisporis lanjouwii*
																					x	*Lycopodiacidites* spp.
																						Aratrisporites tenuispinosus
																						Concavisporites spp.
																						Dictyophyllidites spp.
																						Kraeuselisporites saeptatus
																						Plankton and varia
x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	*Micrhystridium* spp.
													x		x			x				*Cymatiosphaera* spp.
					x	x	x	x				x	x				x	x	x	x		*Veryhachium* spp.
		x										x										Scolecodont
				x	x	x																*Brazilea* spp.
x		x		x												x			x		x	*Tasmanites* spp.
							x					x										*Unellium* spp.
													x	x	x			x	x		x	*Pilasporites* spp.
													x	x	x	x	x	x	x	x	x	Fungal remain
														x					x		x	Fungal type B
														x			x		x	x	x	*Reduviasporonites chalastus*
													x									*Circulisporites parvus*
																				x	x	Megaspore
																						Dictyotidium reticulatum
																				x	x	*Grebespora concentrica*
																						Foram inner lining
Dyup.- H. bullae							Scuta.- Lunati						Uvaesporites imperialis									Assemblages

A.26.1.3 Core 7128/12-U-1, Tempelfjorden and Sassendalen groups, modified tables from Mangerud (1994).

FINNMARK PLATFORM

CORE 7128/9-U-1 Lithostratigraphy	Havert Formation						
Age	EarlyTriassic						
Triassic pollen / Depth in core	87,55	85,15	78,37	78,05	74,85	73,20	72,10
Striatoabieites cf. *aytugii*	x						x
Angustisulcites spp.	x						
Ephedripites spp.	x						
Gordonispora sp. cf. *G. lubrica*	x						
cf. *Uvaesporites* spp.			x				
Todisporites spp.			x				
Deltoidospora spp.			x				
Concavisporites spp.			x				x
Calamospora spp.							x
Composite Assemblage Zone	indeterminate						

A.26.2 Core 7128/9-U-1, Havert Formation, Sassendalen Group.

Permian (Changhsinghian) and Griesbachian age. The latter probably spans the Permian–Triassic boundary.

These composite assemblage zones also have records from Svalbard, at Festningen (Table A.1.1), Reinodden (Table A.3), Vikinghøgda (Table A.7) and Stensiöfjellet (Table A.8).

B.2 Cores from the Nordkapp Basin

Several shallow cores were drilled in the Nordkapp Basin during 1986 and 1987. They have been published by Bugge et al. (2002), but without palynological documentation. The six cores discussed here—7227/8–U–1, 7228/3–U–1 and 7230/5–U–3, –U–4, –U–5 and –U–6—penetrate the Sassendalen and Kapp Toscana groups (Tables A.27–A.32, Fig. 4). Two of the cores represent Triassic/Jurassic transitional beds (Tables A.31 and A.32).

B.2.1, Core 7230/5–U–6, early to possibly middle Anisian

The core was drilled in 1987 and penetrates 71.7 m of the Sassendalen Group. The distribution diagram of palynomorphs (Table A.27) is based on 42 samples. About half of the samples were barren and nine of them represent palaeosols.

Kobbe Formation
Interval 96.02–25.02 m
Throughout this interval there is a high abundance and diversity of the *Aratrisporites* spp. group and of smooth spores (*Calamospora* spp., *Concavisporites* spp., *Deltoidospora* spp. and *Leschikisporis aduncus*). Associated spores include *Apiculatisporites* spp., *Densoisporites nejburgii*, *Jerseyiaspora punctispinosa*, regular to common *Lundbladispora brevicula* and *Raistrickia* sp. Pollen include *Angustisulcites klausii*, *Cordaitina* spp., *Illinites chitonoides* and *Illinites* spp., *Triadispora* spp. and diverse taeniate bisaccates. *Kuglerina meieri* has records from 35.32 m. We assign this assemblage to the *Anapiculatisporites spiniger* Composite Assemblage Zone.

B.2.2, Core 7228/3–U–1, Anisian

This core was drilled in 1986 and penetrates 42.26 m of Middle Triassic strata (Table A.28).

Kobbe Formation
Interval 88.45–41.10 m
Rich palynological associations include dominant bisaccate pollen, *Illinites chitonoides*, *Lunatisporites noviaulensis*, *Podosporites amicus* and the *Protodiploxypinus* and *Triadispora* groups. Spores include dominant *Aratrisporites* spp. and smooth trilete spores. The interval 78.13–72.02 m shows very low productivity and plankton are missing. Above this level we note the incoming of *Accinctisporites* spp., *Protodiploxypinus decus*, *Anapiculatisporites spiniger* and *Kraeuselisporites dentatus* and the reappearance of abundant *leiospheres* and other plankton.

Based on the general assemblage composition we assigned it to the *Protodiploxypinus decus* Composite Assemblage Zone.

B.2.3, Core 7230/5–U–5, Ladinian

This core was drilled in 1987 and penetrates 26.4 m of the Sassendalen Group. The palynological diagram (Table A.29) based on 25 samples (5 barren) documents only the total ranges; quantitative information has been extracted from unpublished descriptive notes.

Snadd Formation
Interval 49.22–24.42 m
The associations are characterised by alternating dominance of bisaccate pollen and the *Aratrisporites* group. Dominant smooth spores include *Calamospora* spp. and *Leschikisporis aduncus*. Associated pollen include *Kuglerina meieri*, *Ovalipollis pseudoalatus*, *Protodiploxypinus macroverrucosus*, *Staurosaccites quadrifidus* and *Voltziaceaesporites heteromorpha*. In this association, *Jerseyiaspora punctispinosa*, with a range from the late Spathian through the middle Anisian, is considered reworked. Marine and rare freshwater plankton occur throughout. *Tasmanites* spp. seems to appear more regularly in the lower part of the core (47.53–46.96 and 42.57–39.72 m). Megaspores have records in its upper part.

Although *E. iliacoides* has not been recorded, the microflora allows confident identification of the *Echinitosporites iliacoides* Composite Assemblage Zone.

NORDKAPP BASIN

CORE 7230/5-U-6	SASSENDALEN GROUP																																									
Lithostratigraphy	Kobbe Formation																																									
Age	early to middle Anisian																																									
Pollen / Depth in core	96.02	92,88	88,42	85,23	81,60	76,08	72,94	70,20	67,10	65,95	65,45	64,60	62,57	61,57	58,73	57,77	55,92	53,24	51,93	51,66	51,31	50,01	49,64	48,89	48,07	47,02	46,47	45,14	42,54	42.34	41.44	40.95	40.25	39,65	37,98	35,32	35,0	33,51	32,81	29,79	28,09	25.02
Illinites chitonoides		x			x																								x						x	x						x
Lunatisporites spp.		x	x							C		C			x		C								x				A						x	x		C			x	x
Striatoabieites multistriatus		C	x		x			x									C					x							A						x	x		x				x
Vitreisporites pallidus		x	x		x																	x														x		x	x			x
Lunatisporites noviaulensis		x			x																								C									x	x		x	
Succinctisporites grandior		x			x																				x				x							x			x		x	
Falcisporites spp.		C	C		x					C		A					C					x			C											x			x			
Lunatisporites pellucidus		x			x					x																													x			
Angustisulcites klausii		x	x		x					x		x										x							x							x						
Brachysaccus spp.		x			C			x																					x						x							
Angustisulcites grandis		x																																								
Protohaploxypinus spp.			x				x																																			x
Alisporites spp.			C		C		x					C			C							C			C				A						x				C		x	
Klausipollenites spp.			x		C		x			C		x										x							x													
Voltziaceaesporites heteromorpha			x		x																																					
Cycadopites spp.					x							C					x					x			x				x						A			x	x			x
Triadispora spp.					x			x		C		x					x					x			x										x	x		C	x			x
Ephedripites spp.					x							x																														x
Lunatisporites acutus					x					x							x								x				x										x		x	
Triadispora crassa					x																																					
Triadispora obscura					x																																					
Accinctisporites spp.												x																														
Cordaitina spp.																	x																		x	x		x				x
Pretricolpipollenites spp.																	x																									
Platysaccus spp.																													x							x						
Triadispora aurea																																			x							
Kuglerina meieri																																				x					x	
Spores	b			b		b			b		b		b			b			s				b				b				s						s			b		
Apiculatisporis spp.		C	x		C		x	x		x		x			x		x					x			C				x						A	x		x	x		x	x
Aratrisporites centratus		C	A		A		A	A		A		A			A		A					A			A				x						A	A		A	A		A	A
Aratrisporites spp.		C	A		A		x	C		C		C			A		A					A			A				C						A	C		A	A		A	A
Aratrisporites tenuispinosus		x	C				x	x		x		x			A		x								x										x	x		x			C	x
Baculatisporites spp.		x	x									x					x																						x		x	x
Calamospora spp.		A	A		A		x	A		A		A			A		A					A			C				A						A	A		A	A		A	A
Deltoidospora spp.		x	C		A		x	x		C		C			C		x					C			A										C	x		C	x		x	x
Gordonispora fossulata		x	x		x												x								x																	x
Jerseyiaspora punctispinosa		x	x		C			x		x		x			C										x				x												x	x
Kraeuselisporites spp.		x			x					x					x		x								x				x						x			x				x
Leschikisporis aduncus		x			x		x	C		x		C			x		x					C			x				C						A	x		x	x		C	x
Neoraistrickia spp.		x					x																						x												x	x
Punctatisporites spp.		x						x							x		x																									x
Punctatosporites spp.		x	x		x		x	x		x		x			x		x					x			x				A									x	x			x
Retusotriletes spp.		x	C		x		x	x		x		x			x														x							x		x				x
Todisporites spp.		x	C		x					x		x					x					x							x												x	x
Densoisporites nejburgii		C	x		x			x		x		x			x		x																		x	x						x
Uvaesporites spp.		x					x	x									x																								x	
Verrucosisporites spp.		x	C		x			C		C		x			C		C					x			C				x						x	x		x	C		C	
Gordonispora lubrica		x	x		x		x					x			x										x										x				x			
Lycopodiacidites spp.		x																																					x			
Striatella spp.		x	x		x					x		x					x								x											x			x			
Lophotriletes novicus		x	x																																							
Anapiculatisporites spiniger			x		x																								x									x				x
Verrucosisporites morula			x					x				x			x		x					x																				
Converrucosisporites spp.					x							x																											x			x
Cyclotriletes spp.					x		x					C			x		x					x																x				
Lundbladispora spp.					x					x																																
Dictyotriletes spp.					x																																					
Kraeuselisporites apiculatus										x		x																														
Acanthotriletes spp.										x																																
Cyclogranisporites spp.										C																																
Lundbladispora brevicula												x																							x							
Lycopodiumsporites spp.												x					x																									
Verrucosisporites thuringiacus												x																														
Dictyophyllidites spp.															x		x																		x							
Deltoidospora concavus																						x																				
Polycingulatisporites spp.																									x																	
Lophotriletes spp.																													x									x				
Semiretisporis sp. A																																				x			x		x	
Kraeuselisporites saeptatus																																				x						
Plankton and varia	b			b		b			b		b		b			b			s				b				b				s						s			b		
Micrhystridium spp.		C								x					x		x																					x			x	x
Veryhachium spp.		x															x												x									x	x		x	x
Tasmanites spp.					x																														x						x	x
Botryococcus spp.					x																				x				x									x				
Composite Assemblage Zone	Anapiculatisporites spiniger																																									

LEGEND
- A abundant
- C common
- x present
- b barren sample
- s paleosol

A.27 Core 7230/5-U-6, Sassendalen Group.

NORDKAPP BASIN

CORE 7228/3-U-1	SASSENDALEN GROUP																																								
Lithostratigraphy	Kobbe Formation																																								
Age	late Anisian																																								
Pollen / Depth in core, metres	88,45	87,67	85,95	85,12	83,85	82,76	82,31	81,48	80,32	79,28	78,13	76.60	76,00	74.78	73,73	73,02	72,02	70,85	68,86	67,40	66,15	64,87	63,62	61,72	58,97	57,90	56,45	55,10	53,95	52,70	51,60	50,50	49,30	48,40	47,50	46,40	45.00	44.00	42,90	41,90	41,10
Bisaccate pollen (indeterminate)	x	A	C	A	C	A	C	C	C	C	C	x	C	x	A	x	x	A	C	C	x	A	x	A	C	C	C	C	C	A	x	x	C	x	C	C	x	x	A	C	C
Illinites chitonoides	x		C		x	x	C	x	C	C					x	x		C	C		x	x	C			x	x	x		C		A		A	x	C		x	C	C	C
Protodiploxypinus ornatus	x		x					x														x				x								x						x	C
Triadispora obscura	x					C			x	x									x					x		C								C	x	C				x	A
Protodiploxypinus gracilis	x		x			x			C	C									x	x												x		x		x			C		C
Podosporites amicus	x							x											x				x							x										x	
Illinites trivisus	x		x		x			x	C	C								x	x				C			x		x				x		C	x	C					
Lunatisporites pellucidus	x																															x									
Chordasporites spp.	x								x	x																x															
Chordasporites cingulichorda	C																																								
Vitreisporites pallidus		x	x	x					C	C													C	x				x		C											C
Lunatisporites noviaulensis		x																	x															x							
Triadispora aurea		x	x																x					x		C															
Dyupetalum vicentinense		x																																							
Staurosaccites quadrifidus			x																				x			x		x		x	x			x		x				x	
Protohaploxypinus spp.			x			C																	C	x										A	x						
Enzonalasporites vigens			x	x																			x																		
Falcisporites stabilis				x		x		x																										C							
Cycadopites spp.					x																		C									x							x		
Angustisulcites klausii							x	x																		x								x						x	
Alisporites microreticulatus								C																												x					
Heliosaccus spp.																		x	x							x	x													x	
Protodiploxypinus decus																			x				x			x								x							
Lunatisporites acutus																							x			x															
Duplicisporites spp.																							x									x									
Aulisporites astigmosus																														x				x		x					
Infernopollenites sulcatus																																x									
Concentrisporites spp.																																								x	
Protodiploxypinus minor																																									C
Spores																																									
Aratrisporites scabratus	x			x	A															A	x		A	C		C		x		C		A		A		x					C
Aratrisporites spp.	x	C	A	A	x	x	x	A	x	x	C		C		A			A	x	A		A	A			A	A			C	x			A	x	C		C	C	C	A
Calamospora spp.	A																	x					x			x	x			x				x				x	x		A
Calamospora tener	x			x					x	x																															x
Deltoidospora minor	x			x		C																	x	x			x				x	x							C	C	C
Perotrilites spp.	x			x														x					x			x		x		x								x			
Aratrisporites palettae	x	x	x	x	x		C		x	x								C	C				C	x		C								A							
Verrucosisporites sp. A	x		x	C														x	x	x			x			x						x		x							
Neoraistrickia spp.	x																						x																		
Conbaculatisporites hopensis		x														x							C					x				x		A					x		
Aratrisporites minimus		x																	x																						
Gordonispora fossulata			x																																						
Lycopodiacidites spp.			x																					x										x							
Aratrisporites macrocavatus				C	A	x	A												A		x	A	x	x		C	x	C		C		A				x		x			C
Nevesisporites limulatus				x																		x	x	x										x							x
Deltoidospora australis				x		x		x																										C							
Todisporites marginales				x																			C									x									
Todisporites minor					x																		x									x		x							
Striatella seebergensis							C	x											x													x							x	x	x
Aratrisporites tenuispinosus									x	x								x				x				x															x
Baculatisporites spp.																	x							x		x													x		
Kraeuselisporites sp. A																		x																					x		
Todisporites spp.																		x	x				x															x			
Anapiculatisporites spiniger																		x					x																		
Kraeuselisporites dentatus																		x																							
Uvaesporites spp.																							x																		
Cyclotriletes spp.																												x													
Verrucosisporites jenensis																																x									
Densoisporites playfordi																																		x							
Todisporites major																																		x							
Plankton and varia																																									
Tasmanites spp.		x						x											C	x					x									C						C	x
Veryhachium spp.		x	x	C																			A			A	A							A		C			A	C	A
Tyttodiscus spp.						x																	C				x							x							
Leiosphere								C													x		x	x						C				C	x						
Botryococcus spp.																			x					x				x													
Micrhystridium spp.																				C						C								x							
Baltisphaeridium spp.																										C															
Dictyotidium tenuiornatum																																				x					
Composite Assemblage Zone	Protodiploxypinus decus																																								

LEGEND
A abundant
C common
x present

A.28 Core 7228/3-U-1, Sassendalen Group.

NORDKAPP BASIN

CORE 7230/5-U-5	KAPP TOSCANA GROUP																								
Lithostratigraphy	Snadd Formation																								
Age	Ladinian																								
Pollen / Depth in core	49.22	48.47	47.53	46.96	46.38	45.18	45.18	44.63	44.18	43.83	42.57	40.87	39.72	38.62	37.92	35.01	34.52	31.11	29.76	28.81	27.85	26.95	25.75	25.47	24.42
Angustisulcites klausii			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Bisaccate alete pollen			C	C	C	C			C	C	C	C	C	C	C	C		C	C	C	C	C	C	C	C
Cordaitina/Heliosaccus complex			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Illinites chitonoides			C	C	C	C			C	C	C	C	C	C	C	C		C	C	C	C	C	C	C	C
Lunatisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Protodiploxypinus spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Protohaploxypinus spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Staurosaccites quadrifidus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Striatoabieites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Triadispora spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Vitreisporites pallidus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Voltziaceaesporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Podosporites amicus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x				
Ephedripites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x						
Kuglerina meieri			x	x	x	x			x	x	x	x	x												
Ovalipollis pseudoalatus				x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Partitisporites spp.				x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Cycadopites spp.									x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Podocarpidites spp.									x	x	x	x	x	x	x	x		x	x	x					
Protodiploxypinus decus									x	x	x	x	x	x	x	x		x	x						
Spores	b						b										b								
Anapiculatisporites spiniger			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Apiculatisporis spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Aratrisporites centratus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Aratrisporites paenulatus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Aratrisporites saturni			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Calamospora spp.			C	C	C	C			C	C	C	C	C	C	C	C		C	C	C	C	C	C	C	C
Conbaculatisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Concavisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Deltoidospora spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Gordonispora fossulata			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Gordonispora lubrica			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Keuperisporites baculatus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Leschikisporis aduncus			C	C	C	C			C	C	C	C	C	C	C	C		C	C	C	C	C	C	C	C
Lophotriletes novicus			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Neoraistrickia taylorii			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Punctatosporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Jerseyiaspora punctispinosa			R	R	R	R			R	R	R	R	R	R	R	R		R	R	R	R	R	R	R	R
Striatella seebergensis			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Todisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Kraeuselisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x	x	x				
Raistrickia spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x						
Verrucosisporites spp.			x	x	x	x			x	x	x	x	x	x	x	x		x	x						
Converrucosisporites spp.			x	x	x	x			x	x	x	x	x	x	x										
Convolutispora spp.			x	x	x	x			x	x	x	x	x	x	x										
Uvaesporites spp.			x	x	x	x			x	x	x	x	x												
Aratrisporites tenuispinosus				x	x	x			x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Lycopodiacidites kuepperi				x	x	x			x	x	x	x	x	x	x	x		x	x	x	x				
Aratrisporites parvispinosus									x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Punctatisporites spp.													x	x	x	x		x	x	x	x	x	x	x	x
Semiretisporis spp.													x												
Baculatisporites wellmannii															x	x		x	x	x	x	x	x	x	x
Scabratisporites scabratus																x									
Retitriletes spp.																									x
Plankton and varia	b						b										b								
Botryococcus spp.			x	x					x	x			x		x	x									x
Fungal remain			x	x						x	x				x										x
Micrhystridium spp.			x	x	x	x					x	x	x		x	x					x	x	x	x	x
Veryhachium spp.			x	x	x	x					x	x	x		x				x	x	x	x	x	x	x
Tasmanites spp.			x	x							x		x												
Dictyotidium tenuiornatum			x																						
Plaesiodictyon spp.				x								x			x				x						x
Megaspore																							x		
Composite Assemblage Zone	Echinitosporites iliacoides (reworked Anisian deposits)																								

LEGEND
*C common
x present
R reworked
barren sample

*C Relative abundance tentave, added from descriptive text

A.29 Core 7230/5-U-5, Kapp Toscana Group.

B.2.4 Core 7230/5–U–4, late Ladinian

This core was drilled in 1987 and penetrates 55.2 m of the Sassendalen Group. Sixty samples were analysed for palynology; four samples from the interval between 51.41 and 46.08 m were barren. The diagram presented as Table A.30 documents the total ranges without quantitative information.

Snadd Formation
Interval 78.53–24.40 m
The *Aratrisporites* group and various smooth spores, including *Calamospora* spp. and *Leschikisporis aduncus*, dominate the assemblages. The bisaccate pollen show abundant *Illinites chitonoides* and a high diversity of the *Triadispora* group. Associated sporomorphs include *Angustisulcites klausii*, *Camarozonosporites rudis*, *Echinitosporites iliacoides*, *Eucommiidites microgranulatus*, *Ovalipollis pseudoalatus*, *Partitisporites* spp.,

NORDKAPP BASIN

CORE 7230/5-U-4	KAPP TOSCANA GROUP																																																							
Lithostratigraphy	Snadd Formation																																																							
Age	late Ladinian																																																							
Pollen / Depth in core	78,53	77,19	76,54	75,63	74,44	72,67	72,30	70,52	69,81	68,34	67,94	66,66	66,39	65,31	64,11	63,35	62,81	62,71	61,81	61,01	60,48	59,88	58,38	57,51	56,11	54,61	54,29	53,29	51,41	50,11	49,31	48,34	47,44	46,78	46,08	45,63	44,35	43,50	42,40	41,37	40,62	39,67	38,25	37,04	36,65	34,84	33,90	33,25	32,40	31,56	30,00	29,00	28,04	26,20	25,49	24,40
Angustisulcites klausii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bisaccate pollen	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cordaitina/Heliosaccus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cycadopites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Echinitosporites iliacoides	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ephedripites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eucommiidites microgranulatus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Illinites chitonoides	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Kraeuselisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Kuglerina meieri	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lunatisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ovalipollis pseudoalatus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Partitisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Podosporites amicus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Protodiploxypinus spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ricciisporites sp. A	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Staurosaccites quadrifidus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Striatoabieites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Triadispora spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Vitreisporites pallidus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Infernopollenites sulcatus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x													
Lagenella martini								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Protohaploxypinus spp.																x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Triadispora verrucata																x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Retisulcites perforatus																																																					x			
Spores																													b					b																						
Anapiculatisporites spiniger	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Apiculatisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Aratrisporites paenulatus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Calamospora spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Conbaculatisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Concavisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Deltoidospora spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gordonispora fossulata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gordonispora lubrica	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Leschikisporis aduncus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Neoraistrickia taylorii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Baculatisporites wellmannii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Punctatosporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Scabratisporites scabratus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Striatella seebergensis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Todisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Verrucosisporites spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Camarozonosporites rudis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Lycopodiacidites kuepperi	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x										
Lophotriletes novicus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x										
Semiretisporis sp. A	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x											
Aratrisporites parvispinosus								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Laevigatosporites spp.								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Polypodiisporites spp.								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Retusotriletes spp.								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Uvaesporites spp.								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Raistrickia spp.								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x								
Punctatisporites spp.																										x	x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Zebrasporites kahleri																																							x																	
Lycopodiumsporites spp.																																							x																	
Converrucosisporites spp.																																											x	x	x	x	x	x	x	x	x	x	x	x	x	x
Polycingulatisporites triangularis																																																								x
Plankton and varia																													b					b																						
Botryococcus spp.	x																																			x																	x			x
Micrhystridium spp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x		x	x	x	x	x		x	x	x				x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x		x
Plaesiodictyon spp.	x			x				x		x				x		x	x	x	x		x		x	x		x						x				x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x
Cymatiosphaera spp.				x	x	x			x	x	x							x	x						x						x						x	x	x		x	x	x	x	x	x	x	x		x	x	x		x	x	x
Veryhachium spp.								x	x						x			x	x				x	x	x	x				x						x			x		x		x		x	x	x		x				x		x	x
Tasmanites spp.																	x																			x																				x
Fungal remain																	x																			x										x							x			x
Composite Assemblage Zone	Echinitosporites iliacoides																																																							

LEGEND
A abundant
C common
x present
b barren sample (shaded)

A.30 Core 7230/5-U-4, Kapp Toscana Group.

Protodiploxypinus spp., *P. doubingeri*, *P. fastidioides*, *Ricciisporites* sp., *Staurosaccites quadrifidus*, *Striatella seebergensis* and *Triadispora verrucata*. Rare green algae, together with some acritarchs, occur throughout.

The association is identified as belonging to the *Echinitosporites iliacoides* Composite Assemblage Zone. The co-appearance of *E. iliacoides*, *Eucommiidites microgranulatus*, *Ricciisporites* sp. and *Triadispora verrucata* suggests a late Ladinian age. Below 34.84 m, there seems to be some reworking of late Spathian to mid Anisian material.

B.2.5 Core 7227/8–U–1, Carnian to Early Jurassic

This core was drilled in 1986 and penetrates 40.9 m of the Snadd, Fruholmen and Stø formations (Table A.31, Fig. 4).

Snadd Formation, upper part
Interval 71.60–57.70 m
The low-diversity associations contain bisaccate pollen, *Araucariacites* spp. and smooth trilete spores including *Kyrtomisporis laevigatus*. Common *Botryococcus* and sporadic *Micrhystridium* have occasional records in the uppermost beds. The stratigraphically insufficient evidence only allows assignment to a Carnian or younger Triassic age.

Fruholmen Formation
Interval 53.60–39.70 m
The diverse assemblages are dominated by bisaccate pollen, including diverse *Protodiploxypinus* spp. and *Ovalipollis pseudoalatus* as well as abundant smooth trilete spores. Other pollen include *Chasmatosporites magnolioides*, *C. apertus* and *Cycadopites* spp. Spores include *Annulispora cicatricosa*, *A. folliculosa*, diverse *Aratrisporites* spp., as well as Con*baculatisporites hopensis*, *Kyrtomisporis* spp., *Limbosporites lundbladii*, *Semiretisporis* spp. and *Zebrasporites interscriptu*s.

As observed in the underlying interval, the samples from 53.60 to 47.75 m have sparse plankton, but with some *Botryococcus*. From 46.70 to 44.70 m abundant plankton include abundant *Micrhystridium* spp. and *Veryhachium* spp. together with *Solisphaeridium* and *Tyttodiscus* spp. The increased marine influence coincides with reduced frequency of *Botryococcus* spp. and reduction of spore abundance. Dinoflagellate cysts have no record. The appearance (43.58–42.73 m) of *Chasmatosporites magnolioides* (in abundance), *Corollina* spp., *C. classoides*, *Crybelosporites vectensis*, *Gleicheniidites* spp., *Ischyosporites variegatus* and *Quadraeculina anellaeformis* marks a shift in vegetation.

All assemblages from the Fruholmen Formation may be assigned to the *Limbosporites lundbladii* Composite Assemblage Zone, indicating a Norian age. Rhaetian strata have not been identified at this locality.

Stø Formation
Interval 38.55–34.70 m
The low-diversity associations recovered from lowermost Stø Formation prevent accurate correlation and dating. An Early Jurassic age is indicated by the presence of *Lycopodiumsporites austroclavatidites* (37.70 m) and is confirmed by the presence of the dinoflagellate cyst *Mendicodinium reticulatum* at 36.60 m.

Interval 33.50–30.70 m
Lowermost in this interval, *Cerebropollenites macroverrucosus* and *Nannoceratopsis gracilis* represent a Pliensbachian or younger age. The diverse dinocyst associations at 31.60 m and above are related to the association Bjærke (1980) described from the Brentskardhaugen Bed at Knorringfjellet on Spitsbergen and allow confident dating to the Toarcian. Reworked Triassic palynomorphs, as were recorded in the oldest Jurassic deposits on Svalbard (Festningen and Klementievfjellet, Tables A.1.2.1, A.1.2.2 and A.11) and in Barents Sea wells (Tables A.43, A.44), seem rare at this locality.

B.2.6 Core 7230/5–U–3, Norian to Early Jurassic

This core was drilled in 1987 and penetrates 88.5 m of the Snadd, Fruholmen, Tubåen, Nordmela and Stø formations of the Kapp Toscana Group (Figure 4). The ages inferred by Bugge et al. (2002) have been revised in the present study. The lithostratigraphic divisions may need to be revised accordingly. The range chart (Table A.32) only lists total ranges of palynomorphs without quantitative data.

Snadd Formation
Interval 115.31–108.54 m
An impoverished association comprising *Anapiculatisporites spiniger*, *Aratrisporites* spp., *Granuloperculatipollis rudis* and *Triadispora* spp., together with *Tasmanites* spp. is recorded in the lowest samples from this core (115.31–113.21 m). The more diverse associations of samples from 111.77 and 108.54 m contain *Corollina* spp., *Kyrtomisporis laevigatus*, *K. speciosus*, *Microreticulatisporites fuscus*, *Quadraeculina anellaeformis* and *Ricciisporites tuberculatus*. The presence of *Tasmanites* spp. and dinoflagellate cysts reflects marine influence.

The lower sample interval is tentatively assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone, indicating a late Carnian age. For the higher interval, the assignment to the *Limbosporites lundbladii* Composite Assemblage Zone implies a late Norian age.

A.31 Core 7227/8-U-1, Kapp Toscana Group. >

NORDKAPP BASIN

CORE 7227/8-U-1 — KAPP TOSCANA GROUP

Triassic pollen / Depth in core	71,60	69,70	67,65	65,65	64,6	63,7	62,7	61,68	60,75	66,52	60,90	59,70	58,80	57,70
Lithostratigraphy	Snadd Fm.													
Age	Carnian													
Araucariacites australis	x												x	
Striatoabieites aytugii		x												
Alisporites spp.		x												
Bisaccate pollen (indeterminate)		x							x	x	x	x	x	
Chasmatosporites magnolioides														
Protodiploxypinus ornatus														
Protodiploxypinus gracilis														
Ovalipollis pseudoalatus														
Eucommiidites spp.														
Protodiploxypinus decus														
Protodiploxypinus minor														
Cycadopites spp.														
Vitreisporites pallidus														
Chasmatosporites apertus														
Corollina spp.														
Triadispora obscura														
Quadraeculina anellaeformis														
Crybelosporites vectensis														
Staurosaccites quadrifidus														
Corollina meyeriana														
Lunatisporites noviaulensis														
Triasssic spores					b									
Deltoidospora minor											x	x		
Kyrtomisporis laevigatus												x		
Baculatisporites wellmannii												x		
Semiretisporis spp.														
Annulispora folliculosa														
Deltoidospora australis														
Aratrisporites macrocavatus														
Deltoidospora juncta														
Aratrisporites spp.														
Perotrilites spp.														
Limbosporites lundbladii														
Lapposisporites loricatus														
Neoraistrickia spp.														
Todisporites minor														
Kyrtomisporis speciosus														
Lycopodiacidites spp.														
Zebrasporites interscriptus														
Calamospora spp.														
Aratrisporites palettae														
Aratrisporites scabratus														
Todisporites major														
Lycopodiumsporites spp.														
Neoraistrickia taylorii														
Todisporites spp.														
Lycopodiacidites rugulatus														
Conbaculatisporites hopensis														
Dictyophyllidites mortoni														
Zebrasporites kahleri														
Kraeuselisporites reissingeri														
Uvaesporites argentaeformis														
Striatella seebergensis														
Lapposisporites spp.														
Converrucosisporites spp.														
Annulispora cicatricosa														
Ischyosporites variegatus														
Gleicheniidites spp.														
Baculatisporites spp.														
Plankton and varia					b									
Micrhystridium spp.											x			
Botryococcus spp.													x	C
Leiosphere														
Veryhachium spp.														
Cymatiosphaera spp.														
Solisphaeridium spp.														
Tyttodiscus spp.														
Jurassic pollen and spores									b					
Lycopodiumsporites austroclavatidites														
Cerebropollenites macroverrucosus														
Baculatisporites comaumensis														
Cerebropollenites thiergartii														
Apiculatisporis ovalis														
Jurassic plankton									b					
Mendicodinium reticulatum														
Nannoceratopsis gracilis														
Mendicodinium spp.														
Comparodinium spp.														
Ellipsoidictyum spp.														
aff. *Parvocysta barbata*														
Dinoflagellate sp. B														
Evachia prisca														
Lagenadinium spp.														
Mancodinium semitabulatum														
Maturodinium inornatum														
Ovalicysta hiata														
Parvocysta bullula														
Parvocysta contracta														
Parvocysta cracens														
Pterospermella spp.														
Valvaeodinium sp. cf. *V. armatum*														
Phallocysta eumekes														
Scriniocassus weberi														
Composite Assemblage Zone / Age	Indeterminate Carnian or younger													

Triassic pollen / Depth in core	53,60	52,75	50,63	49,72	47,75	46,70	45,70	44,70	43,58	42,73	41,70	40,75	39,70
Lithostratigraphy	Fruholmen Formation												
Age	Norian												
Araucariacites australis				C						x			
Striatoabieites aytugii										x			
Alisporites spp.		x		x							x		
Bisaccate pollen (indeterminate)	C	C	C	C	x	C	x	x	x	A	C	C	x
Chasmatosporites magnolioides	x	x	x	x		x				C	A		
Protodiploxypinus ornatus	A	A	C	A	C	x	C	x	x	A	x	x	x
Protodiploxypinus gracilis	x			x								x	
Ovalipollis pseudoalatus		C	x	A	x	x			x	x	x	x	x
Eucommiidites spp.		x											x
Protodiploxypinus decus		x	x										
Protodiploxypinus minor			x								A		
Cycadopites spp.				x				x		C			x
Vitreisporites pallidus					x						x		
Chasmatosporites apertus					x								
Corollina spp.								x		x	x		
Triadispora obscura								x			x		
Quadraeculina anellaeformis									x	x	x		
Crybelosporites vectensis										x			
Staurosaccites quadrifidus										x	x		
Corollina meyeriana										x			
Lunatisporites noviaulensis											x		
Triasssic spores													
Deltoidospora minor	A	A	A	A	A	A	A		x	A			
Kyrtomisporis laevigatus	x	x	x	C	x	x		x	x	x	x	x	
Baculatisporites wellmannii						x							
Semiretisporis spp.	x	x		C		x					x	x	x
Annulispora folliculosa	x	x		C	C	x	x		x	A	x		x
Deltoidospora australis	x	A	x	C	C		x		x	A			x
Aratrisporites macrocavatus	x	C	x	x	x	x				x			
Deltoidospora juncta	x	x		x		x		x					
Aratrisporites spp.	C	C	C	x	x								
Perotrilites spp.	x	x	x										
Limbosporites lundbladii	x	x											
Lapposisporites loricatus	x												
Neoraistrickia spp.		x		x							x		
Todisporites minor		x								x			
Kyrtomisporis speciosus		x	A	x	C				x				
Lycopodiacidites spp.		x	x	x		x		x					
Zebrasporites interscriptus		x				x							
Calamospora spp.		x		x									
Aratrisporites palettae		x											
Aratrisporites scabratus		x											
Todisporites major		x											
Lycopodiumsporites spp.			x										
Neoraistrickia taylorii				C									x
Todisporites spp.				A									x
Lycopodiacidites rugulatus				x							A		
Conbaculatisporites hopensis				x		x				x			
Dictyophyllidites mortoni				x	x	x							
Zebrasporites kahleri					x								
Kraeuselisporites reissingeri					x								
Uvaesporites argentaeformis						x				x			
Striatella seebergensis						x							
Lapposisporites spp.						C							
Converrucosisporites spp.						x							
Annulispora cicatricosa							x			C			
Ischyosporites variegatus									x				
Gleicheniidites spp.										x			
Baculatisporites spp.										x	x		
Plankton and varia													
Micrhystridium spp.					x	A	C	A	x	C	x		x
Botryococcus spp.	x		x	x							x		
Leiosphere	x	C					C						
Veryhachium spp.						A	A	A	A	C	x		C
Cymatiosphaera spp.						x	x	C		x			
Solisphaeridium spp.							C				x		x
Tyttodiscus spp.								x					x
Jurassic pollen and spores							b						
Lycopodiumsporites austroclavatidites													
Cerebropollenites macroverrucosus													
Baculatisporites comaumensis													
Cerebropollenites thiergartii													
Apiculatisporis ovalis													
Jurassic plankton							b						
Mendicodinium reticulatum													
Nannoceratopsis gracilis													
Mendicodinium spp.													
Comparodinium spp.													
Ellipsoidictyum spp.													
aff. *Parvocysta barbata*													
Dinoflagellate sp. B													
Evachia prisca													
Lagenadinium spp.													
Mancodinium semitabulatum													
Maturodinium inornatum													
Ovalicysta hiata													
Parvocysta bullula													
Parvocysta contracta													
Parvocysta cracens													
Pterospermella spp.													
Valvaeodinium sp. cf. *V. armatum*													
Phallocysta eumekes													
Scriniocassus weberi													
Composite Assemblage Zone / Age	*Limbosporites lundbladii*												

Triassic pollen / Depth in core	38,55	37,70	36,60	35,50	34,70	33,50	32,72	31,60	30,70
Lithostratigraphy	Stø Formation								
Age	E. Jurassic								
Araucariacites australis									x
Striatoabieites aytugii					R				
Alisporites spp.									
Bisaccate pollen (indeterminate)	A	x	x	x	C	x	A	A	A
Chasmatosporites magnolioides									x
Protodiploxypinus ornatus									
Protodiploxypinus gracilis									
Ovalipollis pseudoalatus									R
Eucommiidites spp.									
Protodiploxypinus decus									
Protodiploxypinus minor									
Cycadopites spp.									
Vitreisporites pallidus							C		
Chasmatosporites apertus									
Corollina spp.									
Triadispora obscura									
Quadraeculina anellaeformis								x	
Crybelosporites vectensis								x	
Staurosaccites quadrifidus									
Corollina meyeriana									
Lunatisporites noviaulensis									
Triasssic spores									
Deltoidospora minor					x			A	
Kyrtomisporis laevigatus									
Baculatisporites wellmannii									
Semiretisporis spp.									R
Annulispora folliculosa									
Deltoidospora australis									
Aratrisporites macrocavatus									
Deltoidospora juncta									
Aratrisporites spp.									
Perotrilites spp.									
Limbosporites lundbladii									
Lapposisporites loricatus									
Neoraistrickia spp.									
Todisporites minor									
Kyrtomisporis speciosus									
Lycopodiacidites spp.									
Zebrasporites interscriptus									
Calamospora spp.									
Aratrisporites palettae									
Aratrisporites scabratus									
Todisporites major									
Lycopodiumsporites spp.									
Neoraistrickia taylorii									
Todisporites spp.									
Lycopodiacidites rugulatus									
Conbaculatisporites hopensis									
Dictyophyllidites mortoni									
Zebrasporites kahleri									
Kraeuselisporites reissingeri									
Uvaesporites argentaeformis									
Striatella seebergensis									
Lapposisporites spp.									
Converrucosisporites spp.									
Annulispora cicatricosa									
Ischyosporites variegatus									
Gleicheniidites spp.							x		
Baculatisporites spp.		x		x	x				
Plankton and varia									
Micrhystridium spp.							x	x	
Botryococcus spp.	x			x					
Leiosphere							C	C	
Veryhachium spp.								x	
Cymatiosphaera spp.									
Solisphaeridium spp.									
Tyttodiscus spp.									
Jurassic pollen and spores									
Lycopodiumsporites austroclavatidites		x							x
Cerebropollenites macroverrucosus						x	x	x	
Baculatisporites comaumensis								A	
Cerebropollenites thiergartii									x
Apiculatisporis ovalis									x
Jurassic plankton									
Mendicodinium reticulatum			x		x				
Nannoceratopsis gracilis						x	x	C	C
Mendicodinium spp.						x			
Comparodinium spp.							x	x	
Ellipsoidictyum spp.							x		
aff. *Parvocysta barbata*								C	
Dinoflagellate sp. B								x	
Evachia prisca								x	
Lagenadinium spp.								x	
Mancodinium semitabulatum								x	
Maturodinium inornatum								x	
Ovalicysta hiata								x	
Parvocysta bullula								x	
Parvocysta contracta								x	
Parvocysta cracens								x	
Pterospermella spp.								x	
Valvaeodinium sp. cf. *V. armatum*								x	
Phallocysta eumekes									x
Scriniocassus weberi									x
Composite Assemblage Zone / Age	Early Jurassic					(Cere)		Toarc.	

LEGEND
A abundant
C common
x present
R reworked
b barren interval
sample barren in Jurassic palynomorphs

(Cere) marks an informal assemblage with *Cerebropollenites macroverrucosus* recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

NORDKAPP BASIN

CORE 7230/5-U-3	KAPP TOSCANA GROUP																		
Lithostratigraphy	Snadd Fm						Nordmela-Stø Formation											Stø	
Age	I.Car		Nor				Early Jurassic											I.Toa	
Triassic pollen / Depth in core	115,31	113,21	111,77	108,54	105.55	102.09	95,01	94,22	86,91	79,27	78,10	72,37	66,90	62,60	59,19	56,70	40,39	29,03	28,54
Bisaccate pollen (alete)	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Cycadopites spp.	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Eucommiidites spp.	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Lunatisporites spp.	x	x	x	x			R	R	R	R	R	R	R	R	R	R			
Triadispora spp.	x	x	x	x			R	R	R	R	R	R	R	R	R	R			
Granuloperculatipollis rudis	x	x	x	x			R	R	R	R	R	R	R	R					
Chasmatosporites spp.			x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Araucariacites spp.				x			x	x	x	x	x	x	x	x	x	x	x	x	x
Quadraeculina anellaeformis				x			x	x	x	x	x	x	x	x	x	x	x	x	x
Ricciisporites tuberculatus				x			R	R	R	R	R	R	R	R	R	R	R	R	R
Corollina spp.				x			x	x	x	x	x	x	x	x	x	x	x	x	
Protodiploxypinus spp.							R	R	R	R	R	R	R	R	R	R	R	R	R
Retisulcites spp.							R	R	R	R	R	R	R	R	R	R	R	R	R
Concentrisporites sulcatus							x	x	x	x	x	x	x	x	x	x	x	x	x
Ovalipollis pseudoalatus							R	R	R	R	R	R	R	R	R	R			
Striatoabieites spp.							R	R	R	R	R	R	R	R	R	R			
Angustisulcites spp.							R	R											
Perinopollenites elatoides								x	x	x	x	x	x	x	x	x	x	x	x
Schizaeoisporites worsleyi								R	R	R	R	R	R	R	R	R			
Vitreisporites pallidus								x	x	x	x	x	x	x	x	x			
Accinctisporites circumdatus																R			
Triasssic spores																			
Concavisporites spp.	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Aratrisporites centratus	x	x	x	x			R	R	R	R	R	R	R	R	R	R			
Aratrisporites paenulatus	x	x	x	x			R	R	R	R	R	R	R	R	R				
Calamospora spp.		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Anapiculatisporites spiniger		x	x	x			R	R	R	R	R	R	R	R	R	R			
Todisporites spp.			x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Microreticulatisporites fuscus			x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Kyrtomisporis speciosus			x	x			R	R	R	R	R	R	R	R	R	R			
Aratrisporites saturni			x	x			R	R	R	R	R	R	R	R	R				
Deltoidospora spp.				x			x	x	x	x	x	x	x	x	x	x	x	x	x
Convolutispora spp.				x			x	x	x	x	x	x	x	x	x	x	x		
Aratrisporites parvispinosus				x			R	R	R	R	R	R	R	R	R	R	R		
Kyrtomisporis laevigatus				x			R	R	R	R	R	R	R	R	R	R			
Velosporites spp.				x			R	R	R	R	R	R	R	R	R	R			
Anapiculatisporites spp.							x	x	x	x	x	x	x	x	x	x	x	x	x
Apiculatisporites spp.							x	x	x	x	x	x	x	x	x	x	x	x	x
Lycopodiumsporites spp.							x	x	x	x	x	x	x	x	x	x	x	x	x
Cingulizonates rhaeticus							R	R	R	R	R	R	R	R	R	R	R	R	R
Selagosporis mesozoicus							R	R	R	R	R	R	R	R	R	R	R	R	R
Striatella seebergensis							x	x	x	x	x	x	x	x	x	x	x	x	x
Polypodiisporites spp.							x	x	x	x	x	x	x	x	x	x	x	x	x
Uvaesporites spp.							x	x	x	x	x	x	x	x	x	x	x	x	x
Zebrasporites interscriptus							x	x	x	x	x	x	x	x	x	x	x	x	x
Conbaculatisporites mesozoicus							x	x	x	x	x	x	x	x	x	x	x	x	
Kraeuselisporites reissingeri							R	R	R	R	R	R	R	R	R	R	R	R	
Neoraistrickia spp.							x	x	x	x	x	x	x	x	x	x	x	x	
Rogalskaisporites cicatricosus							x	x	x	x	x	x	x	x	x	x	x	x	
Kraeuselisporites spp.							x	x	x	x	x	x	x	x	x	x	x		
Zebrasporites laevigatus							x	x	x	x	x	x	x	x	x	x	x		
Semiretisporis gothae							R	R	R	R	R	R	R	R	R	R	R		
Annulispora folliculosa							R	R	R	R	R	R	R	R	R	R			
Auritulinasporites triclavis							R	R	R	R	R	R	R	R	R	R			
Camarozonosporites laevigatus							R	R	R	R	R	R	R	R	R	R			
Camarozonosporites rudis							R	R	R	R	R	R	R	R	R	R			
Kyrtomisporis gracilis							R	R	R	R	R	R	R	R	R	R			
Limbosporites lundbladii							R	R	R	R	R	R	R	R	R	R			
Rogalskasporites barentzii							R	R	R	R	R	R	R	R	R	R			
Densoisporites spp.							x	x	x	x	x	x	x	x	x	x			
Retusotriletes spp.							x	x	x	x	x	x	x	x	x	x			
Kyrtomisporis niger							R	R	R	R	R	R	R	R	R				
Patinasporites densus							R	R	R	R	R	R	R	R					
Leptolepidites spp.							x	x	x	x	x	x	x						
Rugulatisporites sp. A							x	x	x	x	x	x							
Osmundacidites spp.								x	x	x	x	x	x	x	x	x	x	x	x
Perotrilites spp.								x	x	x	x	x	x	x	x	x	x	x	x
Dictyophyllidites spp.								x	x	x	x	x	x	x	x	x	x	x	
Cavatotriletes spp.								R	R	R	R	R	R	R	R	R			
Densosporites fissus								x	x	x	x	x	x	x	x	x			
Gordonispora fossulata								x	x	x	x	x	x	x	x	x			
Nevesisporites vallatus								x	x	x	x	x	x	x	x	x			
Verrucosisporites spp.								x	x	x	x	x	x	x	x				
Porcellispora longdonensis									R	R	R	R	R	R	R	R			
Punctatosporites spp.										x	x	x	x	x	x	x	x	x	x
Baculatisporites spp.										x	x	x	x	x	x	x	x		
Densosporites spp.											x	x	x	x	x	x	x	x	
Ischyosporites spp.												x	x	x	x				
Decussatisporites spp.												R	R	R	R				
Cyclotriletes spp.												R	R	R					
Converrucosisporites spp.													x	x	x	x	x	x	x
Tigrisporites halleinis													x	x	x	x	x	x	x
Gordonispora lubrica													x	x	x	x	x	x	
Microreticulatisporites asper														x	x	x	x	x	
Plankton and varia																			
Tasmanites spp.		x	x	x								x		x		x		x	x
Dinocyst (indeterminate)			x	x			x			x	x	x	x	x	x			x	x
Botryococcus spp.			x	x			x	x		x	x	x	x		x	x		x	x
Micrhystridium spp.							x	x			x	x	x	x		x	x		
Rhaetogonyaulax rhaetica							R									R			
Cymatiosphaera spp.											x								
Fungal remain												x						x	x
Dapcodinium priscum												R	R			R			R
Suessia swabiana												R	R			R			
Veryhachium spp.													x						v
Leiofusa spp.														x		x			x
Dictyotidium spp.																			x
Restricted Jurassic palynomorphs																			
Cerebropollenites macroverrucosus							x	x	x	x	x	x	x	x	x	x	x	x	
Cerebropollenites thiergartii							x	x	x	x	x	x	x	x	x	x	x	x	x
Phallocysta spp.																		x	x
Facetodinium inflatum																			x
Parvocysta spp.																			x
Composite assemblage zone / Age	(Rha.)		L.lu.		ind.		Early Jurassic (Cerebropollenites zone)											I.Toa	

LEGEND

x present
R reworked Triassic palyn.
(dotted) barren sample

(Cerebropollenites zone) marks an informal assemblage zone with *C. macroverrucosus* recorded in Sinemurian and Pliensbachian deposits (Lund 1977).

A.32 Core 7230/5-U-3, Kapp Toscana Group.

Nordmela–Stø Formation
Interval 95.01–29.03 m
Palynologically barren samples (A.32, 105.55–102.09 m) separate this interval from the underlying Snadd Formation. The recorded *Cerebropollenites macroverrucosus* and *C. thiergartii* represent the oldest confident Early Jurassic evidence. At 72.37 m, the dinoflagellate cyst *Dapcodinium priscum* has a last appearance in the Sinemurian (Williams and Bujak 1985).

The diverse assemblages comprise dominantly Triassic pollen and spores, such as *Cingulizonates rhaeticus*, *Densoisporites fissus*, *Limbosporites lundbladii*, *Lunatisporites* spp., *Patinasporites densus*, *Rogalskaisporites barentzii* and *Triadispora* spp., as well as the dinocyst *Rhaetogonyaulax rhaetica*. We have interpreted these palynomorphs as representing reworked Upper Triassic deposits.

Stø Formation
At 29.03 m, we note the presence of *Phallocysta* spp., *Parvocysta* spp. and *Facetodinium inflatum* spp. These dinoflagellate cysts have been described from the Toarcian Brentskardhaugen Bed at Knorringfjellet, Spitsbergen (Bjærke 1980).

B.3 Cores from the Svalis Dome

B.3.1–11 Dia 84–2 and 7323/7–U–1 to U–10, Griesbachian to Ladinian

During the years of 1984–1986, eleven stratigraphic cores (Dia 84–2 and cores 7323/7–U–1 to –U–10) were drilled through the Triassic succession at the Svalis Dome. The palynomorphs are generally well preserved and their ages are well calibrated by ammonoids recovered from the Havert, Klappmyss, Steinkobbe and Snadd formations (Table A.33, Plates 11–18). These cores have been a major source of information for the Lower and Middle Triassic palynology of the Barents Shelf and Svalbard. Various aspects of the Triassic palynological record and its integration with other disciplines have been described in papers by Mangerud and Rømuld (1991), Vigran et al. (1998), Galfetti et al. (2007) and Hochuli and Vigran (2010).

The composite distribution chart, Table A.33, compiles our data from the Svalis Dome and presents the palynological basis for application of the composite assemblage zones defined by the present paper. The plate descriptions (Plates 11–18) present the Composite Assemblage Zones and selected palynomorphs of the previously defined concurrent range assemblages.

The extended ranges of palynomorphs recorded in other parts of the Barents Sea required some revision of the concurrent range assemblages of Vigran et al. (1998), which were exclusively based on records from the Svalis Dome. The revision (see *Palynolostratigraphy of the Middle Triassic succession*) applies in particular to the assemblages 'Svalis–4', 'Svalis–5' and 'Svalis–8', *i.e.*, to the Spathian–Anisian boundary strata and the Ladinian deposits. Carnian deposits were not drilled on the Svalis Dome.

B.4 Cores from Gardarbanken

During the last two decades, the Norwegian Petroleum Directorate, with SINTEF Petroleum Research as operator, has drilled several shallow cores in order to increase knowledge of the northern Barents Sea. The two cores from Gardarbanken (7427/3–U–1, NPD and 7430/7–U–1, SINTEF) penetrate deposits of the Snadd Formation (Tables A.34–A.35).

B.4.1 Core 7427/3–U–1, Ladinian

This shallow core, drilled in 1990, penetrates 88.8 m of the Kapp Toscana Group. The 31 samples studied (Table A.34) yielded mostly well-preserved palynomorphs.

Snadd Formation
Interval 87.53–2.35 m
Non-taeniate bisaccate pollen comprise more than 50% of an association that regularly includes *Cordaitina gunyalensis*, *Echinitosporites iliacoides*, *Illinites chitonoides*, *Ovalipollis pseudoalatus*, *Podosporites amicus*, *Striatoabieites multistriatus*, *Triadispora obscura* and *T. verrucata*. Spores comprise diverse *Aratrisporites* spp. and abundant smooth forms, including *Leschikisporis aduncus*.

The association represents the *Echinitosporites iliacoides* Composite Assemblage Zone. Marine and non-marine plankton are present in low numbers throughout the cored interval.

B.4.2 Core 7430/7–U–1, early to middle Carnian

This shallow core was drilled in 1988 and penetrates 109.88 m of the Kapp Toscana Group (Table A.35). There are palynologically barren samples and associations of low productivity occur scattered throughout the core.

Snadd Formation
Interval 117.17–7.45 m
Pollen throughout this interval include *Araucariacites* spp., *Aulisporites astigmosus*, *Chasmatosporites apertus*, *Cycadopites* spp. and *Enzonalasporites vigens*, in addition to bisaccates like *Ovalipollis pseudoalatus*, *Podosporites amicus*, *Staurosaccites quadrifidus* and

Cores Dia 84-2 and 7323/7-U-8, U-6, U-3	Late Griesbachian										Late Smithian																							Early Spathian										Sp.		
	Sassendalen Group																																													
	Havert Formation										Klappmyss Formation																																		Ste.		
Core number	Dia-84-2										U-08											U-6												U-3												
Depth in cores	98.70-98.71	98.65-98.70	97.2-97.76	94.45-95.74	92.68-92.69	89.52-89.53	85.00-86.56	81.20-81.21	77.41-77.42	73.98-74.41	136.62-136.67	134.20-134.21	130.18-130.19	128.50-128.70	124.60-124.61	118.70-119.10	112.43-114.21	108.30-111.16	105.15-106.75	103.88-103.89	101.95-101.96	133.73-133.74	130.05-131.06	127.97-127.98	124.90-125.95	121.95-122.46	119.15-120.55	117.28-117.29	113.40-113.85	111.52-111.53	107.70-107.71	100.45-103.46	99.05-99.06	132.01-132.02	130.03 -131.08	126.01-129.02	123.90-124.98	121.02-123.90	118.01-119.93	114.01-117.01	110.99-112.95	108.03-109.71	107.08-107.14	105.95-105.96	101.01-102.02	99.01-99.02
Pollen																																														
Cycadopites spp.		▪	o	o	o	o	o	o	o	o		▪	o	▪	o	▪	o	▪	▪	▪	▪	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o
Indeterminate bisaccates		▪			▪		o			o												▪		▪										●	●	●	o	●	●	o	o	●	●	o	o	o
Lunatisporites noviaulensis		o			▪						▪	▪	▪		o	o	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪		▪	▪			▪	●	●	●	●	●	●	●	●	●	●	o	o	●
Lunatisporites pellucidus		▪												▪	▪	o	▪	▪	▪	▪	▪												▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Lunatisporites spp.		▪			▪		▪	▪		▪					▪							▪												▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Falcisporites spp.		▪										▪																																	
Protohaploxypinus spp.		▪					▪			▪																																			
Lunatisporites transversundatus		▪																																											
Pretricolpipollenites spp.			▪	▪	▪	▪	▪	▪	▪	▪					▪		▪					▪	▪	▪	▪	▪	▪	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			▪	▪	▪
Lunatisporites acutus					▪				▪								▪	▪	▪	▪				▪			▪		▪					o	o	o	o	o	o	o	o	o	o	▪	o	o
Vitreisporites spp.											▪		▪		▪	▪					▪												▪	o	o	▪	o	o	o	o	o	▪	o	▪	●	▪
Alisporites spp.											▪		▪				▪																	▪	▪		▪	▪				▪	▪			
Striatopodocarpidites varius											▪																																		
Lunatisporites obex												▪			▪				▪																										
Platysaccus papilionis															▪																			▪	▪	▪	▪	▪	▪	▪	▪					
Striatoabieites spp.															▪				▪	▪	▪																			▪						
Grebespora concentrica															▪							▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪													
Limitisporites spp.																				▪																									
Striatoabieites balmei																								▪	▪	▪													▪		▪	▪	▪			
Voltziaceaesporites heteromorpha																																		▪	▪	▪	▪	▪	▪		▪		▪		▪	
Klausipollenites schaubergeri																																		▪							▪					
Angustisulcites spp.																																			▪		▪	▪		▪	▪	▪	▪	▪	▪	▪
Falcisporites snopkovae																																			▪				▪							
Spores																																														
Aratrisporites spp.		▪	▪	●	●	o	o	o	o	▪		▪	▪	▪	▪	▪	▪	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪
Densoisporites spp.		▪		▪		▪		▪	▪			▪	▪	o	o	o	o	o	o	▪	▪	▪	▪	▪	▪	▪	▪	o	▪	▪	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		o	▪	▪	▪
Densoisporites nejburgii		▪	▪	▪	o	▪	▪	▪	▪	▪	o	o	o	●	●	●	●	●	●	●	●	o	o	o	o	o	o	o	o	o	o	o	▪	▪	▪	o	▪	▪	o	▪	o	●	o	▪	▪	
Pechorosporites disertus		▪	▪	▪			▪		▪								▪																	o	o	o	o	o	o	o	o	▪	▪		▪	
Densoisporites playfordi		▪				▪	▪		▪					▪	o		●	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o		▪					▪	▪		▪			
Kraeuselisporites spp.		▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪			▪	▪	▪	▪	▪													▪	▪	▪	▪	▪	▪	▪	▪		▪			
Lundbladispora spp.		▪			▪				▪		▪	▪	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			
Proprisporites pococki		▪					▪	▪	▪				▪				▪						▪																						
Deltoidospora minor		▪			▪			▪	▪																																				
Maculatasporites spp.		▪		▪			▪																																						
Baculatisporites spp.		▪			▪																																								
Endosporites papillatus			▪	▪		▪			▪			▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪			
Gordonispora fossulata				▪											▪		▪		▪		▪	▪	▪	▪		▪			▪				▪			▪		▪	▪			▪	▪	▪		▪
Verrucosisporites spp.				▪								▪	▪	▪	▪	▪	▪		▪	▪		▪	▪	▪		▪	▪		▪			▪					▪	▪		▪	▪		▪			
Retusotriletes spp.				▪		▪																														▪	▪	▪								
Aratrisporites tenuispinosus				▪	▪		▪																																						
Retusotriletes spp.				▪		▪																														▪	▪	▪								
Perotrilites spp.						▪				▪																																			
Punctatisporites fungosus											o	o	●	●	●	●	o	o	●	o	o	o	o	o	o	o	o	o	▪	o	▪	o	o	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪		
Calamospora spp.											▪	▪			▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			▪		▪						
Reticulatisporites bunteri											▪						o	o	▪	▪							▪						▪			▪			o	o						
Osmundacidites spp.											▪						▪	▪								▪								▪	▪											
Lundbladispora brevicula											▪	▪	o	o		●	●	o	o	o	▪		▪	▪		▪							▪													
Punctatisporites spp.											o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪																									
Calamospora tener												▪				▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪		▪	▪	▪		▪	▪	▪	▪	▪		▪	▪	▪	▪	▪			
Cyclotriletes spp.												▪	▪				▪					▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪					o	▪			
Kraeuselisporites apiculatus												▪	▪	▪			▪	▪	▪	▪			▪	▪										▪	▪		▪	▪	▪	▪	▪	▪	▪			
Lapposisporites spp.												▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			▪	▪				▪				▪						▪	▪		▪			
Acanthotriletes spp.												▪																						▪	▪			▪	▪	▪	▪	▪				
Verrucosisporites narmianus												▪	▪	▪	o				o	▪		▪		▪		▪			▪																	
Densoisporites complicatus												▪	▪			▪	▪	▪	▪	▪	▪					▪	▪																			
Aratrisporites scabratus												▪			▪			o								▪																				
Dictyophyllidites mortonii												▪						▪	▪	▪	▪																									
Verrucosisporites remyanus													▪		o	▪	▪		▪	▪		▪				▪	▪									▪	▪			▪		▪	▪			
Lundbladispora obsoleta													▪				o		▪	▪			▪	▪		▪				▪			▪	▪	▪	▪	▪	▪		▪	▪					
Aratrisporites parvispinosus													▪	▪	▪	o	o	▪	▪		▪		▪		▪	▪								▪					▪	▪						
Cyclogranisporites orbicularis													▪				▪					▪		▪		▪			▪					▪			▪	▪								
Triletes spp. (megaspores)													▪		o		▪	▪																											
Kraeuselisporites saeptatus														▪			▪		▪		▪		▪			▪																			
Naumovaspora striata																▪						▪	▪					▪						▪									▪			
Deltoidospora spp.																▪	▪		▪	▪	▪		▪	▪		▪	▪		▪									▪		▪		▪				
Pechorosporites spp.																	▪	▪					▪			▪						▪		▪	▪	▪	▪	▪	▪	▪	▪	▪			▪	
Dictyotriletes spp.																	▪			▪				▪			▪		▪					▪	▪	▪		▪	▪	▪	▪		▪			
Leiotriletes spp.																	▪													▪		▪														
Dictyophyllidites spp.																						▪				▪	▪	▪	▪	▪				▪	▪		▪	▪		▪			▪			
Densosporites spp.																						▪		▪		▪																				
Rewanispora foveolata																																		o	o	o	▪	o	▪	o	o	o	▪			
Gibeosporites spp.																																		▪						▪						
Convolutispora spp.																																		▪												
Plankton and varia																																														
Micrhystridium spp.		▪	▪	o	●	o	o	o	o	o	▪	▪			▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪			▪	●	●	●	●	●	●	●	●	●	●	o	●	o
Fungal remain		▪									▪	▪		▪	▪	▪	o	▪	▪	o	▪	▪	▪	▪	▪	o	o	o	o	o	o	o	o	▪						▪	▪		▪		▪	
Veryhachium spp.		▪		▪			▪		▪	o						o	▪	▪	o	▪	▪	o	o	o	▪	o	▪		▪			▪	▪							▪						
Leiosphaeridium spp.		▪	▪		▪	▪	▪	▪	▪	▪																▪					▪	▪														
Cymatiosphaera spp.				▪																															▪							▪	▪			▪
Tasmanites spp.																								▪										●	●	●	●	●	●	●	●	●	o	o	o	▪
Alga incertae sedis																												▪	▪	▪	▪	▪	▪													
Fungal spores																																										▪	▪	▪	o
Assemblages Svalis-1 to Svalis-8	Svalis-1										Svalis-2																							Svalis-3												
Composite Assemblage Zone	Proprisporites pocockii										Naumovaspora striata																							Pechorosporites disertus										indet.		

A.33.1 Cores Dia-84-2, 7323/7-U-8, -6, -3 Sassendalen Group, tables compiled based on Vigran et al. (1998) by including the composite assemblage zones defined herein.

Cores 7323/7 U-4, U-1, U-7, U-9	Late Spathian																	E Anis					Mid Anisian													Late Anisian											
	Sassendalen Group																																														
	Steinkobbe Formation																																														
Core number	U-4																						U-1													U-7		U-9									
Depth in cores	138.61-139.00	138.00-138.02	137.07-137.47	135.94-136.20	135.01-135.02	131.79-132.01	130.01-131.02	127.00-127.01	125.01-125.02	123.01-123.02	120.99-122.00	115.47-116.01	112.01-112.02	110.60-111.00	108.01-108.26	106.97-107.02	105.01-105.02	104.01-104.02	100.01-102.37	97.01-97.18	95.99-96.10	95.53-95.70	126.59-126.80	123.14-124.10	122.48-122.95	120.01-121.25	117.01-117.02	113.00-114.01	111.01-112.02	107.01-107.02	106.01-106.02	103.85-105.01	101.01-101.02	98.01-98.02	94.02-94.03	100.80-102.10	98.45-99.60	122.70-122.85	119.65-119.95	116.10-116.25	112.05-113.25	107.80-108.04	104.27-104.55	98.85-100.07	97.25-97.35	94.55-94.65	93.00-93.01
Pollen																																															
Cycadopites spp.	▪	▪	▪	▪	▪	▪	▪	●	▪	○	○	▪	▪	▪	▪	▪	▪	▪	○	○	○	○	▪	▪	▪	▪	▪		▪		▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	○	▪	▪
Lunatisporites noviaulensis	▪	○	○		▪	▪	▪	▪	○	○	○	○	○	▪	○	▪	▪	○	○	●	▪	▪	▪	▪	▪	▪			▪		▪	○	○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Lunatisporites pellucidus	▪					▪	▪	▪			▪		▪	▪	▪	▪	▪	○	○	○	▪	▪	▪	▪	▪	▪								▪	▪	▪	▪	▪	▪		▪	▪	▪			▪	▪
Protohaploxypinus spp.	▪									▪						▪			▪	▪		▪																	▪	▪	▪	▪	▪				
Lunatisporites spp.	▪	▪	▪	▪	▪	▪	○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	▪	○	▪	○	○	▪	▪												
Protodiploxypinus sittleri	▪										▪						▪				▪	▪	▪	▪	▪	▪	▪								▪												
Pretricolpipollenites spp.	▪	▪	▪	▪	▪	▪	○	○	▪	○	▪	○	○	○	▪	○	▪	▪	▪	▪	▪	○																									
Angustisulcites grandis		▪				▪				▪	▪					▪			▪				▪	▪	▪	▪			▪																		
Striatoabieites balmei			▪			▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	○	○	▪	▪	○	○	○		▪	▪	▪	▪	▪	▪	○	○	○	○	○	○	○	●	●	○
Triadispora spp.			▪			▪		▪	▪	▪	▪			▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			▪	▪		▪	▪	▪	▪	▪	▪		●		○	▪	▪	○	▪	▪
Alisporites spp.			▪			▪		▪				▪					▪	▪	▪	▪	▪	▪	▪	▪	○	○	▪	▪	▪	○	▪	○	○	○	○												
Lunatisporites acutus					▪	▪	▪	▪	▪	▪	▪	▪	▪	▪			▪	▪	▪	▪			▪	▪	▪	▪	▪	▪		▪	▪	▪		▪	▪	○	▪	▪		▪		▪	▪				▪
Triadispora crassa					▪								▪						▪		▪	▪				▪			▪				▪		▪					○							
Platysaccus spp.							▪				▪					▪		▪	▪				▪		▪	▪				▪		▪	▪	▪		▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Platysaccus papilionis							▪			▪								▪	▪																	▪	▪										
Illinites chitonoides									▪		▪		▪			▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	▪			▪	▪	○	▪	▪	▪	○	▪	○	○	▪	▪	▪	○	○	●	▪	○
Protodiploxypinus gracilis								▪		▪	▪			▪										▪											▪	▪	▪	▪	▪	▪		○	▪	▪	▪	▪	▪
Protodiploxypinus spp.									▪	▪	▪					▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪		▪				▪					▪		▪	▪
Striatoabieites spp.										▪		▪	▪	▪			▪	▪	▪			▪																									
Striatoabieites spp.										▪		▪	▪	▪			▪	▪	▪			▪																									
Angustisulcites klausii											▪						▪				▪	▪	▪	▪	▪	▪			▪						▪	▪	▪	○	○	▪	▪	▪	▪	▪	○	▪	▪
Voltziaceaesporites heteromorpha											▪							▪	▪			○														▪	▪	▪		▪	▪	▪	○	▪			▪
Brachysaccus spp.											▪						▪	▪	▪																												
Chordasporites spp.													▪			▪		▪	▪		▪	▪													▪		▪										
Vitreisporites pallidus														▪						▪	▪	▪	●	○	▪	▪		▪					▪	▪			▪	▪	▪	▪	▪	○	▪	▪	▪	▪	▪
Striatoabieites multistriatus															▪	▪	▪	▪	▪	▪	▪	▪	○	○	○	▪	○	○	○	●		▪	▪	▪	▪	▪				▪		▪	▪	▪	▪	○	○
Falcisporites spp.																▪		▪		▪	▪	▪	▪	▪	▪	▪		▪	▪		▪	▪	▪	▪	▪	▪											
Accinctisporites circumdatus																		▪	▪	▪	▪	▪							▪		▪	▪				▪	▪	▪					▪				
Bharadwajispora labichensis																		▪																		▪											
Lueckisporites junior																		▪	▪			▪	▪							▪																	
Alisporites grauvogeli																		▪	▪	▪	▪	▪		▪	▪	▪																					
Falcisporites stabilis																			▪			▪																									
Striatopodocarpidites spp.																			▪		▪	▪																									
Ephedripites spp.																					▪		▪	▪	▪	▪																					
Triadispora obscura																							▪	▪	▪	▪	▪			▪	▪	▪		▪		○	○	▪	▪	▪	▪	▪	▪	▪	○	▪	▪
Alisporites microreticulatus																							▪	▪	▪	▪	▪			▪	▪	▪		▪	▪	▪	▪	▪		▪	○			▪	▪		▪
Podosporites amicus																								▪												▪	▪	▪		▪	▪	○	▪	▪	○	▪	▪
Chordasporites voltziaformis																								▪	▪	▪	▪		▪			▪															
Triadispora modesta																								▪	▪	▪						▪															
Triadispora aurea																								▪	▪	▪																					
Cordaitina minor																										▪		▪										▪	▪	▪		▪	▪	▪			
Triadispora plicata																										▪												▪	▪	▪							
Cordaitina gunyalensis																										▪						▪		▪	▪				▪	▪	▪		▪				
Dyupetalum cf. *vicentinence*																															▪	▪	▪	▪				▪									
Falcisporites keuperianus																															▪																
Indeterminate bisaccates																																				●	●	○	●	●	●	●	●	●	●	○	○
Illinites trivisus																																				▪		●	▪		▪	▪	▪	▪	▪	▪	▪
Podosporites sp. A																																				▪	▪	▪				▪	▪	▪	▪	▪	▪
Podocarpidites spp.																																				▪	▪										
Podosporites spp.																																				○	▪										
Protodiploxypinus decus																																					▪	▪	▪		▪		▪	▪	▪	▪	▪
Protodiploxypinus ornatus																																					▪	▪					▪	▪		▪	▪
Chasmatosporites sp. A																																						▪		▪	▪		▪	▪	▪	▪	▪
Illinites spp.																																						▪	○		▪	▪	▪		▪	▪	▪
Partitisporites spp.																																						▪							▪		
Podosporites sp. B																																						▪				▪			▪		
Retisulcites perforatus																																							▪		▪		▪				▪
Vitreisporites spp.																																														▪	▪
Plankton and varia																																															
Micrhystridium spp.	○	○	○	▪	▪	▪	○	●	○	○	○	▪	▪	○	▪	▪	▪	▪	▪	▪	○	○	●	●	●	●	▪	▪	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	○	●	●	○	○	○
Tasmanites spp.	▪	▪	○	○	○	○	○	●	▪	○	○	○	○	○	○	○	▪	○	○	●	●	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	○	○	○	●	▪	▪	▪	▪	▪	▪	▪		○		▪
Veryhachium spp.	○	○	●	▪	▪	▪	▪	▪	▪	▪	○	●	▪	▪	▪	▪	▪	▪	▪	●	▪	○	▪	○	▪	▪	▪	▪	▪	▪	▪	○	▪	▪	▪	○	▪	○	▪		▪	○		○	○	▪	○
Cymatiosphaera spp.	▪	▪	▪	▪	▪	▪		▪		▪	▪		▪	▪	▪	▪			▪	▪	○	○		▪	▪	▪		▪	▪			▪	▪		▪			▪		▪							
Dictyotidium spp.	▪	○	○	▪	▪	▪		▪	▪	▪	▪	▪	▪	○	○	○		○	▪	●	●	○				▪																					
Pterospermella spp.											▪	▪	▪	▪					▪		▪	▪	▪	▪	▪	▪			▪		▪					▪											
Dictyotidium tenuiornatum																							▪	▪	▪											▪	○	▪	▪	▪			▪	▪	▪		▪
Tyttodiscus spp.																								○	▪	▪										▪			▪		▪		▪				
Leiosphaeridium spp.																															▪							▪					▪		▪		
Plaesiodictyon mosellanum																																						▪								▪	
Botryococcus spp.																																						▪	▪								
Assemblages Svalis-1 to Svalis-8	Svalis-6																						Svalis-6													Svalis-7											
Composite Assemblage Zone	Jerseyiaspora punctispinosa																	A.spiniger					Triadispora obscura													Protodiploxypinus decus											

A.33.2.1 Cores 7323/7-U-4, -1, -7, -9, Sassendalen Group, table compiled based on Vigran et al. (1998) and including the composite assemblage zones defined herein.

Cores 7323/7 U-4, U-1, U-7, U-9	Late Spathian																	E Anis					Mid Anisian													Late Anisian											
	Sassendalen Group																																														
	Steinkobbe Formation																																														
Core number	U-4																						U-1													U-7		U-9									
Depth in cores	138.61-139.00	138.00-138.02	137.07-137.47	135.94-136.20	135.01-135.02	131.79-132.01	130.01-131.02	127.00-127.01	125.01-125.02	123.01-123.02	120.99-122.00	115.47-116.01	112.01-112.02	110.60-111.00	108.01-108.26	106.97-107.02	105.01-105.02	104.01-104.02	100.01-102.37	97.01-97.18	95.99-96.10	95.53-95.70	126.59-126.80	123.14-124.10	122.48-122.95	120.01-121.25	117.01-117.02	113.00-114.01	111.01-112.02	107.01-107.02	106.01-106.02	103.85-105.01	101.01-101.02	98.01-98.02	94.02-94.03	100.80-102.10	98.45-99.60	122.70-122.85	119.65-119.95	116.10-116.25	112.05-113.25	107.80-108.04	104.27-104.55	98.85-100.07	97.25-97.35	94.55-94.65	93.00-93.01
Spores																																															
Aratrisporites spp.	▪		o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	o	●	▪	▪	▪	●	●	●	●			●	●	o	▪	▪	▪		▪	▪	▪
Aratrisporites tenuispinosus	▪						▪			▪	▪	▪							▪						▪	▪					▪		o			▪		▪	o	▪	▪			▪	▪		
Verrucosisporites spp.	o	▪	▪	▪	▪	▪	▪		▪	▪	▪		▪		▪	▪	o	o	o	▪	▪	▪	▪	▪	▪								▪		▪	▪	▪		▪								
Gordonispora lubrica	▪	▪								▪			▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪					▪			▪	▪	▪				▪									
Jerseyiaspora punctispinosa	▪		▪	▪	▪		▪	▪			▪	▪	o	▪	▪	▪	▪	▪	▪						▪	▪					▪	▪	▪	▪	▪		▪										
Punctatisporites spp.	▪	▪						▪		▪	▪								▪				▪	▪	▪	▪	▪		▪				▪	▪													
Densoisporites nejburgii	o	o	o	o	o	o	o	o	o	o	o	▪	▪	o	▪	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪																					
Densoisporites spp.	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪		▪		▪				▪																									
Cyclotriletes triassicus	▪										▪																																				
Calamospora spp.		▪					▪			▪	▪		▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	o				▪	o	▪	▪	▪	▪	▪	▪	▪	▪					▪		
Cyclotriletes spp.		▪	▪								▪					▪	▪	▪	▪	▪	▪															▪			▪								
Granulatisporites spp.		▪						▪											▪				▪	▪	▪	▪			▪	▪																	
Lundbladispora spp.		▪						▪	▪																																						
Cyclotriletes oligogranifer			▪				▪				▪						▪	▪		▪	▪	o							▪	▪																	
Todisporites spp.					▪	▪	▪	▪	▪	▪	▪		▪	▪		▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	▪		▪			▪	▪	▪	▪	▪	▪	▪	▪			▪			▪	▪	
Kraeuselisporites spp.					▪																		▪	▪							▪	▪		▪				▪	▪	▪		▪					
Cyclotriletes pustulatus						▪		▪																																							
Dictyophyllidites mortonii							▪				▪					▪		▪	▪																												
Verrucosisporites jenensis							▪	▪			▪					▪		▪																													
Baculatisporites spp.										▪						▪		▪	▪	▪	▪	▪		▪	▪	▪			▪						▪				▪								
Aratrisporites parvispinosus										▪		▪						▪					▪	▪	▪	▪						▪		▪	▪												
Aratrisporites fimbriatus										▪	▪								▪		▪																										
Cycloverrutriletes presselensis										▪																																					
Gordonispora fossulata										▪	▪					▪			▪	▪	▪	▪	▪	▪	▪	▪							▪	▪	▪			▪	▪			▪				▪	
Deltoidospora spp.											▪						▪					▪	▪	▪	▪	▪			▪	▪		▪	▪	▪	▪			▪	▪		▪				▪	▪	▪
Verrucosisporites morulae															▪	▪	▪	▪		▪			▪		▪	▪	▪																				
Cyclogranisporites spp.																▪				▪	▪																										
Striatella seebergensis																		▪					▪					▪	▪			▪	▪	▪	▪	o	▪	▪		▪			▪				▪
Anapiculatisporites spiniger																		o	▪		▪	▪						▪	▪			▪			▪												
Eresinia spinellata																		▪	▪																						▪						
Osmundacidites senectus																			▪			▪									▪	▪															
Aratrisporites scabratus																					▪	▪	▪	▪	▪	▪	▪				▪	▪	▪	▪	▪	●	●	●	▪	▪	▪	▪	▪	▪	▪	▪	▪
Kraeuselisporites apiculatus																						▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪			▪	▪	▪				▪			
Leschikisporis aduncus																							▪	▪	▪				▪	▪				▪	▪			o	▪	▪	▪	▪	▪	▪	▪	▪	▪
Aratrisporites macrocavatus																							▪	▪	▪	▪	▪	▪		●	o	●	o	o	o	o	o	▪	o	▪						▪	▪
Lycopodiacidites spp.																							▪	▪			▪								▪		▪			▪	▪		▪	▪		▪	
Perotrilites spp.																							▪	▪			▪		▪		▪				▪		▪	▪			▪						
Conbaculatisporites spp.																							▪				▪		▪			▪				▪	▪	▪	o	▪							
Converrucosisporites spp.																							▪	▪					▪									▪									
Converrucosisporites cameronii																							▪	▪					▪																		
Endosporites papillatus																							▪	▪																							
Concavisporites spp.																								▪					▪		▪	▪	▪	▪	▪												
Reticulatisporites spp.																								▪						▪		▪			▪												
Acanthotriletes spp.																								▪	▪	▪						▪		▪													
Uvaesporites spp.																								▪	▪	▪																					
Neoraistrickia spp.																										▪					▪				▪												
Microreticulatisporites spp.																										▪				▪																	
Triplexisporites playfordii																										▪																					
Stereisporites spp.																													▪		▪							▪	▪								
Deltoidospora australis																															▪							▪		▪	▪						▪
Kraeuselisporites punctatus																																▪		▪													
Apiculatisporis spp.																																▪															
Conbaculatisporites hopenensis																																				▪											
Deltoidospora minor																																				▪											
Verrucosisporites remyanus																																						▪							▪		
Retusotriletes spp.																																						▪					▪				
Cycloverrutriletes spp.																																						o		▪	▪						
Ischyosporites spp.																																						▪									
Gibeosporites spp.																																							▪	▪	▪	▪	▪	▪		▪	▪
Osmundacidites spp.																																							▪	▪							
Camarozonosporites rudis																																									▪				▪		
Leptolepidites spp.																																									▪						
Todisporites minor																																														▪	
Zebrasporites spp.																																														▪	
Assemblages Svalis-1 to Svalis-8	Svalis-6																						Svalis-6													Svalis-7											
Composite Assemblage Zone	Jerseyiaspora punctispinosa																	A.spiniger					Triadispora obscura													Protodiploxypinus decus											

A.33.2.2 Cores 7323/7-U-4, -1, -7, -9 and -2, Sassendalen Group, table compiled based on Vigran et al. (1998) and including the composite assemblage zones defined herein.

Cores 7323/7 U-9, U-10, U-5, U-2	L.A			Ladinian																													
	Sassendalen Group																																
	Stei.			Snadd Formation																													
Core number	U-09			U-10									U-05														U-2						
Depth in cores	97.25-97.35	94.55-94.65	93.00-93.01	123.29-124.13	121.28-121.29	119.25-119.26	115.25-115.26	113.30-113.31	107.10-107.11	103.20-103.21	99.05-99.06	97.00-97.01	137.82-137.87	134.99-135.00	132.07-132.08	128.00-129.00	124.01-125.02	120.01-121.01	116.99-118.03	115.05-115.06	112.01-112.02	109.01-109.02	105.97-107.00	103.02-103.03	100.02-100.03	97.01-97.02	112.44-112.46	112.04-112.14	111.73-111.74	108.65-108.66	106.89-106.90	105.05-105.06	104.68-104.69
Pollen																																	
Angustisulcites klausii	o	▪	▪	▪				▪		▪			▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪		▪		▪	▪
Chasmatosporites sp. A	▪	▪	▪		▪			▪				▪			▪	▪		▪	o	▪	▪	o	▪	▪	●	▪				▪		▪	▪
Cycadopites spp.	o	▪	▪	▪	▪	▪	▪	▪	▪	●	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	o		▪	▪	▪	▪	▪	▪	▪
Echinitosporites iliacoides					▪	▪			▪	▪					▪	▪			▪	▪				▪	▪	▪		▪	▪	▪		▪	▪
Illinites chitonoides	●	▪	o		▪	▪	o	●	●	▪	▪	▪	●	▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	o	o	▪	▪	▪	o
Illinites trivisus	▪	▪	▪															▪	▪			▪					▪	o	▪	▪	▪	▪	▪
Podosporites amicus	o	▪	▪		o	▪		▪	▪	▪	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	o			o	o	▪	o
Podosporites sp. A	▪	▪	▪									▪		▪	▪		▪		▪		▪		▪				▪	▪	▪	▪		▪	▪
Podosporites sp. B	▪			▪	o			▪	▪	▪		▪	▪	▪	▪	▪	▪	▪			▪	▪	▪				▪	▪	▪	▪		▪	▪
Protodiploxypinus decus	▪	▪	▪	▪	o	▪	▪	▪	o	▪	o	o		▪	▪			▪	▪				▪	▪	▪	▪	▪					▪	▪
Protodiploxypinus gracilis	▪	▪	▪	▪	o	▪		▪	o				▪	▪	▪	▪				▪	▪	▪	▪	▪			▪					▪	▪
Triadispora obscura	o	▪	▪	●	●	▪		▪	▪			▪			▪		▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	o	▪	o	o	▪	o
Triadispora spp.	o	▪	▪		●	▪	▪	▪	▪	o	o	o																				▪	o
Vitreisporites pallidus	▪	▪	▪	▪	●	●	o	▪	▪	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	●	▪	▪	▪	▪	▪	▪	▪	▪
Partitisporites spp.	▪			▪	▪	▪	▪	▪	▪			▪	▪	▪	▪	▪		▪				▪	▪				▪					▪	
Striatoabieites multistriatus	▪	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪			▪	▪	▪	▪						▪	▪	▪	▪		▪	
Indeterminate bisaccates	●	o	o										o	o	o	o	▪	▪	▪	o	▪	●	●	▪	●	▪	●	●	●	o	o		
Lunatisporites noviaulensis	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪				▪	▪	▪	▪	▪		▪	▪		▪							
Illinites spp.	▪	▪	▪																														
Platysaccus spp.	▪	▪	▪																														
Protodiploxypinus ornatus		▪	▪	o	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Vitreisporites spp.		▪	▪	▪	▪	o	▪	▪	▪	▪	▪	▪																					
Protodiploxypinus spp.		▪	▪																														
Lunatisporites pellucidus		▪	▪																														
Retisulcites perforatus			▪					▪		▪		▪						▪								▪	▪	▪				▪	▪
Lunatisporites acutus			▪										▪					▪															
Voltziaceaesporites heteromorpha			▪																														
Alisporites microreticulatus			▪																														
Ovalipollis pseudoalatus				▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	●	▪	▪	o	▪	o	o				▪	▪
Protodiploxypinus minor				▪	▪		▪					▪	▪	▪	▪	▪					▪	▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪
Triadispora crassa				▪		▪	▪	▪	▪	▪		▪			▪		▪		▪		▪	▪	▪	▪					▪	▪	▪		
Cordaitina minor				▪		▪		▪				▪										▪	▪		▪								
Accinctisporites circumdatus					▪				▪							▪			▪				▪					▪					▪
Protohaploxypinus spp.					o				▪	▪	▪	▪	▪		▪	▪		▪	▪	▪				▪							▪	▪	▪
Staurosaccites quadrifidus					▪	▪		▪			▪	o	●		●	●	▪		▪	▪		▪	▪	▪		▪	▪	▪	▪	▪	o	▪	▪
Triadispora plicata						▪	▪						▪	▪	▪		▪	▪	▪			▪	▪	▪			▪					▪	▪
Triadispora verrucata						▪	▪	▪				▪	▪	▪	▪										▪	▪							
Eucommiidites microgranulatus								▪			▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	●	▪	▪					▪	▪
Alisporites spp.								▪	▪	▪		▪	▪	▪	▪	▪		▪	▪		▪	▪	▪	▪		▪						▪	
Cordaitina gunyalensis								▪				▪				▪						▪					▪	▪	▪				
Schizaeoisporites worsleyi										▪	▪	▪			▪		▪			▪												▪	
Retisulcites sp. A											▪	▪																				▪	▪
Infernopollenites parvus												▪		▪	▪	▪									▪	▪	▪	▪	▪	▪	▪	▪	
Duplicisporites granulatus												▪																					
Enzonalasporites densus													▪	▪	▪	▪		▪		▪						▪	▪	▪					
Triadispora modesta																		▪	▪			▪	▪				▪			▪	▪		
Dyupetalum cf. *vicentinence*																			▪														▪
Ephedripites spp.																			▪	▪		▪	▪	▪	▪							▪	
Paracirculina scurrilis																			▪														
Quadraeculina anellaeformis																											▪	▪				▪	▪
Retisulcites spp.																																	▪
Plankton and varia																																	
Leiosphaeridium spp.	▪					●	o																▪							▪		▪	▪
Micrhystridium spp.	o	o	o	●	●	o	o	▪	▪	o	o	▪	▪	▪	▪	▪		▪	▪	▪	▪		▪	▪	▪	▪				▪			▪
Tasmanites spp.	o		▪		▪				▪				▪	▪					▪	▪	▪			▪	▪								▪
Veryhachium spp.	o	▪	o	▪	▪	o	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪				▪	o	▪	▪	▪
Dictyotidium tenuiornatum	▪		▪																														
Plaesiodictyon mosellanum		▪			▪		▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	●	●		▪						▪	▪
Baltisphaeridium spp.				▪	▪	▪	▪	▪	▪	▪	▪	▪												▪		▪				▪			▪
Cymatiosphaera sp. 1.				o	●	●	o	o	●	▪	●	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	●	●	▪	▪	▪
Dictyotidium spp.				o	o		o	▪	▪	▪			▪			▪	▪	▪	▪	▪	▪		▪	▪	▪	▪				▪		o	▪
Leiofusa spp				▪	▪	▪	▪	▪		▪		▪									▪	▪	▪		▪				▪			▪	▪
Tyttodiscus spp.				▪	▪			o	▪				▪					▪		▪	▪		▪	▪	▪	▪							
Cymatiosphaera spp.									o			●																▪	●	o	▪	▪	▪
Cyst (calcified dinoflagellate)												o																					
Pterospermella spp.																	▪		▪														
Botryococcus spp.																					▪	▪										▪	
Svalid Dome Assemblage	S-7			Svalis-8																													
Composite Assemblage Zone	P.dec			Echinitosporites iliacoides																													

A.33.3.1 Cores 7323/7-U-9, -10, -5, and -2, Sassendalen Group, table compiled based on Vigran et al. (1998) and including the composite assemblage zones defined herein.

Cores 7323/7 U-9, U-10, U-5, U-2	L.A			Ladinian																													
	Sassendalen Group																																
	Stei.			Snadd Formation																													
Core number	U-09			U-10									U-05														U-2						
Depth in cores	97.25-97.35	94.55-94.65	93.00-93.01	123.29-124.13	121.28-121.29	119.25-119.26	115.25-115.26	113.30-113.31	107.10-107.11	103.20-103.21	99.05-99.06	97.00-97.01	137.82-137.87	134.99-135.00	132.07-132.08	128.00-129.00	124.01-125.02	120.01-121.01	116.99-118.03	115.05-115.06	112.01-112.02	109.01-109.02	105.97-107.00	103.02-103.03	100.02-100.03	97.01-97.02	112.44-112.46	112.04-112.14	111.73-111.74	108.65-108.66	106.89-106.90	105.05-105.06	104.68-104.69
Spores																																	
Aratrisporites spp.	▪	▪	▪	▪	▪	▪	▪	○	▪	●	○	○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Aratrisporites tenuispinosus	▪			▪	▪	▪	▪	○	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪		▪	▪	▪	▪	▪	▪				▪	▪
Calamospora spp.	▪			▪	○	▪	▪	▪	▪	○	●	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪				○			▪
Leschikisporis aduncus	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪		▪	▪	▪	▪	●	▪	▪				○	▪
Striatoabieites balmei	●	●	○	○	●	●	○	▪	▪	▪	○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Camarozonosporites rudis	▪																	▪															
Deltoidospora spp.	▪	▪	▪	▪	●	●	▪	○	○	●	●	▪																					
Todisporites spp.	▪	▪				●																											
Aratrisporites scabratus	▪	▪	▪																														
Eresinia spinellata	▪																																
Jerseyiaspora punctispinosa	▪																																
Gordonispora fossulata		▪			▪	▪		▪	▪	○		▪	▪	▪	▪	▪	▪		▪	▪		▪	▪	▪			▪						▪
Todisporites minor		▪		▪	○	▪		▪	▪	▪	▪	▪	▪	▪		▪		▪	▪	▪		▪	▪	▪				▪	▪		▪		▪
Aratrisporites macrocavatus		▪	▪					▪		▪			▪	▪	▪	▪		▪	▪	▪	▪		▪	▪	▪		▪	▪	▪			▪	▪
Gibeosporites spp.		▪	▪		▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪							
Lycopodiacidites spp.		▪																															
Zebrasporites spp.		▪																															
Deltoidospora australis			▪										▪	▪	▪	▪		▪		▪		▪	▪	▪		▪	▪						▪
Striatella seebergensis			▪		▪	▪	▪	▪	▪	○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	○	▪	○	▪
Lycopodiacidites kockenii				▪	▪		▪			▪					▪	▪	▪			▪	▪			▪	▪			▪			▪	▪	▪
Todisporites cinctus				▪	○	▪		▪	▪			▪	▪	▪		▪			▪			▪	▪	▪		▪		▪	▪		▪	▪	▪
Anapiculatisporites spiniger				▪				▪	▪	▪		▪					▪							▪		▪					▪	▪	▪
Triadispora aurea				○	○		○		○		▪	○			▪			▪	▪			▪											
Zebrasporites kahleri				▪	▪	▪	▪					▪		▪	▪					▪													
Acanthotriletes spp.				▪	▪	▪											▪	▪	▪		▪												
Dictyophyllidites mortonii					○		▪	▪	▪	▪			▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	●	▪	○	▪	○	▪	▪	▪
Laevigatosporites spp.					▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪							▪
Staplinisporites camineus					▪							▪							▪													▪	
Punctatosporites spp.					▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	▪		▪	▪		▪	▪	▪	▪	▪	▪							
Zebrasporites interscriptus					▪																												
Annulispora folliculosa						▪	▪			▪									▪				▪	▪								▪	▪
Neoraistrickia taylori						▪							▪	▪	▪	▪	▪	▪	▪			▪					▪	▪				▪	▪
Conbaculatisporites hopenensis						▪		○	▪	○		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	▪	▪	▪	▪	○	▪	▪	▪
Uvaesporites argentaeformis						▪						▪											▪			▪		▪	▪	▪			
Verrucosisporites spp.						▪												▪				▪						▪	▪				
Verrucosisporites applanatus						▪													▪														
Semiretisporis sp. A							▪	▪	▪	▪		○	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	○	▪	▪		▪	▪
Aratrisporites parvispinosus							▪	▪	▪			▪		▪	▪	▪	▪	▪			▪		▪		▪	▪							
Baculatisporites spp.								▪										▪				▪	▪					▪	▪	▪	▪		▪
Uvaesporites gadensis								▪																									
Kraeuselisporites spp.									▪	▪		○	▪	▪	▪	▪	▪	▪		▪			▪	▪	▪	▪	▪					▪	
Annulispora cicatricosa										▪								▪	▪													▪	▪
Stereisporites spp.										○					▪		▪	▪	▪		▪	▪	▪	▪									
Spore sp. V													▪		▪		▪																
Cyclotriletes spp.													▪	▪	▪	▪			▪				▪				▪	▪	▪			▪	▪
Deltoidospora minor													▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	●	▪	▪	▪	○	○	○	○
Kraeuselisporites cooksonae													▪	▪	▪		▪						▪	▪	▪	▪							
Osmundacidites wellmannii													▪		▪					▪				▪		▪							
Aratrisporites centratus													▪	▪	▪	▪					▪		▪	▪	▪								
94 Conbaculatisporites spp.													▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪										
Verrucosisporites morulae														▪																			
Lycopodiacidites kahleri															▪																		
Neoraistrickia spp.																▪			▪														
Ischyosporites spp.																				▪			▪										
Spore sp. C																						▪	▪			▪			▪			▪	▪
Cycloverrutriletes presselensis																						▪	▪			▪							
Perotrilites spp.																						▪	▪	▪		▪							
Gleicheniidites spp.																								▪	▪						▪		
Densoisporites velatus																												▪					▪
Baculatisporites comaumensis																												▪					
Striatella spp.																																○	▪
Svalid Dome Assemblage	S-7			Svalis-8																													
Composite Assemblage Zone	P.dec			Echinitosporites iliacoides																													

A.33.3.2 Cores 7323/7-U-9, -10, -5, and -2, Sassendalen Group, table compiled based on Vigran et al. (1998) and including the composite assemblage zones defined herein.

Triadispora spp. Smooth trilete spores and *Leschikisporis aduncus*, together with the *Aratrisporites*, *Kraeuselisporites* and *Striatella* groups, range throughout the core. Acritarchs have sporadic appearances.

L. aduncus and smooth spores dominate most samples up to 37.83 m. *Camerosporites secatus*, *Duplicisporites granulatus* and *Enzonalasporites vigens* only have records in the lowest samples (117.17–106.01 m). At 88.23 m and upwards, there are sporadic occurrences of *Porcellispora longdonensis* and *Protodiploxypinus ornatus* as well as abundance peaks of the *Polypodiisporite*s and the *Protodiploxypinus* groups. The *Triadispora* group, *Aulisporites astigmosus* and *O. pseudoalatus* have only sporadic appearances. *Annulispora folliculosa*, *Kyrtomisporis* speciosus and *Zebrasporites interscriptu*s have their income at 13.45 m. Most of the abovementioned taxa are not present above 13.45 m. Reworked Permian algae are recorded at 13.45 m.

The interval is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. The core contains several soil horizons and the palynomorph associations in this core reflect alternating marine and terrestrial conditions.

B.5 Cores from the Olga Basin and Sentralbanken areas

In 1990, 1995 and 1998 the Norwegian Petroleum Directorate drilled shallow cores (operated and reported by IKU/SINTEF Petroleum Research). These cores (7532/2–U–1, 7533/2–U–1, 7533/2–U–2, 7533/2–U–3, 7533/3–U–7, 7534/4–U–1 and 7534/6–U–1) penetrate the Klappmyss and the Kobbe formations as well as parts of the Kapp Toscana Group including the Realgrunnen Subgroup (Tables A.36–41, Plates 19–28) and are presented according to their inferred ages.

B.5.1, Core 7532/2–U–1, late Spathian to early Anisian

The core, drilled in 1990, penetrates 15.32 m of deposits around the boundary between the Klappmyss and Kobbe formations. The palynological range chart (Table A.36) is based on seven samples and shows an upwards increasing diversity of the *Lunatisporites*, *Striatoabieites* and *Aratrisporites* groups. The incoming of diverse plankton at 13.2 m, above the formational boundary, indicates a marine depositional environment.

Klappmyss Formation
Interval 15.9–15.6 m
The pollen *Cordaitina gunyalensis*, *Illinites chitonoides* and *Triadispora* spp., together with *Striatella* spp. and *Aratrisporites* spp., allow recognition of the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Kobbe Formation
Interval 13.2–4.64 m
Bisaccate pollen, *Cordaitina gunyalensis* and the diverse *Aratrisporites* group, together with *Leschikisporis aduncus* and smooth trilete spores, dominate the assemblages. Diverse spores include *Anapiculatisporites spiniger* and regular to common *J. punctispinosa*. The association is identified as belonging to the *Anapiculatisporites spiniger* Composite Assemblage Zone.

Striatella spp. has records in the Klappmyss Formation, while *J. punctispinosa* appears in the Kobbe Formation of this core. The opposite succession of these taxa has been recorded from the Svalis Dome (Vigran et al. 1998) and was used to distinguish between the 'Svalis–4' and 'Svalis–5' assemblages. The presence of both spores in the late Spathian shows that their earliest record cannot be used alone to differentiate these two assemblage zones (Table A.33).

B.5.2, Core 7534/6–U–1, late Spathian to Anisian

This core, drilled in 1995, penetrates about 110 m of the Sassendalen Group, in the Klappmyss and Kobbe formations. The formational boundary is marked at 79.6 m. Ammonoids assigned to the late early Anisian *Lenotropites caurus* Zone are present above this boundary. The palynological study comprises 15 samples (Table A.37, Plates 25–28).

Klappmyss Formation, 119.4–84.8 m
Interval 119.4–84.8 m
Diverse assemblages are dominated by spores with the presence of species such as *Anapiculatisporites spiniger*, *Aratrisporites macrocavatus*, *Concentricisporites plurianulatus*, *Cyclotriletes oligogranifer*, *Jerseyiaspora punctispinosa*, *Leschikisporis aduncus* and *Striatella* spp. Pollen include *Illinites chitonoides* and, at 84.80 m, *Lueckisporites junior* and *Accinctisporites circumdatus*. The diverse plankton include common *Tasmanites* spp. and other marine algae as well as *Grebespora concentrica*, acritarchs and freshwater green algae. The association is assigned to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Kobbe Formation, 79.60–9.5 m
Interval 79.6–65.59 m
The major pollen and spore groups from below continue into this interval. The *Aratrisporites*, *Triadispora* and *Striatoabieites* groups have a high diversity and abundance. There are common *Accinctisporites circumdatus* and *Gnetaceaepollenites* spp. The plankton association is less diverse than in samples from the Klappmyss Formation and from the higher parts of the Kobbe Formation.

The assemblage is assigned to the *Anapiculatisporites spiniger* Composite Assemblage Zone. Some reworked

CORE 7427/3-U-1	KAPP TOSCANA GROUP																															
Lithostratigraphy	Snadd Formation																															
Age	Ladinian																															
Pollen / Depth in core	87,53	84,18	82,68	80,9	79.95	78.87	76.01	74.97	68.35	66.90	64.09	58.20	55.39	51.81	49.81	47.97	44.25	38.41	36.97	36.89	33.04	29.39	27.51	25.76	23.64	20.53	17.01	14.35	10.31	7,79	5,33	2,35
Alisporites spp.	C	C		C									C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C		C	C
Cordaitina gunyalensis	x	x	x	x	x				x		C	x	x	x			C	x		x	x	x						x		x		x
Illinites chitonoides	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C		C	C	C	C	C	C	A	C		C	C	C	C	C	C
Protodiploxypinus spp.	C	C	C					C	C	C			C	C	C	C	C		C	C		C	C	C	C	C	C	C		C		C
Striatoabieites multistriatus	x	x		x		x	C	C	x			x	x	x	x	x	x	x	C	x	x		x	x	x	x	x	x	x	x		x
Protodiploxypinus fastidioides	C			C				x	x	C			C	C			C		x	C								C	C	C	C	
Triadispora obscura	C	C	C			C	C	x	C	C		C	C	C	C	C	C	C	C	C		C	x	C		C	C			C		
Angustisulcites klausii	x	x	x	x		x	x	x						x		C	x	C	x	x	x	x		x	C		C	C				
Falcisporites spp.		x			x		x				x		C	C	x			C	x	C	C	C	C	C		C		C	C			C
Podosporites amicus		C	C	C	C		C	C			x		C	C	C		C	C	C	C	C		C	C	C	C	C	C		C	C	C
Triadispora spp.		C			C	C	C		C	C	C	C		C			C	C	C	C		C	x	C	C							C
Triadispora aurea		x					x			x		x		x			x	x	x	x		x					x					
Schizaeoisporites worsleyi			x				x	x						x	x		x															x
Staurosaccites quadrifidus			x		x												x		x	x	C	x	x	x	x		x	x	x	x		x
Striatoabieites aytugii			x		x	x	x	x		x							x	x			x					x			x			x
Chasmatosporites spp.			x			x			x		x	x	x	x	x			x	x	x		C	x	x	x				x	x	x	
Infernopollenites spp.			x														x	x	x		x											
Triadispora modesta			x			x						x				x																
Echinitosporites iliacoides				x		x			x	x		x		x			x		x									x	x	x	x	x
Ovalipollis pseudoalatus				x	x	x	x	x						x	C		x	C	x		x		x		C	C	C	x		x		x
Cycadopites spp.				x		x				x			x					x					x	x		x	x			x		
Brachysaccus spp.				x			x			x					x	x		x			x	x	x	x		x	x	x	x			
Illinites spp.					x											C			C													C
Platysaccus spp.					x																									x		
Vitreisporites pallidus					x					x	x		x		x				x	x			x		x			x				
Institisporites crispus					x										x																	
Bharadwajispora labichensis						x																										
Lunatisporites noviaulensis							x												x			x	x									C
Lunatisporites spp.							C												x			x	x	x	x	x		x	x		x	x
Triadispora verrucata							x	x						x		x		x	x	x		x			x			x		x		
Duplicisporites spp.													x																			
Voltziaceaesporites heteromorpha																		x	x	x		x										
Striatoabieites spp.																			x													
Protodiploxypinus ornatus																				x		x		x					x		x	
Ephedripites spp.																																x
Spores																																
Aratrisporites centratus (*macrocavatus*)	x	x	x	x	x	C	x	C	C	C	C	x	C	C	C	C	C	C	C	C	x	C	x	x	x	x	x	x	A	x	x	C
Aratrisporites palettae	x		x		x													x			x		x	x						x		x
Calamospora spp.	x		C	C	C	x	x	C		C	x	x		C	C	C		x	C	C	C	C	C	C	x	C	C	C	C	C	C	x
Deltoidospora minor	C	C		C	C	x	x	C	x		x	x			C	C	x	x	x		C	C	C	x		x	C	x	C	C	x	x
Densosporites spp.	x	x	x	x							x		x	x	x	x	x	x	x	x	x	x	x	x	C	C	C	x	x	x	C	x
Dictyophyllidites mortoni	C	x	x		C	x	x	x	x	x	x	x	x	x	x	C	C		x	x	x	x	x	C	x	x	x	C	x	x	C	C
Leschikisporis aduncus	x	x		x		x	A	A	x		x			x	x	x		x	x	x	x	x	x	x	x	x	x		x			x
Semiretisporis spp.	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		C	x	x	C	C		C	x		x	x		C
Striatella seebergensis	C	C	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	C	C
Converrucosisporites spp.	x	x		x				x													x								x		x	
Neoraistrickia spp.	x								x	x	x				x		x	x	x	x	x	x				x	x	x	x	x		
Kraeuselisporites spp.		x	x	C	C		x		x				x	x	x		C	x	x	C	x	x	C	C	C	x	C	x	C	x	x	x
Zebrasporites interscriptus		x	x	x		x							x	x	x					x	x			x		x	x	x		x		x
Kraeuselisporites cooksonae			x	x	x		x		x	x	x	x	x	x	x		x	x	x	x	x	x	x							x		x
Lycopodiacidites spp.			x	x		x											x	x		x			x	x								x
Conbaculatisporites spp.			x	C		x	x						x	x					x			x				x	x		C	x		
Kraeuselisporites saeptatus			x	x																						x	x	x	x	x		
Apiculatisporis spp.				x				x							x		x	x					x	x	x	x	x	x	x	x	x	
Anapiculatisporites spiniger					x								x	x		x				x							x			x		x
Thomsonisporites toralis					x	x		x				x		x	x		x				x			x	x	x	x		x	x	x	x
Leptolepidites spp.					x								x	x												x						
Granulatisporites spp.					x																											
Baculatisporites spp.						x	x	x			C	x							C		C											x
Aratrisporites tenuispinosus						x									x	x	x	x	x	x		x	x	x		x	x		x			
Todisporites spp.						x		x	x					C				x		x												
Aratrisporites paenulatus						x	x	C				x	x	x																		
Reticulatisporites spp.						x																										
Aratrisporites spp.							x	C								x			x		x											C
Verrucosisporites spp.								x	x						x				x			x	x		x							
Calamospora tener								x	x	x													x									
Stereisporites spp.										x				x																		
Lycopodiumsporites spp.											x			x	x																	
Deltoidospora australis											x	x																				
Camarozonosporites rudis													x	x	x						x	x	x		x	x			x			x
Lycopodiumsporites semimuris													x																			
Punctatosporites spp.														x		x			x			x			x	x	x		x		x	
Uvaesporites spp.															x			x										x			x	
Gordonispora fossulata																		x	x			x	x	x								
Todisporites cinctus																		x														
Polycingulatisporites spp.																						x		x	x							
Perotrilites spp.																							x									
Lycopodiacidites rugulatus																									x							
Annulispora spp.																										x					x	
Deltoidospora concavus																																x
Plankton and varia																																
Veryhachium spp.		x			x		x	x											x		C	C	x	x	x	x	x	x	x	x		x
Plaesiodictyon mosellanum					x		x	x					x	C	x	x				x				x				x	x	x		x
Tasmanites spp.						x	x							x	x																	
Dictyotidium spp.						x					x						x															
Micrhystridium spp.								x		x				x				x			x	x	x	x	x	x	x		x	x	x	x
Cymatiosphaera sp. A								x																					x			x
Composite Assemblage Zone	Echinitosporites iliacoides																															

LEGEND
A abundant
C common
x present

A.34 Core 7427/3-U-1, Sassendalen Group.

GARDARBANKEN - HOPENDJUPET

CORE 7430/7-U-1	KAPP TOSCANA GROUP																																
Lithostratigraphy	Snadd Formation																																
Age	early - middle Carnian																																
Pollen / Depth in core	117,17	117,13	115,20	113,72	113,45	109,28	106,01	102.01	100,21	97,63	88,23	87,43	81,28	78,25	77,33	73,76	67,62	53,87	50,38	50,21	43,55	38,13	37,83	29,03	21,2	16,3	15,78	14,58	13,45	11,45	9,86	8,87	7.45
Araucariacites spp.	x	x	x	x			x				x		x							x		x							x			x	
Cycadopites spp.	x			x	x		x				x		x		x		x	x	x	x	x											x	
Staurosaccites quadrifidus	x		x			x					x																					x	
Illinites spp.	x			x							x																		x				
Triadispora spp.	x			x	x	x	x					x						x								x		x	x				
Podosporites amicus	x				x	x					x				x													x					
Vitreisporites pallidus	x			x	x						x									x													
Enzonalasporites vigens	x																																
Camerosporites secatus	x																																
Duplicisporites granulatus		x			x																												
Chasmatosporites apertus				x					x		x					x			x	x		x										x	
Triadispora plicata				x											x					x												x	
Ephedripites spp.				x							x									x						x		x					
Aulisporites astigmosus				x											x			x				x	x						x				
Falcisporites spp.				x																						x		x	x				
Ovalipollis pseudoalatus						x	x				x		x			x					x	x				x		x	x			x	
Accinctisporites spp.							x																										
Podocarpidites spp.							x																										
Decussatisporites delineatus									x									x		x													
Protohaploxypinus spp.										x	x																		x				
Protodiploxypinus ornatus											x						x			x												x	
Alisporites spp.											x																		x				
Illinites chitonoides											x		x										x						x				
Protodiploxypinus minor											x											x							x				
Schizaeoisporites worsleyi											x																		x				
Striatoabieites spp.											x															x		x	x				
Porcellispora longdonensis											x									x		x											
Triadispora verrucata											x									x													
Limitisporites spp.															x																		
Angustisulcites klausii																		x								x		x	x				
Protodiploxypinus gracilis																		x					x			x							
Cordaitina gunyalensis																										x		x					
Brachysaccus spp.																												x					
Lunatisporites spp.																													x				
Spores														b											b						b		
Concavisporites spp.	x	x	x	x	x		x	x			x	x	x		x	x	x	x	x			x	x	x		x		x	x	x		x	
Deltoidospora spp.	x										x		x		x			x			x	x							x			x	
Kraeuselisporites spp.	x	x		x	x	x											x	x		x								x				x	
Leschikisporis aduncus	A	A	A	A			A				A	A	A		A			A	A	A	A	A	A									x	
Striatella sp.1	x	x			x	x						x					x	x		x						x		x	x			x	
Aratrisporites spp.	x	x	x	x	x	x					x		x		x		x	x		x	x		x				x	x	x				
Calamospora spp.	x	x	x	x	x		x				x		x		x		x	x	x	x		x	x				x	x	x				
Punctatosporites spp.	x			x	x	x	x	x				A						A								A		x	x				
Polycingulatisporites spp.		x										x																				x	
Converrucosisporites spp.		x		x							x															x							
Camarozonosporites rudis			x		x						x				x			x		x		x							x			x	
Uvaesporites gadensis			x																														
Perotrilites spp.				x																				x									
Osmundacidites spp.				x														x		x													
Convolutispora spp.					x												x											x	x				
Gordonispora fossulata					x															x						x			x				
Annulispora cicatricosa					x										x																		
Aratrisporites macrocavatus						x					x																	x					
Lycopodiacidites spp.						x											x											x					
Conbaculatisporites spp.							x						x					x				x							x				
Anapiculatisporites spp.							x						x		x				x										x				
Camarozonosporites laevigatus							x				x	x								x						x		x	x				
Polypodiisporites spp.											A		A		A					A		A											
Anapiculatisporites spiniger											x							x		x												x	
Neoraistrickia taylorii											x																		x				
Densosporites spp.											x						x												x				
Uvaesporites spp.											x						x			x									x				
Densoisporites spp.											x																						
Granulatisporites spp.												x							x										x				
Semiretisporis sp. A *(barentzii)*												x																x					
Annulispora spp.												x						x		x													
Gordonispora spp.															x			x				x						x					
Stereisporites spp.																				x	x											x	
Lycopodiacidites kokenii																				x													
Aratrisporites laevigatus																						x											
Acanthotriletes spp.																						x											
Verrucosisporites spp.																						x											
Todisporites minor																							x						x				
Microreticulatisporites spp.																								x									
Todisporites cinctus																										x	x	x					
Zebrasporites laevigatus																													x	x			
Kyrtomisporis speciosus																													x				
Zebrasporites interscriptus																													x				
Annulispora folliculosa																													x				
Plankton and varia														b											b						b		
Micrhystridium spp.									x																								
Tasmanites spp.																				x	x												
Veryhachium spp.																												x	x				
Paleospongiosporis europaeus																												x					
Unellium spp.																													R!				
Composite Assemblage Zone	Aulisporites astigmosus																																

LEGEND
A abundant (information (from written text)
x present
b barren sample

A.35 Core 7430/7-U-1, Kapp Toscana Group.

SENTRALBANKEN

CORE 7532/2-U-1	SASSENDALEN Gp						
Lithostratigraphy	Klapp-myss		Kobbe Formation				
Age	l.Spat		early Anisian				
Pollen / Depth in core	15,85	15,63	13,22	10,29	7,66	5,98	4,64
Alisporites spp.	x		x	C	C	x	C
Cordaitina gunyalensis	C		C	x		x	x
Lunatisporites noviaulensis	x		x	x	C	C	C
Protodiploxypinus fastidioides	x	x	x	x		x	x
Falcisporites spp.	x	x		x		x	
Illinites chitonoides	x					x	
Striatoabieites aytugii	x	x					
Striatoabieites multistriatus		x	x	C	C	x	C
Triadispora spp.		x				x	
Triadispora obscura			x				x
Lunatisporites acutus			x			x	
Cycadopites spp.			x		x		
Accinctisporites circumdatus			x				
Triadispora plicata			x				
Protodiploxypinus spp.				x			
Brachysaccus spp.					x		
Lunatisporites spp.					C		
Angustisulcites klausii						x	C
Lueckisporites junior						x	x
Spores							
Aratrisporites centratus	C	C	A	A	A	C	C
Aratrisporites palettae	x		C	C	x	x	C
Aratrisporites spp.	C	C	C	C	C	C	C
Baculatisporites spp.	x		x				x
Calamospora spp.	x		x	C	x	C	C
Leschikisporis aduncus	x	x	x	x	x	x	x
Striatella spp.	x		x	x	x	x	C
Converrucosisporites spp.	x		x		x	x	
Cyclotriletes microgranifer	x	x	x				
Apiculatisporis spp.	x	x					
Perotrilites spp.	x						
Kraeuselisporites spp.		x				x	x
Lycopodiacidites spp.		x					x
Todisporites spp.		x	x	x	x	x	C
Neoraistrickia spp.		x		x	x		
Dictyophyllidites mortoni		x					
Punctatosporites spp.		x					
Gordonispora fossulata			x		x	x	x
Jerseyiaspora punctispinosa			x		x	x	C
Lundbladispora brevicula			x	x			x
Apiculatisporites spp.			x		x	x	
Lycopodiumsporites spp.			x				
Deltoidospora concavus				x	x		x
Deltoidospora minor				x	x	C	C
Cyclotriletes spp.				x	x	x	x
Gordonispora lubrica				x	x		x
Aratrisporites paenulatus				x	x	x	
Conbaculatisporites spp.					x		x
Calamospora tener					x		
Lycopodiumsporites spp.					x		
Uvaesporites spp.	LEGEND				x		
Retusotriletes spp.	x present					x	x
Anapiculatisporites spiniger	C common						x
Microreticulatisporites spp.	A abundant						x
Plankton and varia							
Micrhystridium spp.			x	C	x		x
Tasmanites spp.			x	x			x
Veryhachium spp.			x		x		x
Cymatiosphaera sp. A			x	x			
Dictyotidium spp.				x			x
Composite Assemblage Zone	J.puncti		Anapiculati. spiniger				

A.36 Core 7532/2-U-1, Sassendalen Group.

Permian–Carboniferous palynomorphs are observed. Ammonoids at 79.6 m date the interval to the *Lenotropites caurus* Zone (Wolfgang Weitschat pers. comm.1996).

Interval 55.94–9.5 m middle Anisian
The abundance of *Leschikisporis aduncus*, the variety of smooth trilete spores and the diversity of *Aratrisporites* with common *A. macrocavatus* characterise the interval. There are regular to common records of *Densoisporites nejburgii* and *J. punctispinosa*, as well as common *Triadispora obscura*. *Concentrisporites hallei* (55.94 m), *Podosporites amicus* (29.8 m) and *Staurosaccites quadrifidus* (20.6 m) have their locally lowest occurrence within this interval. The assemblage is correlated with the *Triadispora obscura* Composite Assemblage Zone.

B.5.3 Core 7533/2–U–1, early Carnian

This shallow core was drilled in 1998 and penetrates 198.3 m of the Kapp Toscana Group. The 11 palynological samples studied represent sampling intervals of about 20 m (Table A.38).

Snadd Formation
The interval 200.44–2.60 m contains an assemblage with *Echinitosporites iliacoides* (at 200.44 and 2.60 m) and common *Aulisporites astigmosus* and *Chasmatosporites magnolioides*. The pollen *Concentrisporites* and *Illinites* appear regularly. *Podosporites amicus* and *Triadispora* spp. have scattered records. *Leschikisporis aduncus* and smooth spores (*Calamospora* spp., *Deltoidospora* minor) dominate. Amongst the associated forms we note *Cingulizonates rhaeticus* and *Kyrtomisporis laevigatus*.

The middle interval (131.70–48.89 m) contains *Ricciisporites tuberculatus*, shows a lower diversity of bisaccate pollen and is characterised by acmes of *Aulisporites astigmosus*, *Aratrisporites* spp., smooth trilete spores and *L. aduncus*. The diverse assemblage of the highest sample interval (19.30 and 2.6 m) contains only rare *L. aduncus*. Ornamented trilete spores include *Annulispora folliculosa* (abundant), *Camarozonosporites laevigatus*, *C. rudis*, *Cavatoretisporites obvious*, *Densosporites* sp. (Bjærke and Manum 1977) and a diverse *Kyrtomisporis* group.

The assemblages of the entire interval 200.44–2.6 m are assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

SENTRALBANKEN

CORE 7534/6-U-1	SASSENDALEN GROUP														
Lithostratigraphy	Klapp-myss				Kobbe Formation										
Age	l Spath.				e.A.		middle Anisian								
Pollen / Depth below sea level	119.42	107.34	95.13	84.80	75.25	65.59	55.94	44.10	35.89	29.82	20.60	18.50	14.70	12.49	11.70
Bisaccate alete pollen	C	C	C	C							x	C	C		C
Bisaccate fragmented pollen	C	x	C	C	D	C	A	A	A	C	A	A	A	A	D
Cordaitina gunyalensis	x				x									x	x
Cycadopites spp.	x			x	C		C	x	C	x		C	C		C
Lunatisporites spp.	C	C	x	x	x				C			C	x		C
Voltziaceaesporites heteromorpha	x	C	C	C	C	x	C	x	x	x	C	C	C	x	x
Volziaceaepollenites sp. (large)	x										C				x
Gnetaceaepollenites multistriatus	x	x		x	x	x				x	x	x	x	x	
Pretricolpipollenites spp.	x			x	x		C		x	x	C	x	x	x	
Protohaploxypinus spp.	x	x		C	x						x		x	x	
Triadispora labichensis	x	C	x	x	x	x						C		C	
Cordaitina minor	x	C	x		x	x	x			x	C	x	x		
Crustaesporites spp.	x									x					
Lunatisporites noviaulensis		x				x	x	x			x		x	x	
Lueckisporites junior		x							C					x	
Striatoabieites spp.		C	x		x	C	C		C			x	x		
Striatoabieites multistriatus		x			x	C	C					x			
Lunatisporites acutus		x	x		x	x					C				
Illinites chitonoides			x		x	x	C		x	x		x	x	x	
Alisporites sp. (large)			x										x		
Dyupetalum vicentinense			x						x			x			
Triadispora obscura				x	C	C	x	C	C	C		C		C	
Triadispora spp.				x	C									x	
Angustisulcites klausii				x		x		x	x		x		x		
Accinctisporites circumdatus				x	C		x		x			x			
Vitreisporites spp.					x	C							x		x
Striatoabieites balmei					C	x	C	C						x	
Gnetaceaepollenites spp.					x	C						x			
Alisporites sp. (small)						x					x				
Pollen (alete small)						C			C	C					
Lunatisporites pellucidus						C	C	C							
Triadispora crassa						x									
Concentrisporites hallei							x	x		x	x				x
Striatopodocarpites spp.							x								
Triadispora bölchii								x							
Infernopollenites sulcatus									x		x			x	
Podosporites amicus										x		x	x		
Staurosaccites quadrifidus											x				
Vitreisporites pallidus														x	
Triadispora aurea														x	
Pseudenzonalasporites summus														x	
Plankton and varia															
Micrhystridium spp.	C	C	x	C	C	C	C	C	C	x	x	C	C	x	x
Grebespora concentrica	C	x	x		x	C			C	C	C			C	x
Cymatiosphaera sp. A	x	x	x		x	x	x	x	C	x				x	
Tasmanites spp.	C	x	C	x	x	x				x				x	
Dictyotidium spp.	x	x	C	C				x	x	x		x			
Fungal remains (hyphae)	x		x			x			x	x	x	C			
Cyst alete	C					A	C	x	C	x					
Pterospermella spp.	x		x	x			x								
Tyttodiscus spp.	x		x	x											
Botryococcus spp.		x	C	C			x	x		x		x		x	
Faunal indeterminate remains		C													
Megaspore		x					x								
Dictyotidium reticulatum				x											
Fungal spores					x	x		x				x	x		
Carboniferous/Permian palynomorphs					R	R					R				
Foraminiferal lining					x					x					
Cymatiosphaera spp.					x	C									
Veryhachium spp.						C					C		x	x	
Leech cocoon											x		x		
Composite Assemblage Zone	J.puncti.				A sp		Triadispora obscura								
Sample Code Number	E4809	E4791	E4774	E4760	E4745	E4729	E4713	E4695	E4683	E4673	H3719	E4662	H3718	E4660	H3717

CORE 7534/6-U-1	SASSENDALEN GROUP														
Lithostratigraphy	Klapp-myss				Kobbe Formation										
Age	l.Spath.				e.A.		middle Anisian								
Spores / Depth below sea level	119.42	107.34	95.13	84.80	75.25	65.59	55.94	44.10	35.89	29.82	20.60	18.50	14.70	12.49	11.70
Anapiculatisporites spiniger	x	x	x	x	x				x		x	C	x	x	x
Anapiculatisporites spp.	x	x	x		x				x		x	x	C		C
Aratrisporites macrocavatus	x	x			x	x	C	C	C	C	x	C	x	C	C
Aratrisporites paenulatus	x	x	x	x	x		x	C	x	x					x
Aratrisporites palettae	x	x	x	x						x	C	x	C	x	x
Aratrisporites scabratus	C	C	x	x	C		C	C	C	C	C	C	C	C	C
Aratrisporites sp. (thickwalled)	x	C	C	C	x		x	x	x	x	x		x		x
Calamospora spp.	C	C	C	C	C	C	C	C	C	A	C	C	C	C	C
Conbaculatisporites spp.	C	x	C	C			x	C	C	x	x	x	C		C
Cyclotriletes oligogranifer	A	A	A	A	C	C	C	x	C	C	C	C	C	C	x
Cyclotriletes pustulatus	x	C	C	C		x	x	C	x	C		C			x
Deltoidospora minor	C		x	C				C	C	C	C	C	C		x
Densoisporites nejburgii	x	C	C	C	C	x			x	x	x	C	C	x	C
Densoisporites spp.	x						C	C		x		C	C		x
Gordonispora fossulata	x			x	C	x	x		x	C	C		x	C	x
Leschikisporis aduncus	C	x	C	C		C	x	x	C	C	x	C	C		C
Staplinisporites caminus	x	x	x						x	x					x
Densoisporites complicatus	x		x	C								x		x	
Densoisporites playfordi	x	C	x	C	x	x		x	x	x		x		x	
Kraeuselisporites apiculatus	x		x			x	x			x				x	
Kraeuselisporites punctatus	C	x	x		C	x				x				x	
Ornamented indeterminate spores	x	C	C	x	C	C	C						x	x	
Punctatisporites fungosus	C								x	x				x	
Rewanispora foveolata	x	C		x		x				x		C		x	
Aratrisporites parvispinosus	C	x	x	x						C			x		
Eresinia spinellata		x					x			x			x	x	x
Cycloverrutriletes presselensis		x	C				x								x
Leiotriletes spp.		x								x	x		x		C
Striatella seebergensis		x	x	x	x	x	x	x	C	C	x		x	x	
Rewanispora spp.		x								x		x		x	
Concentricisporites plurianulatus		x	x									x			
Lycopodiacidites spp.		x	x			x					x				
Verrucosisporites spp.		x			x	x									
Nevesisporites vallatus		x		x											
Striatella spp.		x													
Cyclotriletes triassicus		x													
Endosporites papillatus		x													
Kraeuselisporites sp. (punctispina)		x													
Stereisporites spp.			x	x			C						C		C
Calamospora impexa			C								x		C	x	C
Todisporites spp.			C		x			x	C		x	C		C	
Retusotriletes spp.			x		x	x	C		C	C	C	C	C		
Jerseyiaspora punctispinosa			x	x	x		x		x	x		x			
Kyrtomisporis spp.			x			x		x		x	x				
Deltoidospora spp.				C		C	x				x			C	C
Retusotriletes hercynicus				x							x		C	C	C
Gordonispora lubrica				x	x	x			x	C	C		x	x	
Neoraistrickia spp.				x	x							x		x	
Cyclotriletes spp.				x								x			
Raistrickia spp.				x	x		x								
Kraeuselisporites spp.					x		x		x						x
Aratrisporites minimus						x		C		x		x	x	x	
Bocciaspora spp.						x									
Dictyophyllidites spp.							x	x				x			
Verrucosisporites morula								x							
Deltoidospora australis									x	x	x			x	
Conbaculatisporites hopensis											x		C	x	x
Smooth trilete spore											C		C		C
Apiculatisporis spp.												C	x	x	x
Punctatisporites scabratus												x	x		x
Polypodiisporites spp.													C	C	
Polycingulatisporites spp.														x	
Keuperisporites baculatus														x	
Apiculatisporis sp. large															x
Composite Assemblage Zone	J.puncti.				A sp		Triadispora obscura								

LEGEND

x	present	0-1
C	common	2-13
A	abundant	14-25
D	dominant	> 26
R	reworked	

A.37 Core 7534/6-U-1, Sassendalen Group.

SENTRALBANKEN

CORE 7533/2-U-1	KAPP TOSCANA GP										
Lithostratigraphy	De Geerdalen										
Age	early Carnian										
Pollen / Depth in core	200,44	187,50	160,88	151,97	131,70	105,60	84,20	66,67	48,89	19,30	2,60
Araucariacites australis	x	x	x		x	x		x	x		x
Chasmatosporites magnolioides	x	C	x			C		x		x	x
Cycadopites spp.	x	x						x		x	x
Echinitosporites iliacoides	x										x
Lunatisporites noviaulensis	x					x					x
Ovalipollis pseudoalatus	x	x	x	x	x					x	x
Protodiploxypinus ornatus	x	x	x		x		x			x	x
Triadispora obscura	x	x	x								x
Voltziaceaesporites heteromorpha	x	C	x	x	x						x
Aulisporites astigmosus	C	C	C	C	A	A	A	x	C		
Vitreisporites pallidus	x				x		x				
Protodiploxypinus macroverrucosus	x				x						
Protodiploxypinus minor	C				x						
Illinites chitonoides	x	x	x	x							
Podosporites amicus	x			x							
Doubingerispora filamentosa	x	x									
Staurosaccites quadrifidus	x	x									
Protodiploxypinus doubingeri	x										
Angustisulcites klausii	x	x									
Concentrisporites pseudosulcatus		x	x	x	x	x		x		x	x
Concentrisporites hallei		x	x	x	x	x		x		x	x
Alisporites spp. (small)		x		x							
Accinctisporites circumdatus		x	x								
Perinopollenites elatoides		x	x								
Protodiploxypinus gracilis			x		x	x				x	x
Protodiploxypinus microsaccus			x			x				x	x
Infernopollenites spp.			x	x							
Chasmatosporites sp.A			x								
Alisporites spp. (large)				x		x				x	x
Eucommiidites minor				x					x		
Schizaeoisporites worsleyi					x						
Kuglerina meieri						x	x	x			x
Ricciisporites tuberculatus						x					
Striatoabieites balmei											x
Triadispora verrucata											x
Spores											
Anapiculatisporites spiniger	x	x	x	x		x				x	x
Annulispora folliculosa	x					x				x	A
Aratrisporites fimbriatus	x						x				x
Aratrisporites macrocavatus	x			x		x	A		x		x
Aratrisporites spp.	x	x	x			x	x	x	x		x
Auritulinasporites intrastriatus	x	x	x								x
Baculatisporites spp.	x		x	x	x		x		x	x	x
Cingulizonates rhaeticus	x	x								x	x
Conbaculatisporites hopensis	x				x	A	A	x	x		x
Conbaculatisporites spp.	x	x	x	x	A	x	x	x	x	x	x
Deltoidospora minor	C	C	x	x	A	A	C	x	x	x	x
Dictyophyllidites mortonii	x	x	x	x	x	x	x		x	x	x
Polypodiisporites ipsviciensis	x	x	x	x	x	x	x			x	x
Kraeuselisporites cooksonae	x	x									x
Kyrtomisporis laevigatus	x	x	x		x	x	C			C	x
Striatella seebergensis	x	x	x	x		x	x			x	C
Todisporites spp.	x		x		x	x	x			x	x
Dictyophyllidites spp.	x	x		x	x	x	x			x	
Gleicheniidites senonicus	x	x			x		x		x		
Leschikisporis aduncus	C	C	C	C	A	A	A	C	A		
Cyclotriletes oligogranifer	x		x		x						
Gordonispora fossulata	x	x	x								
Retusotriletes sp. (granula/bacula)	x		x								
Kraeuselisporites (apiculate)	x	x									
Aratrisporites paenulatus	x	x									
Aratrisporites laevigatus	x										
Deltoidospora australis		x	x	x	x		x			x	x
Rugulatisporites ramosus		x		x	x	x					x
Foveosporites spp.		x	x								
Calamospora spp.			A	C	x	A	A	C	x	x	x
Retusotriletes mesozoicus			x			x	x				
Camarozonosporites rudis					x	x				x	
Neoraistrickia spp.					x					x	
Megaspore, smooth							x				
Camarozonosporites laevigatus										x	x
Cavatoretisporites obvius										x	x
Kyrtomisporis gracilis										x	C
Uvaesporites argentaeformis										x	x
Densosporites spp.											x
Zebrasporites interscriptus											x
Zebrasporites laevigatus											x
Plankton and varia											
Botryococcus spp.	x	x	x	x		x			x	x	C
Cymatiosphaera spp.	x										x
Psophosphaera spp.	x	x	x		C	x				x	x
Fungal remain (hyphae)		C	x	x							
Resin duct		C	x	C							
Leech cocoon					x			x	x		
Plaesiodictyon spp.								x			x
Micrhystridium spp.											x
Pterospermella spp.											x
Leiosphere											x
Veryhachium spp.											x
Composite Assemblage Zone	Aulisporites astigmosus										

LEGEND
A abundant
C common
x present
R reworked

A.38 Core 7533/2-U-1, Kapp Toscana Group.

B.5.4 Core 7533/3–U–7, early Carnian

This shallow core was drilled in 1998 and penetrated 199.7 m of the Kapp Toscana Group. Seventeen samples, spaced at about 10 m intervals, were selected for palynological investigation (Table A.39, Plate 22).

Snadd Formation

Interval 200.31–2.05 m

Diverse associations with bisaccates and other pollen, abundant smooth spores and diverse ornamented spores dominate samples up to 54.00 m and allow confident identifications of composite assemblage zones (Table A.39).

The lowest interval (200.31–157.48 m) contains a diverse assemblage. Pollen include common to abundant *Triadispora* spp., *Araucariacites* spp. and *Chasmatosporites* spp. and rare specimens of *Aulisporites astigmosus*, *Echinitosporites iliacoides*, *Retisulcites* spp. and *Retisulcites* sp. 2 sensu Hochuli et al. (1989). The spores comprise abundant smooth forms, including *Leschikisporis aduncus*, diverse *Aratrisporites* and other ornamented spores. *Porcellispora longdonensis* and *Ricciisporites* spp. are present at the top of the interval. Algal remains are represented by *Plaesiodictyon* spp. and *Botryococcus* spp. The associations are correlated with the *Aulisporites astigmosus* Composite Assemblage Zone.

The 141.71–62.50 m interval shows reduced abundance and diversity, particularly of bisaccate pollen. The genera *Araucariacites*, *Chasmatosporites*, *Concentrisporites*, *Cycadopites* and *Retisulcites* have abundance peaks that alternate with maxima of *A. astigmosus*. Smooth trilete spores generally dominate and the spore diversity seems unchanged through the interval. *Leschikisporis aduncus* appears in reduced abundance throughout this interval. Algae comprise *Plaesiodictyon* spp., *Psophosphaera* spp. and *Botryococcus* spp.

The uppermost interval, 54.00–2.05 m, is recognised by dominant *L. aduncus* alternating with assemblages dominated by *A. astigmosus*, *Protodiploxypinus ornatus*, *Aratrisporites* spp. and *Polypodiisporite*s spp. The spores *Gleicheniidites* senonicus, Ne*oraistrickia* spp. and *Zebrasporites interscriptu*s, together with *Camerosporites secatus*, are recorded for the first time. Algae comprise *Cymatiosphaera* sp. A. *Psophosphaera* spp., *leiospheres* and *Botryococcus* spp.

The associations from the interval 141.71–2.05 m show no presence of *Echinitosporites iliacoides* and are therefore correlated with the *Aulisporites astigmosus* Composite Assemblage Zone. The oldest cored coal bed occurs at the base of this interval. The organic residues comprise dominantly degraded terrestrial debris, tracheidal matter and fairly large fragments resembling leaf cuticles. The latter tend to have records in connection with acmes of *A. astigmosus*.

SENTRALBANKEN

CORE 7533/3-U-7	KAPP TOSCANA GROUP																
Lithostratigraphy	De Geerdalen Formation																
Age	early Carnian																
Pollen / Depth in core	200,31	164,70	157,48	141,71	113,94	94,40	91,56	77,10	72,06	62,50	54,00	53,41	41,45	30,47	21,60	16,23	2,05
Araucariacites australis	x	x	x	x	x	C	C	A	x	A	x		x	x		x	x
Chasmatosporites magnolioides	x	x	x	x	C	C	C	A	A	A	x			x	A	x	x
Podosporites amicus	x	x	x	x	x	x				x	x		x	x	x	x	x
Triadispora spp.	C	A	x			A			x	x					x	x	x
Concentrisporites spp.	x	x			x	A		x	x			x	x	x	x		
Duplicisporites spp.	x								x					x	x		
Eucommiidites minor	x							x	x	x		x			x		
Kuglerina meieri	x														x		
Protodiploxypinus ornatus	x	x	x	x	x			x	x	x	x	x	C	C	x		
Striatoabieites multistriatus	x		x				x		x	x	x				x		
Triadispora aurea	x														x		
Triadispora obscura	C	C	x					x		x					x		
Voltziaceaesporites heteromorpha	x	x	x	x	x	x	x	x	x	x	x	x		x	x		
Concentrisporites pseudosulcatus	x	x			x	A		x						x			
Ovalipollis pseudoalatus	x	x	x			x		x	x	x	x	x		x			
Staurosaccites quadrifidus	x	x	x						x	x	x	x					
Accinctisporites circumdatus	x	x							x		x						
Chasmatosporites spp.	x		x		x				x	x	x						
Illinites chitonoides	x	C	x	x			x	x		x	x						
Striatoabieites balmei	x		x			x	x			x	x						
Cycadopites spp.	x		x	C		x	x	C	x	x							
Retisulcites spp.	x					x		x	x								
Retisulcites sp. 1	x				x	C		C									
Protodiploxypinus doubingeri	x		x		x												
Enzonalasporites spp.	x	x		x													
Schizaeoisporites worsleyi	x			x													
Doubingerispora filamentosa	x																
Fossapollenites moderatus	x																
Ovalipollis spp.	x		x														
Araucariacites sp. (coarse ornament)		x	x	x	x	C		x	x	A	x		x	x	x	x	x
Protodiploxypinus gracilis		x			x					x	x		x	x			
Volziaceaepollenites sp. (large spec.)		x	x			x				x				x			
Eucommiidites intrareticulatus		x	x						x	x	x						
Striatoabieites spp.		x	x														
Protodiploxypinus microsaccus		x															
Aulisporites astigmosus			x	A	A					x	C	A				x	x
Porcellispora longdonensis			x												x		
Triadispora verrucata			x						x		x						
Angustisulcites klausii			x	x					x		x						
Cordaitina minor			x								x						
Gnetaceaepollenites multistriatus			x					x									
Protodiploxypinus decus			x					x									
Protodiploxypinus minor			x					x									
Echinitosporites iliacoides			x														
Infernopollenites spp.			x														
Ricciisporites spp.			x														
Vitreisporites pallidus				x													
Retisulcites perforatus					x			x	x						x		
Protodiploxypinus spp.					C												
Protodiploxypinus macroverrucosus								x	x	x	x			x	x		
Tetrasaccus sp.									x		x						
Lunatisporites noviaulensis										x				x		x	x
Concentricisporites plurianulatus											R						
Alisporites spp. (large specimens)														x		x	x
Lunatisporites spp.														x			
Chasmatosporites apertus															x		
Plankton and varia												©					
Botryococcus spp.	x		x	x	x	x	x	x	x	x	A	A	A		C	x	x
Plaesiodictyon spp.	x			x					x								
Psophosphaera spp.				x						x	A			x	A		
Leiosphere														x		x	
Cymatiosphaera sp. A																	x
Composite Assemblage Zone	Aulisporites astigmosus																

LEGEND
A abundant
C common
x present
R reworked
© coal layer

CORE 7533/3-U-7	KAPP TOSCANA GROUP																
Lithostratigraphy	De Geerdalen Formation																
Age	early Carnian																
Spores / Depth in core	200,31	164,70	157,48	141,71	113,94	94,40	91,56	77,10	72,06	62,50	54,00	53,41	41,45	30,47	21,60	16,23	2,05
Deltoidospora australis	x			x	x	x		x			x	x	x	x	x		x
Conbaculatisporites hopensis	x	x		x							x			x	x		x
Deltoidospora minor	x	x	x	C	x	C	x	A	C	x	x	x	x	x	x	A	x
Dictyophyllidites mortonii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	A	x	x
Leschikisporis aduncus	C	C	C	x	x	x	x	x	x	x	A	A	A	A	C	A	A
Anapiculatisporites spiniger	x	x				x		x	x	x				x	x	x	
Aratrisporites macrocavatus	x	x	x	x			x		x							A	
Aratrisporites spp.	x								x							A	
Aratrisporites paenulatus	x	x	x			x									x		
Auritulinasporites intrastriatus	x				x			x			x				x		
Conbaculatisporites spp.	x			x		x	x	x						x	x		
Gordonispora fossulata	x	x	x			x		x							x		
Striatella seebergensis	x	x	x			x	x		x	x	x				x		
Anapiculatisporites spp.	x	x						x	x		x						
Cingulizonates rhaeticus	x										x						
Kraeuselisporites cooksonae	x	x			x	x	x	C			x						
Foveosporites spp.	x			x				x	x	x							
Striatella spp.	x	x	x			x	x										
Aratrisporites scabratus	x			x													
Aratrisporites fimbriatus	x		x														
Kraeuselisporites spp.	C																
Leptolepidites macroverrucosus	x																
Retusotriletes spp.		x		x	x		x								x		x
Calamospora spp.		x	x	x	x	x		x	x		x	x		x	x		
Cyclotriletes oligogranifer		x	x		x	x	x	x	x		x	x		x			
Polypodiisporites spp.				x		x		x						x	A	x	x
Polypodiisporites ipsviciensis				x	x			x	x	x	x	x		x	x	x	x
Camarozonosporites laevigatus				x		x	x	x	x	x	x			x	x		
Camarozonosporites rudis				x	x			x		x	x			x	x		
Lycopodiacidites spp.				x	x			x						x	C		
Conbaculatisporites spp.				x	x							x					
Gordonispora fossulata				x				x	x		x						
Zebrasporites kahleri				x	x			x		x	x						
Annulispora folliculosa				x													
Staplinisporites caminus					x	x	x								x		
Ornamented indeterminate.spores					x							x	x	x			
Rugulatisporites ramosus					x			x	x	x	x						
Stereisporites spp.					x												
Aratrisporites laevigatus						x									x		
Kraeuselisporites sp. (apiculate)						x					x						
Punctatisporites spp.							x				x						
Acanthotriletes spp.								x			x						
Gordonispora lubrica								x			x						
Baculatisporites spp.								x									
Nevesisporites vallatus									x								
Kyrtomisporis laevigata										x	x			x			
Annulispora sp. A											x						
Cingulizonates spp.											x						
Polycingulatisporites crenulatus											x						
Laevigatosporites spp.												x					x
Cyclotriletes pustulatus												x					
Cyclotriletes spp.													x	x			
Camerosporites secatus														x			
Neoraistrickia spp.														x			x
Gleicheniidites senonicus															x		
Zebrasporites interscriptus															C		
Densoisporites velatus												©					x
Composite Assemblage Zone	Aulisporites astigmosus																

A.39 Core 7533/3-U-7, Kapp Toscana Group.

B.5.5 Core 7534/4–U–1, early Carnian

The core was drilled in 1995 and penetrates 229.6 m of the Snadd Formation. The 31 samples selected for the palynological study are of variable diversity. Coal beds and palynologically barren samples occur mostly in the upper part of the core (Table A.40, Plates 23–24).

Snadd Formation

Interval 233.48–5.97 m

Bisaccate pollen (*Alisporites*, *Illinites*, *Lunatisporites*, *Ovalipollis*, *Podosporites*, *Protodiploxypinus* and *Triadispora* groups), *Leschikisporis aduncus* and smooth trilete spores dominate the assemblages. Age-significant taxa include *Retisulcites* spp., *Camarozonosporites laevigatus*, *C. rudis*, *Chasmatosporites magnolioides*, *C. apertus*, *Concentricisporites plurianulatus*, *Echinitosporites*

SENTRALBANKEN

CORE 7534/4-U-1	KAPP TOSCANA GROUP																																	
Lithostratigraphy	Snadd Formation																																	
Age	early Carnian																																	
Pollen, saccate / Depth in core	233.48	226.72	216.09	206.53	197.38	194.53	189.66	179.33	175.10	171.83	163.48	154.17	141.74	127.53	112.32	98.94	94.29	83.97	©	74.11	62.26	©	54.09	53.27	42.70	42.49	42.32	33.60	32.77	22.05	14.82	6.24	©	5.97
Bisaccates (indeterminate, fragmented)	A	C	C	A	C	A	C	C	C	A	A	A	A	A	x	A	A	A		D	D		D	C	A	A	x	A	A	A	D	A		C
Alisporites spp. (large)	x	C	x	x	C	x	C	x	C		C		C	C							x		C	C				C				C		
Alisporites spp. (small)	x		C									C				x							C		x		x	C	x	x		C		
Lunatisporites spp.	x	C		x	x	x	C	C		C	x			x				x			C		x		C			x	C		x	x		
Ovalipollis pseudoalatus	C			x		C	x		x	C	x	C		C			C	x		C	C		x	x	x	x		x	x	C	C	C		
Ovalipollis spp.	x																						x									x		
Staurosaccites quadrifidus	x	x	x			x	x		x							x				x			x	x	x			C	C	x	x	x		
Protodiploxypinus ornatus	C	C	C	C	x		x	C	C		x		C	C									x	C	x			x	C	x	C			
Podosporites sp. A	x	x	x	x	x	C		C			x												x	C	x			x		x	x			
Angustisulcites klausii	x	x				x	x	x	x			x	x			x					x				x					x				
Illinites chitonoides	x	x	C		x	C	C	x	x	x	x	C	C	x		x				x			x	x				x		x				
Striatoabieites multistriatus	x			x	x																x							x	x					
Triadispora obscura	x	C	C			x		C	C	x	C	C	x	C		x	x			x			x		x			x	x					
Protodiploxypinus decus	x	x						C			x						x						x					x						
Voltziaceaesporites heteromorpha	C	C	C		x		x	C	x	C			x	C	x	C	x				x		x	C	x			x						
Protodiploxypinus gracilis	x	C	x	x		x			x	x			x												x									
Triadispora spp.	x		x				C	C	C	C	x					C		C																
Vitreisporites spp. (including *V. pallidus*)		C		C		C	x	x	C	C	x	x	x		C	C	x	C		C	x		x		x			C	C	x		C		
Volziaceaepollenites sp. (large)		x									x																	x						
Striatoabieites spp.		C												C	C						C													
Protohaploxypinus spp.		C						x																										
Triadispora aurea		x	x			x																												
Cordaitina gunyalensis			x	x				x	x				x	x		x				x				x				x		x		x		
Podosporites amicus			x	x		x				x	x		C			C				x	x		x	x	C			x	C			x		
Striatoabieites balmei			x	C	x		x	x	x	x	x	x				C	x			x	x			x		C		x		x		C		
Protodiploxypinus sp. (large thinwalled)			C			x	x	C	x				C				x							x										
Podosporites sp. B					x			x					C										x		x			x			x			
Triadispora verrucata					x		x			x																								
Alisporites microsaccus							x																					x						
Dyupetalum vicentinense							x		x					x		x										x								
Accinctisporites circumdatus										x	x	x	C																x	x		x		
Protodiploxypinus minor										x				C			x						x		x						C			
Striatopodocarpites spp.												x																						
Protodiploxypinus microsaccus																	x						x					x						
Infernopollenites spp.																							x					x						
Lunatisporites noviaulensis																							C					x						
Cordaitina minor																												x						
Pollen (exclusive of mono- and bisaccates)																			©			©											©	
Cycadopites spp.	x	x				x	C	x	x		x	C	C		x	C		C		C	x		C	C		C	x	x	C	x	x	x		C
Araucariacites australis	x		C	x		C	C		C		C	C	C	C	C	C	x	x							x			C	C		C	C		
Concentrisporites pseudosulcatus	x	x		x			x	x	x	C			x			x	x			x			x		x			x			x	x		
Echinitosporites iliacoides	x					x		x								x		x										x	x	x		x		
Ricciisporites tuberculatus	C	x																x						x				x		x		x		
Porcellispora longdonensis	x						x			x																x		x		x	x			
Chasmatosporites sp. A	x			C	x	x		C	x		C												x					C						
Camerosporites secatus	x																								x									
Schizaeoisporites worsleyi		x					x		x																									
Ephedripites multistriatus			x						x	x	x				C	x				x			x		x			x	x	x	x			
Eucommiidites minor						x	x																C		x			x						
Eucommiidites spp.								x	x	x	x														x	x		x				x		
Retisulcites spp.								x				x						x					x	x		x		x						
Retisulcites sp. 2								x																										
Pretricolpipollenites spp.								x	C	x	x														x	x		x				x		
Chasmatosporites magnolioides										x		C	x	C		x		C			x		C	x	x	C		C	C	x	x	C		
Chasmatosporites apertus										x													x											
Chasmatosporites spp.																				x			x		C			C						
Eucommiidites intrareticulatus																							x	x						x	x	x		
Concentrisporites spp.																							x		x			x						
Plankton and varia																			©			©											©	
Dictyotidium spp.	x	C		x	C	C	C							x		x				x								x			C			
Veryhachium spp.	x			x		x	x	x			x						x							x	x			x		x				
Micrhystridium spp.	C	C	x	x	C	x	x	x		x	x	x				x	x	x			x							C	x					
Late Spathian-Anisian evidence	R							R	R	R			R																					
Fungal remain (hyphae)		C	C	C		C			C		x	C			C					x												C		
Plaesiodictyon mosellanum		C	C	C		C		x	C		x	x						x			C			x						x				
Cymatiosphaera sp. A		C	C	C	D	C	C	C	C	x							C																	
Foraminiferal lining				C										x														C						
Faunal indeterminate remains					C																													
Botryococcus spp.						C		x	x	x	x			C						x				x		x								
Tasmanites spp.								x				x															x							C
Leiosphere								x		C	x			C	C	x											C	x						
Dictyotidium reticulatum								x			x	x																						
Tyttodiscus spp.												C											x											
Fungal spore																	x																	
Pterospermella spp.																									x									
Composite Assemblage Zone	Aulisporites astigmosus																																	

LEGEND

x present 0-4
C common 5-14
A abundant 15-49
D dominant > 49
R reworked palynom.
© coal layer

A.40.1 Core 7534/4-U-1, Kapp Toscana Group.

SENTRALBANKEN

CORE 7534/4-U-1	KAPP TOSCANA GROUP
Lithostratigraphy	Snadd Formation
Age	early Carnian

Spores / Depth in core	233.48	226.72	216.09	206.53	197.38	194.53	189.66	179.33	175.10	171.83	163.48	154.17	141.74	127.53	112.32	98.94	94.29	83.97	©	74.11	62.26	©	54.09	53.27	42.70	42.49	42.32	33.60	32.77	22.05	14.82	6.24	©	5.97
Baculatisporites wellmannii	C	x	x	x	x				C			x	x	x	x		C	x			x		x	x	x				x			x		
Cingulizonates rhaeticus	x						x			x		x					x	C			C			x	x	x			C		x	x		
Conbaculatisporites hopensis	x	x	C		x		C	x		x	C	x			x								x	x	x				x	x	x	x		
Conbaculatisporites spp.	C	x		x		C			x		x		x	x			C				C		x		x	C						C		
Dictyophyllidites spp.	C	C	C	C		C	C	C	C		C		C	C		x	C	C		C				C	C	C		C	C	C	C	C		
Kraeuselisporites dentatus	x						x	x										C		x	x		x	C	x							x		
Leschikisporis aduncus	C	C	C	C	A	A	C	C	C	C	A	C	C	C	C	C	A	C		x	C		C	C		D	C	C	x	D	A	C		
Neoraistrickia spp.	x	C						x															x			x						x		
Striatella seebergensis Mädler	C		C			x	x	x	x	x	x	x					x	C					x	x		x		x		C	x	C		
Camarozonosporites rudis	x	x	x	x			x	x	x									x						x	x			x			x			
Kyrtomisporis spp.	x																						x		C			x		x				
Anapiculatisporites spiniger	x										x		x	x		x									x			x						
Cyclotriletes spp.	x	x																										x						
Todisporites spp.	C	C			x	C			x			C		x						x	x							x						
Densoisporites spp.	x	x											x	x									x			C								
Raistrickia spp.	R																						R		R									
Annulispora folliculosa	x																							x										
Densosporites sp. (Bjærke & Manum 1977)	x																	x						x										
Striatella spp.	x			C						C		C											x											
Velosporites cavatus	x									x										x														
Lycopodiumsporites spp.	x							x	x				x																					
Annulispora sp. A (Bjærke & Manum 1977)	x																																	
Cosmosporites elegans	x																																	
Calamospora spp.		C	C	C	x	C	x	C		C	C	x	x	C	C	C	C			C	x		x	x	x	C		x	C	C	C	C		C
Retusotriletes spp.		C						C													x			x	C									
Semiretisporis sp. A *("barentzii")*		x	x	x				x	x	x						x							x	x	x									
Cyclotriletes oligogranifer			x						C												x							C		C	x			
Punctatisporites scabratus			x				x			x	x																	x						
Smooth trilete indeterminate spores				C			C	A		C		C	C	C			x	C			C		C	C		C	C							C
Staplinisporites caminus				x							x																				x			
Ornamented trilete indeterminate spores				x			x				x												x		C	x								
Kraeuselisporites spp.						x												C			C			C	x			x			x	x		
Kraeuselisporites cooksonae						x	x	x	C	x	x						C	x		C	x			C	x			x			x			
Apiculatisporis sp. (large)						x		x																										
Kyrtomisporis laevigata							x																	x	x	x				x				
Lycopodiacidites spp.								x			x														x			x						
Kraeuselisporites apiculatus								x			x									x				x										
Gordonispora lubrica								x		x																								
Ornamented indeterminate.spores										x							C	C			C		x		C						x			
Camarozonosporites laevigatus										x															x				x					
Jerseyiaspora punctispinosa										R																								
Nevesisporites limulatus											C					C																		
Kraeuselisporites punctatus														x							x											x		
Stereisporites spp.																x									x			x						
Polycingulatisporites spp.																	x																	
Zebrasporites interscriptus																		x							x							x		
Uvaesporites argentaeformis																		x							x									
Deltoidospora minor																				C	C		A					C						
Deltoidospora australis																					x		x					C						
Dictyophyllidites mortoni																					x		C											
Rugulatisporites spp.																								x										
Taurocusporites segmentatus																								x										
Concentricisporites plurianulatus																								x										
Gleicheniidites senonicus																												x						
Anapiculatisporites spp.																														x		x		
Spores, monolete																			©			©											©	
Aratrisporites macrocavatus	x	x		C		x	C	C	x	x	x	C	C	x	x	C				x	C		x		x	x		x				x		
Aratrisporites paenulatus	x		x				C	x	x	x	x							x							x							x		
Aratrisporites scabratus	C	x	x	x		x	x	C	x	x	C	C		x	x	C	x	A		x	x		x	C	C			x	x	C		C		
Aratrisporites spp.	x						C		C	C	C	C	C	C	C		C			C	x		C	C	C	x		x	C	x	C	x		
Polypodiisporites spp.	C			C	x	x	C	x	x	C	C			C	C	x				x	C		x	C	x	C	C	C	C		C			
Laevigatosporites spp.		x					C	C		x					x													x				x		
Polypodiisporites sp. (coarse sculpture)																							x	x	x			C						
Aratrisporites minimus																								x										
Composite Assemblage Zone	Aulisporites astigmosus																																	

LEGEND

x	present	0-4
C	common	5-14
A	abundant	15-49
D	dominant	> 49
R	reworked palynom.	
©	coal layer	

A.40.2 Core 7534/4-U-1, Kapp Toscana Group.

iliacoides, *Porcellispora longdonensis*, *Ricciisporites tuberculatus* and *Semiretisporis* cf. *barentzii*. In the upper part of the core there is an incoming of *Uvaesporites argentaeformis*. There is peak abundance for the monolete spores (the *Aratrisporites*, *Laevigatosporites* and *Polypodiisporites* groups). Some reworked Spathian–Anisian forms are observed.

The appearance of the pollen *Retisulcites* spp., *Chasmatosporites magnolioides* and *C. apertus* (179.33–171.83 m) coincides with peak abundances of monolete spores (the *Aratrisporites*, *Laevigatosporites* and *Polypodiisporites* groups), the regular presence of *Botryococcus*, as well as reworking of Spathian–Anisian deposits. These features are often recognised in lower Carnian strata in the Barents Sea. The rich associations are referred to the *Aulisporites astigmosus* Composite Assemblage Zone.

The interval up to 154.17 m contains a rich and diverse association of fresh and brackish water green algae and marine acritarchs (Table A.40). The layers from 141.74–112.32 m and the upper part of the core have more sporadic appearances of algal remains and their diversity seems generally reduced. Coal and root beds are present above 83.97 m.

Echinitosporites iliacoides is present throughout in these rich assemblages that are correlated with the *Aulisporites astigmosus* Composite Assemblage Zone and thus dated as early Carnian.

B.5.6 Core 7533/2–U–2, Carnian–Norian

This core, drilled in 1998, penetrated 83.82 m of the Kapp Toscana Group (Table A.41, Plates 19–21). We apply the general lithostratigraphic nomenclature for the Barents Sea for the Snadd Formation, although noting the close similarities with the De Geerdalen Formation on Svalbard. For the upper part of the core (the Flatsalen and Svenskøya formations) we use the Svalbard terminology due to the close similarity with Hopen and Kong Karls Land, where Upper Triassic is present onshore.

Snadd Formation

Interval 86.85–69.60 m

This, less than 20 m-thick interval shows increasing diversity upwards. The well-preserved material contains diverse pollen including *Chasmatosporites magnolioides*, *Concentrisporites* spp., *Ovalipollis pseudoalatus*, *Protodiploxypinus* spp. and *Triadispora* spp. The two highest samples contain *Corollina meyeriana*, *Duplicisporites granulatus*, *Kuglerina meieri* and *Pinuspollenites* spp. The highly diverse spores are dominated by *Deltoidospora* spp., *Kyrtomisporis gracilis* and *K. laevigatus*. There are common to abundant *Annulispora folliculosa*, diverse *Aratrisporites* spp., as well as *Dictyophyllidites*, *Stereisporites* and *Polycingulatisporites* spp., and regular occurrences of *Cingulizonates rhaeticus*.

Fresh or brackish water algae are represented by *Botryococcus* and *Plaesiodictyon mosellanum*. The increased abundance (from 70.65 to 69.60 m) of marine plankton such as common *Psophosphaera* spp. and *Tasmanites* spp., as well as the incoming of *Cymatiosphaera* spp., *Dictyotidium* spp., *Tyttodiscus* spp. and *Veryhachium* spp., reflects increased marine influence. The assemblages of this interval represent the *Aulisporites astigmosus* Composite Assemblage Zone.

Flatsalen Formation

Interval 68.50–33.65 m

The sample interval 68.50–67.98 m, representing the Slottet Bed, has an assemblage similar to that highest in the Snadd Formation, but with additions of *Kuglerina meieri*, *Porcellispora longdonensis*, *Quadraeculina anellaeformis* and *Zebrasporites laevigatus* representing the stratigraphically youngest group of taxa. The diverse microplankton include common *Micrhystridium* spp. and small indeterminate dinocysts. The association is assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

The assemblages of the interval 59.12–33.65 m show a lower diversity of pollen and spores. *Chasmatosporites* spp. and *Protodiploxypinus* spp., together with *Cycadopites* spp., are the dominant pollen. *Illinites chitonoides* has its last record near the top and *Limbosporites lundbladii*, *Lycopodiumsporites austroclavatidites* and *Rogalskaisporites barentzii* have their lowest record at the top of this interval.

The presence and acme of a diverse group of dinoflagellate cysts (*Hebecysta*, *Heibergella*, *Noricysta*, *Rhaetogonyaulax* and *Sverdrupiella*) distinguish this interval from the underlying samples (Table A.38). This cyst association also has records in the lower Flatsalen Formation on Hopen and Wilhelmøya and in the Tverrbekken Member of the Knorringfjellet Formation at Festningen, Spitsbergen. Towards the formational boundary (33.65 m) the abundance of *Botryococcus* increases and the near absence of dinocysts suggest more proximal depositional conditions. The interval is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

Svenskøya Formation

Interval 23.36–9.07 m

The association of pollen and spores is similar to that of the underlying formation. The continued acme of the *Heibergella* group at 22.71 m is followed by the acme of *Heibergella salebrosacea*, *Noricysta* spp., *N. fimbriata* and *Rhaetogonyaulax* spp. at 16.57 m. As in the Flatsalen Formation, the cyst association has been identified as the *Limbosporites lundbladii* Composite Assemblage Zone.

SENTRALBANKEN

CORE 7533/2-U-2	KAPP TOSCANA GROUP															
Lithostratigraphy	Snadd Fm				Flatsalen (Sl)	Flatsalen						Svenskøya Fm				
Age	Carn				Norian											
Pollen / Depth in core	86,85	75,10	70,65	69,60	68,50	67,98	59,12	52,62	42,88	42,65	33,65	22,71	22,65	17,50	16,57	9,07
Araucariacites australis	C	x	x	C	x	x	x	x	x	x	x	x	x	x	x	x
Chasmatosporites magnolioides	x	x	x	C	A	C	C	C	C	C	C	x	x	x	A	x
Ovalipollis pseudoalatus	x	x	x	x	C	C	x		x		x	x	x		x	x
Protodiploxypinus minor	x		x	x	C	x									x	x
Protodiploxypinus gracilis	C		x	x	x	C	x	x	x	x	x	x	x		x	
Protodiploxypinus ornatus	C	x	x	C	x	x	x	x	C	x	x	x	x	x	x	
Cycadopites spp.	x		x	C	x	x	x	x	C	C	x		x	x		
Protodiploxypinus decus	x	x	x	x	x	x	x		x		x			x		
Striatoabieites spp.	x	x	x	x	x	x	x	x				x		x		
Protodiploxypinus microsaccus	x			x	x	x	x	x		x	x		x			
Protodiploxypinus sp. (large thinw.)	x		x	x	x	A		x	x							
Protodiploxypinus sp. (thick, minute sacs)	x		x	x		x		x								
Doubingerispora filamentosa	x			x	x	x										
Pityosporites scaurus	x		x	x	x	C										
Concentricisporites plurianulatus	x		x													
Triadispora obscura	x	x	x													
Alisporites spp. (small)			x	x	x	x	x				x	x			x	x
Araucariacites sp. (coarse ornament)			x	x							x	x				x
Chasmatosporites apertus			x	x	x		x					x	x			x
Corollina meyeriana			x						x					x		x
Lunatisporites noviaulensis			x	x	x			x	x	x			x	x	x	x
Accinctisporites circumdatus			x	x						x	x		x		x	
Alisporites microreticulatus			x	x	x	x	x		x	x		x			A	
Corollina spp.			x	x	x	x	x								x	
Pinuspollenites spp.			x	x		x		x	x					x	x	
Concentrisporites spp.			x	x	x	x	x	x		x	x	x				
Vitreisporites spp.			x	x	x	x	x					x				
Protodiploxypinus macroverrucosus			x	x	x	x	x									
Duplicisporites granulatus			x	x		x										
Podosporites amicus			x													
Eucommiidites intrareticulatus				x	x	x	x		x		x					
Vitreisporites pallidus				x				x			x					
Illinites chitonoides				x		x			x							
Eucommiidites spp.				x		x										
Kuglerina meieri				x	x	x										
Podocarpidites spp.				x	x	x										
Schizaeoisporites worsleyi					x				x				x			
Porcellispora longdonensis					x											
Quadraeculina anellaeformis						x		x	x		x		x	x	x	x
Alisporites microsaccus						x	x	x	x							
Triadispora verrucata						x										
Ricciisporites tuberculatus															x	
Plankton and varia																
Plaesiodictyon mosellanum	x	x	A	A	x		x	x	x	x	x	x	C	x	C	x
Botryococcus spp.	x	x	x	A	C	C	x	x			C	A	x	x	A	x
Psophosphaera spp.			x	C	x		x		x	x			x		x	
Tasmanites spp.			x	C	C	x	x	x	x			x	x	C		
Cymatiosphaera spp.				x	C	x		x				x	x	x		x
Veryhachium spp.				x	C	C	C	C	x	x	x	x			A	
Dictyotidium spp.				x	x										x	
Tyttodiscus spp.				x	x	x							x		x	
Tetraporina horologica				x		x										
Dinocyst (small indeterminate)					x		x		x			C	C	x	x	x
Micrhystridium spp.					C	x	x					x	x		x	
Paleospongiosporis spp.					x					x						
Foraminiferal lining					C	x	x	C								
Heibergella spp.							x	C					x	x	x	x
Noricysta spp.							C	C				x	C		x	x
Heibergella asymmetrica							C	C	x			A		C	C	
Rhaetogonyaulax spp.							x	x		x		x	x		A	
Sverdrupiella mutabilis							x	x				x	x		C	
Noricysta fimbriata							A	x				x	x			
Noricysta pannucea							x	x	x							
Hebecysta spp.							x	x								
Noricysta varivallata							x									
Hebecysta brevicornuta								x								
Heibergella aculeata												x		x		
Heibergella salebrosacea												x				
Rhaetogonyaulax rhaetica													x		A	
Tasmanites (large specimens)													x			
Pterospermella spp.														C		
Sverdrupiella manicata															x	
Sverdrupiella usitata															x	
Composite Assemblage Zone	A.astigm.				Rh.	Limbospor. lundbladii										

LEGEND
A abundant
C common
x present

CORE 7533/2-U-2	KAPP TOSCANA GROUP															
Lithostratigraphy	Snadd Fm				Flatsalen (Sl)	Flatsalen						Svenskøya Fm				
Age	Carn				Norian											
Spores / Depth in core	86,85	75,10	70,65	69,60	68,50	67,98	59,12	52,62	42,88	42,65	33,65	22,71	22,65	17,50	16,57	9,07
Aratrisporites spp.	x		x	x	x	x										x
Auritulinasporites intrastriatus	x	x	x	x	x		x				x		x			x
Deltoidospora australis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X	x
Deltoidospora minor	x	A	x	C	x	C	C	C	C	C	C	x	x	x	A	C
Kyrtomisporis gracilis	x	C	C	C	x	x	x		x	x	x	x	C	x	x	x
Kyrtomisporis laevigatus	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Polypodiisporites ipsviciensis	x	x	x	x	x	x					x	x	x		x	x
Retusotriletes spp.	x		x	x	x	x										x
Striatella seebergensis	x		x	x	x	x	x	C	x	x	x	x	x	x	x	x
Annulispora folliculosa	x	x	C	A	x	x	x		x	x	C		x	x	x	
Cingulizonates rhaeticus	x	x	x	x		x				x	x	x	x	x	x	
Conbaculatisporites spp.	x		x	x	x	x					x	x	x	x		
Polycingulatisporites crenulatus		x	x	x	x	x	x				C		x	x	x	
Aratrisporites macrocavatus			x	x	x	x	x	x		x	x	x	x	x		x
Leptolepidites spp.			x	x	x	x					x					x
Baculatisporites wellmannii			x	x								x		x	x	x
Stereisporites aulosenensis			x	x		x	x	x	x						x	x
Camarozonosporites laevigatus			x	x	x	x	x	x			x	x			x	
Dictyophyllidites mortonii			x	x	x	x	x	x	x	x	x	x	x		x	
Dictyophyllidites spp.			x	x		x	x				x				x	
Striatella spp.			x	x			x		x			x			x	
Kraeuselisporites sp. (apiculate)			x	x				x	x	x	x			x		
Aratrisporites fimbriatus			x						x				x			
Camarozonosporites rudis			x	x	x	x	x					x				
Stereisporites spp.			x			x	x					x				
Cavatoretisporites obvius			x	x	x	C	x		x		x					
Neoraistrickia taylorii			x	x	x			x	x	x	x					
Densoisporites velatus			x							x						
Densosporites spp.			x	x			x			x						
Todisporites spp.			x		x				x							
Foveosporites spp.			x		x		x									
Leschikisporis aduncus			x	x	x	x										
Baculatisporites spp.			x	x	x											
Concavisporites spp.			x	x	x											
Anapiculatisporites spiniger				x	x	x	x								x	
Anapiculatisporites spp.				x	x	x	x								x	
Conbaculatisporites hopensis				x		x	x	x	x	x	x				x	
Zebrasporites interscriptus				x			x	x	x	x			x		x	
Calamospora spp.				x			x				x			x		
Polycingulatisporites densatus				x	x						x		x			
Aratrisporites laevigatus				x		x						x				
Cingulizonates spp.				x	x	x	C									
Cosmosporites elegans				x	x	x										
Staplinisporites caminus					x	x										
Gleicheniidites senonicus						x							x		x	x
Zebrasporites laevigatus						x	x				x		x			x
Limbosporites lundbladii											x			x		x
Rogalskaisporites barentzii											x			x		
Kraeuselisporites cooksonae											x					
Lycopodiumsporites austroclavatoides											x					
Kraeuselisporites reissingeri													x			
Composite Assemblage Zone	A.astigm.				Rh.	Limbospor. lundbladii										

Sl Slottet Member

A.41 Core 7533/2-U-2, Kapp Toscana Group.

B.6 Cores from offshore Kong Karls Land

In 2005, the Norwegian Petroleum Directorate drilled five shallow stratigraphic cores east of Kong Karl Land with SINTEF as operator. One of the cores penetrates the uppermost part of the Botneheia Formation, one penetrates the Tschermakfjellet Formation and three cores represent the Snadd Formation. We use the Svalbard lithostratigraphic terminology for the two lower formations due to great similarities with exposures on eastern Svalbard, but keep the Barents Sea terminology for the Snadd Formation, which is similar to other cores further south. However, we also recognise the close similarity with the De Geerdalen

CORES OFF KONG KARLS LAND - SASSENDALEN AND KAPP TOSCANA GROUPS

Lithostratigraphy	Core 7831/2-U-2											
	Botneheia Formation											
Age *	*Ladinian					*I.Lad/e.Carn						
Pollen / Depth below sea level	18.79	17.87	14.89	14.32	13.88	11.43	10.28	9.85	7.70	6.83	6.21	6.16
Angustisulcites spp.	x	C	x			x				x		x
Bisaccate pollen (abundance)	D	D	D	D	D	D	D	D	D	D	D	D
Granasporites magnus	x	x	x		x	x	C	x	x	x	C	x
Illinites chitonoides	C	x	x	x	C	x	C	x	C	x	x	x
Podosporites amicus	x	C		x	C		x	x	C	A	A	C
Protodiploxypinus spp.	x	C	C	x		A	C	x	x	x		x
Staurosaccites quadrifidus	x	C	C	x	x	x	x	A	A	C	C	A
Striatoabieites balmei	A	x	A	C	A	A	A	A	A	C	C	C
Striatoabieites multistriatus	x		x	x		x	x	x	x	x		x
Triadispora spp.	x	A	x	C		C	A	C	A	C		x
Protodiploxypinus macroverrucosus	x					x			x		x	
Lunatisporites pellucidus	x						x					
Schizaeoisporites worsleyi	x					x		x	x	x	x	
Angustisulcites klausii	x	x		C	x		C	x		C	C	
Cordaitina spp.		x										x
Pinuspollenites spp.		x		x		x	x			x		x
Protodiploxypinus decus		x	x	x	x	x	x	x	x		x	x
Triadispora verrucata		x		C	C	A	C	x	A	x	C	x
Lunatisporites noviaulensis		x	x			C	x			C	x	C
Protodiploxypinus doubingeri		x	x				x					
Striatoabieites aytugii		x	x	x		x	C	A	A	x	x	x
Protodiploxypinus sittleri		x										
Protodiploxypinus ornatus			x	x	x	x		x	x	x	x	x
Lunatisporites spp.			x									
Heliosaccus dimorphus			x	x	x		x		x		x	
Dyupetalum vicentinense			x									
Aulisporites astigmosus				x	x			C	C	C		
Ovalipollis pseudoalatus						x	x	x	x	x	x	x
Protodiploxypinus minor						x						
Infernopollenites spp.						x				x		
Echinitosporites iliacoides						x		x				
Chasmatosporites spp.									C	x	x	x
Protodiploxypinus gracilis									x			
Lunatisporites acutus									x		x	
Camerosporites secatus												x
Vitreisporites pallidus												
Bisaccate pollen (large specimens)												
Schizosporis spp.												
Tetrasaccus spp.												
Protohaploxypinus spp.												
Triadispora labichensis												
Retisulcites perforatus												
Succinctisporites grandior												
Corollina spp.												
Enzonalasporites vigens												
Accinctisporites ligatus												
Tsugaepollenites spp.												
Monosulcate pollen												
Granasporites spp.												
Cordaitina gunyalensis.												
Illinites spp.												
Composite Assemblage Zone	E. iliac.			Aulispor. astigmosus								

Lithostratigraphy	Core 7831/2-U-1				
	Tschermakfj. Fm				
Age *	*L/C		*	*ely C	
Pollen / Depth below sea level	26.61	24.36	19.66	14.83	11.85
Angustisulcites spp.					
Bisaccate pollen (abundance)	D	D	D	D	D
Granasporites magnus	C	C	x	x	A
Illinites chitonoides	C	x	C	C	C
Podosporites amicus	A	C	A	A	C
Protodiploxypinus spp.		x		A	
Staurosaccites quadrifidus	C	A	C	x	x
Striatoabieites balmei	A	C	A	D	x
Striatoabieites multistriatus	x	x	x	x	x
Triadispora spp.					
Protodiploxypinus macroverrucosus			x		
Lunatisporites pellucidus				x	
Schizaeoisporites worsleyi	x	x	x	x	x
Angustisulcites klausii				x	
Cordaitina spp.					
Pinuspollenites spp.	x		x		x
Protodiploxypinus decus	x	x			
Triadispora verrucata					
Lunatisporites noviaulensis	x	x	C	A	x
Protodiploxypinus doubingeri	x				
Striatoabieites aytugii					
Protodiploxypinus sittleri					
Protodiploxypinus ornatus	C	A	D	x	x
Lunatisporites spp.					
Heliosaccus dimorphus		x		x	
Dyupetalum vicentinense					
Aulisporites astigmosus	x	C	A	D	D
Ovalipollis pseudoalatus					
Protodiploxypinus minor				x	
Infernopollenites spp.				x	
Echinitosporites iliacoides	x	x			
Chasmatosporites spp.	x	x	C	C	A
Protodiploxypinus gracilis					
Lunatisporites acutus		x		x	
Camerosporites secatus					
Vitreisporites pallidus		x			
Bisaccate pollen (large specimens)			x		
Schizosporis spp.			x		
Tetrasaccus spp.			x	x	
Protohaploxypinus spp.			x		
Triadispora labichensis				x	
Retisulcites perforatus					C
Succinctisporites grandior					x
Corollina spp.					x
Enzonalasporites vigens					
Accinctisporites ligatus					
Tsugaepollenites spp.					
Monosulcate pollen					
Granasporites spp.					
Cordaitina gunyalensis.					
Illinites spp.					
Composite Assemblage Zone	Aulispor. astigmosus				

Lithostratigraphy	Core 7830/6-U-1										
	Snadd Formation										
Age *	early Carnian										
Pollen / Depth below sea level	52.79	46.91	40.70	38.88	33.76	28.06	24.75	20.10	14.87	8.88	3.93
Angustisulcites spp.	x		x								
Bisaccate pollen (abundance)	D	D	D	D	D	D	D	D	D	D	D
Granasporites magnus				C		x	x	x	x	C	x
Illinites chitonoides	x	x	x	x	x	x	x	x	x	x	x
Podosporites amicus	x	C	C	C	x	C	C	C	C	C	C
Protodiploxypinus spp.	x		x	x	C	x	x	x	x	x	
Staurosaccites quadrifidus	C	C	A	x	x	x	x	x	x		x
Striatoabieites balmei	C	x	C	x		x	x		x		x
Striatoabieites multistriatus	x	x	x	x	x		x	x	x	x	x
Triadispora spp.	A	A	A	D	x	C	x	C	C	A	C
Protodiploxypinus macroverrucosus	x				x	x				x	
Lunatisporites pellucidus							x		x	x	
Schizaeoisporites worsleyi		x	x	x							
Angustisulcites klausii	x										
Cordaitina spp.					x						C
Pinuspollenites spp.	x	x						x			x
Protodiploxypinus decus									x		x
Triadispora verrucata	A	C	x	D		x			x	C	
Lunatisporites noviaulensis	x		x	x		x	x	x			
Protodiploxypinus doubingeri						x		x			
Striatoabieites aytugii											
Protodiploxypinus sittleri											
Protodiploxypinus ornatus	x		x	x	x			x			x
Lunatisporites spp.							x		x		
Heliosaccus dimorphus	x					x		x			
Dyupetalum vicentinense											
Aulisporites astigmosus	C	x		A	A	A	D	D	A	C	D
Ovalipollis pseudoalatus	x	x	x	x	x	C	A	A	x		x
Protodiploxypinus minor	x										
Infernopollenites spp.											
Echinitosporites iliacoides											
Chasmatosporites spp.	C	x	x	C	x	C	C	x	x	x	x
Protodiploxypinus gracilis	x	x									x
Lunatisporites acutus											
Camerosporites secatus			x								
Vitreisporites pallidus											
Bisaccate pollen (large specimens)				A	A	D	A	A	D	D	D
Schizosporis spp.				C	x					x	
Tetrasaccus spp.				x	x			x	x		
Protohaploxypinus spp.											
Triadispora labichensis											
Retisulcites perforatus	x	x	x	x	x	x		x	x	x	x
Succinctisporites grandior						x	x				
Corollina spp.											
Enzonalasporites vigens			x					x			
Accinctisporites ligatus				x	x	x				x	x
Tsugaepollenites spp.						x					
Monosulcate pollen							x		x		x
Granasporites spp.											
Cordaitina gunyalensis.											
Illinites spp.											
Composite Assemblage Zone	Aulisporites astigmosus										

LEGEND

D	>16	dominant
A	7-15	abundant
C	3-6	common
x	1-2	present

A.42.1 Core 7831/2-U-2, Sassendalen Group, and cores 7831/2-U-1, 7830/6-U-1, 7830/3-U-1 and 7830/5-U-1, Kapp Toscana Group.

Formation on eastern Svalbard. The palynological distribution charts and the discussions of the cores arranged according to their stratigraphic succession (7831/2–U–2, 7831/2–U–1, 7830/6–U–1, 7830/3–U–1 and 7830/5–U–1) are compiled in Table A.42.

B.6.1, Core 7831/2–U–2, late Ladinian to early Carnian

This core penetrates 13.3 m of the uppermost Sassendalen Group and has been correlated with the Botneheia Formation of eastern Svalbard. Twelve samples were studied for palynology (Table A.42, 18.79–6.16 m).

CORES OFF KONG KARLS LAND - SASSENDALEN AND KAPP TOSCANA GROUPS

Core 7830/3-U-1																		CORE 7830/5-U-1												Lithostratigraphy
Snadd Formation																		Snadd Formation												
ely C			Carnian															Carnian												Age
199.49	188.19	173.36	166.08	154.88	144.96	132.76	121.66	117.49	99.55	87.85	78.80	67.40	58.78	47.59	36.53	27.86	08.73	146.84	138.13	127.02	115.16	102.55	91.61	82.67	68.88	56.72	48.11	36.53	28.06	Pollen
				x	x	x			C									x			x						x			*Angustisulcites* spp.
D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Bisaccate pollen
A		D	x	x	x	x		C			x	A		C	x		x	C	C	x	x	x	C		C	x	C	A	C	*Granasporites magnus*
x	x	x	x	C	x	x	x	x	x	x	A	x	C	x	x	x	x	C	x	D	x	x	x	x	x	x	x		x	*Illinites chitonoides*
C	x	A	C	C	x	C	x	A	x	x	x	A	x	x	C	x		C	C	C	x	C	x	x	x	x	x		x	*Podosporites amicus*
	C	x	x	x	x	x			x			C	x	x	C		C		x	x	x			C		x			C	*Protodiploxypinus* spp.
	A	x	x	x	x	x		x	x	x	x		x		C		x	x	x	A		x	x	x	x	x	x			*Staurosaccites quadrifidus*
C	C	x	x	x	x	x	x		x	x	x		x	x	C		x	x	C	A	D	C		x	C	x	x	x	x	*Striatoabieites balmei*
x	x		x	x			x	x	x	x	x		x				x		x		x	x	x	x	x		x			*Striatoabieites multistriatus*
x	x	C	C	x	x	A	x	x	A	C	C		C	x	x		x	C	C	D	A	A	x	D	A	x	C		x	*Triadispora* spp.
x		C		x	x	x	x	x	x	x	x			x		x		x	x	x	x	C	x	x	x	x	x	C	C	*Protodiploxypinus macroverrucosus*
																					x									*Lunatisporites pellucidus*
	x		x								x						x	x	x	x	x	x	x		x		x			*Schizaeoisporites worsleyi*
	x	x	x	x	x	x										x			x	x		x	x							*Angustisulcites klausii*
x						x		x	x	x			x	x	x								x		x		x		x	*Cordaitina* spp.
								x	x	x						x									x					*Pinuspollenites* spp.
x		x	x	x	x	x		x										x			x									*Protodiploxypinus decus*
x	x	x	C	C	x	x	x	x	C	C		x	x				C	x	A	A	C	A	x	A	x	x	x	x	x	*Triadispora verrucata*
x	x		x	x			x		x	x				x					x	C	x	x	x	x	x		x		x	*Lunatisporites noviaulensis*
					x																									*Protodiploxypinus doubingeri*
	x		x						x		x		x						x	C	x			x			x			*Striatoabieites aytugii*
	x								x					x																*Protodiploxypinus sittleri*
		x						x	C	x		x	x	C	C		x		C	x	x	C	C	A	C	C	x	x	x	*Protodiploxypinus ornatus*
		x			x		x																							*Lunatisporites* spp.
x			x	x	x					x											x									*Heliosaccus dimorphus*
																														Dyupetalum vicentinense
C		A	A	C	A	x	D	A	A	A	A	A	A	A	C	x	A	A		x		x			C	x	C	x	C	*Aulisporites astigmosus*
x	x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	C	x	A	C	x	x	x	x	x	x		*Ovalipollis pseudoalatus*
																			x		x	x	x	x	x	x	x			*Protodiploxypinus minor*
																														Infernopollenites spp.
x		x																												*Echinitosporites iliacoides*
x	x	D	A	A	A	C	A	A	A	A	C	D	C	D	A	A	C	x	A	x	x	C	x	x	x	x	x	C	A	*Chasmatosporites* spp.
					x		x			x			x			x	x		x	x	x	x	x	C			x	x		*Protodiploxypinus gracilis*
x	x			x	x						x		x				x						x		x					*Lunatisporites acutus*
									x																x					*Camerosporites secatus*
																		x	x		x			x	x					*Vitreisporites pallidus*
C	D	C	x	C	A	A	D	C										x	A	A		A	A	x	D	D	C	A	D	Bisaccate pollen (large specimens)
			x		x				x	x	x							C	x	x	x	C	x	x	x		x		x	*Schizosporis* spp.
					x	x											x	x		x		x			x	x				*Tetrasaccus* spp.
																														Protohaploxypinus spp.
																														Triadispora labichensis
x		x	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		*Retisulcites perforatus*
																														Succinctisporites grandior
																														Corollina spp.
														x																*Enzonalasporites vigens*
	x		x						x										x	x				x	x		x			*Accinctisporites ligatus*
																														Tsugaepollenites spp.
															x															Monosulcate pollen
								x					x		x															*Granasporites* spp.
																		x												*Cordaitina gunyalensis*.
																					x									*Illinites* spp.
Aulisporites asigmosus																		Aulisporites astigmosus												Composite assemblage zone

Botneheia Formation
Interval 18.79–14.89 m
Bisaccate pollen such as *Illinites chitonoides* (common), *Podosporites amicus* (common), *Protodiploxypinus* spp., *Staurosaccites quadrifidus*, *Striatoabieites balmei* (abundant) and *Triadispora* spp. (abundant) dominate. Spores have a low representation. The abundant plankton includes diverse green algae such as *Crassosphaera* spp., *leiospheres* and *Tasmanites* spp. of variable sizes together with some acritarchs.

CORES OFF KONG KARLS LAND - SASSENDALEN AND KAPP TOSCANA GROUPS

Lithostratigraphy	Core 7831/2-U-2												Core 7831/2-U-1					Core 7830/6-U-1										
	Botneheia Formation												Tschermakfj. Fm					Snadd Formation										
Age *	*Ladinian					*l.Lad/e.Carn							*L/C		*	*ely C		early Carnian										
Spores / Depth below sea level	18.79	17.87	14.89	14.32	13.88	11.43	10.28	9.85	7.70	6.83	6.21	6.16	26.61	24.36	19.66	14.83	11.85	52.79	46.91	40.70	38.88	33.76	28.06	24.75	20.10	14.87	8.88	3.93
Deltoidospora minor	x	C		x	x	C	C	A	x	D	A	A	A	C	A	A	A	A	D	x	D	D	A	x	A	A	A	D
Kyrtomisporis laevigatus		x		x					x	x	x	x	x		x	x	x		x	x		x	x	x			x	x
Leschikisporis aduncus		x			x	C	x	x	C	x	x	C	x	C	C	A	C	x	x	C	A	x	C	C	x	C	C	x
Baculatisporites/Osmundacidites			x		x		x	x	x	x	x	x		x	x	C	C										x	
Anapiculatisporites spiniger			x	x							x		x													x		
Thomsonisporites toralis					x							x						x			x	x		x				
Gordonispora fossulata					x	x			x		x			x				x	x									
Todisporites minor						x		C		x	x								x	x	x	x	C	x	x		x	x
Conbaculatisporites spp.						x	x	C	x	C	C	x		x	x	x	C			x	x	C	x	x	x	x	x	x
Camarozonosporites laevigatus						x									x		x			x		x	x	x	x	x	x	x
Dictyophyllidites spp.							x	x	x		x		x	x	C	x	C		x	x	x		x			x	x	x
Anapiculatisporites spp.							x	x	x			x					x		x	x							x	
Semiretisporis spp.							x		x			x			x		x				x		x	x	x	x	x	x
Camarozonosporites rudis								x	x	x	x	x	x	x	x		x	x	x	x	C	x	x	x	x	x	x	C
Verrucosisporites spp.								x			x	C						x			x	x	x	x	x		x	
Kraeuselisporites spp.								x		x	x								x				x		x		x	
Punctatosporites walcomii								x	x	x										x	x		x					
Leptolepidites spp.								x					x	x														
Calamospora tener									x		x								x	x	x	x	x	x	x	x	x	x
Semiretisporis barentzii									x							x		x			x	x	x			x	x	
Conbaculatisporites sp.1									C		C									x								
Nevesisporites limatulus									x	x		x		x	x	x												
Retusotriletes mesozoicus										x		x			x		x									x		x
Uvaesporites spp.										x	x	x				x	x					x			x		x	
Kraeuselisporites cooksonae										x	x			x			A	x	x	x	C	x	C	x	x	C	A	C
Lycopodiacidites spp.										x					x					x		x	x		x		x	x
Deltoidaspora toralis										x	x			x	x													
Aratrisporites fimbriatus											x				x		x					x	C	C	x			x
Todisporites major											x							x								x		x
Zebrasporites fimbriatus												x									x						x	x
Aratrisporites scabratus												x	x		x		x				x	x	C				x	
Polycingulatisporites spp.													x						x			x	x					
Leiotriletes spp.													x	x														
Aratrisporites palettae															x						x	x				x	x	
Cingulate zonate spores															x		x				x	x	x	x	x	x	x	x
Striatella seebergensis																x	A	x		x	C	C	C	x	C	C	C	A
Aratrisporites parvispinosus																x	x				x	x		x	x			x
Calamospora spp.																x	x									x		
Stereisporites perforatus																x			x									
Decisporis variabilis																	x				x	x	x		x	x	x	
Anapiculatisporites dawsonensis																	x											
Decisporis reticulatus																	x											
Semiretisporis gothae																	x											
Baculatisporites comaumensis																		x	x	x	x	A	C	C	C	C	C	x
Tigrisporites halleinis																			x					x				
Aratrisporites laevigatus																				x								x
Densoisporites spp.																					x						x	x
Verrucosisporites pseudomorulae																								x				
Dictyophyllidites harrisii																									x			
Gordonispora lubrica																									x			
Cyclotriletes spp.																										x	x	
Concavisporites spp.																											x	
Cyclogranisporites spp.																												x
Composite Assemblage Zone	E. iliac.			Aulispor. astigmosus									Aulispor. astigmosus					Aulisporites astigmosus										

LEGEND
D >16 dominant
A 7-15 abundant
C 3-6 common
x 1-2 present

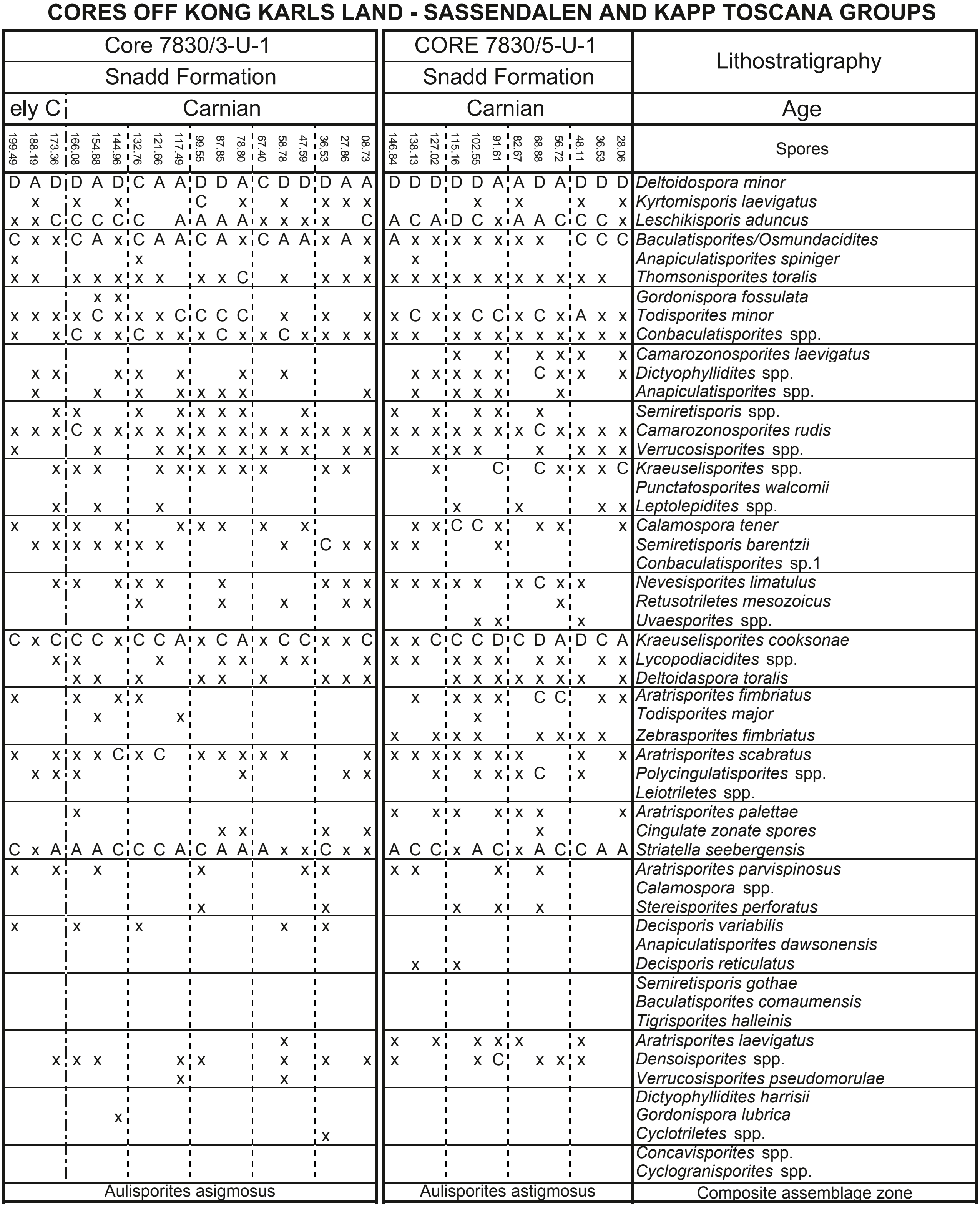
* Ladinia/Carnian boundary levels discussed by Xu et al. (in press 2014) are marked by ¦

A.42.2 Core 7831/2-U-2, Sassendalen Group, and cores 7831/2-U-1, 7830/6-U-1, 7830/3-U-1 and 7830/5-U-1, Kapp Toscana Group.

Echinitosporites iliacoides has no record, and in the absence also of *Aulisporites astigmosus*, the association is tentatively assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone based on its general characteristics.

Interval 14.32–6.16 m

The diversity of the assemblages increases upwards, with records of the pollen *A. astigmosus*, *E. iliacoides*, *Ovalipollis pseudoalatus* and *Protodiploxypinus* spp. and the spores *Camarozonosporites laevigatus*, *C. rudis* and



Semiretisporis spp. The algal association is similar to that from the underlying interval; only *Botryococcus* increases to abundant and indicates an increased freshwater supply to the depositional environment of this part of the core.

The incoming of a number of spores typical for younger assemblages, in association with the stratigraphically important *E. iliacoides* and *A. astigmosus*, allows confident correlation to the *Aulisporites astigmosus* Composite Assemblage Zone.

Xu et al. (in press) have investigated Re–Os data for three intervals of this core (i.e., 18.32–18.18 m, 11.30–11.12 m and 10.34–10.18 m) and suggest an isochron age of ca. 236.5 ± 3.6 Ma. The same age range has also been suggested for the Ladinian Carnian boundary by Mietto et al. (2012).

B.6.2 Core 7831/2–U–1, early Carnian

The core penetrates 20.95 m of the Kapp Toscana Group and five palynological samples have been investigated (Table A.42). The deposits are correlated to the Tschermakfjellet Formation on eastern Svalbard.

Tschermakfjellet Formation
Interval 26.61–11.85 m
The pollen comprises common to dominant *Aulisporites astigmosus* and dominant bisaccates such as *Illinites chitonoides*, *Podosporites amicus*, *Protodiploxypinus ornatus*, *Staurosaccites quadrifidus* and *Striatoabieites balmei*. The dominating smooth spores (*Deltoidospora* minor, *Dictyophyllidites* spp. and *Leschikisporis aduncus*) appear together with common *Baculatisporites*/*Osmundacidites* spp. There are local first appearances for *Corollina* spp., *Decisporis reticulatus*, *D. variabilis*, *Limulatulisporites* spp., *Semiretisporis* spp. and

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Lithostratigraphy	Core 7831/2-U-2												Core 7831/2-U-1					Core 7830/6-U-1										
	Botneheia Formation												Tschermakfj. Fm					Snadd Formation										
Age *	*Ladinian					*l.Lad/e.Carn							*L/C		*	*ely C		early Carnian										
Spores continued	18.79	17.87	14.89	14.32	13.88	11.43	10.28	9.85	7.70	6.83	6.21	6.16	26.61	24.36	19.66	14.83	11.85	52.79	46.91	40.70	38.88	33.76	28.06	24.75	20.10	14.87	8.88	3.93
Raistrickia spp.																												
Aratrisporites macrocavatus																												
Camarozonosporites spp.																												
Kraeuselisporites splendens																												
Verrucosisporites morulae																												
Aratrisporites tenuispinosus																												
Kraeuselisporites apiculatus																												
Aratrisporites paenulatus																												
Stereisporites spp.																												
Densoisporites velatus																												
Conbaculatisporites mesozoicus																												
Cyclotriletes triassicus																												
Densoisporites fissus																												
Decisporis spp.																												
Kyrtomisporis speciosus																												
Plankton & varia / Heigth in correlated section	5018.79	5017.87	5014.89	5014.32	5013.88	5011.43	5010.28	5009.85	5007.70	5006.83	5006.21	5006.16																
Micrhystridium spp.	A		A	C	x	x	x	x	x	x	x	x	D	x	x	x		A	D	A	x						x	
Leiosphere	D	D	D	D	D	D	x	D	x	D	D	D	A	A	D	A	A	D	D	D	A	x		A	A	A	A	A
Crassosphaera spp.	A	C	A	A	x	C	x	x		x	x	C	D	D	C	C		x	x	A	x				x	x	x	
Leiosphere (large)	x						x		x		C	x		x		x												
Pterospermella spp.	x		x		x				x			x	x		x													
Spherical body (large)	C	C	D																									
Botryococcus spp.			x	C				C			x				x		x		x	x	C	A	x	x	x	x	x	x
Tasmanites spp.					C				x			x																
Acanthomorph acritarch						D								x				x		x	x							
Veryhachium spp.						C	x	C				C		x				x		x	x	x	x					
Cymatiosphaera sp.1 sensu Hochuli et al.													x	x														
Plaesiodictyon spp.															x			x			x	x		x	x		C	
Cymatiosphaera spp.															x	C		x										
Sphaeromorph cluster															x													
Schizocystia ssp.																						x					x	
Plaesiodictyon mosellanum																												
Composite Assemblage Zone	E. iliac.			Aulispor. astigmosus									Aulispor. astigmosus					Aulisporites astigmosus										

LEGEND
D >16 dominant
A 7-15 abundant
C 3-6 common
x 1-2 present

* Ladinia/Carnian boundary levels discussed by Xu et al. (in press 2014) are marked by ¦

A.42.3 Core 7831/2-U-2, Sassendalen Group, and cores 7831/2-U-1, 7830/6-U-1, 7830/3-U-1 and 7830/5-U-1, Kapp Toscana Group.

Stereisporites perforatus, which are typical Late Triassic sporomorphs. *Echinitosporites iliacoides* has records only at 26.61 and 24.36 m, the lowest samples.

The association from this core, considering the presence of *E. iliacoides* together with *A. astigmosus* and the many stratigraphically young taxa, is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. The presence of *E. iliacoides* together with *A. astigmosus* is also recorded from lower Carnian deposits on Bjørnøya (Table A.25).

New Re–Os isotopic data from this core suggest an isochronous age of 236.5 ± 3.6 Ma (Xu et al. in press). Compared to the isotopic data from the late Ladinian deposits of the Botneheia Formation in the underlying Core 7831/2–U–02, they interpret an age of 236.6 ± 5 Ma for the boundary beds of the Ladinian–Carnian.

B.6.3 Core 7830/6–U–1, early Carnian

This core penetrates 49.35 m of the Kapp Toscana Group and according to seismic data it is overlain by the deposits recovered in Core 7830/3–U–1. Eleven samples were studied for palynology (Table A.42).

Snadd Formation
Interval 52.79–3.93 m
The rich assemblages include common to dominant *Aulisporites astigmosus*, dominant pollen including abundant *Triadispora* spp., common *Ovalipollis pseudoalatus*, *P. amicus*, *Protodiploxypinus* spp. and *Chasmatosporites* spp. Smooth spores (*Deltoidospora* spp., D. minor, *Dictyophyllidites* spp. and *Leschikisporis aduncus*) and some ornamented trilete spores (*Kraeuselisporites* spp. and *Striatella* spp.) represent the other dominant group. The interval from 38.8 m and above contains abundant large bisaccates and diverse *Aratrisporites*.

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Core 7830/3-U-1																		CORE 7830/5-U-1												Lithostratigraphy
Snadd Formation																		Snadd Formation												
ely C			Carnian															Carnian												Age
199.49	188.19	173.36	166.08	154.88	144.96	132.76	121.66	117.49	99.55	87.85	78.80	67.40	58.78	47.59	36.53	27.86	08.73	146.84	138.13	127.02	115.16	102.55	91.61	82.67	68.88	56.72	48.11	36.53	28.06	Spores
x			x	x		x						x			x	x					x								x	*Raistrickia* spp.
x		x	x	x	x	x	x		x	x	x	x	x	x	x			x	x		x	x	x		x	C	x	x	x	*Aratrisporites macrocavatus*
	x	x	x		x	x	x			x	x						x													*Camarozonosporites spp.*
		x	x															x	x	x						x	x			*Kraeuselisporites splendens*
		x	x	x	x						x												x			x				*Verrucosisporites morulae*
		x				x																								*Aratrisporites tenuispinosus*
			x															x	x											*Kraeuselisporites apiculatus*
					x		x	x		x	x								x			x					x	x		*Aratrisporites paenulatus*
						x																		x						*Stereisporites* spp.
										x																	x	x		*Densoisporites velatus*
											x																			*Conbaculatisporites mesozoicus*
																			x	x						x				*Cyclotriletes triassicus*
																			x											*Densoisporites fissus*
																									x			x		*Decisporis* spp.
																													x	*Kyrtomisporis speciosus*
																														Plankton & varia
x	A		x						x									x	x	x	x			C	x				x	*Micrhystridium* spp.
	A		C	C	A	A	C	A	A	A	C	A	A	C	C	A	A	x	x	C	C	A		D	A	D	C	x		Leiosphere
	C			x	x	C	x		C	C	x		A		x	A	x	x	x	x	C	C		x	x	C	x			*Crassosphaera* spp.
																														Leiosphere (large)
																														Pterospermella spp.
																														Spherical body (large)
x		x	x	x	x		x	x	C	x	A	x	C	A	C	x	C			x	C	C	x		A	x	A	x	C	*Botryococcus* spp.
	x					x							x				x													*Tasmanites* spp.
			x																											Acanthomorph acritarch
	x																													*Veryhachium* spp.
																														Cymatiosphaera sp.1 sensu Hochuli et al.
C	x	x	x	x		x			x	x		x	x				x													*Plaesiodictyon* spp.
			x	x					x		x		x			x	x	x				x		x						*Cymatiosphaera* spp.
																														Sphaeromorph cluster
																		x					x		x		x			*Schizocystia* ssp.
																		x		x		x			x	x	x			*Plaesiodictyon mosellanum*
Aulisporites asigmosus																		Aulisporites astigmosus												Composite Assemblage Zone

The increased diversity of spores and pollen, together with a temporarily increased abundance of *Botryococcus* may support increased freshwater influence and possibly a more humid climate.

Comparable assemblages that include *E. iliacoides* occur in Core 7830/3–U–1 that is stratigraphically younger than Core 7830/6–U–1 according to seismic data. We therefore interpret the deposits discussed above as representing the lower part of the *Aulisporites astigmosus* Composite Assemblage Zone.

B.6.4 Core 7830/3–U–1, early to middle Carnian

This core penetrates 196.46 m of the lower part of Snadd Formation. Eighteen samples were studied for palynology (Table A.42). The palynological association resembles that of the highest part of the stratigraphically lower core (7830/6–U–1 see above).

Snadd Formation
Interval 199.49–173.36 m
Pollen include abundant *Aulisporites astigmosus* and *Chasmatosporites* spp. The bisaccate pollen show high diversity, with dominant *Podosporites amicus*, *Protodiploxypinus* spp. and *Triadispora verrucata*. Spores are equally dominant including the *Aratrisporites*, *Baculatisporites*, *Deltoidospora* and the *Kraeuselisporites* groups as well as *Leschikisporis aduncus*, *Striatella seebergensis* and *Todisporites minor*. *Aratrisporites* spp. shows a high diversity. Large bisaccate pollen grains are particularly common.

The continued presence of *Echinitosporites iliacoides* allows assignment to the *Aulisporites astigmosus* Composite Assemblage Zone and suggests an early Carnian age for this interval.

Interval 166.08–08.73 m
The assemblages throughout the core show a high diversity of bisaccate pollen and spores, including the *Aratrisporites* group. *Granasporites* spp. has an incoming at 117.49 m. In absence of *E. iliacoides*, the association is assigned to the upper part of the *Aulisporites astigmosus* Composite Assemblage Zone.

B.6.5, Core 7830/5–U–1, Carnian

This core penetrated 127.0 m of the Snadd Formation. The 12 samples studied for palynology (Table A.42) contain an assemblage similar to that of the samples from the underlying deposits (Core 7830/3–U–1).

Snadd Formation
Interval 146.84–28.06 m
As in Core 7830/3–U–1, *Chasmatosporites* spp. and large bisaccate pollen continue to be the dominant groups. *Angustisulcites klausii* is present only in samples up to 91.61 m, while *Illinites chitonoides* is recorded throughout the core. There is a high diversity of spores, including dominant *Deltoidospora* minor and *Leschikisporis aduncus*. The *Kraeuselisporites* group and *Striatella seebergensis* represent characteristic elements. The decrease in diversity and abundance of pollen and spores at 36.53 m coincides with a decrease of marine plankton. The association is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone and may represent middle to late Carnian deposits.

C. Exploration wells

The palynology of 10 exploration wells has been included to complete the records from the Upper Triassic succession (Tables A.47–A.53, Plates 29–33). Palynological data from sidewall and conventional cores have been selected for the range charts. The wells are discussed according to stratigraphy, from the oldest to youngest unit, in order to conform to the presentation of the outcrop sections (Tables A.1–A.25) and stratigraphic cores (Tables A.26–A.46). Range charts are provided from selected wells only (Figure A.1). Lithostratigraphic boundaries refer to unpublished reports, literature or the Norwegian Petroleum Directorate Fact pages (http://factpages.npd.no/factpages/default.aspx). There are discrepancies due to definition of formations and their boundaries according to the various sources. However, no new formations or formational boundaries are suggested based on palynology.

C.1 Well 7120/12–1

Well 7120/12–1 was the second well drilled in the Hammerfest Basin (Troms I area) offshore northern Norway in 1980. Total depth (TD) was at 3573 m in the Kobbe Formation (see 15.1.12/NPD Factpages). The palynological range charts (Table A.43.1 and 2) are based on sidewall and conventional cores. The ages interpreted from palynology in this study show fair agreement within the Snadd Formation below 2900 m. The deposits above (2900–2429 m) being dated to the Norian, rather represent the Fruholmen Formation. Above the Norian interval, Jurassic palynomorphs (2417.5–2250 m) suggest presence of the Tubåen and the Nordmela formations.

Snadd Formation: 3570–2535 m (15.1.12/NPD Factpages)
Interval 3570–3515 m, Carnian
Associations recorded from this interval include abundant small, taeniate bisaccate pollen, *Aratrisporites* spp. and *Camarozonosporites rudis*. There are subordinate numbers of *Illinites chitonoides*, diversity of the *Protodiploxypinus* group (*P. gracilis*, *P. minor*, *P. ornatus*), *Staurosaccites quadrifidus* and sporadic observations of

HAMMERFEST BASIN

WELL 7120/12-1	KAPP TOSCANA GROUP																																																				
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																																							Fruholmen Formation									Tubå Fm			
Age	Carnian																	late Carnian									Norian														Nor		Early Jurassic										
Pollen / Depth in metres	3570 swc	3443.5 swc	3534 swc	3525.5 C	3524.47 C	3523.43 C	3522.49 C	3521.95 C	3515.5 swc	3508 swc	3505 swc	3472 swc	3445 swc	3425 swc	3337 swc	3275 swc	3219 swc	3201 swc	3167 swc	3135 swc	3097 swc	3085 swc	3043 swc	2959 swc	2925 swc	2902 swc	2850 swc	2834 swc	2816 swc	2787 swc	2747 swc	2716 swc	2713 swc	2670 swc	2662 swc	2636 swc	2627 swc	2616 swc	2600 swc	2575 swc	2534 swc	2500 swc	2417.5 swc	2404 swc	2387 swc	2375 swc	2350 swc	2344 swc	2339 swc	2333.5 swc	2265 swc	2239 swc	2223.6 swc
Lunatisporites spp.	x				x							x		x		x		x		x				x		x	x					x																		R			R	
Lunatisporites noviaulensis	x		A	A	x	x		A					x			x		x		x			x			x		x	x	x	x	x	x																	R				
Ricciisporites tuberculatus	x													x									x							C																			R				
Illinites spp.	x	x	x	x														x																																			
Protodiploxypinus minor	x																																																				
Cycadopites nitidus	x																																																				
Protodiploxypinus ornatus			x									x			x					x																					x								R			R	
Schizaeoisporites worsleyi			x		x			x																						x																							
Protodiploxypinus gracilis			x																																																		
Rhaetipollis spp.				x	x								x																													x											
Triadispora spp.				x																						x	x																										
Staurosaccites quadrifidus					x	x	x	x					C					x					x			x																											
Lunatisporites acutus						x	x	x																																													
Infernopollenites spp.								x																																													
Ephedripites spp.									x																																												
Chasmatosporites magnolioides										x								x								x	x	x		x										x	x	x	x				x	x	x			x	→
Bisaccate pollen (indeterminate)											x													x			x					x				x				x	x	x	A	x			x	A	A		x	x	→
Porcellispora longdonensis												x	x																																								
Echinitosporites iliacoides												x																																									
Chasmatosporites apertus													x	x			x	x										x		C																		x	x			x	→
Enzonalasporites spp.														x																																							
Alisporites spp.															x								x		x	x																							x			A	→
Ovalipollis pseudoalatus																x		x							C	C	x		A												x												
Quadraeculina anellaeformis																		x																																		x	
Chasmatosporites sp. A																		x																																			
Nuskoisporites spp.																		x																																			
Ephedripites steevesi																		x																																			
Eucommiidites minor																				x						x			x	x																							
Concentrisporites spp.																										x																											
Ricciisporites spp.																														x	x																						
Cerebropollenites thiergartii																																											x						x			x	→
Cerebropollenites macroverrucosus																																											x										→
Spores																																		b					b						b					b			
Lycopodiacidites rugulatus	x																								x		x			x		x										x	x						x				→
Aratrisporites scabratus	x	x							x	x			x	x	x					x			x																	x	x								R				
Lundbladispora obsoleta	x		x									x		x	x																																						
Kraeuselisporites reissingeri	x																																																				
Anapiculatisporites spiniger		x			x							x	x									x				x			x																								
Camarozonosporites rudis			x						x			x																																									
Aratrisporites macrocavatus					x										x																																						
Dictyophyllidites mortoni										x																				x											x										x		x
Smooth trilete spores										x							x			x	x			x	x		x			x							x	x		x	x						x	x	x		x	A	→
Stereisporites spp.										x			x	x	x	x																									x											x	
Kyrtomisporis laevigatus										x	A	x	x	x		x																									x	x						R					
Velosporites spp.										x						x		x		x																																	
Densoisporites spp.												x			x						x								x	x							x					x						x					→
Cingulizonates rhaeticus												x			x								x							x																							
Zebrasporites laevigatus													x																																								
Conbaculatisporites hopensis														x		x							x				A																										
Neoraistrickia taylorii															x	x																																					
Verrucosisporites spp.																		x																															x				→
Limbosporites lundbladii																		x							x																	x					R		R				
Polypodiisporites spp.																		x																																			
Patinasporites densus																												x																				R					
Striatella seebergensis																														x																		x	x				→
Annulispora folliculosa																														x											x												
Zebrasporites interscriptus																														x																							
Aratrisporites laevigatus																																x																					
Kyrtomisporis speciosus																																									x												
Baculatisporites spp.																																																x			A	x	→
Plankton and varia	3570 swc	3443.5 swc	3534 swc	3525.5 C	3524.47 C	3523.43 C	3522.49 C	3521.95 C	3515.5 swc	3508 swc	3505 swc	3472 swc	3445 swc	3425 swc	3337 swc	3275 swc	3219 swc	3201 swc	3167 swc	3135 swc	3097 swc	3085 swc	3043 swc	2959 swc	2925 swc	2902 swc	2850 swc	2834 swc	2816 swc	2787 swc	2747 swc	2716 swc	2713 swc	2670 swc	2662 swc	2636 swc	2627 swc	2616 swc	2600 swc	2575 swc	2534 swc	2500 swc	2417.5 swc	2404 swc	2387 swc	2375 swc	2350 swc	2344 swc	2339 swc	2333.5 swc	2265 swc	2239 swc	2223.6 swc
Megaspore	x																																																				
Veryhachium spp.				x								x																												x	C	x											
Micrhystridium spp.				x																																																	
Indeterminate cyst												x		x	x			x	x						x																												
Late Triassic evidence																																															R	R	R		R	R	
Composite Assemblage Zone	Aulisporites astigmosus																	Rhaetogonyaulax spp.									Limbosporites lundbladii																(Cerebropollenites zone)										

LEGEND
- D dominant
- A abundant
- C common
- x present
- R reworked
- → continues
- C conv. core
- swc sidewall core
- ⁙ barren / low productivity

(Cerebropollenites zone) marks an informal assemblage zone with *Cerebropollenites macroverrucosus*, recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

A.43.1 Well 7120/12-1, Kapp Toscana Group, bases.

HAMMERFEST BASIN

WELL 7120/12-1	KAPP TOSCANA GROUP																																																				
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																																							Fruholmen Formation									Tubå Fm			
Age	Carnian																	late Carnian									Norian														Nor		Early Jurassic										
Pollen / Depth in metres	3570 swc	3443.5 swc	3534 swc	3525.5 C	3524.47 C	3523,43 C	3522.49 C	3521.95 C	3515.5 swc	3508 swc	3505 swc	3472 swc	3445 swc	3425 swc	3337 swc	3275 swc	3219 swc	3201 swc	3167 swc	3135 swc	3097 swc	3085 swc	3043 swc	2959 swc	2925 swc	2902 swc	2850 swc	2834 swc	2816 swc	2787 swc	2747 swc	2716 swc	2713 swc	2670 swc	2662 swc	2636 swc	2627 swc	2616 swc	2600 swc	2575 swc	2534 swc	2500 swc	2417.5 swc	2404 swc	2387 swc	2375 swc	2350 swc	2344 swc	2339 swc	2333.5 swc	2265 swc	2239 swc	2233.6 swc
Chasmatosporites magnolioides										x								x								x	x	x		x										x	x	x	x				x	x	x			x	→
Bisaccate pollen (indeterminate)											x													x			x					x				x				x	x	x	A	x			x	A	A		x	x	→
Chasmatosporites apertus													x	x			x	x										x		C																		x	x			x	→
Alisporites spp .															x								x		x	x																							x			A	→
Quadraeculina anellaeformis																		x																																		x	→
Cerebropollenites thiergartii																																											x						x			x	→
Protodiploxypinus ornatus			x									x			x					x																					x								R			R	
Lunatisporites spp.	x				x							x		x		x		x		x				x		x	x					x																	R			R	
Lunatisporites noviaulensis	x		A	A	x	x		A					x			x		x		x			x			x		x	x	x	x	x	x																R				
Ricciisporites tuberculatus	x													x									x							C																			R				
Cerebropollenites macroverrucosus																																											x										
Rhaetipollis sp.				x	x								x																													x											
Ovalipollis pseudoalatus																x		x							C	C	x		A												x												
Ricciisporites spp.																														x	x																						
Schizaeoisporites worsleyi			x		x			x																						x																							
Eucommiidites minor																				x						x			x	x																							
Porcellispora longdonensis												x	x																x																								
Triadispora spp.				x																					x	x																											
Staurosaccites quadrifidus					x	x	x	x										x					x			x																											
Concentrisporites spp.																										x																											
Illinites spp.	x	x	x	x														x																																			
Chasmatosporites sp. A																		x																																			
Ephedripites steevesii																		x																																			
Nuskoisporites spp.																		x																																			
Enzonalasporites spp.														x																																							
Echinitosporites iliacoides												x																																									
Ephedripites spp.									x																																												
Lunatisporites acutus						x	x	x																																													
Infernopollenites spp.								x																																													
Protodiploxypinus gracilis			x																																																		
Protodiploxypinus minor	x																																																				
Cycadopites nitidus	x																																																				
Spores																																		b					b						b					b			
Dictyophyllidites mortoni										x																				x											x										x		x
Smooth trilete spores										x							x			x	x			x	x		x			x							x	x		x	x						x	x	x		x	A	
Stereisporites spp.										x			x	x	x	x																									x											x	
Baculatisporites spp.																																																x			A	x	
Aratrisporites scabratus	x	x							x	x			x	x	x					x			x																	x	x								R				
Lycopodiacidites rugulatus	x																								x		x			x		x										x	x						x				
Limbosporites lundbladii																		x							x																	x					R		R				
Verrucosisporites spp.																		x																															x				
Striatella seebergensis																														x																		x	x				
Kyrtomisporis laevigatus										A		x	x	x		x																									x	x						R					
Densoisporites spp.												x			x						x								x	x							x					x						x					
Patinasporites densus																												x																				R					
Annulispora folliculosa																														x											x												
Kyrtomisporis speciosus																																									x												
Aratrisporites laevigatus																																x																					
Anapiculatisporites spiniger		x			x							x	x									x				x			x																								
Cingulizonates rhaeticus												x			x								x							x																							
Zebrasporites interscriptus																														x																							
Conbaculatisporites hopensis														x		x							x				A																										
Velosporites spp.										x						x		x		x																																	
Polypodiisporites spp.																		x																																			
Neoraistrickia taylorii															x	x																																					
Lundbladispora obsoleta	x		x									x		x	x																																						
Aratrisporites macrocavatus					x										x																																						
Zebrasporites laevigatus													x																																								
Camarozonosporites rudis			x						x			x																																									
Kraeuselisporites reissingeri	x																																																				
Plankton and varia	3570 swc	3443.5 swc	3534 swc	3525.5 C	3524.47 C	3523,43 C	3522.49 C	3521.95 C	3515.5 swc	3508 swc	3505 swc	3472 swc	3445 swc	3425 swc	3337 swc	3275 swc	3219 swc	3201 swc	3167 swc	3135 swc	3097 swc	3085 swc	3043 swc	2959 swc	2925 swc	2902 swc	2850 swc	2834 swc	2816 swc	2787 swc	2747 swc	2716 swc	2713 swc	2670 swc	2662 swc	2636 swc	2627 swc	2616 swc	2600 swc	2575 swc	2534 swc	2500 swc	2417.5 swc	2404 swc	2387 swc	2375 swc	2350 swc	2344 swc	2339 swc	2333.5 swc	2265 swc	2239 swc	2233.6 swc
Veryhachium spp.				x								x																												x	C	x											
Indeterminate cyst												x		x	x			x	x						x																												
Micrhystridium spp.				x																																																	
Megaspore	x																																																				
Late Triassic evidence																																															R	R	R		R	R	
Composite Assemblage Zone	Aulisporites astigmosus																	Rhaetogonyaulax spp.									Limbosporites lundbladii																(Cerebropollenites zone)										

LEGEND
- D dominant
- A abundant
- C common
- x present
- R reworked
- → continues
- C core
- swc sidewall c.
- barren /low product. (stippled)

(Cerebropollenites zone) marks an informal assemblage zone with *Cerebropollenites macroverrucosus,* recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

A43.2 Well 7120/12-1, Kapp Toscana Group, tops.

Rhaetipollis spp., *Ricciisporites tuberculatus* and *Schizaeoisporites worsleyi* (A.43.1 and 2). In the absence of *Echinitosporites iliacoides* the assemblage is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

Interval 3508–3219 m, Carnian
The palynological assemblages comprise *Chasmatosporites apertus*, *C. magnolioides*, Con*baculatisporites hopensis* and *Kyrtomisporis laevigatus*. The record of *Velosporites* sp. Bjærke and Manum (1977) at 3508 m and of *Porcellispora longdonensis* at 3472 m, as well as the regular presence of *Chasmatosporites apertus* and *C. magnolioides*, suggest assignment to the *Aulisporites astigmosus* Composite Assemblage Zone. The single record of *Echinitosporites iliacoides* at 3472 m has been interpreted as contamination. Microplankton include indeterminate dinoflagellate cysts indicating somewhat stronger marine influx compared to the interval below.

Interval 3275–2900 m, late Carnian
The oldest records of *Limbosporites lundbladii*, *Eucommiidites minor*, *Quadraeculina anellaeformis* (3201 m) and consistent to abundant *Ovalipollis pseudoalatus* characterise this assemblage. The interval is defined by the youngest records of *Institisporites crispus*, *Podosporites amicus*, *Staurosaccites quadrifidus*, *Illinites* spp., *I. chitonoides* and *Triadispora* spp. (T. *verrucata*). The association is assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone, although the eponymous dinocysts have not been recorded.

Interval 2900–2575 m, Norian
The lower part of this interval (2850–2787 m) contains *Annulispora folliculosa*, *Cingulizonates rhaeticu*s, *Kyrtomisporis gracilis*, *Limbosporites lundbladii*, *Ricciisporites tuberculatus* and *Zebrasporites interscriptu*s and common to abundant Con*baculatisporites hopensis*, *Chasmatosporites apertus* and *Ovalipollis pseudoalatus*. Dinoflagellate cysts have not been recorded. The association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

Fruholmen Formation: 2535–2337 m (15.1.12/NPD Factpages)
Interval 2535–2429 m, Norian
A few age-diagnostic taxa are present in this interval, but most species represent long-ranging taxa continuing into the overlying units. Plankton are represented by *Veryhachium* spp. (Table A.47.1 and 2). Restricting evidence for Rhaetian or Jurassic ages is missing. The interval is tentatively assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

Interval 2417.5–2350 m, Early Jurassic
The low-diversity assemblage at 2417.5 m was recovered from a sidewall core. The first confident records of the taxa *Cerebropollenites macroverrucosus* and *C. thiergartii* support an Early Jurassic age for the deposits. The restricted Late Triassic palynomorphs present in this sample have been interpreted as recycled, as also observed in outcrops on Svalbard (Tables A.1, A.11). However, we note that the Jurassic pollen do have records in the palynological assemblages from Upper Triassic ditch cuttings samples (Hochuli and Vigran 2010).

Tubåen Formation: 2337–2250 m (15.1.12/NPD Factpages)
The presence of *C. thiergartii* and C. *macroverrucosus* and diversity of *Chasmatosporites* spp., as for the underlying interval, are considered as Jurassic evidence. The association of spores and pollen suggesting a Norian age are interpreted as reworked deposits.

C.2 Well 7120/12–2

Well 7120/12–2 is located in the Hammerfest Basin, south of the Snøhvit area. It was drilled to A TD of 4680 m in basement rocks. The well represents the stratotype for the Kobbe and Snadd formations (Worsley et al. 1988, Mørk et al. 1999). A major fault, penetrated at 2410 m, has been interpreted to result in the loss of approximately 400 m of the Triassic section (15.1.12/NPD Factpages).

The age interpretations (Tables A.44.1 and 2) are based on palynological data from sidewall and conventional cores. However, the assigned ages based on this evidence are not consistent with those expected from assigned formations and boundaries, which according to the 15.1.12/NPD Factpages are: ‘Kobbe Formation: 3095–2927 m; Snadd Formation: 2927–2354 m; Fruholmen Formation: 2354–2234 m; Tubåen Formation: 2234–2152 m’. For this reason, the palynological interpretations are presented in this paper for given stratigraphic intervals.

Interval 3176–3120 m, early to middle Anisian
The four sidewall-core samples studied show low diversity. Spores, mainly *Aratrisporites* spp. and *Cyclotriletes* spp., dominate. Pollen include mainly representatives of the *Lunatisporites* group. The two uppermost samples also contain *Alisporites* spp. and *Lueckisporites* spp. The presence of *Densoisporites nejburgii* suggests an age not younger than the middle Anisian. The palynological association is tentatively assigned to the *Anapiculatisporites spiniger* Composite Assemblage Zone.

Interval 3103–3026 m, Ladinian
Diverse spores dominate the assemblages in the lower part of this interval (samples 3103–3072 m). There are abundant *Anapiculatisporites spiniger* and *Aratrisporites* spp., together with *Porcellispora longdonensis*. Bisaccate pollen include abundant *Lunatisporites* spp., *Triadispora* spp. and rare *Staurosaccites quadrifidus*. Confident Ladinian evidence includes *Echinitosporites iliacoides*

together with *Illinites chitonoides* (at 3103 m). Although the highest samples (3038–3026 m) are of low diversity, the presence of *A. spiniger*, *Chasmatosporites magnolioides* (3038 m), *Ricciisporites tuberculatus* and bisaccate pollen allows correlation of this interval with the *Echinitosporites iliacoides* Composite Assemblage Zone. Assemblages of Ladinian age in other parts of the Barents Sea seem to support an assignment to the Snadd Formation.

Interval 3018–2954 m, early Carnian

The assemblages present in the sidewall cores from this interval are distinguished from those below by the general dominance of pollen. At 2954 m, *Eucommiidites minor* and *Institisporites crispus* are recorded together with the youngest record of *E. iliacoides*. Cuticles are abundant and rare acritarchs occur near the top of the interval that is assigned to the lower part of the *Aulisporites astigmosus* Composite Assemblage Zone.

According to the published lithostratigraphy for this well (15.1.12/NPD Factpages), the palynological evidence for Ladinian to Carnian deposits appearing in the Kobbe Formation represent contradicting evidence, as does the boundary between Kobbe and Snadd formations being situated within Carnian deposits. The correlated ages presented for the Kobbe Formation from elsewhere in the Barents Sea range from the Spathian–Anisian (7121/1–1R) to Anisian–Ladinian (7124/3–1).

HAMMERFEST BASIN

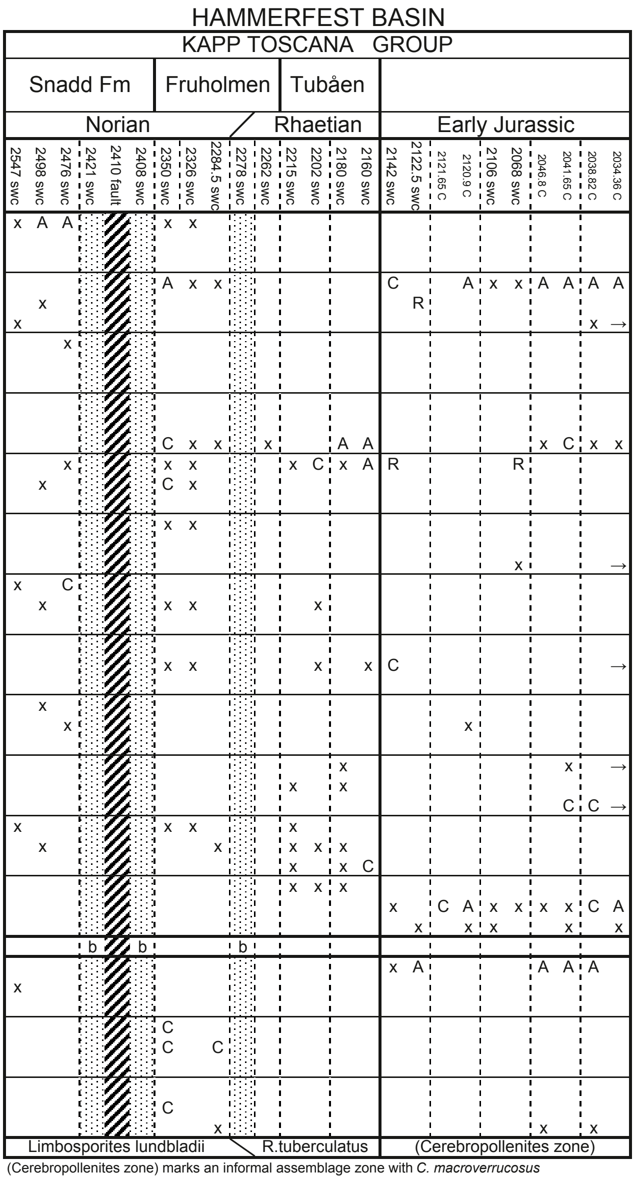
WELL 7120/12-2	SASSENDALEN GROUP																			KAPP TOSCANA GROUP																					
Lithostratigraphy 15.1.12/NPD Factpages						Kobbe Formation														Snadd Formation																					
Age	e-m.Anis				Ladinian								Early Carn					Carnian																						L.C	
Pollen / Depth of cores	3176 swc	3157 swc	3131 swc	3120 swc	3103 swc	3085 swc	3072 swc	3061 swc	3051.9 swc	3038 swc	3027 swc	3026 swc	3018 swc	2992 swc	2981.9 swc	2964 swc	2954 swc	2943 swc	2935 swc	2922.1 swc	2912 swc	2890 swc	2878 swc	2867 swc	2855 swc	2843 swc	2830 swc	2814.9 swc	2799.9 swc	2785 swc	2740 swc	2728 swc	2703 swc	2686 swc	2664.1 swc	2647.1 swc	2636 swc	2622 swc	2587.9 swc	2577 swc	2554 swc
Lunatisporites spp.	A			C		A	A						A	C	A	C	A		A	A	x	A	A	C	C	C	A	A				x	A	C	A	A	A	A	x	A	C
Lunatisporites noviaulensis	x				A												x											x								x		x			x
Lueckisporites spp.			x		x																																				
Bisaccate pollen (indeterminate)				x	A			x			A		A	A	A		A		A	A		A	A		A	A	A								A	A	x	A			
Porcellispora longdonensis					x	x								x					x	x																	x				
Alisporites spp				A															x	A			x					x			x		C					x	A	A	x
Illinites chitonoides					x		x										A						x			x	x	x	x		x		x	x		C		x			
Echinitosporites iliacoides					x												x																								
Triadispora spp.					x		C				x									x																					
Staurosaccites quadrifidus							x																					x													
Infernopollenites spp.							x																																		
Chasmatosporites magnolioides										x							C												x		x	x				x	x		x	x	
Ricciisporites tuberculatus										x																	x														
Ovalipollis pseudoalatus													x				x						x					A	x		x			x	x	x	A	C	C	x	C
Pollen abundance													A	A	A		A		A	A		A	A		A	A	A							C	A	A		A			
Protodiploxypinus gracilis																x	C															x									x
Samaropollenites spp.																x			x	x								x													
Eucommiidites minor																	x														x									C	
Institisporites crispus																	x											x													
Protodiploxypinus spp.																	x											x												x	x
Platysaccus spp.																	x																								
Vitreisporites pallidus																										x		x													
Chasmatosporites apertus																										x	x								x	x		x	x	x	
Scutasporites spp.																											x														
Concentrisporites sp.																													x							x				x	x
Chasmatosporites sp. A																																						x		x	
Vallasporites spp.																																						x			
Quadraeculina anellaeformis																																								x	
Camerosporites pseudoverrucatus																																								x	
Corollina meyeriana																																									x
Rhaetipollis germanicus																																									
Striatoabieites spp.																																									
Ricciisporites umbonatus																																									
Granuloperculatipollis rudis																																									
Cerebropollenites thiergartii																																									
Cerebropollenites macroverrucosus																																									
Plankton and varia												b						b												b											
Cuticle													A	C	A		A						C								C	x							C		
Veryhachium sp. 4-5 horns																	x		C															x	x					x	
Baltisphaeridium spp.																						A																	x	x	x
Micrhystridium spp.																						A												x	x						x
Tasmanites spp.																															x										
Indeterminate cyst																																					C			x	
Rhaetogonyaulax spp.																																								x	
Veryhachium spp.																																									
Botryococcus spp.																																									
Composite Assemblage Zone	A.spiniger				Echinitosp. iliacoides								Aulisporites astigmosus																											Rh.	

LEGEND
- D dominant
- A abundant
- C common
- x present
- R reworked
- ca caved
- → continues upwards
- (stippled) barren samples b
- (hatched) interpreted fault zone
- C conventional core
- swc sidewall core

A.44.1.1 Well 7120/12-2, Sassendalen and Kapp Toscana groups, bases.

Interval 2935–2587.9 m, mid Carnian

The youngest record of *Triadispora* spp. is at 2922 m. *Kraeuselisporites dentatus, Semiretisporis* spp. and *Patinasporites densus* occur from 2878 m upwards. These records and common *Chasmatosporites* spp., abundant *Ovalipollis pseudoalatus* and the presence of *Illinites chitonoides*, *Kyrtomisporis laevigatus*, *Limbosporites lundbladii*, *Eucommiidites major* (2740 m) and *Camarozonosporites rudis* support a mid Carnian age. Cuticles from land plants appear at irregular intervals. Acritarchs have irregular representation up to 2890 m, reflecting marine influence. Indeterminate dinoflagellate cysts are present in the very highest part of the interval (2636 m). The association is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.



(Cerebropollenites zone) marks an informal assemblage zone with *C. macroverrucosus*
It is recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

Interval 2577–2554 m, late Carnian

The earliest record of the pollen *Corollina meyeriana* and *Quadraeculina anellaeformis* and *Rhaetogonyaulax* spp. allows assignment to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

Interval 2547–(2326 m) 2284.5 m, Norian

A major fault is interpreted to occur at the 2410 m level and separates the Snadd and Fruholmen formations. There is a supposed loss of 400 m of deposits (15.1.12/ NPD Factpages). Below the fault zone (2547–2476 m), assemblages of low diversity contain the oldest records of *Rhaetipollis germanicus* and *Thomsonisporites* spp. The interval has the highest recorded number of *Institisporites crispus* and only sporadic plankton. There are barren samples at 2421 m and 2408 m.

Above the fault zone (2350–2284.5 m), there is increased spore diversity, with *Apiculatisporis ovalis*, Con*baculatisporites mesozoicus*, *Densoisporites cavernatus*, abundance and diversity of the *Kyrtomisporis* and *Stereisporites* groups, besides presence of *Ricciisporites tuberculatus*, *Semiretisporis* spp. and *Zebrasporites interscriptus*. Pollen include common *Chasmatosporites magnolioides* and *O. pseudoalatus*. The youngest record for a large number of taxa, among them the *Lunatisporites* group, marks the top of the interval and distinguishes it from overlying assemblages. The abundant microplankton comprise common *Micrhystridium*, *Tasmanites* and *Veryhachium* reflecting a marine environment. The sidewall-core samples from the top of the interval are virtually barren of palynomorphs.

The palynological assemblages are correlated with the *Limbosporites lundbladii* Composite Assemblage Zone and are interpreted as of Norian age. The major fault at 2410 m and the formational boundary above it (Table A.44) are both located within the assemblage zone and therefore difficult to deduce from the palynological record.

Interval 2278–2160 m, Rhaetian

Palynologically almost barren samples separate this interval from the correlated Norian deposits below. The oldest occurrence of *Granuloperculatipollis rudis* at 2215 m is in an interval characterised by peak abundance of *Chasmatosporites magnolioides*, *Limbosporites lundbladii* and abundant *R. tuberculatus* and *R. umbonatus*. No algal remains have been recorded. The association is assigned to the *Ricciisporites tuberculatus* Composite Assemblage Zone.

Interval 2142–2034 m, Early Jurassic

An Early Jurassic age for this interval (as for deposits on Svalbard) is based on the presence of *Cerebropollenites macroverrucosus* and *C. thiergartii* recovered from conventional and sidewall cores. The Late Triassic palynomorphs recovered in the samples are considered to be reworked.

C.3 Well 7120/12–3

Well 7120/12–3 is located in the Hammerfest Basin, south of the Snøhvit area. It was drilled to a TD of 2523 m in the Fruholmen Formation (15.1.12/NPD Factpages). The reported palynological data represent a few sidewall cores and 16 cutting samples. The stratigraphically important data considered as representing caved material are marked in the range chart (Table A.45).

Fruholmen Formation: 2523 m TD–2342 m (15.1.12/NPD Factpages)

Interval 2523 m sidewall core–2522 m cuttings sample, Norian

Assemblages from this interval are characterised by the abundant to common appearance of *Chasmatosporites apertus*, *C. magnolioides*, *Cingulizonates rhaeticus*, *Kyrtomisporis laevigatus*, *K. gracilis*, *K. speciosus*, together with *Limbosporites lundbladii* and rare *Ricciisporites tuberculatus*. The palynomorphs *Micrhystridium* spp., *Veryhachium* spp. and foraminiferal linings (in cuttings) reflect a marine depositional environment. The association (based on the sidewall core at 2523 m) is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

HAMMERFEST BASIN

WELL 7120/12-2	SASSENDALEN GROUP																			KAPP TOSCANA GROUP																					
Lithostratigraphy 15.1.12/NPD Factpages						Kobbe Formation														Snadd Formation																					
Age	e-m.Anis				Ladinian								Early Carn					Carnian																						L.C	
Spores / depth of cores	3176 swc	3157 swc	3131 swc	3120 swc	3103 swc	3085 swc	3072 swc	3061 swc	3051.9 swc	3038 swc	3027 swc	3026 swc	3018 swc	2992 swc	2981.9 swc	2964 swc	2954 swc	2943 swc	2935 swc	2922.1 swc	2912 swc	2890 swc	2878 swc	2867 swc	2855 swc	2843 swc	2830 swc	2814.9 swc	2799.9 swc	2785 swc	2740 swc	2728 swc	2703 swc	2686 swc	2664.1 swc	2647.1 swc	2636 swc	2622 swc	2587.9 swc	2577 swc	2554 swc
Trilete spores	x							x					C				A											A	A		C							A			
Aratrisporites scabratus	C			A	A	A	A	A	A				A	A	C	x	A		A	C	x	C	A	C	A	A	A	A	A		x		x	x	x		x	C	x	C	x
Aratrisporites spp.	C		A		A				A								x									A	A	A	A		x	x	x	x	x		C	A		x	C
Aratrisporites fimbriatus	x		x	x	A	C	A	x	A	x							x									x	x	C									x		x		
Nevesisporites limulatus	x		x				x		x	x																							x								
Cyclotriletes spp.	A		x		x		A			x																		x													
Endosporites spp.	x		x				x																		x																
Punctatisporites spp.			x				x															x	x	x	x		x	C													
Densoisporites nejburgii			x																																						
Apiculatisporis spp.					x																	x			x		x	C													
Aratrisporites macrocavatus						x	x							x	C										x	x	C		C							x			x		
Kyrtomisporis speciosus							x																				x	A													
Uvaesporites reissingeri									x								x				x								x							x		x			
Anapiculatisporites spiniger										x									x	x	x						x				A						C	x	x	x	x
Stereisporites spp.																	x												x		C		x			x			x		x
Aratrisporites laevigatus																	x																								x
Aratrisporites fimbriatus																	x									x	x	C									x		x		C
Conbaculatisporites hopensis																			x	x		C	x	x			x	x	x												
Striatella seebergensis																				x						x	x	x					x		x	C		C	x	x	
Semiretisporis sp. A																							x		x	x	C	A	x												
Kraeuselisporites dentatus																							x				x		x						x	x			A	x	x
Patinasporites densus Leschik																							x	x				x	x									x	x		x
Patinasporites spp.																								x				x	x												
Densoisporites cavernatus																									x											x	x	x			
Densosporites spp.																									x	x		A	x									x			
Kyrtomisporis laevigatus																												x							x			x	x	x	
Limbosporites lundbladii																												x										x			
Convolutispora microfoveolata																												x													
Semiretisporis sp. A																													x												
Smooth trilete spore																															x					C					
Cingulizonates rhaeticus																																				x	x	x			x
Lycopodiacidites spp.																																						x			
Lundbladispora playfordi																																						x			
Lycopodiacidites rugulatus																																						x			
Thomsonisporites spp.																																									
Apiculatisporis ovalis																																									
Zebrasporites interscriptus																																									
Kyrtomisporis gracilis																																									
Stereisporites annulosus																																									
Conbaculatisporites mesozoicus																																									
Triancorasporites ancora																																									
Baculatisporites spp.																																									
Foveosporites spp.																																									
Microreticulatisporites fuscus																																									
Composite Assemblage Zone	A.spiniger				Echinitosp. iliacoides								Aulisporites astigmosus																											Rh.	

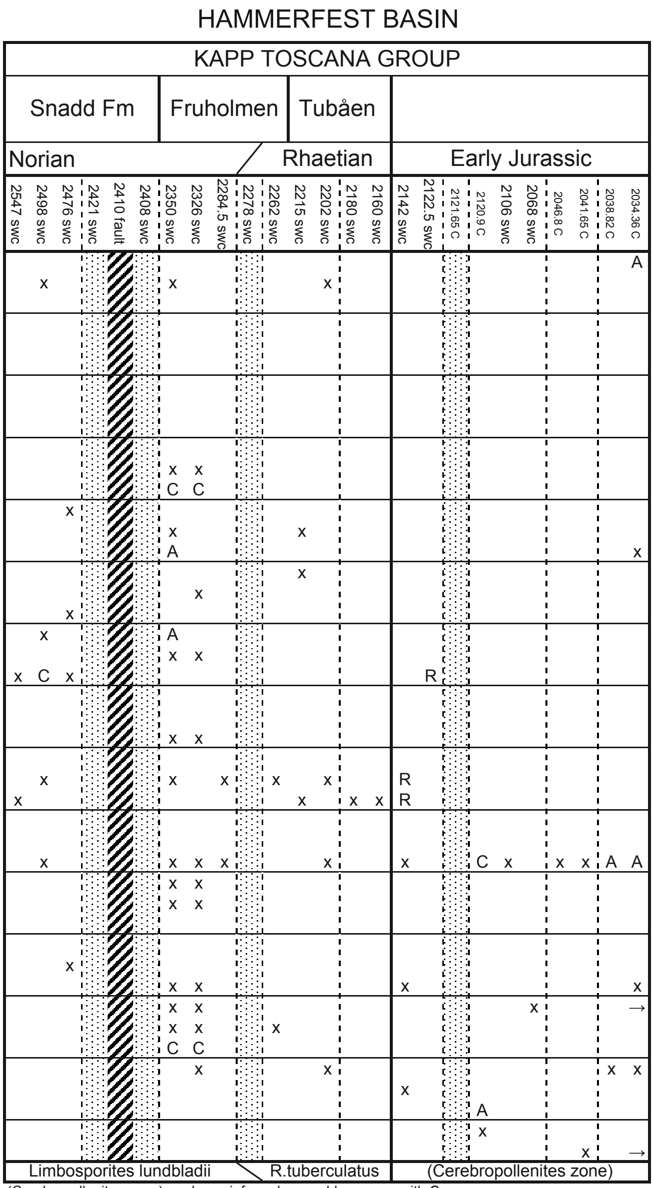
LEGEND

D	dominant
A	abundant
C	common
x	present
R	reworked
ca	caved
→	continues upwards
(dotted)	barren samples
(hatched)	interpreted fault zone
C	conventional core
swc	sidewall core

A.44.1.2 Well 7120/12-2, Sassendalen and Kapp Toscana groups, bases.

Interval 2513.5–2430.4 m sidewall core–2345 m cuttings sample, Rhaetian

Late Triassic palynomorphs dominate cuttings samples above 2430.4 m (2427 m–2410 m). The sidewall cores in the interval 2403–2369 m are palynologically almost barren. Most taxa occurring in this interval are also present in the underlying Norian interval. Common to abundant *R. tuberculatus* and *L. lundbladii*, together with *Cingulizonates rhaeticu*s, *Semiretisporis gothae* and *S. maljavkina* characterise the assemblages. The *Chasmatosporites* group dominates up to 2435 m. The youngest observation of common *Franconisporites laevigat*a is recorded in the 2495 m cuttings sample. The common *Sulcatisporites* spp. and *Corollina meyeriana* are interpreted as in situ, while *Cerebropollenites macroverrucosus* and *C. thiergartii* are considered as Jurassic markers that are caved into this interval.



(Cerebropollenites zone) marks an informal assemblage zone with *C. macroverrucosus*
It is recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

The association is identified as belonging to the *Ricciisporites tuberculatus* Composite Assemblage Zone. A Rhaetian age for the entire interval is based on the common occurrences of *L. lundbladii* (2513 m sidewall core) and *R. tuberculatus* (2458 m sidewall core), and the presence of *C. rhaeticu*s, *Eucommiidites microgranulatus* and *Rhaetipollis germanicus* in the 2410 m and 2385 m cuttings samples.

The Tubåen–Nordmela formations: 2342–2148 m (15.1.12/NPD Factpages)

Interval 2338–2251 m, Early Jurassic

Cerebropollenites thiergartii at 2338 m (sidewall core) and co-occurrence of common *C. thiergartii* with *C. macroverrucosus* and *Apiculatisporis ovalis* at 2274 m (sidewall core) represent the lowest stratigraphically reliable Early Jurassic evidence. Similar presence of abundant Triassic palynomorphs is seen also in the oldest Jurassic deposits on Svalbard (Table A.1.2) as well as in cored sample intervals of other exploration wells in the Barents Sea (A.32).

C.4 Well 7120/9–1

Well 7120/9–1 was drilled in the Snøhvit Field in the Hammerfest Basin. It was drilled to a TD of 2300 m in the Snadd Formation (15.1.12/NPD Factpages). The palynological results of this well are included due to the well-preserved and diverse assemblages allowing confident recognition of the two youngest Late Triassic composite assemblage zones. No range chart has been included.

Snadd Formation: 2300 TD–2173 m (15.1.12/NPD Factpages)

Interval 2300–2179.0 m, Norian

The interval from TD up to 2285 m is characterised by an association of dinoflagellate cysts including *Hebecysta* spp., *Heibergella* spp., *Noricysta* spp. and *Shublikodinium* spp. The spore-pollen association recorded up to 2210 m is dominated by the *Kyrtomisporis* group (*K. laevigatus* and *K. speciosus*), common to abundant *Protodiploxypinus* spp., *Aratrisporites* spp., *Chasmatosporites* spp., *C. magnolioides*, *Cingulizonates rhaeticu*s, *Densosporites cavernatus*, *Kraeuselisporites dentatus*, *Ovalipollis pseudoalatus* and *Striatella seebergensis*. The uppermost samples from this interval also include *Limbosporites lundbladii*. We assign the interval to the *Limbosporites lundbladii* Composite Assemblage Zone.

Fruholmen Formation: 2173–2077 m (15.1.12/NPD Factpages)

Interval 2170–2072 m, Rhaetian

From 2170 m to 2105 m there are regular to abundant *Aulisporites* sp. (2162 m) and *Enzonalasporites vigens*. The top of the interval is marked by the youngest record of abundant *Aratrisporites* spp., together with *Densoisporites cavernatus*, *Kyrtomisporis* spp. and *Protodiploxypinus* spp. and by the youngest records of *Semiretisporis gothae*, abundant *C. rhaeticus*, *L. lundbladii* and rare to abundant *Ricciisporites tuberculatus* (2079 m). This association resembles that of Well 7120/12–3 (see above) and is also assigned to the *Ricciisporites tuberculatus* Composite Assemblage Zone.

C.5 Well 7121/1–1R

Well 7121/1–1R was drilled on the Loppa High in the northern part of the Tromsøflaket area in the Hammerfest Basin. The well was drilled to a TD of 5000 m in Late Carboniferous sediments of the Ørn Formation (15.1.12/NPD Factpages). The range chart (Table A.46.1 and 2, Plates 29–30) is compiled from the palynological results for the Havert, Klappmyss, Kobbe and Snadd formations, only including conventional core samples.

Havert Formation: 2993–2786 m (15.1.12/NPD Factpages)

Interval 2791–2745 m, Induan (Griesbachian)

Spores dominate the association and the presence of

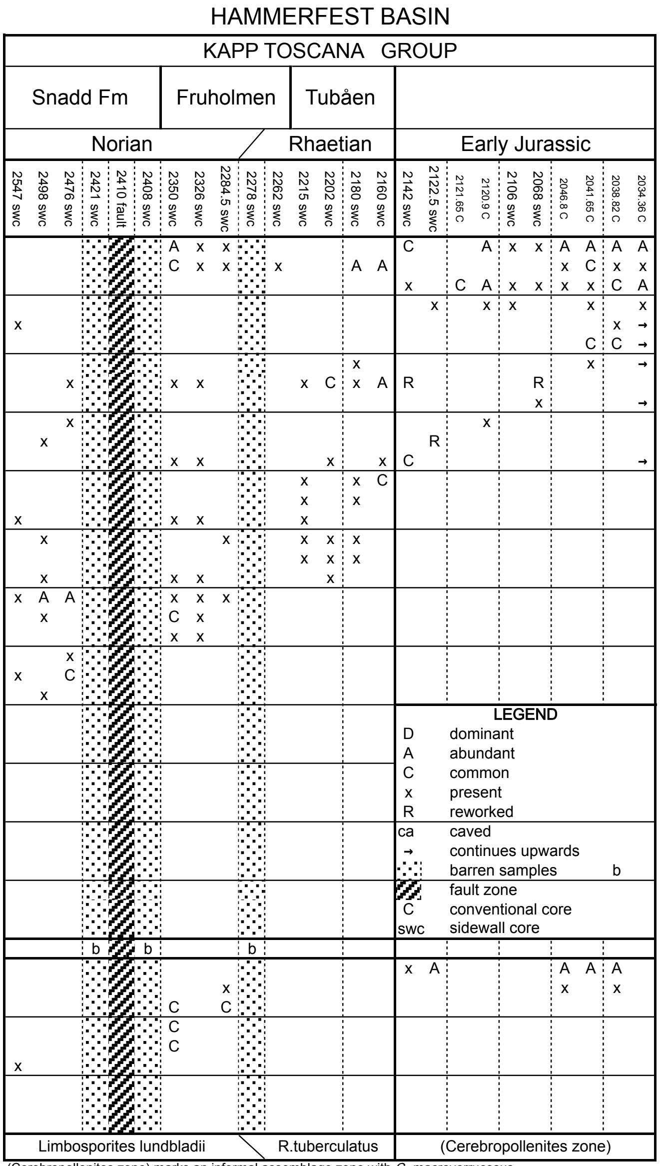
HAMMERFEST BASIN

Pollen / Depth of cores	3176 swc	3157 swc	3131 swc	3120 swc	3103 swc	3085 swc	3072 swc	3061 swc	3051.9 swc	3038 swc	3027 swc	3026 swc	3018 swc	2992 swc	2981.9 swc	2964 swc	2954 swc	2943 swc	2935 swc	2922.1 swc	2912 swc	2890 swc	2878 swc	2867 swc	2855 swc	2843 swc	2830 swc	2814.9 swc	2799.9 swc	2785 swc	2740 swc	2728 swc	2703 swc	2686 swc	2664.1 swc	2647.1 swc	2636 swc	2622 swc	2587.9 swc	2577 swc	2554 swc
WELL 7120/12-2	SASSENDALEN GROUP																			KAPP TOSCANA GROUP																					
Lithostratigraphy 15.1.12/NPD Factpages						Kobbe Formation														Snadd Formation																					
Age	e-m.Anis				Ladinian								Early Carn					Carnian																						L.C	
Bisaccate pollen (indeterminate)				x	A			x			A		A	A	A		A		A	A		A	A		A	A	A								A	A	x	A			
Chasmatosporites magnolioides										x							C												x		x	x				x	x		x	x	
Cerebropollenites thiergartii																																									
Cerebropollenites macroverrucosus																																									
Alisporites/Vesicaspora spp				A															x	A			x					x			x		C					x	A	A	x
Corollina meyeriana																																									x
Quadraeculina anellaeformis																																								x	
Ricciisporites tuberculatus											x																x														
Eucommiidites minor																	x														x									C	
Chasmatosporites sp. A																																						x		x	
Porcellispora longdonensis					x	x								x					x	x																	x				
Chasmatosporites apertus																										x	x								x	x		x	x	x	
Ricciisporites umbonatus																																									
Camerosporites pseudoverrucatus																																								x	
Rhaetipollis germanicus																																									
Striatoabieites spp.																																									
Granuloperculatipollis rudis																																									
Protodiploxypinus spp.																	x											x												x	x
Lunatisporites spp.	A			C		A	A						A	C	A	C	A		A	A	x	A	A	C	C	C	A	A				x	A	C	A	A	A	A	x	A	C
Ovalipollis pseudoalatus													x				x						x					A	x		x			x	x	x	A	C	C	x	C
Protodiploxypinus gracilis																x	C															x									x
Illinites chitonoides					x		x										A						x			x	x	x	x		x		x	x		C		x			
Institisporites crispus																	x											x													
Concetrisporites sp.																													x							x				x	x
Lunatisporites noviaulensis	x				A												x											x								x		x			x
Pollen abundance													A	A	A		A		A	A		A	A		A	A	A							C	A	A		A			
Vallasporites spp.																																						x			
Staurosaccites quadrifidus							x																					x													
Samaropollenites spp.																x			x	x								x													
Vitreisporites pallidus																										x		x													
Scutasporites spp.																											x														
Triadispora spp.					x		C				x									x																					
Echinitosporites iliacoides					x												x																								
Platysaccus spp.																	x																								
Infernopollenites spp.							x																																		
Lueckisporites spp.			x		x																																				
Plankton and varia		b							b			b						b												b											
Cuticle													A	C	A		A						C								C	x							C		
Botryococcus spp.																																									
Tasmanites spp.																															x										
Micrhystridium spp.																						A												x	x						x
Veryhachium spp.																																									
Veryhachium sp. 4-5 horns																	x		C															x	x					x	
Baltisphaeridium spp.																						A																	x	x	x
Indeterminate cysts																																					C			x	
Rhaetogonyaulax spp.																																								x	
Composite Assemblage Zone	A.spiniger				Echinitosp.iliacoides								Aulisporites astigmosus																											Rh.	

A.44.2.1 Well 7120/12-2, Sassendalen and Kapp Toscana groups, tops.

Reduviasporonites chalastus, *Densoisporites* spp. and *Lundbladispora obsoleta* allows assignment to the *Reduviasporonites chalastus* Composite Assemblage Zone.

Klappmyss Formation: 2786–2605 m (15.1.12/NPD Factpages)
Interval 2717–2627 m, Smithian
Spores dominate the assemblages, with abundant *Densoisporites nejburgii* together with an association of *Punctatisporites fungosus*, *Kraeuselisporites spinosus* and *Verrucosisporites* spp. characterising this interval. The presence of *Apiculatisporis lanjouwii*, *Cyclotriletes oligogranifer* and *Rewanispora foveolata* is recorded in its uppermost part. The association is assigned to the *Naumovaspora striata* Composite Assemblage Zone.



(Cerebropollenites zone) marks an informal assemblage zone with *C. macroverrucosus*
It is recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

Kobbe Formation: 2605 m–2210 m (15.1.12/NPD Factpages)
Interval 2606–2510 m, late Spathian
Only the upper of two samples from this interval contains stratigraphically significant material. The association includes *Accinctisporites circumdatus*, *Angustisulcites klausii*, *Illinites chitonoides*, *I. trivisus*, *Jerseyiaspora punctispinosa*, *Pechorosporites* spp., *Podosporites amicus*, *Proprisporites pocockii*, *Protodiploxypinus doubingeri*, *P. gracilis* and *Triadispora* spp. This association is assigned to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Interval 2405–2233 m, middle Anisian
Pollen dominate the assemblages of this interval, which is characterised by abundant bisaccate pollen and representatives of the *Aratrisporites* group, including the lowest records of *A. macrocavatus*. We note the oldest records of *Angustisulcites grandis*, *A. klausii*, *Araucariacites* spp. (contaminant?), *Concentrisporites pseudosulcatus*, *Cordaitina gunyalensis*, *Ephedripites* spp., *Eucommiidites minor*, *Inaperturopollenites nebulosus*, *Pretricolpipollenites* spp. and *Triadispora* spp. Spores include *Anapiculatisporites spiniger*, *Densoisporites nejburgii*, *Leschikisporis aduncus*, *Semiretisporis* sp. 'A' and *Neoraistrickia taylorii*. The interval is assigned to the *Triadispora obscura* Composite Assemblage Zone.

Level 2232 m, late Anisian
The presence of *Chasmatosporites* sp. A, *Podosporites* sp. A, *Retisulcites perforatus*, *Staurosaccites quadrifidus* and *Triadispora aurea* distinguishes this sample from the ones below. The association is interpreted as belonging to the *Protodiploxypinus decus* Composite Assemblage Zone, although the eponymous taxon has no record at this level.

Snadd Formation: 2210 m–792 m (15.1.12/NPD Factpages)
Interval 2123–1501 m, Ladinian
The base of the interval is marked by the earliest records of *Camerosporites secatus*, *Chasmatosporites magnolioides*, *Concentrisporites*, *Cordaitina minor*, *Echinitosporites iliacoides*, *I. chitonoides*, *Kyrtomisporis* spp., *Ovalipollis pseudoalatus*, *Protodiploxypinus microsaccus*, *Ricciisporites tuberculatus* and *Voltziaceaesporites heteromorpha*. The regular occurrence of *E. iliacoides* allows assignment to the *Echinitosporites iliacoides* Composite Assemblage Zone. The presence of *C. secatus* and *R. tuberculatus* suggests a latest Ladinian to early Carnian age, which is supported by the abundant *Leschikisporis aduncus* in the upper part of this interval.

Interval 1464–937.5 m, early to middle Carnian
The rich assemblages include abundant *L. aduncus* and diverse smooth trilete spores. Further, we note the presence of *Angustisulcites klausii*, *Aratrisporites macrocavatus*, *C. magnolioides*, *I. chitonoides*, *E. iliacoides* (at 1464 m), *Kraeuselisporites* sp. A, *Kyrtomisporis* spp. (diverse),

Podosporites amicus, *Protodiploxypinus* spp. (diverse), *Retisulcites* spp., *Schizaeoisporites worsleyi*, *Striatoabieites* spp., *Triadispora labichensis*, *T. verrucata* and *Voltziaceaesporites heteromorpha*. Regular to abundant *Botryococcus* spp. reflect fresh to brackish water conditions. The palynological association is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

Compared to the section below, the assemblages highest in this interval (Table A.46, 1025–937.5 m) are of lower diversity. They are distinguished by the presence of *Porcellispora longdonensis* and *E. iliacoides* (at 1025 m) and include acritarchs and the algae *Cymatiosphaera* spp., *Dictyotidium* spp. and *Plaesiodictyon* spp. The association reflects a stronger marine influence as well as continued freshwater influx. Similar records are known from the Skuld Formation on Bjørnøya (Table A.25) and from the De Geerdalen and Snadd formations in stratigraphic cores from the Barents Sea (Tables A.40, A.42, A.43).

Sample 920 m, possibly Norian

A single core sample at 920 m includes some of the pollen and spores present in the underlying deposits. There is no clear biostratigraphic evidence for the age of this assemblage. Marine plankton comprise *Dictyotidium* spp., *Micrhystridium* spp. and the fresh/brackish water plankton groups *Botryococcus* and *Plaesiodictyon* spp.

HAMMERFEST BASIN

WELL 7120/12-2	SASSENDALEN GROUP																		KAPP TOSCANA GROUP																						
Lithostratigraphy 15.1.12/NPD Factpages						Kobbe Formation													Snadd Formation																						
Age	e-m.Anis				Ladinian								Early Carn					Carnian																						L.C	
Spores / depth of cores	3176 swc	3157 swc	3131 swc	3120 swc	3103 swc	3085 swc	3072 swc	3061 swc	3051.9 swc	3038 swc	3027 swc	3026 swc	3018 swc	2992 swc	2981.9 swc	2964 swc	2954 swc	2943 swc	2935 swc	2922.1 swc	2912 swc	2890 swc	2878 swc	2867 swc	2855 swc	2843 swc	2830 swc	2814.9 swc	2799.9 swc	2785 swc	2740 swc	2728 swc	2703 swc	2686 swc	2664.1 swc	2647.1 swc	2636 swc	2622 swc	2587.9 swc	2577 swc	2554 swc
Trilete spores	x							x					C				A											A	A		C							A			
Stereisporites spp.																	x												x		C		x			x			x		x
Smooth trilete spores																															x					C					
Apiculatisporis ovalis																																									
Conbaculatisporites mesozoicus																																									
Microreticulatisporites fuscus																																									
Zebrasporites interscriptus																																									
Baculatisporites spp.																																									
Foveosporites spp.																																									
Kraeuselisporites dentatus																							x				x		x						x	x			A	x	x
Kyrtomisporis laevigatus																												x							x			x	x	x	
Limbosporites lundbladii																												x										x			
Triancorasporites ancora																																									
Aratrisporites scabratus	C			A	A	A	A	A	A				A	A	C	x	A		A	C	x	C	A	C	A	A	A	A	A		x		x	x	x		x	C	x	C	x
Anapiculatisporites spiniger										x									x	x	x						x				A						C	x	x	x	x
Aratrisporites laevigatus																	x																								x
Kyrtomisporis gracilis																																									
Aratrisporites macrocavatus						x	x							x	C										x	x	C		C							x			x		
Kyrtomisporis speciosus							x																				x	A													
Aratrisporites fimbriatus																	x									x	x	C									x		x		C
Semiretisporis sp. A																							x		x	x	C	A	x												
Densoisporites cavernatus																									x											x	x	x			
Cingulizonates rhaeticus																																				x	x	x			x
Lycopodiacidites spp.																																						x			
Stereisporites annulosus																																									
Striatella seebergensis																				x						x	x	x					x		x	C		C	x	x	
Uvaesporites reissingeri									x								x				x								x							x		x			
Conbaculatisporites hopensis																			x	x		C	x	x			x	x	x												
Thomsonisporites spp.																																									
Aratrisporites spp.	C		A		A				A								x									A	A	A	A		x	x	x	x	x		C	A		x	C
Patinasporites densus Leschik																							x	x				x	x									x	x		x
Aratrisporites fimbriatus	x		x	x	A	C	A	x	A	x							x									x	x	C									x		x		
Densosporites spp.																									x	x		A	x									x			
Lundbladispora playfordi																																						x			
Lycopodiacidites rugulatus																																						x			
Nevesisporites limulatus	x		x				x		x	x																							x								
Patinasporites spp.																								x				x	x												
Semiretisporis sp. A																													x												
Cyclotriletes spp.	A		x		x		A			x																		x													
Punctatisporites spp.			x				x															x	x	x	x		x	C													
Apiculatisporis spp.					x																	x			x		x	C													
Convolutispora microfoveolata																												x													
Endosporites spp.	x		x				x																		x																
Densoisporites nejburgii			x																																						
Composite Assemblage Zone	A.spiniger				Echinitosp.iliacoides								Aulisporites astigmosus																											Rh.	

A.44.2.2 Well 7120/12-2, Sassendalen and Kapp Toscana groups, tops.

C.6 Well 7124/3–1

Well 7124/3–1 is located east of the Hammerfest Basin in the Nyslepp Fault Complex on the Bjarmeland Platform. It was drilled to a TD of 4730 m into rocks of Carboniferous age (15.1.12/NPD Factpages). It may be noted that this well represents the type section of the Upper Permian Ørret Formation. The palynological range chart covering the Havert, Klappmyss, Kobbe and Snadd formations presents only results from productive samples of conventional and sidewall cores (Table A.47.1 and 2).

Havert and Klappmyss formations: 3475–2334 m
According to the NPD Factpages (15.1.12/), the interval comprises the Havert Formation, 3475–2671 m, overlain by the Klappmyss Formation between 2671 and 2334 m. However, as we record a Griesbachian to early Spathian age for the interval 3475–2671 m, we question this lithostratigraphic breakdown.

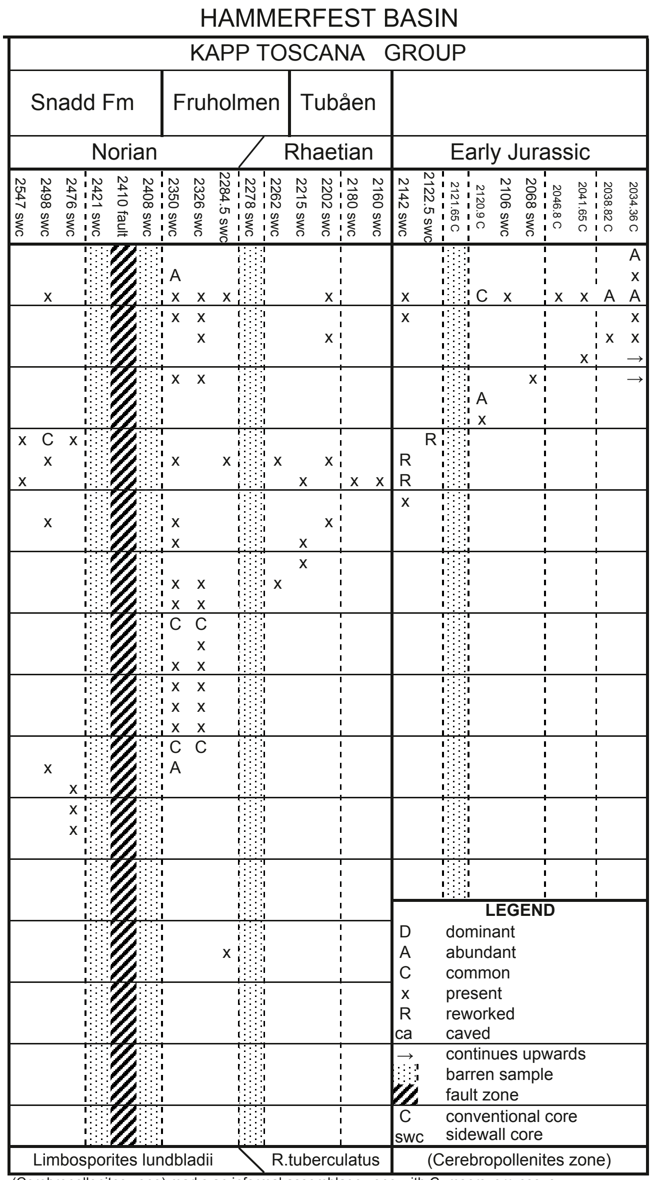
Interval 3489–3297 m, Griesbachian
The palynological productivity is low in the lowermost interval (3489–3477 m), but the presence of *Rewanispora foveolata*, *Densoisporites nejburgii* and *Reduviasporonites chalastus* allows recognition of the *Reduviasporonites chalastus* Composite Assemblage Zone. The even less productive layers above are tentatively assigned to the *Proprisporites pocockii* Composite Assemblage Zone.

Interval 3262–3072 m, Smithian
Assemblages of this interval show more diverse spores, common to abundant *Densoisporites* spp., *D. nejburgii*, *D. playfordi*, *Lundbladispora* spp., *Punctatisporites* spp. and *P. fungosus*, together with *Triadispora labichensis* and 'Fungal remain type 1' of Hochuli et al. (1989). The association allows recognition of the *Naumovaspora striata* Composite Assemblage Zone.

Interval 3060 m–2671 m, early Spathian
Spores dominate the association and their diversity increases throughout this interval. Besides the earliest appearances of *Gordonispora fossulata*, *Kraeuselisporites* spp., *Pechorosporites* spp., *P. disertus* and *Proprisporites* spp., abundant *Densoisporites complicatus*, *D. nejburgii*, *D. playfordi* and *Lundbladispora* spp. allow assignment to the *Pechorosporites disertus* Composite Assemblage Zone.

Klappmyss Formation: 2671 m–2334 m (15.1.12/NPD Factpages)
Interval 2661–2385 m, late Spathian to early Anisian
The dominant and diverse spores in this interval include various *Aratrisporites* spp., *Gordonispora lubrica*, *Jerseyiaspora punctispinosa* (2635 m), *Striatella seebergensis* (2415 m) and other ornamented spores. Pollen increase in diversity and show the first records of *Crustaesporites globosus*, *Lunatisporites acutus*, *L. pellucidus*, *Pretricolpipollenites* spp., the *Protohaploxypinus* and *Striatoabieites* groups and higher records of *Angustisulcites klausii* (2564 m), *Lueckisporites junior* (2511 m), *Striatoabieites balmei* (2425 m), *Cordaitina minor* (2415 m) and *Illinites chitonoides* (2385 m). The association is assigned to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Lowermost in the formation, the presence of *Reduviasporonites chalastus*, appearing together with the first evidence of a late Spathian age is considered reworked (Table 47, sample level 2671 m). It is worth noticing that corresponding evidence of *R. chalastus* occurs in the lowest Smithian deposits at Bravaisberget, Svalbard.



(Cerebropollenites zone) marks an informal assemblage zone with *C. macroverrucosus*
It is recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

HAMMERFEST BASIN

Pollen / Depth of cores and cuttings	2523 swc	2523 cu	2522 cu	2513.5 swc	2510 cu	2505.5 swc	2495 cu	2483 swc	2458 swc	2435 cu	2430.4 swc	2427 cu	2425 cu	2420 cu	2410 cu	2403 swc	2395 cu	2385 cu	2369 swc	2355 cu	2345 cu	2338 swc	2317 cu	2300 cu	2274 swc	2255 cu	2251 swc
WELL 7120/12-3 cores and cuttings	KAPP TOSCANA GROUP																										
Lithostratigraphy 15.1.12/NPD Factpages	Fruholmen Formation																					Tubåen Fm					
Age	Norian			Rhaetian																		E. Jurassic					
Bisaccate pollen	x	C		C	x	C		C	x			x	x	x	A		C	C		C	C	x	A	A	A	C	C
Chasmatosporites apertus	A	A	A	A	A	x	C		x	C							C						x	x	x	x	x
Chasmatosporites magnolioides	A	A	A	A	A	x	C		x	C							C						x	x	x	x	x
Ovalipollis pseudoalatus	x		C						x																		
Porcellispora longdonensis		x					x		x				x		x												
Protodiploxypinus ornatus		x	x	x		x	x		x	x			x	x													
Enzonalasporites vigens		x								x		x															
Granuloperculatipollis operculatus		ca					x																				
Duplicisporites spp.		x																									
Enzonalasporites spp.		x																									
Quadraeculina anellaeformis			x																					x	x		
Rhaetipollis germanicus			ca										x	x			x	x									
Ricciisporites tuberculatus			x	x			A	x	A	x		C	C	A	x												
Eucommiidites microgranulatus				x			x			x				x	x		x										
Aulisporites astigmosus				x	C	x	C		x																		
Franconisporites laevigata				x	C	x	C		x																		
Accinctisporites spp.				C																							
Classopollis harrisii							x																				
Cerebropollenites thiergartii								ca						ca				ca		ca		x	x	A	C	C	x
Cerebropollenites macroverrucosus															ca		ca	ca			ca		x	x	x		x
Alisporites spp.																	C			x	x		x		C		x
Corollina meyeriana																	C	x					x				
Vitreisporites pallidus																									x		
Spores																											
Smooth trilete spore	C	C	C						A		x			C			x				C		C	C	C	C	C
Cingulizonates rhaeticus	x	A	A	x	A		C	C	x	x		A	x	C	x		x	x									
Camerozonosporites spp.	x	x	C	C	x	C	C	x	A	x			x														
Kyrtomisporis laevigatus	x	x	A	A	A	C		x	x	x																	
Camerosporites secatus	x						x		x																		
Annulispora folliculosa	x	x		x	x																						
Kyrtomisporis gracilis	x	x	x	x	x																						
Aratrisporites macrocavatus	x	x	x	x																							
Leptolepidites spp.	x																										
Deltoidospora australis		A	A	x	x																			x			x
Spore abundance		A		A	A	C			A			A	A	A				x		x	x	x	x	C	C	C	C
Limbosporites lundbladii		x	x	C	A	A	A		A	A		C	C	C	x												
Densosporites foveocingulatus		x						C				x	x	x													
Acanthotriletes varispinosus		x		x					x	x															x		
Anapiculatisporites spiniger		x	x				x		x																		
Kyrtomisporis speciosus		x	C	C	x		x																				
Striatella seebergensis			x				x									x									x		
Ceratosporites spp.			ca						C																		
Aratrisporites scabratus			x	x	x			x																			
Striatella spp.			x				x									x									x		
Convolutispora microrugulata				C			x	x	A	C		x	C	x	x												
Densosporites irregulatus				x			x	x	x	x				x													
Semiretisporis gothae				x	x								x	x													
Foveotriletes spp.				x			x		x																		
Zebrasporites interscriptus				x	x																						
Podocarpidites rousei				x																							
Densosporites fissus					C		x			x				x													
Lycopodiacidites rugulatus						x							x	x							ca			x		x	x
Semiretisporis maljavkinae							x						x	x													
Kraeuselisporites reissingeri							x																				
Convolutispora klukiforma								x	x				C														
Stereisporites spp.									x												x			C	x		
Camarozonosporites laevigatus									x																		
Zebrasporites laevigatus												x	x														
Densosporites spp.												x															
Lycopodiumsporites austroclavatidites														ca			ca	ca						x	x		x
Apiculatisporis ovalis																					ca				C	x	
Densoisporites velatus																											x
Plankton and varia																											
Lining of foraminifera		C	C	x	C	A			A																		
Micrhystridium spp.			x	x	x	x			C																x		
Veryhachium spp.			x	x	x	x			C																x		
Botryococcus spp.														x		x	x					x				x	
Triassic evidence																A	C	C	C		A	C	x	x		C	C
Composite assemblage zone	L.lundbl.			Ricciisporites tuberculatus																		(Cerebropollen. z)					

LEGEND

D	dominant
A	abundant
C	common
x	present
R	reworked
ca	caved
cu	cuttings
swc	sidewall core

(Cerebropollen. z) marks an informal assemblage zone with *Cerebropollenites macroverrucosus* recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

A.45.1 Well 7120/12-3, Kapp Toscana Group, bases.

HAMMERFEST BASIN

WELL 7120/12-3 cores and cuttings	KAPP TOSCANA GROUP																										
Lithostratigraphy 15.1.12/NPD Factpages	Fruholmen Formation																					Tubåen Fm					
Age	Norian			Rhaetian																		E. Jurassic					
Pollen / Depth of cores and cuttings	2523 swc	2523 cu	2522 cu	2513.5 swc	2510 cu	2505.5 swc	2495 cu	2483 swc	2458 swc	2435 cu	2430.4 swc	2427 cu	2425 cu	2420 cu	2410 cu	2403 swc	2395 cu	2385 cu	2369 swc	2355 cu	2345 cu	2338 swc	2317 cu	2300 cu	2274 swc	2255 cu	2251 swc
Chasmatosporites apertus	A	A	A	A	A	x	C		x	C							C						x	x	x	x	x
Chasmatosporites magnolioides	A	A	A	A	A	x	C		x	C							C						x	x	x	x	x
Undifferentiated bisaccate pollen		C		C	x	C		C	x			x	x	x	A		C	C		C	C	x	A	A	A	C	C
Cerebropollenites thiergartii														ca				ca		ca		x	x	A	C	C	x
Cerebropollenites macroverrucosus															ca		ca	ca			ca		x	x	x		x
Alisporites spp.																	C			x	x		x		C		x
Quadraeculina anellaeformis			x																					x	x		
Vitreisporites pallidus																									x		
Corollina meyeriana																	C	x					x				
Rhaetipollis germanicus			ca										x	x			x	x									
Eucommiidites microgranulatus				x			x			x				x	x		x										
Porcellispora longdonensis		x					x		x				x		x												
Ricciisporites tuberculatus			x	x			A	x	A	x		C	C	A	x												
Protodiploxypinus ornatus		x	x	x		x	x		x	x			x	x													
Enzonalasporites vigens		x								x		x															
Ovalipollis pseudoalatus	x		C						x																		
Aulisporites astigmosus				x	C	x	C		x																		
Franconisporites laevigata				x	C	x	C		x																		
Granuloperculatipollis operculatus		ca					x																				
Classopollis harrisii							x																				
Accinctisporites spp.				C																							
Duplicisporites spp.		x																									
Enzonalasporites spp.		x																									
Spores																											
Smooth trilete spore	C	C	C						A		x			C			x				C		C	C	C	C	C
Deltoidospora australis		A	A	x	x																			x			x
Spore abundance		A		A	A	C			A			A	A	A				x		x	x	x	x	C	C	C	C
Lycopodiacidites rugulatus						x							x	x							x			x		x	x
Lycopodiumsporites austroclavatidites														ca			ca	ca						x	x		x
Densoisporites velatus																											x
Apiculatisporis ovalis																					ca				C	x	
Acanthotriletes varispinosus		x		x					x	x															x		
Striatella spp.			x				x									x									x		
Stereisporites spp.									x												x			C	x		
Striatella seebergensis																x									x		
Cingulizonates rhaeticus	x	A	A	x	A		x	C	x	x		A	x	C	x		x	x									
Limbosporites lundbladii		x	x	C	A	A	A		A	A		C	C	C	x												
Convolutispora microrugulata				C			x	x	A	C		x	C	x	x												
Densosporites foveocingulatus		x						C				x	x	x													
Densosporites irregulatus				x			x	x	x	x				x													
Semiretisporis gothae				x	x								x	x													
Densosporites fissus					C		x			x				x													
Semiretisporis maljavkinae							x						x	x													
Camerozonosporites spp.	x	x	C	C	x	C	C	x	A	x			x														
Convolutispora klukiforma								x	x				C														
Zebrasporites laevigatus												x	x														
Densosporites spp.												x															
Kyrtomisporis laevigatus	x	x	A	A	A	C		x	x	x																	
Camerosporites secatus	x						x		x																		
Anapiculatisporites spiniger		x	x				x		x																		
Ceratosporites spp.			x						C																		
Foveotriletes spp.				x			x		x																		
Camarozonosporites laevigatus									x																		
Aratrisporites scabratus			x	x	x			x																			
Kyrtomisporis speciosus		x	C	C	x		x																				
Kraeuselisporites reissingeri							x																				
Annulispora folliculosa	x	x		x	x																						
Kyrtomisporis gracilis	x	x	x	x	x																						
Zebrasporites interscriptus				x	x																						
Aratrisporites macrocavatus	x	x	x	x																							
Podocarpidites rousei				x																							
Leptolepidites spp.	x																										
Plankton and varia																											
Triassic evidence																A	C	C	C		A	C	x	x		C	C
Botryococcus spp.														x		x	x					x				x	
Micrhystridium spp.			x	x	x	x			C																x		
Veryhachium spp.			x	x	x	x			C																x		
Lining of foraminifera		C	C	x	C	A			A																		
Composite assemblage zone	L.lundbl.			Ricciisporites tuberculatus																		(Cerebropollen. z)					

LEGEND

D	dominant
A	abundant
C	common
x	present
R	reworked
ca	caved
cu	cuttings
swc	sidewall core

(Cerebropollen. z) marks an informal assemblage zone with *Cerebropollenites macroverrucosus* recorded in Sinemurian and Pliensbachian deposits (Lund 1977)

A.45.2 Well 7120/12-3, Kapp Toscana Group, tops.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7121/1-1 R	SASSENDALEN GROUP										KAPP TOSCANA GROUP																	
Lithostratigraphy 15.1.12/NPD Factpage	Hav		Klapp.Fm.			Kobbe Fm.					Snadd Formation																	
Age	P/T		TRIASSIC																									
	Induan		Olenekian					Anisian			late Ladinian							ely to mid Carn					Carnian				N	
	Grie		Smith			Spath-Anisian																						
							l. S	m. Anis		l.An																		
Pollen / Depth of core samples	2791C	2745 C	2717 C	2684 C	2627 C	2606 C	2510 C	2405 C	2333 C	2232 C	2123 C	1963 C	1942.5C	1924 C	1855 C	1726 C	1501 C	1463.5C	1373 C	1276 C	1249.5C	1164 C	1143 C	1063 C	1025 C	937.5 C	920.0 C	→
Bisaccate indeterminate pollen		x	x		x	x	A	A		A	x			A	A	A												
Illinites spp.					x	x	x																					
Cycadopites nitidus							x	x			x	x	x	x	x	x	x	x	x		x	x			x	x	x	→
Illinites chitonoides							x	x	x	x	x		x	x	x	x	x	x					x		x	x	x	→
Infernopollenites spp.							x		x		x	x	x	x	x			x		x	x	x			x	x	x	→
Lunatisporites noviaulensis							x	x		x	x			x	x	x						x				x	x	→
Podosporites amicus							x	x	x	x							x	x	x	x	x	x			x	x	x	→
Protodiploxypinus doubingeri							x	A	x	x	x	x	x	x	x	x										x	x	→
Protodiploxypinus gracilis							x								x	x						x			x	x	x	→
Striatoabieites balmei							x			x	x	A	x	x	x			x				x			x		x	→
Vitreisporites pallidus							x	x		x	x			x	x	x	x	x				x	x		x		x	→
Striatoabieites spp.							x		x	x			x	x	x			x							x			
Bharadwajispora labichensis							x	x	x	x	x	x	x	x											x			
Accinctisporites circumdatus							x				x	x			x	x				x		x						
Angustisulcites klausii							x		x	x			x			x			x		x							
Illinites trivisus							x	x		x				x	x	x	x											
Lunatisporites pellucidus							x	x				x	x	x	x	x												
Striatoabieites multistriatus							x									x												
Angustisulcites grandis							x																					
Araucariacites spp.								C	A	A	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	→
Concentrisporites pseudosulcatus								x	A	A	x		x	x	x	x	x	x	x		x	x			x		x	→
Eucommiidites minor								x		x		x		x	x	x	x	x	x	x	x	x			x	x	x	→
Triadispora obscura								x	x	x	x	x		x	x	x	x			x	x	x			x	x		
Inaperturopollenites nebulosus								x											x	x					x			
Pretricolpipollenites spp.								x								x												
Protohaploxypinus spp.									x		x		x		x	x	x	A		x						x		
Triadispora plicata									x				x		x		x				x	x				x		
Ephedripites spp.									x					x	x	x												
Cordaitina gunyalensis									x																			
Chasmatosporites sp. A										x	x	x	x	x		x		x	x	x	x	x			x	x	x	→
Staurosaccites quadrifidus										x	x	x		x	x	x		x		x	x					x	x	→
Triadispora aurea										x				x	x			x							x			
Lunatisporites acutus										x	x							x				x						
Retisulcites perforatus										x				x	x	x	x	x										
Podosporites sp. A										x							x											
Chasmatosporites magnolioides											x		x						x	x	x	x			x	x	x	→
Cordaitina minor											x	x			x		x									x	x	→
Ovalipollis pseudoalatus											x	x	x	x	x	x	x	x	x	x	A	A	x	x	A	x	x	→
Ricciisporites tuberculatus											x	x		x	x	x											x	→
Triadispora spp.											x		x	x	x			x		x	x	A			A	x	x	→
Echinitosporites iliacoides											x	x		x		x	x	x							x			
Ricciisporites spp.											x	x	x		x	x	x					x			x			
Triadispora verrucata											x		x	x	x		x					x			x			
Alisporites spp.											x	x	x		x	x	x	x		x								
Concentrisporites hallei											x	x	x															
Concentrisporites spp.											x	x																
Protodiploxypinus microsaccus											x																	
Schizaeoisporites worsleyi												x				x						x			x			
Protodiploxypinus ornatus													x		x										x	x	x	→
Retisulcites sp. 1													x	x		x	x					x			x			
Protodiploxypinus minor														x	x		x					x			x	x	x	→
Voltziaceaesporites heteromorpha														x	x	x	x	x			x	x			x	x	x	→
Chasmatosporites apertus														x							x							
Eucommiidites microgranulatus																x			x			x						
Protodiploxypinus sivaki																				x	x	x						
Podosporites spp.																						x				x	x	→
Protodiploxypinus decus																						x				x	x	→
Haberkornia gudati																						x						
Kuglerina meieri																						x						
Porcellispora longdonensis																										x	x	→
Plankton and varia																												
Reduviasporonites chalastus	x	x																										
Micrhystridium spp.							A	A	A	A	x	x	x										x		x	x	x	
Cymatiosphaera spp.								A			x	C	x				x								x			
Tasmanites spp.								C															x		x			
Veryhachium spp.								A					x												x			
Veryhachium sp. (large specimens)								A	A	A			x															
Plaesiodictyon moesellanum										x	C	C	x			x										x	x	→
Dictyotidium tenuiornatum											x	x	x												A	x	x	→
Botryococcus spp.													x		x			x			x	A			x			
Fungal remain																									x	x	x	→
Grebespora concentrica																									x			
Composite Assemblage Zone	R.cha.		N.striata				J.p	T.obscu		P.d	Echinitopollenites iliacoides							Aulisporites astigmosus									indet.	

LEGEND
D dominant
A abundant
C common
x present
→ continues upw.

A.46.1.1 Well 7121/1-1R, Sassendalen and Kapp Toscana groups, bases.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7121/1-1 R	SASSENDALEN GROUP										KAPP TOSCANA GROUP																	
Lithostratigraphy 15.1.12/NPD Factpage	Hav		Klapp.Fm.			Kobbe Fm.					Snadd Formation																	
Age	P/T		TRIASSIC																									
	Induan		Olenekian					Anisian			late Ladinian							ely to mid Carn					Carnian				N	
	Grie		Smith			Spath-Anisian																						
							I. S	m. Anis		I.An																		
Spores / Depth of core samples	2791C	2745 C	2717 C	2684 C	2627 C	2606 C	2510 C	2405 C	2333 C	2232 C	2123 C	1963 C	1942.5C	1924 C	1855 C	1726 C	1501 C	1463.5 C	1373 C	1276 C	1249.5C	1164 C	1143 C	1063 C	1025 C	937.5 C	920.0 C	→
Punctatisporites fungosus	x	x		x	A		x			x																		
Lundbladispora obsoleta		x		x			x																					
Densoisporites spp.		x	x	x	x																							
Kraeuselisporites spp.			x				x			x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	→
Verrucosisporites spp.			x	x	x		x	x						x			x											
Densoisporites nejburgii			A	x	x	x	x	x																				
Kraeuselisporites spinosus			x		x																							
Cyclotriletes oligogranifer					x				x	x						x	x											
Lundbladispora spp.					x		x																					
Apiculatisporis lanjouwii					x																							
Rewanispora foveolata					x																							
Calamospora spp.							x			x	x			x	x	x				x	x	x			x	x	x	→
Conbaculatisporites hopensis							x			x	x	x		x		x	x	x			x				x	x	x	→
Deltoidospora australis							x								x	x		x					x			x	x	→
Deltoidospora minor							x	x	x	x	x	x	x		x	C	C	x	x	x	x	x	A		x	x	x	→
Kraeuselisporites dentatus							x					x	x	x	x	x	x	x	x	x	x	x				x	x	→
Lycopodiacidites kuepperi							x	x		x			x	x			x		x		x					x	x	→
Lycopodiacidites spp.							x	x		x			x	x			x		x		x					x	x	→
Smooth, indeterminate miospores							x	x	x	x	x	x	x		x	x	C	x	x	x	x	x	A		x	x	x	→
Striatella seebergensis							x	x	x	x	x	A	x	x	x	x	x	x		x	x	x	x		x	x	x	→
Uvaesporites argentaeformis							x			x			x	x			x						x				x	→
Aratrisporites spp.							x	C	x	x	x	x	x	x		x		x		x					x			
Gordonispora lubrica							x							x		x									x			
Cyclotriletes pustulatus							x		x					x	x		x	x			x	x						
Retusotriletes hercynicus							x			x				x								x						
Verrucosisporites morulae							x								x													
Jerseyiaspora punctispinosa							x		x																			
Raistrickia spp.							x	x																				
Cycloverrutriletes presselensis							x																					
Densoisporites playfordi							x																					
Pechorosporites spp.							x																					
Proprisporites pocockii							x																					
Aratrisporites macrocavatus								C	x	x	x	x	x	x	x	x		x		x	x				x	x	x	→
Anapiculatisporites spiniger									x	x	x	x			x	x					x	x			x	x	x	→
Aratrisporites scabratus									x	x	x				x	x	x								x		x	→
Conbaculatisporites spp.									x	x					x	x									x	x	x	→
Leschikisporis aduncus									x	x	x	x	x	A	C	C	C	A	A	A	A	x	A		A	A	x	→
Semiretisporis "barentzii"									x		x	x	x	x		x	x	x								x	x	→
Punctatisporites spp.									x	x			x			x			x						x			
Perotrilites spp.									x	x												x						
Verrucosisporites sp. 1 (coarse bacula)									x		x		x	x	x		x			x	x							
Neoraistrickia taylorii									x									x										
Baculatisporites spp.										x	x								x	x	x							
Aratrisporites tenuispinosus											x		x	x	x		x									x	x	→
Dictyophyllidites mortoni											x		x	x	x	x	x	x	x	x	x	x			x	C	x	→
Kyrtomisporis spp.											x	x	x	x				x		x	x	x	x		x	x	x	→
Auritulinasporites triclavis											x		x	x	x	x	x	x	x	x	x	x	x	x				
Deltoidospora juncta											x		x	x	x	x	x	x	x	x	x	x	x	x				
Camerosporites secatus											x					x												
Aratrisporites palettae											x		x															
Zebrasporites interscriptus												x		x												x	x	→
Zebrasporites laevigatus												x		x												x	x	→
Cingulizonates rhaeticus													x	x					x		x	x				x	x	→
Velosporites spp.													x													x	x	→
Thomsonisporites undulatus													x				x					x						
Camarozonosporites laevigatus													x						x	x								
Polypodiisporites spp.														x	x	x	x		x		x	x			x	x	x	→
Stereisporites spp.															x	x												
Staplinisporites caminus																		x			x	x						
Eresinia spinellata																						x						
Gleicheniidites senonicus																						x			x	x	x	→
Aulisporites astigmosus																							x					
Composite Assemblage Zone	R.cha.		N.striata				J.p	T.obscu		P.d	Echinito. iliacoides							Aulisporites astigmosus									indet.	

LEGEND
- D dominant
- A abundant
- C common
- x present
- → continues upw.

A.46.1.2 Well 7121/1-1R, Sassendalen and Kapp Toscana groups, bases.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7121/1-1 R	SASSENDALEN GROUP										KAPP TOSCANA GROUP																	
Lithostratigraphy 15.1.12/NPD Factpage	Hav		Klapp.Fm.			Kobbe Fm.					Snadd Formation																	
Age	P/T		TRIASSIC																									
	Induan		Olenekian					Anisian			late Ladinian							ely to mid Carn					Carnian				N	
	Grie		Smith			Spath-Anisian																						
							l. S	m. Anis		l.An																		
Pollen / Depth of core samples	2791C	2745 C	2717 C	2684 C	2627 C	2606 C	2510 C	2405 C	2333 C	2232 C	2123 C	1963 C	1942.5C	1924 C	1855 C	1726 C	1501 C	1463.5C	1373 C	1276 C	1249.5C	1164 C	1143 C	1063 C	1025 C	937.5C	920.0C	→
Cycadopites nitidus							x	x			x	x	x	x	x	x	x	x	x		x	x			x	x	x	→
Illinites chitonoides							x	x	x	x	x		x	x	x	x	x	x					x		x	x	x	→
Infernopollenites spp.							x		x		x	x	x	x	x			x		x	x	x			x	x	x	→
Lunatisporites noviaulensis							x	x		x	x			x	x	x						x				x	x	→
Podosporites amicus							x	x	x	x							x	x	x	x	x	x			x	x	x	→
Protodiploxypinus doubingeri							x	A	x	x	x	x	x	x	x	x										x	x	→
Protodiploxypinus gracilis							x								x	x						x			x	x	x	→
Striatoabieites balmei							x			x	x	A	x	x	x			x				x			x		x	→
Vitreisporites pallidus							x	x		x	x			x	x	x	x	x				x	x		x		x	→
Araucariacites spp.								C	A	A	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	→
Concentrisporites pseudosulcatus								x	A	A	x		x	x	x	x	x	x	x		x	x			x		x	→
Eucommiidites minor								x		x		x		x	x	x	x	x	x	x	x	x			x	x	x	→
Chasmatosporites sp. A										x	x	x	x	x		x		x	x	x	x	x			x	x	x	→
Staurosaccites quadrifidus										x	x	x		x	x	x		x		x	x					x	x	→
Chasmatosporites magnolioides											x		x						x	x	x	x			x	x	x	→
Cordaitina minor											x	x			x		x									x	x	→
Ovalipollis pseudoalatus											x	x	x	x	x	x	x	x	x	x	A	A	x	x	A	x	x	→
Ricciisporites spp.											x	x	x		x	x	x					x			x		x	→
Triadispora spp.											x		x	x	x			x		x	x	A			A	x	x	→
Protodiploxypinus ornatus													x		x										x	x	x	→
Protodiploxypinus minor														x	x		x					x			x	x	x	→
Voltziaceaesporites heteromorpha														x	x	x	x	x			x	x			x	x	x	→
Podosporites spp.																						x				x	x	→
Protodiploxypinus decus																						x				x	x	→
Porcellispora longdonensis																										x	x	→
Triadispora obscura								x	x	x	x	x		x	x	x	x			x	x	x			x	x		
Protohaploxypinus spp.									x		x		x		x	x	x	A		x						x		
Triadispora plicata									x				x		x		x				x	x				x		
Striatoabieites spp.							x		x	x			x	x	x			x							x			
Bharadwajispora labichensis							x	x	x	x	x	x	x	x											x			
Inaperturopollenites nebulosus								x											x	x					x			
Triadispora aurea										x				x	x			x							x			
Echinitosporites iliacoides											x	x		x		x	x	x							x			
Triadispora verrucata											x		x	x	x		x					x			x			
Schizaeoisporites worsleyi												x				x						x			x			
Retisulcites sp. 1													x	x		x	x					x			x			
Accinctisporites circumdatus							x				x	x			x	x				x		x						
Lunatisporites acutus										x	x							x				x						
Eucommiidites microgranulatus																x			x			x						
Protodiploxypinus sivaki																				x	x	x						
Haberkornia gudati																						x						
Kuglerina meieri																						x						
Angustisulcites klausii							x		x	x			x			x			x		x							
Chasmatosporites apertus														x							x							
Alisporites spp.											x	x	x		x	x	x	x		x								
Retisulcites perforatus										x				x	x	x	x	x										
Illinites trivisus							x	x		x				x	x	x	x											
Podosporites sp. A										x							x											
Bisaccate indeterminate pollen		x	x		x	x	A	A		A	x			A	A	A												
Lunatisporites pellucidus							x	x				x	x	x	x	x												
Striatoabieites multistriatus							x									x												
Pretricolpipollenites spp.								x								x												
Ephedripites spp.									x					x	x	x												
Ricciisporites tuberculatus											x	x		x	x	x												
Concentrisporites hallei											x	x	x															
Concentrisporites spp.											x	x																
Protodiploxypinus microsaccus											x																	
Cordaitina gunyalensis									x																			
Angustisulcites grandis							x																					
Illinites spp.					x	x	x																					
Plankton and varia																												
Micrhystridium spp.							A	A	A	A	x	x	x										x		x	x	x	→
Plaesiodictyon moesellanum										x	C	C	x			x										x	x	→
Dictyotidium tenuiornatum											x	x	x												A	x	x	→
Fungal remain																									x	x	x	→
Cymatiosphaera spp.								A			x	C	x				x								x			
Tasmanites spp.								C															x		x			
Veryhachium spp.								A					x												x			
Botryococcus spp.													x		x			x			x	A			x			
Grebespora concentrica																									x			
Veryhachium sp. (large specimens)								A	A	A			x															
Reduviasporonites chalastus	x	x																										
Composite Assemblage Zone	R.cha.		N.striata				J.p	T.obscu		P.d	Echinito. iliacoides							Aulisporites astigmosus									indet.	

LEGEND
D dominant
A abundant
C common
x present
→ continues upw.

A.46.2.1 Well 7121/1-1R, Sassendalen and Kapp Toscana groups, tops.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7121/1-1 R	SASSENDALEN GROUP										KAPP TOSCANA GROUP																	
Lithostratigraphy 15.1.12/NPD Factpage	Hav		Klapp.Fm.			Kobbe Fm.					Snadd Formation																	
Age	P/T		TRIASSIC																									
	Induan		Olenekian					Anisian			late Ladinian							ely to mid Carn					Carnian				N	
	Grie		Smith			Spath-Anisian																						
							l. S	m. Anis		l.An																		
Spores / Depth of core samples	2791C	2745 C	2717 C	2684 C	2627 C	2606 C	2510 C	2405 C	2333 C	2232 C	2123 C	1963 C	1942.5C	1924 C	1855 C	1726 C	1501 C	1463.5C	1373 C	1276 C	1249.5C	1164 C	1143 C	1063 C	1025 C	937.5C	920.0C	→
Kraeuselisporites spp.			x				x			x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	→
Calamospora spp.							x			x	x			x	x	x				x	x	x			x	x	x	→
Conbaculatisporites hopensis							x			x	x	x		x		x	x	x			x				x	x	x	→
Deltoidospora australis							x								x	x		x					x			x	x	→
Deltoidospora minor							x	x	x	x	x	x	x		x	C	C	x	x	x	x	x	A		x	x	x	→
Kraeuselisporites dentatus							x					x	x	x	x	x	x	x	x	x	x	x				x	x	→
Lycopodiacidites kuepperi							x	x		x			x	x			x		x		x					x	x	→
Lycopodiacidites spp.							x	x		x			x	x			x		x		x					x	x	→
Smooth, indeterminate miospores							x	x	x	x	x	x	x		x	x	C	x	x	x	x	x	A		x	x	x	→
Striatella seebergensis							x	x	x	x	x	A	x	x	x	x	x	x		x	x	x	x		x	x	x	→
Uvaesporites argentaeformis							x			x			x	x			x						x				x	→
Aratrisporites macrocavatus								C	x	x	x	x	x	x	x	x		x		x	x				x	x	x	→
Anapiculatisporites spiniger									x	x	x	x			x	x					x	x			x	x	x	→
Aratrisporites scabratus									x	x	x				x	x	x								x		x	→
Conbaculatisporites spp.									x	x					x	x									x	x	x	→
Semiretisporis "barentzii"									x		x	x	x	x		x	x	x								x	x	→
Leschikisporis aduncus									x	x	x	x	x	A	C	C	C	A	A	A	A	x	A		A	A	x	→
Aratrisporites tenuispinosus											x		x	x	x		x									x	x	→
Dictyophyllidites mortoni											x		x	x	x	x	x	x	x	x	x	x			x	C	x	→
Kyrtomisporis spp.											x	x	x	x				x		x	x	x	x		x	x	x	→
Zebrasporites interscriptus												x		x												x	x	→
Zebrasporites laevigatus												x		x												x	x	→
Cingulizonates rhaeticus													x	x					x		x	x				x	x	→
Velosporites spp.													x													x	x	→
Polypodiisporites spp.														x	x	x	x		x		x	x			x	x	x	→
Gleicheniidites senonicus																						x			x	x	x	→
Aratrisporites spp.							x	C	x	x	x	x	x	x		x		x		x					x			
Gordonispora lubrica							x							x		x									x			
Punctatisporites spp.									x	x			x			x			x						x			
Auritulinasporites triclavis											x		x	x	x	x	x	x	x	x	x	x	x	x				
Deltoidospora juncta											x		x	x	x	x	x	x	x	x	x	x	x	x				
Aulisporites astigmosus																							x					
Cyclotriletes pustulatus							x		x					x	x		x	x			x	x						
Retusotriletes hercynicus							x			x				x								x						
Perotrilites spp.									x	x												x						
Thomsonisporites undulatus													x				x					x						
Staplinisporites caminus																		x			x	x						
Eresinia spinellata																						x						
Verrucosisporites sp. 1 (coarse bacula)									x		x		x	x	x		x			x	x							
Baculatisporites spp.										x	x								x	x	x							
Camarozonosporites laevigatus													x						x	x								
Neoraistrickia taylorii									x									x										
Verrucosisporites spp.			x	x	x		x	x						x			x											
Cyclotriletes oligogranifer					x				x	x						x	x											
Camerosporites secatus											x					x												
Stereisporites spp.															x	x												
Verrucosisporites morulae							x								x													
Aratrisporites palettae											x		x															
Punctatisporites fungosus	x	x		x	A		x			x																		
Jerseyiaspora punctispinosa							x		x																			
Densoisporites nejburgii			A	x	x	x	x	x																				
Raistrickia spp.							x	x																				
Lundbladispora obsoleta		x		x			x																					
Lundbladispora spp.					x		x																					
Cycloverrutriletes presselensis							x																					
Densoisporites playfordi							x																					
Pechorosporites spp.							x																					
Proprisporites pocockii							x																					
Densoisporites spp.		x	x	x	x																							
Kraeuselisporites spinosus			x		x																							
Apiculatisporis lanjouwii					x																							
Rewanispora foveolata					x																							
Composite Assemblage Zone	R.cha.		N.striata				J.p	T.obscu		P.d	Echinito. iliacoides							Aulisporites astigmosus									indet.	

LEGEND
- D dominant
- A abundant
- C common
- x present
- → continues upw.

A.46.2.2 Well 7121/1-1R, Sassendalen and Kapp Toscana groups, tops.

Kobbe Formation: 2334 m–1893 m (15.1.12/NPD Factpages)

Interval 2325–1960 m, early to mid Anisian

Two nearly barren samples at 2325 m and 2181 m represent the lowermost part of the Klappmyss Formation.

The overlying association (2010–1960 m) is distinguished by the increased diversity of bisaccate pollen viz. the *Podosporites*, *Protodiploxypinus* and *Triadispora* groups (including *T. obscura*). In spite of the relatively reduced diversity of spores, the incoming of

HAMMERFEST BASIN, BJARMELAND PLATFORM

WELL 7124/3-1 Lithostratigraphy 15.1.12/NPD Factpages	T		SASSENDALEN GROUP																																						K.TOSCANA						
			Havert Formation																		Klappmyss Fm											Kobbe Fm								Snadd Fm						
Age	P		P/T		EARLY TRIASSIC																											MIDDLE TRIASSIC														
	L.P		Gri.		G/D		Smithian							early Spathian								late Spathian										e-m. Anis.					Ladin.			e-m.C.			Carnian			
Pollen / Depth of core samples	3522	3491	3489	3477	3437	3297	3262	3220	3215	3147	3127	3088	3072	3060	3047	3022	2985	2972	2947	2916	2897	2671	2661	2635	2595	2564	2525	2511	2498	2425	2415	2385	2325	2181	2010	1980	1960	1925	1909	1901	1865	1855	1845	1815	1796	1710	1560
Lueckisporites virkkiae		x																																													
Vittatina spp.		x																																													
Bharadwajispora labichensis							x			x												x	x												x			x									
Bisaccate indeterminate pollen															x		x	x	x	x	x	x	A		A																						
Cycadopites nitidus																						x	x								x						x	x					x				
Lunatisporites noviaulensis																						x	x			x		x				C			A	x	x	x	A	A		x	x				
Pretricolpipollenites spp.																						x	x		x						x	x				x	x						x				
Striatoabieites spp.																						x										x			x	x	x			A		x	x				
Lunatisporites/Illinites																						x	C																								
Lunatisporites acutus																							x															x		x							x
Protohaploxypinus spp.																							x									x											x				
Lunatisporites pellucidus																							C														x	x									
Striatodiploxypinus spp.																							x																								
Crustaesporites globosus																							x																								
Angustisulcites klausii																										x		x							x	x		x	x	x		x	x				
Lueckisporites junior																												x			x	x															
Striatoabieites balmei																														x							x	x	A	A		x	x				
Cordaitina minor																															x										x	x	x				
Illinites chitonoides																																x			x	x	x	x		x		x	x			x	
Triadispora spp.																																			x												A
Dyupetalum vicentinense																																			x								x				
Accinctisporites circumdatus																																			x		C			x							
Falcisporites spp.																																			x												
Staurosaccites quadrifidus																																				x		x		x		x	x				x
Triadispora obscura																																				x	C	x	x	A		x	C				
Voltziaceaesporites heteromorpha																																				x						x	x				
Cordaitina gunyalensis																																				x	x	x	x								
Angustisulcites grandis																																				x											
Podosporites amicus																																					x	x		x			x				
Protodiploxypinus minor																																					x					x	x				
Protodiploxypinus ornatus																																					x					x	x				
Retisulcites spp.																																					x			x			x				
Illinites trivisus																																					x										
Ovalipollis pseudoalatus																																						x		x			x	C	x	x	x
Institisporites crispus																																						x				x	x				
Protodiploxypinus gracilis																																						x		x		x	x				
Triadispora plicata																																						x		A		x	x				
Striatoabieites multistriatus																																						x	x	x							
Protodiploxypinus doubingeri																																						x									
Schizaeoisporites worsleyi																																							x	x							
Protodiploxypinus decus																																								x		x	x				
Ricciisporites spp.																																								x		x	x				
Inaperturopollenites nebulosus																																								x		x					
Echinitosporites iliacoides																																									x	x	x	x			
Triadispora verrucata																																										x	x	x	x	x	x
Concentrisporites pseudosulcatus																																										x	x				
Concentrisporites spp. (small)																																										x	x				
Eucommiidites minor																																										x	x				
Ricciisporites tuberculatus																																										x	x				
Vitreisporites pallidus																																										x	x				
Alisporites spp.																																											x				
Araucariacites spp.																																											x				
Perinopollenites elatoides																																											x				
Plankton and varia																																															
Fungal bodies	x					A	x	C		C	x	x			x	C					x	C																R									
Reduviasporonites chalastus	x		A	A																			R																R								
Tetraporina horologica																	x																														
Tasmanites spp.																					x																										
Micrhystridium spp.																									x			x				A											x				
Veryhachium spp.																										x		x				x							x			x	x				
Fungal spores																																x								x							
Veryhachium sp. (large forms)																																			x			x				x					
Dictyotidium tenuiornatum																																						x									
Tyttodiscus spp.																																								x			x				
Botryococcus spp.																																								x							
Plaesiodictyon moesellanum																																										x	x	x	x		
Pterospermella spp.																																											x				
Composite Assemblage Zone			R.ch		(P.p)		Naumovasp. striata							Pechorosp. disertus								Jerseyiaspora punctispinosa											T. obscura					E.Iliac.			A. astigmosus						

LEGEND
D dominant
A abundant
C common
x present
R reworked

A.47.1 Well 7124/3-1, Sassendalen and Kapp Toscana groups, bases.

Anapiculatisporites spiniger and *Aratrisporites macrocavatus* as well as the youngest record of *J. punctispinosa* define this interval. The association is assigned to the *Triadispora obscura* Composite Assemblage Zone.

Interval 1925–1901 m, Ladinian

Pollen dominance continues with the incoming of *Institisporites crispus*, *Ovalipollis pseudoalatus*, *Protodiploxypinus decus*, *P. gracilis* and *Triadispora plicata*. Spores show lower diversity. The presence of *Ricciisporites* sp.

HAMMERFEST BASIN, BJARMELAND PLATFORM

WELL 7124/3-1	T		SASSENDALEN GROUP																																						K.TOSCANA						
Lithostratigraphy 15.1.12/NPD Factpages			Havert Formation																			Klappmyss Fm											Kobbe Fm								Snadd Fm						
Age	P		P/T		EARLY TRIASSIC																												MIDDLE TRIASSIC														
	L.P		Gri.		G/D		Smithian							early Spathian								late Spathian											e-m. Anis.					Ladin.			e-m.C.			Carnian			
Spores/ Depth of core samples	3522	3491	3489	3477	3437	3297	3262	3220	3215	3147	3127	3088	3072	3060	3047	3022	2985	2972	2947	2916	2897	2671	2661	2635	2595	2564	2525	2511	2498	2425	2415	2385	2325	2181	2010	1980	1960	1925	1909	1901	1865	1855	1845	1815	1796	1710	1560
Rewanispora foveolata	x													x								x	x																								
Trilete indeterminate spore	x						x	C	x	C	C	C	x	x	C	x	x	x	x	x	A	A	x																								
Densoisporites nejburgii		C			C		C		x	x		A	A	A	A	A					A		A				x	C	C	A	x	A	x			x											
Lundbladispora obsoleta		x	x																				x																								
Punctatisporites fungosus						x	x	C		C	C	C	x	x	x	x					A	x	x		x			x																			
Densoisporites playfordi							C							A	A	A					C						x	x	x							x											
Kraeuselisporites apiculatus							x							x							x							x								x											
Punctatisporites spp.							x	x		x		x	x	x		x					x	x	C					x				x				x											
Lundbladispora spp.							x							A									C					x	C		x	x															
Pechorosporites spp.							x							x			x	x	x	x		C	x		x			x																			
Kraeuselisporites cf. *K. cuspidus*														x								x	x														x	x									
Gordonispora fossulata														x									x		x	x		x								x											
Densoisporites complicatus														C							x								x																		
Lundbladispora willmotti														x					x	x	x		x			x		x																			
Pechorosporites disertus														x			x	x	x	x		C	x					x																			
Rewanispora spp.														x									x					x																			
Proprisporites pocockii														x									x																								
Aratrisporites spp.																					x														A	C	C			x			x				x
Calamospora spp.																					x		A			x		x			x							x					x				
Verrucosisporites spp.																					C				C			A	C			x					x		x	x		x					
Densoisporites spp.																					A																			x							
Aratrisporites palettae																					x	x	x					x			x	x					C	x									
Aratrisporites scabratus																							x														x						x				
Gordonispora lubrica																							x		x											x											
Staplinisporites caminus																							x													x											
Jerseyiaspora punctispinosa																								x				A	x		x	x			x	C	x										
Raistrickia spp.																								x	x	x		C	x		x	x		C		C	x										
Cyclotriletes pustulatus																									C			C	C		C	x															
Cycloverrutriletes presselensis																									x			x			x																
Cycloverrutriletes spp.																									x			A			A																
Verrucosisporites pseudomorulae																									C	x		A			x																
Verrucosisporites remyanus																									x						x																
Verrucosisporites thuringiacus																									x	x		x	x	x	x																
Aratrisporites robustus																									x	x		x			x																
Aratrisporites tenuispinosus																												x			C				x	x		x		x							
Kraeuselisporites saeptatus																												x																			
Lundbladispora brevicula																														x																	
Striatella seebergensis																															x						x	x		x		x	C				
Cordaitina spp.																																x															
Aratrisporites macrocavatus																																	x	x	x	x	C	x				x	x	x	x	x	x
Conbaculatisporites hopensis																																			x							x	x				
Deltoidospora minor																																				x				x			x				
Retusotriletes hercynicus																																				x						x					
Polypodiisporites spp.																																				x	x										
Anapiculatisporites spiniger																																					x	x	x	x		x	x				
Apiculatisporis spp.																																						x	x								
Uvaesporites gadensis																																						x									
Spore sp. coarsely apiculate																																							x	x							
Lycopodiacidites spp.																																								x		x	x				
Kraeuselisporites sp. A																																										x	x	x	x	x	
Leschikisporis aduncus																																										x	x				
Neoraistrickia taylorii																																										x	x				
Cingulizonates rhaeticus																																										x					
Kraeuselisporites spp.																																										x					
Eresinia spinellata																																											x				
Baculatisporites spp.																																											x				
Conbaculatisporites spp.																																											x				
Perotrilites spp.																																											x				
Composite Assemblage Zone			R.ch		(P.p)		Naumovasp. striata							Pechorosp. disertus								Jerseyiaspora punctispinosa											T. obscura					E.Iliac.			A. astigmosus						

Only productive samples have been included in the table uppermost in the interval (1901 m) is a feature usually connected with late Ladinian assemblages. The association allows assignment to the *Echinitosporites iliacoides* Composite Assemblage Zone, although *E. iliacoides* has no record. *Reduviasporonites chalastus* is again recorded above Anisian–Ladinian boundary strata (Table 47, sample level 1909 m) and is considered reworked. There is no consistent record of this taxon above the Griesbachian anywhere in the study area.

HAMMERFEST BASIN, BJARMELAND PLATFORM

WELL 7124/3-1	T		SASSENDALEN GROUP																																						K.TOSCANA						
Lithostratigraphy 15.1.12/NPD Factpages			Havert Formation																			Klappmyss Fm											Kobbe Fm								Snadd Fm						
Age	P		P/T		EARLY TRIASSIC																												MIDDLE TRIASSIC														
	L.P		Gri.		G/D		Smithian							early Spathian								late Spathian											e-m. Anis.					Ladin.			e-m.C.			Carnian			
Pollen / Depth of core samples	3522	3491	3489	3477	3437	3297	3262	3220	3215	3147	3127	3088	3072	3060	3047	3022	2985	2972	2947	2916	2897	2671	2661	2635	2595	2564	2525	2511	2498	2425	2415	2385	2325	2181	2010	1980	1960	1925	1909	1901	1865	1855	1845	1815	1796	1710	1560
Lunatisporites acutus																							x															x		x							x
Triadispora spp.																																			x												A
Staurosaccites quadrifidus																																				x		x		x		x	x				x
Ovalipollis pseudoalatus																																						x		x			x	C	x	x	x
Triadispora verrucata																																										x	x	x	x	x	x
Illinites chitonoides																																x			x	x	x	x		x		x	x			x	
Echinitosporites iliacoides																																									x	x	x	x			
Cycadopites nitidus																						x	x								x						x	x					x				
Lunatisporites noviaulensis																						x	x			x		x				C			A	x	x	x	A	A		x	x				
Pretricolpipollenites spp.																						x	x		x						x	x				x	x						x				
Striatoabieites spp.																						x										x			x	x	x			A		x	x				
Protohaploxypinus spp.																							x									x											x				
Angusticulcites klausi																										x		x							x	x		x	x	x		x	x				
Striatoabieites balmei																														x							x	x	A	A		x	x				
Cordaitina minor																															x										x	x	x				
Dyupetalum vicentinense																																			x								x				
Triadispora obscura																																				x	C	x	x	A		x	C				
Voltziaceaespora heteromorpha																																				x						x	x				
Podosporites amicus																																					x	x		x			x				
Protodiploxypinus minor																																					x					x	x				
Protodiploxypinus ornatus																																					x					x	x				
Retisulcites spp.																																					x			x			x				
Institisporites crispus																																						x				x	x				
Protodiploxypinus gracilis																																						x		x		x	x				
Triadispora plicata																																						x		A		x	x				
Protodiploxypinus decus																																								x		x	x				
Ricciisporites spp.																																								x		x	x				
Concentrisporites pseudosulcatus																																										x	x				
Concentrisporites sp. (small)																																										x	x				
Eucommiidites minor																																										x	x				
Ricciisporites tuberculatus																																										x	x				
Vitreipollenites pallidus																																										x	x				
Alisporites spp.																																											x				
Araucariacites sp.																																											x				
Perinopollenites spp.																																											x				
Inaperturopollenites nebulosus																																								x		x					
Accinctisporites circumdatus																																			x		C			x							
Striatoabieites multistriatus																																						x	x	x							
Schizaeoisporites worsleyi																																							x	x							
Cordaitina gunyalensis																																				x	x	x	x								
Bharadwajispora labichensis							x			x												x	x												x			x									
Lunatisporites pellucidus																							C														x	x									
Protodiploxypinus doubingeri																																						x									
Podosporites spp.																																			x		x										
Illinites trivisus																																					x										
Angustisulcites grandis																																				x											
Falcisporites spp.																																			x												
Lueckisporites junior																												x			x	x															
Bisaccate indeterminate pollen															x		x	x	x	x	x	x	A		A																						
Lunatisporites / Illinites																						x	C																								
Crustaesporites globosus																							x																								
Lueckisporites virkkiae		x																																													
Vittatina spp.		x																																													
Plankton and varia																																															
Plaesiodictyon moesellanum																																										x	x	x	x		
Micrhystridium spp.																									x			x				A											x				
Veryhachium spp.																										x		x				x							x			x	x				
Tyttodiscus sp.																																								x			x				
Pterospermella sp.																																											x				
Veryhachium large																																			x			x				x					
Fungal spores																																x								x							
Botryococcus																																								x							
Reduviasporonites chalastus	x		A	A																			R																R								
Dictyotidium tenuiornatum																																							x								
Fungal bodies	x					A	x	C		C	x	C			x	C					x	C																R									
Tasmanites spp.																					x																										
Tetraporina horologica																	x																														
Composite Assemblage Zone			R.ch		(P.p)		Naumovasp. striata							Pechorosp. disertus								Jerseyiaspora punctispinosa											T. obscura					E.Iliac.			A. astigmosus						

LEGEND
D dominant
A abundant
C common
x present
R reworked

A.47.2 Well 7124/3-1, Sassendalen and Kapp Toscana groups, tops.

Snadd Formation: 1893–1438 m (15.1.12/NPD Factpages)
Interval 1865.0–1845 m, early Carnian

The diverse assemblages of this interval are dominated by pollen. They are characterised by the regular occurrence of *Echinitosporites iliacoides*, the oldest record of *Concentrisporites pseudosulcatus*, *Eucommiidites minor* and *Perinopollenites elatoides*, common and diverse *Triadispora* spp. (including *T. obscura* and *T. verrucata*) and presence of *Podosporites amicus*. Spores include *Cingulizonates rhaeticus*, *Kraeuselisporites* sp. A, *Leschikisporis aduncus*, *Neoraistrickia taylorii* and *Ricciisporites tuberculatus*. Plankton appear more diverse than below

HAMMERFEST BASIN, BJARMELAND PLATFORM

WELL 7124/3-1 Lithostratigraphy 15.1.12/NPD Factpages	T		SASSENDALEN GROUP																		
			Havert Formation																		
Age	P		P/T		EARLY TRIASSIC																
	L.P		Gri.		G/D		Smithian							early Spathian							
Spores / Depth of core samples	3522	3491	3489	3477	3437	3297	3262	3220	3215	3147	3127	3088	3072	3060	3047	3022	2985	2972	2947	2916	2897
Aratrisporites spp.																					x
Aratrisporites macrocavatus																					
Kraeuselisporites sp. A																					
Calamospora spp.																					x
Aratrisporites scabratus																					
Striatella seebergensis																					
Conbaculatisporites hopensis																					
Deltoidospora minor																					
Anapiculatisporites spiniger																					
Lycopodiacidites sp.																					
Leschikisporis aduncus																					
Neoraistrickia taylorii																					
Eresinia spinellatea																					
Baculatisporites spp.																					
Conbaculatisporites spp.																					
Perotrilites spp.																					
Verrucosisporites spp.																					C
Retusotriletes hercynicus																					
Cingulizonates rhaeticus																					
Kraeuselisporites spp.																					
Densoisporites spp.																					A
Aratrisporites tenuispinosus																					
Spore sp. coarsely apiculate																					
Apiculatisporis spp.																					
Kraeuselisporites cf. *cuspidus*														x							
Aratrisporites palettae																					x
Uvaesporites gadensis																					
Jerseyaspora punctispinosa																					
Raistrickia spp.																					
Polypodiisporites spp.																					
Densoisporites nejburgii		C			C		C		x	x		A	A	A	A	A					A
Densoisporites playfordii							C							A	A	A					C
Kraeuselisporites apiculatus							x							x							x
Punctatisporites spp.							x	x		x		x	x	x		x					x
Gordonispora fossulata														x							
Gordonispora lubtica																					
Staplinisporites caminus																					
Lundbladispora spp.							x							A							
Cyclotriletes pustulatus																					
Cordaitina spp.																					
Aratrisporites robustus																					
Cycloverrutriletes presselensis																					
Cycloverrutriletes spp.																					
Verrucosisporites pseudomorulae																					
Verrucosisporites remyanus																					
Verrucosisporites thuringiacus																					
Lundbladispora brevicula																					
Densoisporites complicatus														C							x
Pechorospporites spp.							x							x			x	x	x	x	
Punctatisporites fungosus							x	C		C	C	C	x	x	x	x					A
Lundbladispora willmottii														x					x	x	x
Pechorosporites disertus														x			x	x	x	x	
Rewanispora spp.														x							
Kraeuselisporites saeptatus																					
Trilete indeterminate spore	x						x	C	x	C	C	C	x	x	C	x	x	x	x	x	A
Rewanispora foveolata	x													x							
Lundbladispora obsoleta		x	x																		
Proprisporites pococki														x							
Composite Assemblage Zone			R.ch		(P.p)		Naumovasp. striata							Pechorosp. disertus							

WELL 7124/3-1 Lithostratigraphy 15.1.12/NPD Factpages																				K.TOSCANA						
	Klappmyss Fm											Kobbe Fm								Snadd Fm						
Age												MIDDLE TRIASSIC														
	late Spathian											e-m. Anis.					Ladin.			e-m.C.			Carnian			
Spores / Depth of core samples	2671	2661	2635	2595	2564	2525	2511	2498	2425	2415	2385	2325	2181	2010	1980	1960	1925	1909	1901	1865	1855	1845	1815	1796	1710	1560
Aratrisporites spp.														A	C	C						x				x
Aratrisporites macrocavatus												x	x	x	x	C	x				x	x	x	x	x	x
Kraeuselisporites sp. A																					x	x	x	x	x	
Calamospora spp.		A			x		x			x							x					x				
Aratrisporites scabratus		x														x						x				
Striatella seebergensis										x						x	x		x		x	C				
Conbaculatisporites hopensis														x							x	x				
Deltoidospora minor															x				x			x				
Anapiculatisporites spiniger																x	x	x	x		x	x				
Lycopodiacidites sp.																			x		x	x				
Leschikisporis aduncus																					x	x				
Neoraistrickia taylorii																					x	x				
Eresinia spinellatea																						x				
Baculatisporites spp.																						x				
Conbaculatisporites spp.																						x				
Perotrilites spp.																						x				
Verrucosisporites spp.				C			A	C			x					x		x	x		x					
Retusotriletes hercynicus															x						x					
Cingulizonates rhaeticus																					x					
Kraeuselisporites spp.																					x					
Densoisporites spp.																			x							
Aratrisporites tenuispinosus							x			C				x	x		x		x							
Spore sp. coarsely apiculate																		x	x							
Apiculatisporis spp.																	x	x								
Kraeuselisporites cf. *cuspidus*	x	x														x	x									
Aratrisporites palettae	x	x					x			x	x					C	x									
Uvaesporites gadensis																	x									
Jerseyaspora punctispinosa			x				A	x		x	x			x	C	x										
Raistrickia spp.			x	x	x		C	x		x	x		C		C	x										
Polypodiisporites spp.															x	x										
Densoisporites nejburgii		A				x	C	C	A	x	A	x			x											
Densoisporites playfordii						x	x	x																		
Kraeuselisporites apiculatus							x								x											
Punctatisporites spp.	x	C					x				x				x											
Gordonispora fossulata		x		x	x		x								x											
Gordonispora lubtica		x		x											x											
Staplinisporites caminus		x													x											
Lundbladispora spp.		C					x	C		x	x															
Cyclotriletes pustulatus				C			C	C		C	x															
Cordaitina spp.											x															
Aratrisporites robustus				x	x		x			x																
Cycloverrutriletes presselensis				x			x			x																
Cycloverrutriletes spp.				x			A			A																
Verrucosisporites pseudomorulae				C	x		A			x																
Verrucosisporites remyanus				x						x																
Verrucosisporites thuringiacus				x	x		x	x	x	x																
Lundbladispora brevicula									x																	
Densoisporites complicatus								x																		
Pechorospporites spp.	C	x		x			x																			
Punctatisporites fungosus	x	x		x			x																			
Lundbladispora willmottii		x			x		x																			
Pechorosporites disertus	C	x					x																			
Rewanispora spp.		x					x																			
Kraeuselisporites saeptatus							x																			
Trilete indeterminate spore	A	x																								
Rewanispora foveolata	x	x																								
Lundbladispora obsoleta																										
Proprisporites pococki		x																								
Composite Assemblage Zone	Jerseyiaspora punctispinosa											T. obscura					E.Iliac.			A. astigmosus						

Only productive samples have been included in the table and include *Micrhystridium*, *Tyttodiscus* and *Veryhachium*, as well as the freshwater alga *Plaesiodictyon mosellanum*.

The association corresponds to the *Aulisporites astigmosus* Composite Assemblage Zone in its lower range, indicating an early Carnian age.

Interval 1815–1560 m, Carnian
A strong reduction in diversity distinguishes the assemblages of this interval from those below. Presence of *Aratrisporites macrocavatus*, *Illinites chitonoides*, *Ovalipollis pseudoalatus*, *Staurosaccites quadrifidus* and abundant *Triadispora* spp. (including *T. verrucata*), together with *Echinitosporites iliacoides* at the base of the interval, suggests an assignment to the *Aulisporites astigmosus* Composite Assemblage Zone. Only the freshwater alga *Plaesiodictyon mosellanum* is recorded within the interval.

Interval 1560–1291m, Norian and Rhaetian
There is no range chart included herein for this interval. Poor preservation and low productivity of palynomorphs prevent dating of the interval between 1560.0 m and 1409.0 m. The interval 1409.0–1307.0 m contains a characteristic association of dinoflagellate cysts, including *Heibergella* spp. The spores and pollen include *Kyrtomisporis* spp., *K. gracilis*, *K. laevigatus*, *K. speciosus*, *Cingulizonates* spp., *C. rhaeticus*, *Annulispora folliculosa*, *Aratrisporites* spp. and *Chasmatosporites* spp. The association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

The uppermost interval, 1307.0–1291.0 m, comprises an association including *Limbosporites lundbladii*, common *Ricciisporites* sp. and *R. tuberculatus*, suggesting assignment to the *Ricciisporites tuberculatus* Composite Assemblage Zone.

C.7 Well 7125/1–1

Well 7125/1–1 was drilled in the eastern part of the Loppa High area, on the southern part of the Bjarmeland Platform, towards the Nyslepp Fault Complex. It was drilled to a TD of 2200 m into Triassic rocks (15.1.12/NPD Factpages). The Upper Triassic deposits penetrated by this well contain diverse palynological associations. The palynological record is outlined and discussed below, but no range chart is included.

Snadd Formation: 2105–1612 m (15.1.12/NPD Factpages)
Interval 2105–2001 m, Ladinian
The associations are characterised by *Echinitosporites iliacoides* (2102.0–2077.0 m), *Cordaitina minor* and *Chasmatosporites magnolioides*. Common to abundant acritarchs and *Plaesiodictyon mosellanum* are present throughout this interval. The association allows assignment to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Interval 2001–1627 m, Carnian
Sporadically rich palynomorph assemblages form three subintervals reflecting the local floral development. The lower interval (2001.0 –1931.1 m) represents a gradual reduction of diversity of an association including *Semiretisporis* spp. (up to 1954.5 m) and rare algae.

The sample interval 1885.0–1803.0 m has common *Illinites chitonoides* in the lowermost sample. *Staurosaccites quadrifidus*, *Schizaeoisporites worsleyi* and *Triadispora verrucata* are observed at 1885.1 m.

The interval 1680.0–1627.0 m is characterised by the last occurrence of the *Verrucosisporites* complex and *Illinites chitonoides* (1680.0 m), *Aratrisporites macrocavatus* (1635 m) and *Carnisporites telephorus* at1826.0 m. A successive disappearance of *Staurosaccites quadrifidus*, *Schizaeoisporites worsleyi*, *Triadispora verrucata*, Carnisporites telephorus and *Semiretisporis* spp. is recorded within this interval. The associations of the entire interval are assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

Fruholmen Formation: 1612–1521 m (15.1.12/NPD Factpages)
Interval 1627–1537 m, Norian
Sample 1615.5 m contains abundant *Ovalipollis pseudoalatus*. The diverse spore assemblages of this interval are dominated by the *Kyrtomisporis* group (*K. gracilis*, *K. laevigatus* and *K. speciosus*) together with *Cingulizonates* spp. (including *C. rhaeticus*), *Chasmatosporites* spp., *Annulispora folliculosa* and *Aratrisporites* spp. The oldest records of *Ricciisporites tuberculatus* and *R. umbonatus* are at 1542.5 m. The diverse dinoflagellate cyst association includes the *Heibergella*, *Shublikodinium* and *Sverdrupiella* groups. The association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

Interval 1537–1520.5 m
A single, palynologically barren sidewall core has been prepared from this interval. In this well, there is insufficient evidence from the cuttings samples to differentiate Rhaetian from Jurassic beds.

C.8 Well 7224/7–1B

Well 7224/7–1 was drilled in 1988 in the eastern part of the Loppa High area, on the Bjarmeland Platform, and reached a TD of 3067 m in Triassic rocks (15.1.12/NPD Factpages). The Snadd and Fruholmen formations were penetrated in this well.(Table A.48.1 and 2, Plates 31–32).

Snadd Formation: 1642–1028 m (15.1.12/NPD Factpages)

Interval 1512.5–1434.5 m, Ladinian

Pollen include *Echinitosporites iliacoides*, *Eucommiidites granulosus*, *Staurosaccites quadrifidus* and *Striatoabieites aytugii*, with incoming *Accinctisporites circumdatus*, *Infernopollenites sulcatus*, *Chasmatosporites apertus* and *Ovalipollis pseudoalatus*. Spores comprise *Aratrisporites* spp., *Leschikisporis aduncus*, *Lycopodiumsporites semimuris* and *Neoraistrickia taylorii*. Subordinate plankton include *Micrhystridium* spp. and *Veryhachium* spp. The association is assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Interval 1419.5–1246.4, early Carnian

This palynologically rich interval shows a progressively increasing diversity of pollen and spores. The records of the pollen *Duplicisporites* spp. and *Infernopollenites sulcatus* and single records of *Enzonalasporites densus*, *Ephedripites steevesii*, *Haberkornia parva*, *Kuglerina meieri* and *Protodiploxypinus doubingeri* mark the top of this interval. The association is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone, although the index taxon has only sporadic appearances in this well.

Interval 1238.4–1029.0 m, mid Carnian

Although the associations in this interval are dominated by bisaccate pollen together with smooth trilete spores, we note a progressive decline of pollen diversity. The youngest occurrences of *Angustisulcites*, *Eucommiidites* and *Illinites* as well as representatives of the *Triadispora* groups are observed within the 1156.0–1115.0 m interval. *Aulisporites astigmosus* (1043 m) has records in both cored material and cuttings samples. Spores show a similar decrease in number e.g., the *Aratrisporites* group, *Leschikisporis aduncus* and *Porcellispora longdonensis*. This association is also assigned to the *Aulisporites astigmosus* Composite Assemblage Zone. The difference between the assemblages of the two intervals is interpreted to reflect floral variations responding to changes in environmental and depositional conditions.

Fruholmen Formation: 1028–931 m (15.1.12/NPD Factpages)

Interval 1028 m cutting sample–973.0 m, late Carnian–Norian

The lowest samples contain assemblages of low diversity offering insufficient biostratigraphic evidence.

Interval 973.0–929.6 m, Norian

The diverse assemblages recorded from this interval are dominated by spores. Pollen include *Chasmatosporites* (*C. apertus*, *C. magnolioides*), *Corollina meyeriana* and *Protodiploxypinus* (*P. gracilis*, *P. minor*, *P. ornatus*). Spores comprise a number of smooth trilete forms in an association of *Cingulizonates rhaeticus*, *Kyrtomisporis* spp. (*K. laevigatus*, *K. niger*, *K. speciosus*), *Limbosporites lundbladii*, *Lycopodiacidites rugulatus*, *Lycopodiumsporites austroclavatidites*, *L. microreticulatus*, *L. semimuris*, *Ricciisporites tuberculatus*, *Zebrasporites interscriptus* and *Z. laevigatus*. Beside *Noricysta fimbriata*, *Sverdrupiella* spp., S. fimbriata and *S. septentrionalis*, there are some indeterminate dinoflagellate cysts. Acritarchs and green algae include *Micrhystridium* spp., *Veryhachium* spp. *Tasmanites* spp. and *Botryococcus* spp. The interval is attributed to the *Limbosporites lundbladii* Composite Assemblage Zone.

C.9. Well 7228/2–1S

Well 7228/2–1S is located on the western margin of the Nordkapp Basin, close to the Nyslepp Fault Complex. It was drilled to a TD of 4300 m into the Early Triassic Havert Formation (15.1.12/NPD Factpages) and penetrated 2900 m of Triassic rocks. The assemblages from this well are briefly described below, but range charts are not included.

Kobbe Formation: 3574–2438 m (15.1.12/NPD Factpages)

An influx of common *Veryhachium* is seen at 2542 m.

Snadd Formation: 2438–1523 m (15.1.12/NPD Factpages)

Interval 2402–2287 m, Ladinian

The interval contains moderately to poorly preserved (pyritised) material and is characterised by the regular presence of *Echinitosporites iliacoides*, *Nevesisporites fossulatus*, *Striatoabieites* spp. and abundant non-taeniate bisaccate pollen. Low numbers of plankton such as *Cymatiosphaera* spp. and *Plaesiodictyon mosellanum* are present throughout. The associations are assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Interval 2287–1963 m, early Carnian

The associations show last occurrences of *Staurosaccites quadrifidus* (2176 m), *Semiretisporis* sp. (2150 m), *Schizaeoisporites worsleyi* (1981 m sidewall core) and *Illinites chitonoides* (1963 m sidewall core). In the interval between 2040 m and 1945 m, there is an acme of *Leschikisporis aduncus*. Persistent, but low numbers of tasmanitids and other green algae, acritarchs and foraminiferal test linings as well as *Plaesiodictyon mosellanum*, represent marine depositional conditions with some fresh or brackish water influx. The assemblages are assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

Interval 1963–1766.5 m sidewall core, early–mid Carnian

The interval contains associations of *Aratrisporites* spp. and *Podosporites amicus* with common to dominant *L. aduncus* and rare *E. iliacoides*. There are persistent, but low numbers of green algae such as

LOPPA HIGH, HAMMERFEST BASIN

WELL 7224/7-1B	KAPP TOSCANA GROUP																																	
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																												Fruholmen					
Age	Lad/Carn				Carnian																								l.C/N		Norian			
Depths of cores, swc cores and cuttings	1512.5	1478.0	1450.0	1434.5	1419.5	1391.0	1372.5	1357.5	1339.0	1302.5	1282.5	1263.0	1246.4	1238.4	1217.4	1215 cu	1188 cu	1185 cu	1176.9	1156.0	1144.9	1128.9	1115.0 cu	1087.9	1073 cu	1058 cu	1043cu	1029.0	1019.5	998.0	973.0	962.5	930.9	929.6
Pollen																																		
Alisporites/Vesicaspora spp.	x	x	x	C	x	C			x	x			x	x	x		C						x		x						x	x		x
Bisaccate pollen (indeterminate)	x	x	x	C	x	x	x	x	x	x	x	x	C	x	x		x		x		x		x		x	x	x	x	x		x	x	x	x
Cycadopites nitidus	x	x	x	x			x		x	x	x		x	x	x		x			x	x	x	x		C	C	x					x	x	x
Vitreisporites pallidus	x	x	x	x	x	x	x		x				x				x				x		x		x		x	x				x		x
Staurosaccites quadrifidus	x	x	x	C	x	C	A	x	x	x	x	x	x	x	C				x			x												
Eucommiidites granulosus	x	x				x	x	x				x	x							x														
Striatoabieites aytugii	x			x			x			x	x	x	C				x		x															
Echinitosporites iliacoides	x	x		x																														
Triadispora spp.		x		x		x		x				x	C				x		x	C		x	x		x									
Infernopollenites sulcatus		x	x	x		x		x			x		x																					
Accinctisporites circumdatus			x	x				x			x		x		x		x																	
Chasmatosporites apertus				x	x		x		x		x		x		x		x															x		x
Ovalipollis pseudoalatus				x		x				C			C				C		C	C		C	C			C	x				x	x	x	x
Eucommiidites intrareticulatus				x				x									x				x	x												
Lunatisporites acutus				x		x							x		x					x														
Platysaccus papilionis					x	x	x		x				x							x					x								x	x
Angustisulcites spp.					x	x									C							x												
Lunatisporites spp.						x						x					x						x			x								x
Aulisporites astigmosus						x											x		x	x		x	x		x	x	x							
Schizaeoisporites worsleyi						x			x						x											x								
Angustisulcites klausii						x							x	x	x		x					x												
Illinites chitonoides						x		C		x			C		x		x		x	x														
Triadispora crassa							x		x	x			C				x		x	C			x											
Triadispora verrucata							x	x					x				x			x		x	x											
Protodiploxypinus minor								x									x					x	x		x		x						x	x
Brachysaccus spp.								x				x	x				x		x		x	x												
Chordasporites spp.								x											x	x														
Duplicisporites spp.									x	x	x	x	x																					
Chasmatosporites magnolioides										x					C																	x	x	x
Parvisaccites spp.											x												x		C						x	x		
Triadispora obscura												x	x				x			x			x											
Triadispora stabilis												x	x				x			x	x		x											
Protodiploxypinus gracilis													x												x								x	
Angustisulcites grandis													x		x				x															
Haberkornia parva													x																					
Kuglerina meieri													x																					
Protodiploxypinus doubingeri													x																					
Ephedripites steevesii													x																					
Enzonalasporites densus														x																				
Porcellispora longdonensis															x		x																	
Protodiploxypinus ornatus																	x					x	C		x		x						x	x
Striatoabieites balmei																	x																x	x
Striatoabieites multistriatus																						x				x								
Alisporites microreticulatus																															x			
Ricciisporites tuberculatus																																x	x	x
Corollina meyeriana																ca																x		
Pityosporites spp.																																	x	
Spores																b		b																
Aratrisporites macrocavatus	x	x	x	x	x	x		x		x		x	x				x		x	x	x	x	x		x		x							x
Calamospora tener	x	x	x	x				x	x	x	x	x	x		x		x		x				x		C	C	x					x		x
Conbaculatisporites mesozoicus	x	x	x	x	x	x	x	x		x		x	x	x			x						x		x	x	x		x				x	x
Deltoidospora australis	x	x	x	x	x	x	x	x		x	x		x		x		x		x				x		x	x	x					x		x
Deltoidospora spp.	x	C	x	x	x	x			x		x	x	x	x	x		x		x	x			x	x	C		x	x		x			x	x
Smooth trilete spores	x	x	x							x	C	C											x		x	x	C	x		x	x	x	x	x
Striatella seebergensis	x	x	x	x	x			x	x	x	x	x	x	x	C		x			x						x	x	x	x			x	x	x
Verrucosisporites spp.	x		x	x	x	x		C	x	x		x	x		x		x		C	x		x			x		x	x						x
Leschikisporis aduncus	x	C	x	x	x	x	C	C	x	x	x	C	x	x	C		C		A	x	x	x	x		x	x								
Aratrisporites spp.	x			x	x			x									x				x													
Kraeuselisporites spp.	x	x	C	C	x	x	x			x	x	x	x	x	x					x														
Punctatisporites spp.	x	x		x	x	x		x							x				x															
Deltoidospora minor		C	x	x	x	x	x	x	x	x		x	x	x	x		x		C	x		x	C		x	x	C				x	x	x	x
Cyclogranisporites spp.		x	x										x		x																			
Neoraistrickia taylorii			x		x			x			x						x											x						x
Aratrisporites saturni			x			x					x																							
Dictyophyllidites mortoni				x	x	C	C	x	x	x	C	x	x	C	x		C		C	C	x	x	C		x	x	C	x		x		x	x	x
Lycopodiumsporites semimuris				ca								x	x	x	x		x			x					x			x					x	
Camarozonosporites rudis					x	x	x			x		x		x	x		x			x			x								x	x		x
Lycopodiacidites rugulatus					x								x	x													x					x		x
Baculatisporites spp.						x						x		x								x												
Anapiculatisporites spiniger								x					x	x	x		x									x	x							x
Sphagnumsporites spp.								x							x										x		x		x					x
Striatella spp.								x																								x		
Concavisporites spp.								x									x		x												x			
Annulispora folliculosa										x	x	x	x										x			x					x	C	x	
Camarozonosporites laevigatus											x	x	x	x																	x			x
Apiculatisporis parvispinosus											x	x																						
Rugulatisporites spp.												x																						
Apiculatisporis spp.													x	x	x																			x
Stereisporites perforatus													x																			x		x
Zebrasporites interscriptus													x				x															x		
Composite Assemblage Zone	E. Iliacoides				Aulisporites astigmosus																								indet.		L.lundbladii			

LEGEND
- D dominant
- A abundant
- C common
- x present
- ca caved/pollution
- cu cuttings
- (stippled) barren sample

A.48.1.1 Well 7224/7-1B, Kapp Toscana Group, bases.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7224/7-1B	KAPP TOSCANA GROUP																																	
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																												Fruholmen					
Age	Lad/Carn				Carnian																								l.C/N		Norian			
Depths of cores, swc cores and cuttings	1512.5	1478.0	1450.0	1434.5	1419.5	1391.0	1372.5	1357.5	1339.0	1302.5	1282.5	1263.0	1246.4	1238.4	1217.4	1215 cu	1188 cu	1185 cu	1176.9	1156.0	1144.9	1128.9	1115.0 cu	1087.9	1073 cu	1058 cu	1043cu	1029.0	1019.5	998.0	973.0	962.5	930.9	929.6
Spores continued																																		
Zebrasporites laevigatus													x				x														x	x		
Densosporites spp.														x																			x	
Cingulizonates rhaeticus															x		x																	x
Stereisporites spp.															x																	x	x	x
Stereisporites aulosenensis															x																			
Kyrtomisporis laevigatus																	x								x		x		x		x	x	x	x
Kyrtomisporis speciosus																	x						x							x	x	x	x	x
Lycopodiumsporites austroclavatidites																	x								x	x					x		x	x
Retusotriletes mesozoicus																	x						x		x	x								x
Densosporites fissus																	x																x	
Conbaculatisporites hopensis																	x		x				x			x								
Concavisporites scabratus																	x		x	x														
Deltoidospora toralis																							x				x					x		
Aratrisporites palettae																										x	x							
Kraeuselisporites reissingeri																															x			
Kyrtomisporis niger																																x	x	x
Limbosporites lundbladii																																	x	x
Uvaesporites argentaeformis																																	x	x
Aratrisporites fimbriatus																																		x
Aratrisporites laevigatus																																		x
Lycopodiumsporites microreticulatus																																		x
Plankton and varia																b		b			b			b				b						
Micrhystridium spp.			x	x	x			x																						x	x	x		x
Veryhachium spp.			x	x	x																		x		x						x	x		
Botryococcus spp.						C	C	C	x						C		x					x									x	C	x	x
Megaspore																						x												x
Tasmanites spp.																							x							x	A	x		
Foraminifera (inner lining)																							x											
Cymatiosphaera spp.																										x					x			
Sverdrupiella spp.																														x	x			
Dinoflagellate cyst (indeterminate)																															x			
Noricysta fimbriata																															x			
Sverdrupiella septentrionalis																															x			
Schizocystia spp.																																x		

LEGEND
D dominant
A abundant
C common
x present
ca caved/pollution
cu cuttings
(stippled) barren sample b

A.48.1.2 Well 7224/7-1B, Kapp Toscana Group, bases.

Plaesiodictyon mosellanum, together with acritarchs and microforaminiferal test linings. The association is correlated with the *Aulisporites astigmosus* Composite Assemblage Zone.

Interval 1766.5–1549 m, Late Carnian
The association of the interval 1766.5 (sidewall core)–1549 m comprises common to abundant *Chasmatosporites* spp., *Kyrtomisporis* spp. (*K. laevigatus*) and *Protodiploxypinus* spp. (*P. gracilis*, *P. macroverrucosus*). There are some specimens of *Plaesiodictyon mosellanum* at 1672 m. The association is tentatively assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

Fruholmen Formation: 1523–1404 m (15.1.12/NPD Factpages)
Interval 1549–1411 m, Norian
Punctatosporites walkomii (1477 m), rare *Limbosporites lundbladii* (1436 m) and the association of *Cingulizonates rhaeticus*, *Semiretisporis gothae*, *Triancoraesporites ancorae* and rare *Ricciisporites tuberculatus* (1411 m) characterise this interval. The association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

C.10 Well 7228/7–1A

Well 7228/7–1A was drilled in the Nordkapp Basin. It reached a TD of 2881 m in the Klappmyss Formation and penetrates almost 1400 m of Triassic sediments. Conventional cores were taken in the oil- and gas-bearing interval of the Snadd Formation and in the gas-bearing Klappmyss Formation.

A complete palynological record of the Triassic, including 218 cuttings samples, 3 sidewall core and 22 core samples, was published by Hochuli and Vigran (2010) focussing on palaeoenvironmental changes. Distinct changes in the spore/pollen ratio have been interpreted as reflecting floras responding to varying relative humidity.

C.11 Well 7324/10–1

Well 7324/10–1 was drilled on the Alpha structure in the Maud Basin on the Bjarmeland Platform, to a TD of 2919 m in the Early Triassic Havert Formation (15.1.12/NPD Factpages). The palynological range chart covers the succession up to 947.0 m (Tables A.49.1 and 2). The

LOPPA HIGH, HAMMERFEST BASIN

WELL 7224/7-1B	KAPP TOSCANA GROUP																																	
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																												Fruholmen					
Age	Lad/Carn				Carnian																								I.C/N		Norian			
Depths of cores, swc cores and cuttings	1512.5	1478.0	1450.0	1434.5	1419.5	1391.0	1372.5	1357.5	1339.0	1302.5	1282.5	1263.0	1246.4	1238.4	1217.4	1215 cu	1188 cu	1185 cu	1176.9	1156.0	1144.9	1128.9	1115.0 cu	1087.9	1073 cu	1058 cu	1043cu	1029.0	1019.5	998.0	973.0	962.5	930.9	929.6
Pollen																																		
Alisporites/Vesicaspora spp	x	x	x	C	x	C			x	x			x	x	x		C						x		x						x	x		x
Bisaccate pollen (indeterminate)	x	x	x	C	x	x	x	x	x	x	x	x	C	x	x		x		x		x		x		x	x	x	x	x		x	x	x	x
Cycadopites nitidus	x	x	x	x			x		x	x	x		x	x	x		x			x	x	x	x		C	C	x					x	x	x
Vitreisporites pallidus	x	x	x	x	x	x	x		x				x				x				x		x		x		x	x				x		x
Chasmatosporites apertus				x	x		x		x		x		x		x		x															x		x
Ovalipollis pseudoalatus				x		x				C			C				C		C	C		C	C			C	x				x	x	x	x
Platysaccus papilionis					x	x	x		x				x							x					x								x	x
Lunatisporites spp.						x						x					x						x			x								x
Protodiploxypinus minor								x									x					x	x		x		x						x	x
Chasmatosporites magnolioides										x					C																	x	x	x
Protodiploxypinus ornatus																	x					x	C		x		x						x	x
Striatoabieites balmei																	x																x	x
Ricciisporites tuberculatus																																x	x	x
Protodiploxypinus gracilis													x												x								x	
Pityosporites spp.																																	x	
Parvisaccites spp.											x												x		C						x	x		
Corollina meyeriana																ca																x		
Alisporites microreticulatus																															x			
Aulisporites astigmosus						x											x		x	x		x	x		x	x	x							
Schizaeoisporites worsleyi						x			x						x											x								
Striatoabieites multistriatus																						x				x								
Triadispora spp.		x		x		x		x				x	C				x		x	C		x	x		x									
Triadispora crassa							x		x	x			C				x		x	C			x											
Triadispora verrucata							x	x					x				x			x		x	x											
Triadispora obscura												x	x				x			x			x											
Triadispora stabilis												x	x				x			x	x		x											
Staurosaccites quadrifidus	x	x	x	C	x	C	A	x	x	x	x	x	x	x	C				x			x												
Eucommiidites intrareticulatus				x				x									x				x	x												
Angustisulcites spp.					x	x									c							x												
Angustisulcites klausii						x							x	x	x		x					x												
Brachysaccus spp.								x				x	x				x		x		x	x												
Eucommiidites granulosus	x	x				x	x	x				x	x							x														
Lunatisporites acutus				x		x							x		x					x														
Illinites chitonoides						x		C		x			C		x		x		x	x														
Chordasporites spp.								x											x	x														
Striatoabieites aytugii	x			x			x			x	x	x	C				x		x															
Angustisulcites grandis													x		x				x															
Accinctisporites spp.			x	x				x			x		x		x		x																	
Porcellispora longdonensis															x		x																	
Enzonalasporites densus														x																				
Infernopollenites sulcatus		x	x	x		x		x			x		x																					
Duplicisporites spp.									x	x	x	x	x																					
Ephedripites steevesii													x																					
Haberkornia parva													x																					
Protodiploxypinus doubingeri													x																					
Kuglerina meieri													x																					
Echinitosporites iliacoides	x	x		x																														
Spores																b		b																
Aratrisporites macrocavatus	x	x	x	x	x	x		x		x		x	x				x		x	x	x	x	x		x		x							x
Calamospora tener	x	x	x	x				x	x	x	x	x	x		x		x		x				x		C	C	x					x		x
Conbaculatisporites mesozoicus	x	x	x	x	x	x	x	x		x		x	x	x			x						x		x	x	x		x				x	x
Deltoidospora australis	x	x	x	x	x	x	x	x		x	x		x		x		x		x				x		x	x	x					x		x
Deltoidospora spp.	x	C	x	x	x	x			x		x	x	x	x	x		x		x	x			x	x	C		x	x		x			x	x
Smooth trilete spores	x	x	x							x	C	C											x		x	x	C	x		x	x	x	x	x
Striatella seebergensis	x	x	x	x	x			x	x	x	x	x	x	x	C		x			x						x	x	x	x			x	x	x
Verrucosisporites spp.	x		x	x	x	x		C	x	x		x	x		x		x		C	x		x			x		x	x						x
Deltoidospora minor		C	x	x	x	x	x	x	x	x		x	x	x	x		x		C	x		x	C		x	x	C				x	x	x	x
Neoraistrickia taylorii			x		x			x			x						x											x						x
Dictyophyllidites mortoni				x	x	C	C	x	x	x	C	x	x	C	x		C		C	C	x	x	C		x	x	C	x		x		x	x	x
Camarozonosporites rudis					x	x	x			x		x		x	x		x			x			x								x	x		x
Lycopodiacidites rugulatus					x								x	x													x					x		x
Anapiculatisporites spiniger								x					x	x	x		x									x	x							x
Sphagnumsporites spp.								x							x										x		x		x					x
Camarozonosporites laevigatus											x	x	x	x																	x			x
Stereisporites perforatus													x																			x		x
Apiculatisporis spp.													x	x	x																			x
Stereisporites spp.															x																	x	x	x
Cingulizonates rhaeticus															x		x																	x
Kyrtomisporis laevigatus																	x								x		x		x		x	x	x	x
Kyrtomisporis speciosus																	x						x							x	x	x	x	x
Lycopodiumsporites austroclavatidites																	x								x	x					x		x	x
Retusotriletes mesozoicus																	x						x		x	x								x
Kyrtomisporis niger																																x	x	x
Ricciisporites tuberculatus																																x	x	x
Limbosporites lundbladii																																	x	x
Uvaesporites argentaeformis																																	x	x
Lycopodiumsporites microreticulatus																																		x
Aratrisporites fimbriatus																																		x
Aratrisporites laevigatus																																		x
Lycopodiumsporites semimuris				ca								x	x	x	x		x			x					x			x					x	
Annulispora folliculosa										x	x	x	x										x			x					x	C	x	
Composite Assemblage Zone	E. Iliacoides				Aulisporites astigmosus																								indet.		L.lundbladii			

LEGEND
D dominant
A abundant
C common
x present
ca caved/pollution
cu cuttings
barren sample b

A.48.2.1 Well 7224/7-1B, Kapp Toscana Group, tops.

LOPPA HIGH, HAMMERFEST BASIN

WELL 7224/7-1B	KAPP TOSCANA GROUP																																	
Lithostratigraphy 15.1.12/NPD Factpages	Snadd Formation																												Fruholmen					
Age	Lad/Carn				Carnian																								I.C/N		Norian			
Depths of cores, swc cores and cuttings	1512.5	1478.0	1450.0	1434.5	1419.5	1391.0	1372.5	1357.5	1339.0	1302.5	1282.5	1263.0	1246.4	1238.4	1217.4	1215 cu	1188 cu	1185 cu	1176.9	1156.0	1144.9	1128.9	1115.0 cu	1087.9	1073 cu	1058 cu	1043cu	1029.0	1019.5	998.0	973.0	962.5	930.9	929.6
Spores continued																																		
Densosporites spp.														x																			x	
Densosporites fissus																	x																x	
Striatella spp.								x																								x		
Zebrasporites interscriptus													x				x															x		
Zebrasporites laevigatus													x				x														x	x		
Deltoidospora toralis																							x				x					x		
Concavisporites spp.								x									x		x												x			
Kraeuselisporites reissingeri																															x			
Aratrisporites palettae																										x	x							
Leschikisporis aduncus	x	C	x	x	x	x	C	C	x	x	x	C	x	x	C		C		A	x	x	x	x		x	x								
Conbaculatisporites hopensis																	x		x				x			x								
Baculatisporites spp.						x						x		x								x												
Aratrisporites spp.	x			x	x			x									x				x													
Kraeuselisporites spp.	x	x	C	C	x	x	x			x	x	x	x	x	x					x														
Concavisporites scabratus																	x		x	x														
Punctatisporites spp.	x	x		x	x	x		x							x				x															
Stereisporites aulosenensis															x																			
Cyclogranisporites spp.		x	x										x		x																			
Apiculatisporis parvispinosus											x	x																						
Rugulatisporites sp.												x																						
Aratrisporites saturni			x			x					x																							
Plankton and varia																b		b						b				b						
Micrhystridium spp.			x	x	x			x																						x	x	x		x
Botryococcus spp.						C	C	C	x						C		x					x									x	C	x	x
Megaspore																						x												x
Veryhachium spp.			x	x	x																		x		x						x	x		
Tasmanites spp.																							x							x	A	x		
Schizocystia spp.																																x		
Cymatiosphaera spp.																										x					x			
Sverdrupiella spp.																														x	x			
Dinoflagellate cyst (indeterminate)																															x			
Noricysta fimbriata																															x			
Sverdrupiella septentrionalis																															x			
Foraminifera (inner lining)																							x											
Composite Assemblage Zone	E. Iliacoides				Aulisporites astigmosus																								indet.		L.lundbladii			

LEGEND
D dominant
A abundant
C common
x present
ca caved/pollution
cu cuttings
barren sample

A.48.2.2 Well 7224/7-1B, Kapp Toscana Group, tops.

photographic illustrations (Plate 33) and our correlation are based on the core samples. There are very few core samples available below 2155.00 m (i.e., in the Havert and Klappmyss formations) and they are almost barren.

Havert Formation: 2919 m TD–2512 m (15.1.12/NPD Factpages)

Interval 2918–2690 m, Griesbachian

The associations recovered from cuttings samples of this interval are characterised by an acme of the *Densoisporites* and *Lundbladispora* groups (*Densoisporites nejburgii*, *D. complicatus*, *D. playfordi* and *Lundbladispora obsoleta*). Other recorded species include *Calamospora* spp., *Granulatisporites* sp., *Grebespora concentrica*, *Indotriradites* spp., *Kraeuselisporites apiculatus*, *K. punctatus*, *K. spinosus*, *Lueckisporites virkkiae*, *Maculatasporites* sp. (2833.0 m), *Proprisporites pocockii* (2786.0 m) and *Punctatisporites fungosus*. No marine algae have been recorded. The association is assigned to the *Proprisporites pocockii* Composite Assemblage Zone.

Interval 2645.5–2557.5 m, Dienerian

The low-diversity assemblages in residues from cuttings samples from this interval comprise opaque or very dark-brown palynomorphs. Abundant cavate spores (*Densoisporites* spp. and *Lundbladispora* spp.), smooth trilete spores and rare monosulcate pollen (*Cycadopites*, *Pretricolpipollenites*) characterise the association. The residues are dominated by terrestrial woody remains and there is no evidence of marine influence.

The association is assigned to the *Maculatasporites* spp. Composite Assemblage Zone. However, it should be noted that the low number of monosulcate pollen contrasts with their abundance recorded in associations of this zone in other parts of the Barents Shelf.

Klappmyss Formation: 2512–2272 m (15.1.12/NPD Factpages)

Interval 2521–2272 m, Smithian

The interval below 2305.0 m (based on cuttings) is characterised by very dark, nearly opaque organic material and associations of low diversity. Spores, such as *Aratrisporites* spp., *Densoisporites nejburgii*, *Gordonispora fossulata*, *Lundbladispora* spp. and *Punctatisporites fungosus*, dominate. There are rare pollen of the *Lunatisporites* group and an acme of 'Fungal remain type 1' of Hochuli et al. (1989). The association recovered from cuttings samples in the higher part of the interval (2305 to 2212.0 m) contains poorly preserved palynomorphs

MAUD BASIN

WELL 7324/10-1 Lithostratigraphy 15.1.12/NPD Factpages	Sassendalen Group																														K.Toscana					
										Ingøydjupet Subgroup																		Storfjorden Subgp.									
	Havert						Kl.			Kobbe Formation																		Snadd Formation									
Age	EARLY TRIASSIC													MIDDLE TRIASSIC																		L.TRIASSIC					
	Induan					Olenekian								Anisian														Ladin				Carnian					
										e.Sp		l.Sp		early								middle					lt.										
Pollen / depth of core and cuttings samples	2919 cu	2732.00	2690.00	2645.5 cu	2557.5 cu	2521 cu	2512 cu	2305 cu	2272 cu	2245 cu	2212 cu	2155.00	2118.00	1925.00	1912.00	1856.00	1834.00	1822.00	1802.00	1783.00	1756.00	1733.00	1696.00	1671.00	1667.00	1640.00	1619.00	1587.00	1561.00	1543.00	1399.00	1360.00	1284.00	1185.00	1148.00	1108.00	947.00
Falcisporites spp.												x			x			C			C			C	C	C	x	C	A	C			C	C	x		x
Striatoabieites aytugii												x													x		x	x		x	x		x	x			x
Striatoabieites multistriatus												C		x	C	x	x	C	x	C	x	x			A	x	x	A	x	C	x	A	x		x	x	x
Vitreisporites pallidus												x																		x		x		x	x	C	
Lunatisporites spp.												A		C		A	x	A	A	A	A	x		C	A	C		C	C	C	C		x		x		
Protodiploxypinus spp.												x			x	C	x	C	C	x	x				x	x		x							x		
Alisporites spp.												C			x	x		C	C	x	x	x		C	C	A		C	A	C	x		C	x	A		
Angustisulcites klausii												x		x	C	C	x	x	C	C	C	x		C	x	x	x	x	C	x	x	x	x				
Cordaitina gunyalensis												x	x		C	x			x		C			x	x	C	x		x	x	x						
Triadispora obscura												C			x															x							
Lunatisporites acutus													x	x	x			x		x			x	C		x	x		x	x							
Lunatisporites pellucidus													x		x			x		x	x			C	x	x											
Illinites trivisus													x							x	C																
Triadispora spp.														x	x	C		A	C	C	C			C	A	A	x	C	A	A	C	C	C	C	x	C	x
Illinites chitonoides															x		x	C	C	A	C	x		A	C	C		C	A	C	C	C	C			x	C
Lunatisporites noviaulensis															x					x				C	x											x	
Bharadwajispora labichensis															x		x		x		x				x												
Protohaploxypinus spp.																		x		x				x						x					x		
Voltziaceaesporites heteromorpha																		x		x		x		x			x			x							
Succinctisporites grandior																		x	x	x	x		x		x	x	x	x									
Protodiploxypinus fastidioides																		C	C								C										
Cycadopites spp.																			x	x					x	x				x				A	x	C	x
Brachysaccus spp.																			x										C	x		x	x				
Dyupetalum cf. *vicentinense*																			x							x											
Angustisulcites grandis																				x	x						x			x							
Platysaccus spp.																				x																	
Podosporites amicus																								x			x	x			x	x	C	x	C	x	C
Podosporites spp.																								x				x	x	C	x			x	x	x	
Protohaploxypinus samoilovichii																									x	x											
Staurosaccites quadrifidus																										x	x			x	x	x	x	x		x	x
Protodiploxypinus ornatus																												x				x		x		x	C
Ovalipollis pseudoalatus																												x	x		C	C		C		C	
Sulcate pollen sp. A																												x	x	x	C	x	A		A	C	
Protodiploxypinus decus																												x							x	x	
Schizaeoisporites worsleyi																												x			x	x			x		
Echinitosporites iliacoides																												x	x	x	x						
Retisulcites sp.1																												x			x						
Accinctisporites circumdatus																													x	x							
Triadispora verrucata																													x	x							
Institisporites crispus																														x							
Triadispora modesta																														x							
Peroaletes spp.																																x					
Aulisporites astigmosus																																	C		x		
Enzonalasporites vigens																																			x	x	x
Tetrasaccus spp.																																			x		
Chasmatosporites spp.																																				C	A
Sulcate pollen																																					x
Spores																																					
Densoisporites nejburgii		A	A									x		x																							
Calamospora spp.												x			C	A		C	C	x				C	A	A	x	C	A	A	C	C	A	x	C	C	A
Todisporites spp.												x		x	x	C		x		C					x	x	x						x	x	x	x	x
Verrucosisporites spp.												x		C	x	C	x		x	C	x			x		x		x	C	C				x		x	x
Baculatisporites spp.												x												x	x	C			C	x						x	
Cyclotriletes spp.												x		x	x																	x	x		x	x	
Aratrisporites spp.												A	C	C	A	A	x	A	A	A	A	C		A	A	A	x	C		C			x	C	x		
Converrucosisporites spp.												x			x						x						x	x	x	x	C						
Kraeuselisporites apiculatus												x						x	x	x				x		x											
Cycloverrutriletes spp.												x																									
Deltoidospora minor													x			C	x		C	x	x	x				x		x	C	C	x		C	C	x	A	C
Jerseyiaspora punctispinosa													x	x	x		x	C	x	C	A	C	x	x	C	x											
Lycopodiacidites spp.														x					x	x							x		x	x	x		x		C	x	x
Aratrisporites centratus/macrocavatus														x	C	C	x	A	C	A	A			A	A	A		A	C	x	x	C				C	
Kraeuselisporites spp.														x	x			x	C	x				x				C	x	C		C	x	x	A	A	
Kraeuselisporites hystrix														x																			x		C		
Deltoidospora concavus														x	x						x				x												
Rewanispora spp.														x						x	x																
Foveotriletes spp.														x																							
Punctatosporites spp.														x																							
Verrucosisporites narmianus														x																							
Verrucosisporites thuringiacus														x																							
Anapiculatisporites spiniger															x												x		x								C
Apiculatisporites spp.															x			x	x					x		x	x		x	C	x		x	C	A	C	C
Striatella spp.															C	x	x	C	C	x	C			x		x		C	C	C	x	C	C	x	C	x	A
Deltoidospora australis															x																					x	
Leschikisporis aduncus															x	x					x				x	C					x	x			x	x	
Lundbladispora brevicula															x				x		x																
Microreticulatisporites spp.															x	x		x																			
Conbaculatisporites spp.																x		x	C	x				x	x	x	x	x	x	x	x	x	x			x	C
Composite Assemblage Zone	(P.poc)			(M.)		(N.s)				ind.		J.pu.		Anapiculatisp.spiniger								Triadi.obscura					P	E. iliacoid.				A. astigmosus					

LEGEND
D dominant
A abundant
C common
x present
cu cuttings

A.49.1.1 Well 7324/10-1, Sassendalen and Kapp Toscana groups, bases.

MAUD BASIN

Spores (cont.) / depth of core and cuttings samples	2919 cu	2732.00	2690.00	2645.5 cu	2557.5 cu	2521 cu	2512 cu	2305 cu	2272 cu	2245 cu	2212 cu	2155.00	2118.00	1925.00	1912.00	1856.00	1834.00	1822.00	1802.00	1783.00	1756.00	1733.00	1696.00	1671.00	1667.00	1640.00	1619.00	1587.00	1561.00	1543.00	1399.00	1360.00	1284.00	1185.00	1148.00	1108.00	947.00
WELL 7324/10-1 Lithostratigraphy 15.1.12/NPD Factpages	Sassendalen Group																														K.Toscana					
									Ingøydjupet Subgroup																		Storfjorden Subgp.									
	Havert						Kl.			Kobbe Formation																		Snadd Formation									
Age	EARLY TRIASSIC													MIDDLE TRIASSIC																		L.TRIASSIC					
	Induan					Olenekian								Anisian														Ladin				Carnian					
									e.Sp		l.Sp		early								middle					lt.										
Gordonispora lubrica																		x	x						x						x				x		
Cyclogranisporites spp.																		x			x																
Kraeuselisporites echinoides																		x																			
Retusotriletes spp.																				x	x							x							x		
Aratrisporites tenuispinosus																								x													
Dictyophyllidites spp.																											x	x	C	x							A
Thomsonisporites toralis																												x			C		x		x		
Densosporites spp.																												C	x	x	x	C	x		x	x	x
Semiretisporis spp.																												x	x	x	x					x	
Dictyotriletes spp.																												x		x							
Granulatisporites spp.																												x									
Kraeuselisporites cooksonae																													x	x	x				C	C	x
Zebrasporites fimbriatus																													x		x						x
Kraeuselisporites splendens																													x	x							
Acanthotriletes spp.																													x								
Leptolepidites spp.																														x					x		x
Neoraistrickia spp.																																				x	
Polycingulatisporites spp.																														x							
Concavisporites spp.																															x	C	C		A		
Planisporites spp.																															x				x		
Annulispora spp.																																	x				x
Camarozonosporites laevigatus																																	x	x	x	x	x
Camarozonosporites rudis																																	x		x	x	x
Lophotriletes spp.																																	x				
Gibeosporites hirsutus																																			x		x
Kyrtomisporis spp.																																			x		x
Lycopodiumsporites spp.																																			x		
Cingulizonates spp.																																				x	
Alete spore																																					C
Aratrisporites laevigatus																																					x
Kyrtomisporis laevigatus																																					x
Plankton and varia																																					
Tasmanites spp.												x	x		x	x		x		x				x					x						x		
Veryhachium spp.												x		x	x	x		x	x					x	x	x	A	x	x	x	C		x				
Cymatiosphaera spp.															x					x					x					x						x	
Micrhystridium spp.																x															x					x	
Dictyotidium spp.																												x		x							
Plaesiodictyon moesellanum																													C	x	x	A	C	C	x		
Botryococcus spp.																															x		C	C	x		C
Composite Assemblage Zone	(P.poc)			(M.)		(N.s)				ind.		J.pu.		Anapiculatisp.spiniger								Triadi.obscura					P	E. iliacoid.				A. astigmosus					

LEGEND
D dominant
A abundant
C common
x present
cu cuttings

(P. poc) = A composite assemblage zone, or age, in brackets has a low level of confidence

A.49.1.2 Well 7324/10-1, Sassendalen and Kapp Toscana groups, bases.

with rare occurrences of *Cycadopites* and *Pretricolpipollenites*.

The whole interval is assigned to the *Naumovaspora striata* Composite Assemblage Zone, although the presence of possibly caved material and the poor preservation results in identifications and correlation of low confidence for the interval from 2305 m up-section.

Kobbe Formation: 2272–1607 m (15.1.12/NPD Factpages)

Undated strata in the interval between 2245 and 2212 m (cuttings samples) coincide with the interpreted boundary between the Klappmyss and Kobbe formations. In the lower parts of the Kobbe Formation the sparse organic material is of dark colour and has little biostratigraphic value.

Interval 2183–2118 m, late Spathian

The associations are characterised by bisaccate pollen (*Angustisulcites klausii*, *Illinites chitonoides*, *Lueckisporites junior*, *Podosporites amicus*, *Protodiploxypinus doubingeri* and *Voltziaceaesporites heteromorpha*), common to abundant *Densoisporites nejburgii*, regularly occurring *Anapiculatisporites spiniger*, *Jerseyiaspora punctispinosa*, *Raistrickia* spp. and *Striatella seebergensis*. The regular presence of diverse marine algae (*Cymatiosphaera* spp., *Dictyotidium tenuiornatum* and *Veryhachium* spp.) confirms a marine depositional environment. This interval belongs to the *Jerseyiaspora punctispinosa* Composite Assemblage Zone.

Interval 2095–1756 m, early Anisian

This interval is separated by an undated interval of 23 m (2118.0–2095.0 m) from the underlying strata. Diverse bisaccate pollen (*Podosporites* spp., *Protodiploxypinus* spp. and *Triadispora* spp.) together with *Aratrisporites* (*A. palettae*, *A. macrocavatus*) dominate the associations from this interval. Other characteristic species include *Accinctisporites circumdatus*, *Cordaitina gunyalensis* (acme) and regular to common *D. nejburgii*, *J. punctispinosa*, *Gordonispora fossulata*, *Protodiploxypinus ornatus*, *Raistrickia* spp., *Staurosaccites quadrifidus*, *S. seebergensis* and *Triadispora verrucata*.

At 1856.0 m there is a record of *Lundbladispora brevicula* and at 1781.9 m of *Lueckisporites junior*. Of note is an acme of *J. punctispinosa* at 1822.0 m. Palynomorphs, cuticles and dark woody material dominate the generally coarse, variably degraded organic remains. Palynomorphs account for a large proportion of the residues. Compared to the abundance of pollen and spores, the algal remains are subordinate; *Micrhystridium* spp. may be common and *Veryhachium* spp. appears regularly together with the green algae *Cymatiosphaera* spp. and *Tasmanites* spp. The interval is assigned to the *Anapiculatisporites spiniger* Composite Assemblage Zone.

Interval 1750–1640 m, Middle Anisian
Abundant *Illinites chitonoides* and *Cordaitina gunyalensis* together with the *Aratrisporites* and the *Calamospora* groups, and the regular to common occurrence of *J. punctispinosa*, characterise this association dominated by bisaccate pollen. The presence of *Triadispora labichensis* and *Verrucosisporites* spp. distinguishes the interval from that above. The pollen *Accinctisporites circumdatus*, *S. quadrifidus* and *Striatoabieites balmei* occur together with spores such as *Aratrisporites centratus/macrocavatus*, *A. palettae*, *P. fungosus* and *Cyclotriletes pustulatus*. The samples comprise dominant sheet-like material (evaluated as AOM), woody organic matter and pollen. The organic remains are generally strongly fragmented and poorly preserved. Marine algae, *Veryhachium* spp., sporadic *Cymatiosphaera* and *Tasmanites* occur in the upper part. The association is assigned to the *Triadispora obscura* Composite Assemblage Zone.

1612 m, Late Anisian
The association recovered from the highest sample level of the Kobbe Formation shows mostly low numbers of pollen, including *A. circumdatus*, *Angustisulcites klausii*, *Araucariacites australis*, C. *gunyalensis*, *I. chitonoides*, *Podosporites amicus*, *Protodiploxypinus* fastidioides (common), *S. quadrifidus*, *Striatoabieites* spp. and *Triadispora* spp. Spores also occur in low numbers; including smooth forms together with *Anapiculatisporites spiniger*, Con*baculatisporites* spp. and *Kraeuselisporites* spp. The marine plankton *Veryhachium* spp. occurs in abundance and seems to represent a marine environment different from that of the underlying interval. The sample is tentatively assigned to the *Protodiploxypinus decus* Composite Assemblage Zone.

Snadd Formation: 1607–606 m (15.1.12/NPD Factpages)
Interval 1587–1399 m, Ladinian
Dark-brown, variably degraded, partly very coarse remains of woody tissues dominate the residues. They contain diverse palynological associations dominated by the pollen groups *Angustisulcites*, *Illinites*, *Lunatisporites*, *Striatoabieites* and *Triadispora*. Abundant spores of the *Aratrisporites*, *Calamospora* and *Striatella* groups occur together with *Leschikisporis aduncus*. The latter shows an acme zone ranging from 1414 m to 1148 m of the interval above. Otherwise the association is characterised by a number of incoming records such as the pollen *Echinitosporites iliacoides*, *Protodiploxypinus decus*, *Ovalipollis pseudoalatus*, *Protodiploxypinus ornatus*, *Schizaeoisporites worsleyi* and *Triadispora verrucata* and the spores *Kraeuselisporites cooksonae*, *K. splendens*, *Semiretisporis* sp. 'A' and *Zebrasporites fimbriatus*.

Freshwater plankton (*Botryococcus* spp. and *Plaesiodictyon mosellanum*) and marine plankton (*Dictyotidium* spp., *Micrhystridium* spp., *Tasmanites* spp. and *Veryhachium* spp.) occur regularly up to 1399 m. The association is assigned to the *Echinitosporites iliacoides* Composite Assemblage Zone.

Interval 1360.00–676.5 m, early to mid Carnian
Together with an acme of *Aulisporites astigmosus*, the acme phase of *Leschikisporis aduncus* continues up to 1148 m. The diverse association from the core samples between 1360 m and 947 m (Tables A.49.1 and 2) is distinguished from the *E. iliacoides* Zone below by the presence of *Aulisporites astigmosus*, *Enzonalasporites vigens*, *Tetrasaccus* spp. and *Chasmatosporites*, together with common smooth trilete spores, as well as *Camarozonosporites* spp., *Cingulizonates* spp., *Concavisporites* spp., *Gibeosporites* spp., *Kyrtomisporis* spp. and a highest record of *Aratrisporites laevigatus*.

Marine plankton include sporadic *Micrhystridium* spp., *Veryhachium* spp., *Cymatiosphaera* spp. and *Tasmanites* spp. Fresh and brackish water plankton are common and include *Botryococcus* and *Plaesiodictyon mosellanum*. Fairly coarse, variably coloured plant remains occur together with degraded woody tissues, large cuticle fragments and some pale or grey, degraded organic sheets. The interval is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

Diverse associations are reported from the uppermost part of the interval, 924.0–676.5 m, with acme levels of *Leschikisporis* and *Aulisporites astigmosus*, in the presence of *Schizaeoisporites worsleyi* and common *Kraeuselisporites* spp. up to 858.0 m. *Duplicisporites granulatus*, *Enzonalasporites vigens* and *Retisulcites perforatus* occur at 814.5 m, whereas *Angustisulcites klausii* and *Illinites chitonoides* are recorded at 698 m. The sample at 686.0 m is characterised by the abundance and diversity of pollen of the *Triadispora* group (*T. verrucata* and *T. plicata*) as well as the presence of *Eucommiidites granulosus*, *Gibeosporites hirsutus* and *Voltziaceaesporites heteromorpha*. The uppermost sample (676.5 m) contains *Discisporites* spp., *Ovalipollis pseudoalatus* (common), *Retusotriletes* spp., *Sellaspora foveorugulata*, *S. rugoverrucata* and *Semiretisporis* sp. A. This association, like the underlying one, is assigned to the *Aulisporites astigmosus* Composite Assemblage Zone.

MAUD BASIN

WELL 7324/10-1	Sassendalen Group																															K.Toscana					
Lithostratigraphy										Ingøydjupet Subgroup																		Storfjorden Subgp.									
15.1.12/NPD Factpages	Havert						Kl.			Kobbe Formation																		Snadd Formation									
Age	EARLY TRIASSIC													MIDDLE TRIASSIC																		L.TRIASSIC					
	Induan					Olenekian								Anisian														Ladin				Carnian					
										e.Sp		l.Sp		early								middle					lt.										
Pollen / depth of core and cutttings samples	2919 cu	2732.00	2690.00	2645.5 cu	2557.5 cu	2521 cu	2512 cu	2305 cu	2272 cu	2245 cu	2212 cu	2155.00	2118.00	1925.00	1912.00	1856.00	1834.00	1822.00	1802.00	1783.00	1756.00	1733.00	1696.00	1671.00	1667.00	1640.00	1619.00	1587.00	1561.00	1543.00	1399.00	1360.00	1284.00	1185.00	1148.00	1108.00	947.00
Falcisporites spp.												x			x			C			C			C	C	C	x	C	A	C			C	C	x		x
Striatoabieites aytugii												x													x		x	x		x	x		x	x			x
Striatoabieites multistriatus												C		x	C	x	x	C	x	C	x	x			A	x	x	A	x	C	x	A	x		x	x	x
Vitreisporites pallidus														x	x	C		A	C	C	C			C	A	A	x	C	A	A	C	C	C	C	x	C	x
Lunatisporites spp.															x		x	C	C	A	C	x		A	C	C		C	A	C	C	C	C			x	C
Protodiploxypinus spp.																			x	x					x	x				x				A	x	C	x
Alisporites spp.																								x			x	x			x	x	C	x	C	x	C
Angustisulcites klausii																										x	x			x	x	x	x	x		x	x
Cordaitina gunyalensis																												x				x		x		x	C
Triadispora obscura																																			x	x	x
Lunatisporites acutus																																				C	A
Lunatisporites pellucidus																																					x
Illinites trivisus												x																		x		x		x	x	C	
Triadispora spp.															x					x				C	x											x	
Illinites chitonoides																								x				x	x	C	x			x	x	x	
Lunatisporites noviaulensis																												x	x		C	C		C		C	
Bharadwajispora labichensis																												x	x	x	C	x	A		A	C	
Protohaploxypinus spp.																												x							x	x	
Voltziaceaesporites heteromorpha												A		C		A	x	A	A	A	A	x		C	A	C		C	C	C	C		x		x		
Succinctisporites grandior												x			x	C	x	C	C	x	x				x	x		x							x		
Protodiploxypinus fastidioides												C			x	x		C	C	x	x	x		C	C	A		C	A	C	x		C	x	A		
Cycadopites spp.																		x		x				x						x					x		
Brachysaccus spp.																												x			x	x			x		
Dyupetalum cf. *vicentinense*																																	C		x		
Angustisulcites grandis																																			x		
Platysaccus spp.												x		x	C	C	x	x	C	C	C	x		C	x	x	x	x	C	x	x	x	x				
Podosporites amicus																			x										C	x		x	x				
Podosporites spp.																																x					
Protohaploxypinus samoilovichii												x		x	C	x			x		C			x	x	C	x		x	x	x						
Staurosaccites quadrifidus																												x	x	x	x						
Protodiploxypinus ornatus																												x			x						
Ovalipollis pseudoalatus												C			x															x							
Sulcate pollen sp. A														x	x			x		x			x	C		x	x		x	x							
Protodiploxypinus decus																		x		x		x		x			x			x							
Schizaeoisporites worsleyi																				x	x						x			x							
Echinitosporites iliacoides																													x	x							
Retisulcites sp.1																													x	x							
Accinctisporites circumdatus																														x							
Triadispora verrucata																														x							
Institisporites crispus																		x	x	x	x		x		x	x	x	x									
Triadispora modesta																		C	C								C										
Peroaletes spp.															x			x		x	x			C	x	x											
Aulisporites astigmosus																			x							x											
Enzonalasporites vigens																									x	x											
Tetrasaccus spp.															x		x		x		x				x												
Chasmatosporites spp.																				x	C																
Sulcate pollen																				x																	
Spores																																					
Densoisporites nejburgii												x		x	x	C		x		C					x	x	x						x	x	x	x	x
Calamospora spp.												C		C	x	C	x		x	C	x			x		x		x	C	C				x		x	x
Todisporites spp.												x			C	A		C	C	x				C	A	A	x	C	A	A	C	C	A	x	C	C	A
Verrucosisporites spp.																C	x		C	x	x	x				x		x	C	C	x		C	C	x	A	C
Baculatisporites spp.														x					x	x							x		x	x	x		x		C	x	x
Cyclotriletes spp.															C	x	x	C	C	x	C			x		x		C	C	C	x	C	C	x	C	x	A
Aratrisporites spp.															x												x		x								C
Converrucosisporites spp.															x			x	x					x		x	x		x	C	x		x	C	A	C	C
Kraeuselisporites apiculatus																x		x	C	x				x	x	x	x	x	x	x	x	x	x			x	C
Cycloverrutriletes spp.																											x	x	C	x							A
Deltoidospora minor																												C	x	x	x	C	x		x	x	x
Jerseyiaspora punctispinosa																													x		x						x
Lycopodiacidites spp.																													x	x	x				C	C	x
Aratrisporites centratus/macrocavatus																														x					x		x
Kraeuselisporites spp.																																	x				x
Kraeuselisporites hystrix																																	x	x	x	x	x
Deltoidospora concavus																																	x		x	x	x
Rewanispora spp.																																			x		x
Foveotriletes spp.																																			x		x
Punctatosporites spp.																																					C
Verrucosisporites narmianus																																					x
Verrucosisporites thuringiacus																																					x
Anapiculatisporites spiniger												x		x	x																	x	x		x	x	
Apiculatisporites spp.												x												x	x	C			C	x						x	
Striatella spp.														x	x			x	C	x				x				C	x	C		C	x	x	A	A	
Deltoidospora australis														x	C	C	x	A	C	A	A			A	A	A		A	C	x	x	C				C	
Leschikisporis aduncus															x																					x	
Lundbladispora brevicula															x	x					x				x	C					x	x			x	x	
Microreticulatisporites spp.																												x	x	x	x					x	
Conbaculatisporites spp.																														x						x	
Composite Assemblage Zone	(P.poc)				(M.)	(N.s)				ind.		J.pu.		Anapiculatisp.spiniger								Triadi.obscura					P	E. iliacoid.				A. astigmosus					

LEGEND
D dominant
A abundant
C common
x present
cu cuttings

(P. poc) = A composite assemblage zone, or age, in brackets has a low level of confidence

A.49.2.1 Well 7324/10-1, Sassendalen and Kapp Toscana groups, tops.

Interval 676.5–663.0 m, Late Carnian

A distinct and diverse association of spores and pollen is recorded in this interval, primarily in the sample at 667.5 m (Plate 32). The diverse assemblage of spores comprises *Anapiculatisporites spiniger* (very common), *Leschikisporis aduncus*, *Kyrtomisporis* spp. and *Zebrasporites*

MAUD BASIN

WELL 7324/10-1 Lithostratigraphy 15.1.12/NPD Factpages	Sassendalen Group																															K.Toscana					
									Ingøydjupet Subgroup																		Storfjorden Subgp.										
	Havert						Kl.			Kobbe Formation																	Snadd Formation										
Age	EARLY TRIASSIC													MIDDLE TRIASSIC																		L.TRIASSIC					
	Induan					Olenekian								Anisian														Ladin				Carnian					
										e.Sp		l.Sp		early								middle					lt.										
Spores (cont.) / depth of core and cuttings samples	2919 cu	2732.00	2690.00	2645.5 cu	2557.5 cu	2521 cu	2512 cu	2305 cu	2272 cu	2245 cu	2212 cu	2155.00	2118.00	1925.00	1912.00	1856.00	1834.00	1822.00	1802.00	1783.00	1756.00	1733.00	1696.00	1671.00	1667.00	1640.00	1619.00	1587.00	1561.00	1543.00	1399.00	1360.00	1284.00	1185.00	1148.00	1108.00	947.00
Cingulizonates spp.																																				x	
Aratrisporites spp.												A	C	C	A	A	x	A	A	A	A	C		A	A	A	x	C		C			x	C	x		
Kraeuselisporites hystrix														x																			x		C		
Gordonispora lubrica																		x	x						x						x				x		
Retusotriletes spp.																				x	x							x							x		
Thomsonisporites toralis																												x			C		x		x		
Concavisporites spp.																															x	C	C		A		
Planisporites spp.																															x				x		
Lycopodiumsporites spp.																																			x		
Lophotriletes spp.																																	x				
Converrucosisporites spp.												x			x						x						x	x	x	x	C						
Dictyotriletes spp.																												x		x							
Kraeuselisporites splendens																													x	x							
Polycingulatisporites spp.																														x							
Acanthotriletes spp.																													x								
Granulatisporites spp.																												x									
Kraeuselisporites apiculatus												x						x	x	x				x		x											
Jerseyiaspora punctispinosa													x	x	x		x	C	x	C	A	C	x	x	C	x											
Deltoidospora concavus														x	x						x				x												
Aratrisporites tenuispinosus																								x													
Rewanispora spp.														x						x	x																
Lundbladispora brevicula															x				x		x																
Cyclogranisporites spp.																		x			x																
Microreticulatisporites spp.															x	x		x																			
Kraeuselisporites echinoides																		x																			
Densoisporites nejburgii		A	A									x		x																							
Foveotriletes potoniei														x																							
Punctatosporites spp.														x																							
Verrucosisporites narmianus														x																							
Verrucosisporites thuringiacus														x																							
Cycloverrutriletes spp.												x																									
Plankton and varia																																					
Botryococcus spp.																															x		C	C	x		C
Cymatiosphaera spp.															x					x					x					x						x	
Micrhystridium spp.																x															x					x	
Tasmanites spp.												x	x		x	x		x		x				x					x						x		
Plaesiodictyon moesellanum																													C	x	x	A	C	C	x		
Veryhachium spp.												x		x	x	x		x	x					x	x	x	A	x	x	x	C		x				
Dictyotidium spp.																												x		x							
Composite Assemblage Zone	(P.poc)			(M.)		(N.s)				ind.		J.pu.		Anapiculatisp.spiniger								Triadi.obscura					P	E. iliacoid.				A. astigmosus					

LEGEND
D dominant
A abundant
C common
x present
cu cuttings

A.49.2.2 Well 7324/10-1, Sassendalen and Kapp Toscana groups, tops.

interscriptus, as well as the pollen taxa *Aulisporites astigmosus*, *Staurosaccites quadrifidus* and *Triadispora crassa.*

Plankton from a marginal marine environment include rare *Micrhystridium* spp. and *Rhaetogonyaulax* spp., as well as freshwater forms such as abundant *Botryococcus* spp. and *Plaesiodictyon mosellanum*. The oldest records of *Rhaetogonyaulax* spp. are in sample 667 m. The assemblage is assigned to the *Rhaetogonyaulax* spp. Composite Assemblage Zone.

Fruholmen Formation: 606–577 m (15.1.12/NPD Factpages)

Interval 633–582 m, Norian

The diverse assemblage from this level comprises abundant *Araucariacites australis* and *Chasmatosporites magnolioides*, as well as *Anapiculatisporites spiniger*, *Annulispora folliculosa*, *Aratrisporites macrocavatus*, *Baculatisporites comaumensis*, *Cingulizonates rhaeticus*, *Duplicisporites* sp., *Kyrtomisporis gracilis*, *K. laevigata* (common), *K. niger* (common), *K. speciosus* (common), *Lunatisporites noviaulensis*, *Ovalipollis pseudoalatus* (common), *Protodiploxypinus gracilis*, *P. minor*, *P. ornatus*, *Ricciisporites tuberculatus*, *Stereisporites* spp. and *Striatella seebergensis* (common). At 615.0 m, *Duplicisporites* spp., *Enzonalasporites vigens*, *Gordonispora fossulata*, *Podosporites amicus*, *Porcellispora longdonensis* and *Striatoabieites multistriatus* are recorded. At 599 m, the plankton comprise dinoflagellate cysts (*Hebecysta* spp., *Heibergella* spp. and cf. *Rhaetogonyaulax* spp.). The acritarchs *Micrhystridium* spp. and *Veryhachium* spp. and the green algae *Botryococcus* spp. and *Plaesiodictyon mosellanum* occur throughout the section. This association is assigned to the *Limbosporites lundbladii* Composite Assemblage Zone.

576.5 m, Norian/Rhaetian

The association includes the *Aratrisporites* group, *Araucariacites australis*, *Baculatisporites comaumensis*, *Kraeuselisporites* spp., *Lunatisporites* spp., *Lycopodiacidites rugulatus*, *Protodiploxypinus minor*, *P. ornatus*, *Striatella seebergensis* and *Striatoabieites* spp. Brown to black, variably degraded woody fragments and cuticles dominate the residue. The association may tentatively be assigned to the *Limbosporites lundbladii* Composite Assemblage Zone or to the *Ricciisporites tuberculatus* Composite Assemblage Zone.

Stratigraphic evidence clearly differentiating Rhaetian deposits is missing in this well.

D. Plates illustrating palynomorphs

D.1 Svalbard

Plates 1–10

D.2 Barents Sea Cores

Plates11–18:	Svalis Dome,	7323/7–U–1 to U–10
Plates 19–21:	Sentralbanken,	7533/2–U–2
Plate 22:	Sentralbanken,	7533/3–U–7
Plates 23–24:	Sentralbanken,	7534/4–U–1
Plates 25–28:	Sentralbanken,	7534/6–U–1

D.3 Barents Sea exploration wells

Plates 29–30:	Finnmark Platform,	7121/1–1R
Plates 31–32:	Bjarmeland Platform, Lopparyggen,	7224/7–1B
Plate 33:	Bjarmeland Platform, Maud Basin,	7324/10–1

Most plates present pictures produced for restricted industrial reports dated 1989 to 1999

D.1 SVALBARD PLATES 1–10

Plate 1: Early Triassic Palynomorphs from Svalbard

Illustrated specimens are enlarged according to the scale bars representing 50 μm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets. Some of the photographs have been presented by Mørk et al. (1999b).
Note the shorter scale bar for figures A* and D*.

Spitsbergen, Vikinghøgda (Locality No. 11):
Vikinghøgda Formation, Deltadalen Member (Table A.7, 0.2–67.8 m)
A. Palynofacies, terrestrial OM* (13 m x2: O24).
D. Palynofacies, terrestrial OM* (1.0–1.2 m x2: N26).

Spitsbergen, Bravaisberget (Locality Nos. 2a and b):
Vardebukta (Table A.2, 0.0–205.0 m) and Tvillingodden (Table A.2, 205.0–470.0 m) formations
E. *Kraeuselisporites apiculatus* (1.5 m x2: Y22/1).
G. 'Fungal remain type 1' sensu Hochuli et al. 1989 (230.0 m x: G29).
H. *Densoisporites nejburgii* (1.5 m x: S21/2).
M. *Lundbladispora* sp. (6.5 m x2: Y22/3).
Q. *Rewanispora* sp. (230.0 m x: G28/2).

Spitsbergen, Festningen (Locality No. 1a):
Vardebukta Formation (Table A.1.1, 0.2–8.3 m)
C. *Falcisporites* sp. (0.2 m x: D26/3).
J. *Ephedripites* sp. (6.5 m x: O26/3).
K. *Proprisporites pocockii* (0.2 m x2: X 16/2).
L. *Vittatina* sp. (0.2 m x2: W17).
N. *Lycospora imperialis* (0.2 m x: C13/4).
P. *Reduviasporonites chalastus* (6.5 m x: S29).

Spitsbergen, Tschermakfjellet (Locality No. 9a):
Vikinghøgda Formation, Deltadalen Member (Table A.5.1, 0.5–32.0 m)
B. *Pechorosporites* sp. (0.5 m si: D28/4).
F. Taeniate bisaccate pollen (0.5 m si: T6/16)
I. *Kraeuselisporites* sp. (0.5 m x: X18/3).
O. *Micrhystridium* sp. (0.5 m si: D23/2).
R. *Densoisporites* sp. (0.5 m si: D15).

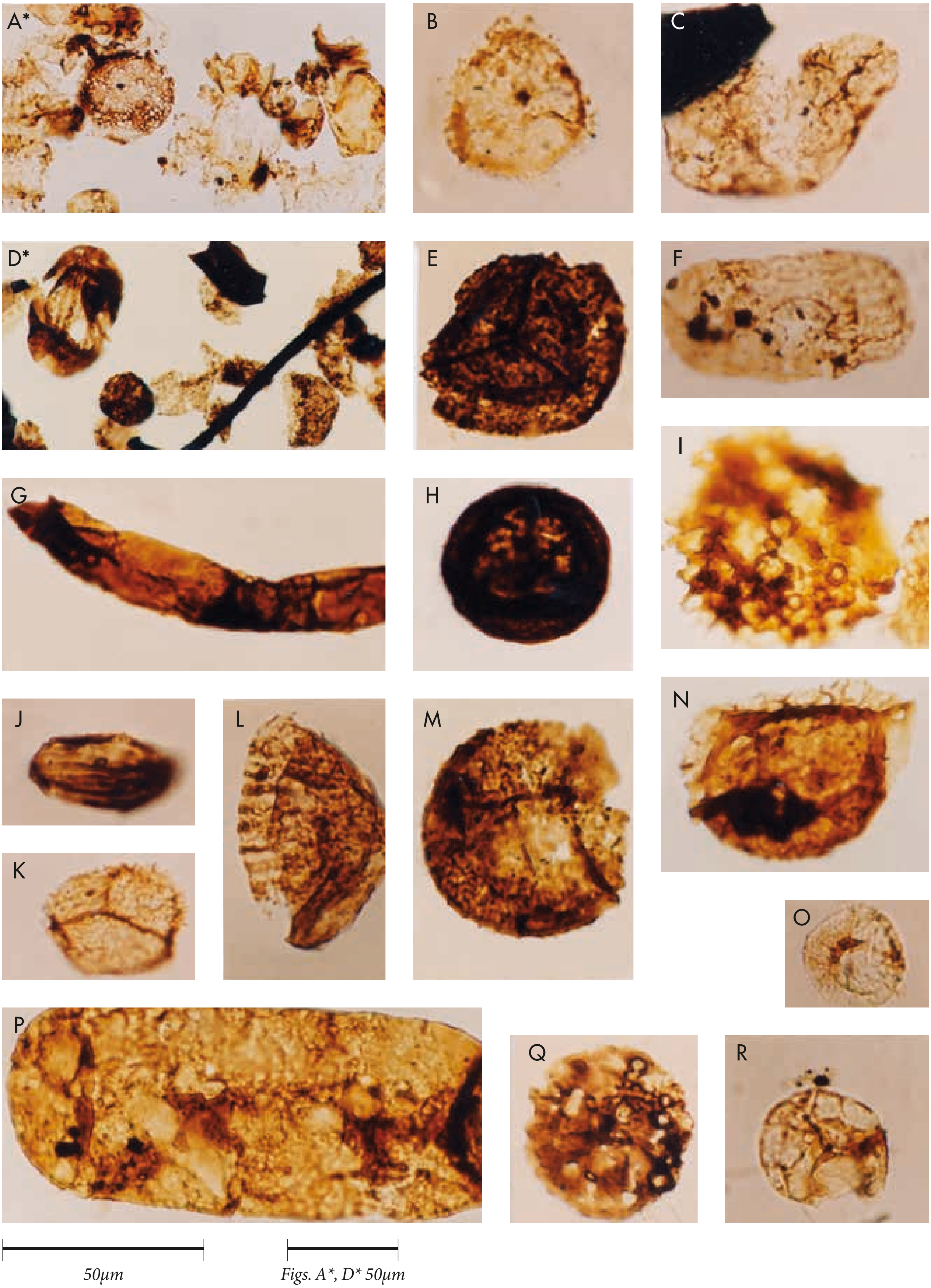

A*
B
C
D*
E
F
G
H
I
J
L
M
N
K
O
P
Q
R
50μm
Figs. A*, D* 50μm

Plate 2: Early Triassic palynomorphs from Svalbard

Illustrated specimens are enlarged according to the scale bars representing 50 µm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets. Some of the photographs have been presented by Mørk et al. (1999b). Note the short scale bar for Fig. H*.

Spitsbergen, Vikinghøgda (Locality No. 11): Vikinghøgda Formation, Deltadalen Member (Table A.7, 0.2–67.8 m)
A. *Crustaesporites globosus* (11.2 m x2: R28).
B. *Pechorosporites intermedius* (27.5 m x3: L21).
C. *Reduviasporonites chalastus* (67.0 m x: Q33/4).
D. *Densoisporites playfordi* (11.2 m x2: R22/4).
F. *Pechorosporites coronatus* (62.2 m si: U32/4).
G *Proprisporites pococki* (11.2 m x3: K–L25).

Spitsbergen, Vikinghøgda: Vikinghøgda Formation, Lusitaniadalen Member (Table A.7, 68.6.6–156.8 m)
E. 'Fungal remain type 1' sensu Hochuli et al. 1989 (137.5 m si: Q25–26).
I. *Kraeuselisporites spinosus* (144.2 m si: Q20/4).
J. 'Planktonic alga type A' sensu Mørk et al. 1999b (122.3 m x: N32–33).
K. *Micrhystridium* sp. and Planktonic alga type A (m: R30/3).

Spitsbergen, Vikinghøgda: Vikinghøgda Formation, Vendomdalen Member (Table A.7, 168.0–233.8 m)
H. Palynofacies with *Rewanispora foveolata** (X25, 168 m x2: W34–35).
L. *Tasmanites* sp. (168 m x2: H/J27).
M. *Jerseyiaspora punctispinosa* (190.3 m x5: R23).
N. *Uvaesporites* sp. (233.8 m x2: K35).
O. *Cyclotriletes pustulatus* (197.4 m x3: P24).
P. *Gordonispora fossulata* (175.0 m, x2: M32–33).
Q. *Lycopodiacidites* cf. *kuepperi* (226.0 m x5: S33–34).
R. *Kraeuselisporites apiculatus* (213.0 m x3: N29–28).
S. *Cymatiosphaera* sp. (221.8 m x5: M27).

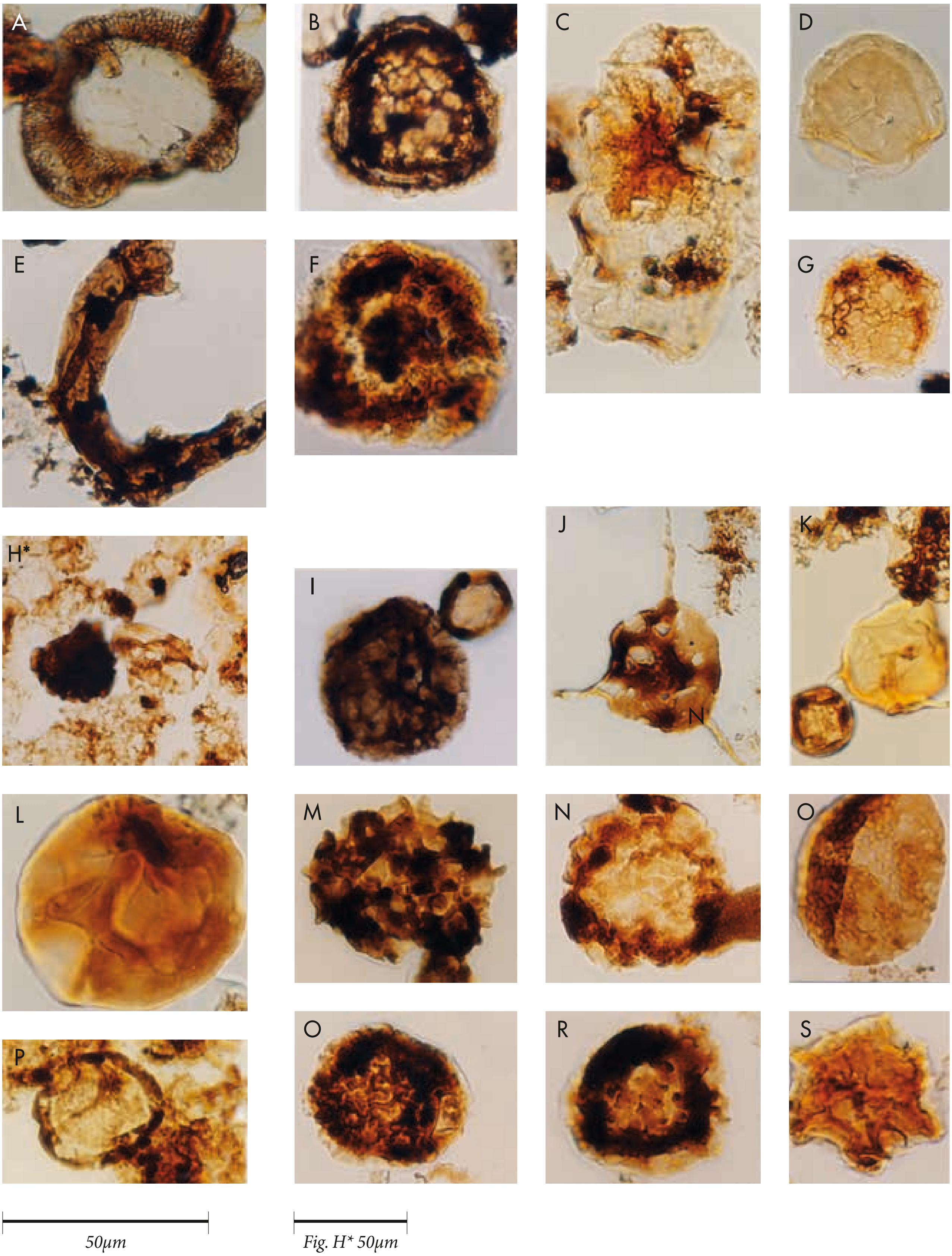

A
B
C
D
E
F
G
H*
I
J
K
N
L
M
N
O
P
O
R
S
50µm
Fig. H* 50µm

Plate 3: Early Triassic palynomorphs from Svalbard

Illustrated specimens are enlarged according to the scale bar representing 50 μm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets.

Barentsøya, Høgrinden (Locality No. 20): Vikinghøgda Formation m, Lusitaniadalen (Table A.16, 2.0–32.0 m) and Vendomdalen (Table A.16, 44–113.0 m) members

A. *Striatoabieites* sp. (8.0 m x: D25/2).
B. *Rewanispora* sp. (2.0 m x: E11).
C. *Lundbladispora* sp. (8.0 m x: Q37).
D. *Verrucosisporites* sp. (8.0 m x: D39/3).
F. 'Planktonic alga type A' sensu Mørk et al. (1999b) (2.0 m x: H26).
G. *Polycingulatisporites* sp. (8.0 m x: R19).
L. *Cymatiosphaera* sp. L (55.0 m x: Z14).

Edgeøya, Skrukkefjellet (Locality No. 21): Vikinghøgda Formation, Lusitaniadalen Member (Table A.17, 13.0 m)

E. *Podosporites* sp. (13.0 m x: V31/1).
H. *Gordonispora fossulata* (13.0 m x4: R17/3).
I. *Verrucosisporites triassicus* (13.0 m x4: N13/3).
J. *Pretricolpipollenites* sp. (13.0 m x4: Q31).
K. *Densoisporites nejburgii* (13.0 m x4: N16).
M. *Verrucosisporites* sp. (13.0 m x4: O31/3).
N. *Proprisporites pocockii* (13.0 m x4: S18/1).

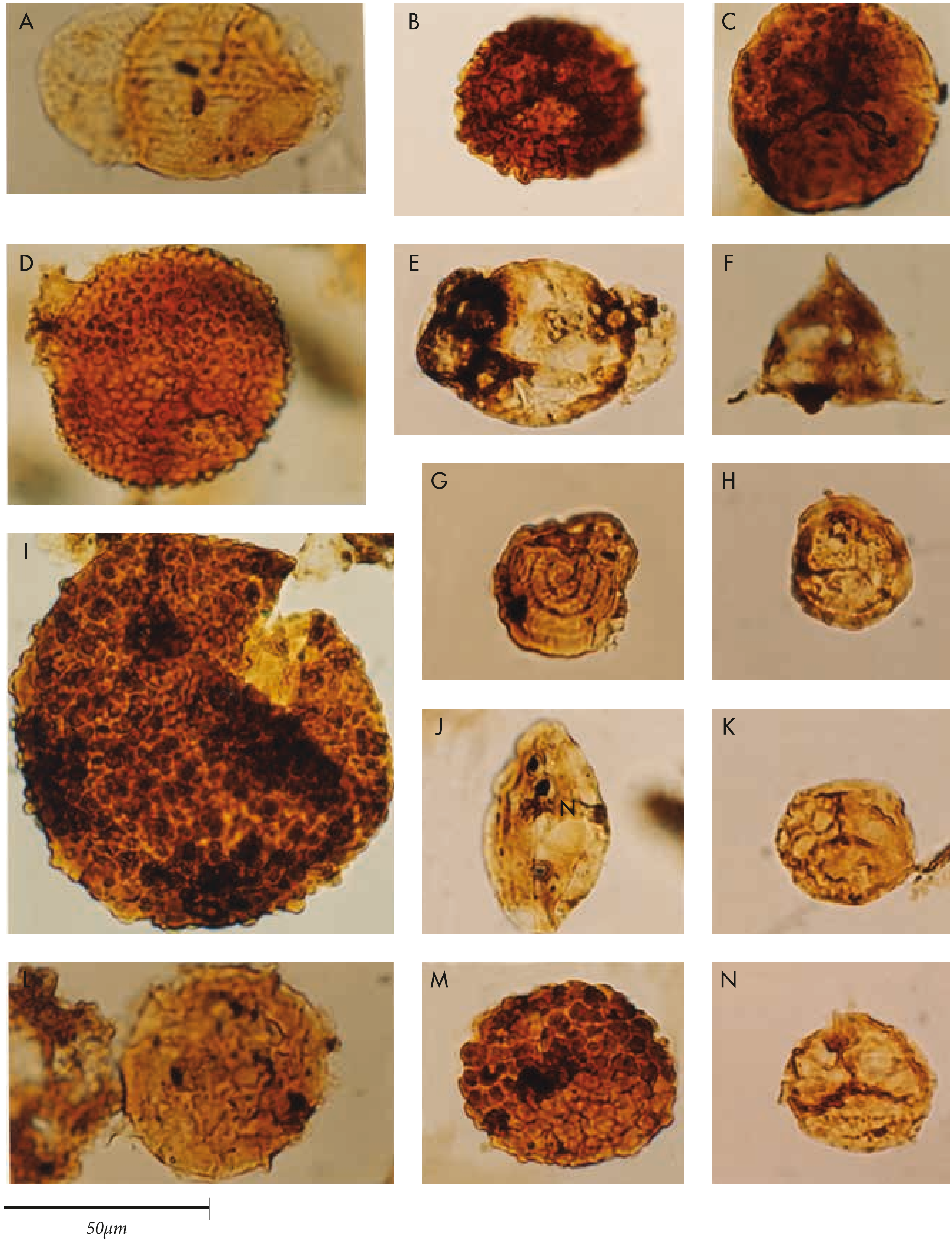

A
B
C
D
E
F
G
H
I
J
N
K
L
M
N
50μm

Plate 4: Middle Triassic palynomorphs from Svalbard

Illustrated specimens are enlarged according to the scale bars representing 50 µm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets. Note the longer scale bar for Figure H*.

Barentsøya, Høgrinden (Locality No. 20): Vikinghøgda Formation, Vendomdalen Member (Table A.16, 44–113.0 m)
E. *Striatella seebergensis*. (92.0 m x2: K19).

Barentsøya, Høgrinden: Botneheia Formation (Table A.16, 125.0–200.0 m).
C. *Kraeuselisporites* sp. (143.0 m x: D31).
D. Indeterminate spore (143.0 m x: U26).
F. *Densoisporites* sp. (155.0 m x3: Z34).
G. *Cymatiosphaera* sp. L (125.0 m x2: M25/1).
I. Ephedripites sp. (155.0 m x3: Q16).
J. *Micrhystridium* sp. F. (167.0 m x3: F30/4)
M. *Densoisporites* sp. (125.0 m x2: H19).
N. *Triadispora* sp. (125.0 m x2: O18).
P. *Veryhachium* sp. L. (143.0 m x2: F22/4).

Edgeøya, Skrukkefjellet (Locality No. 21): Botneheia Formation (Table A.17, 79.0 m)
A. Indeterminate spore (79.0 m x2: D19).
B. Indeterminate spore (79.0 m x2: F22/1).

Spitsbergen, Tschermakfjellet (Locality No. 9a): Botneheia Formation (Table A.5.1, 166.0–200.0 m)
H. *Eresinia spinellata* * (185.0 m x2: E22/2).
K. *Gordonispora fossulata* (166.0 m x: P26/2).
L *Uvaesporites* sp. (92.0 m x2: U31/3).
O. *Kraeuselisporites cuspidus* (175.0 m x2: Y21/3).
Q. *Lapposisporites* sp., tetrad (175.0 m: H19/2).

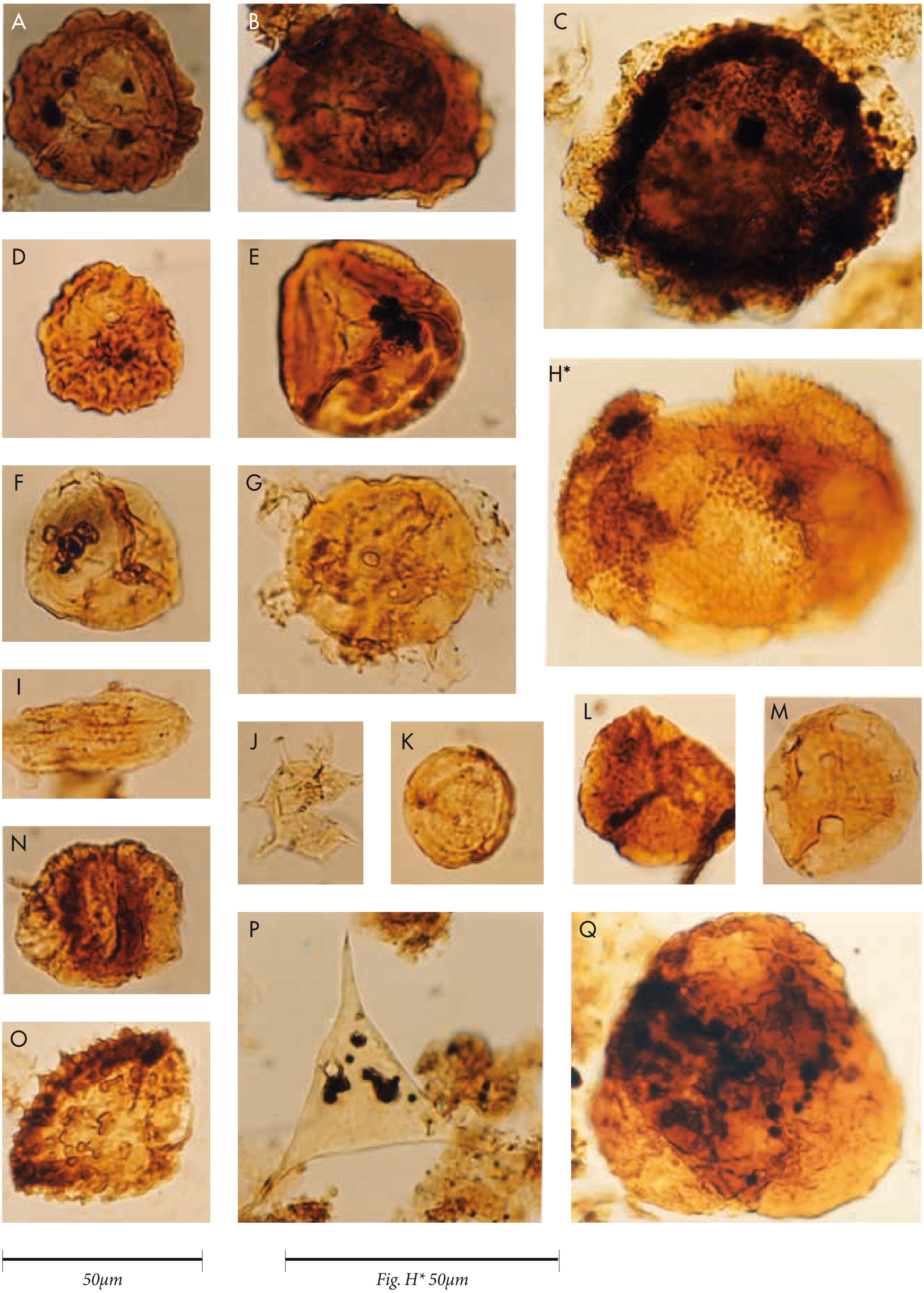

A
B
C
D
E
H*
F
G
I
J
K
L
M
N
P
Q
O
50µm
Fig. H* 50µm

Plate 5: Middle Triassic palynomorphs from Svalbard

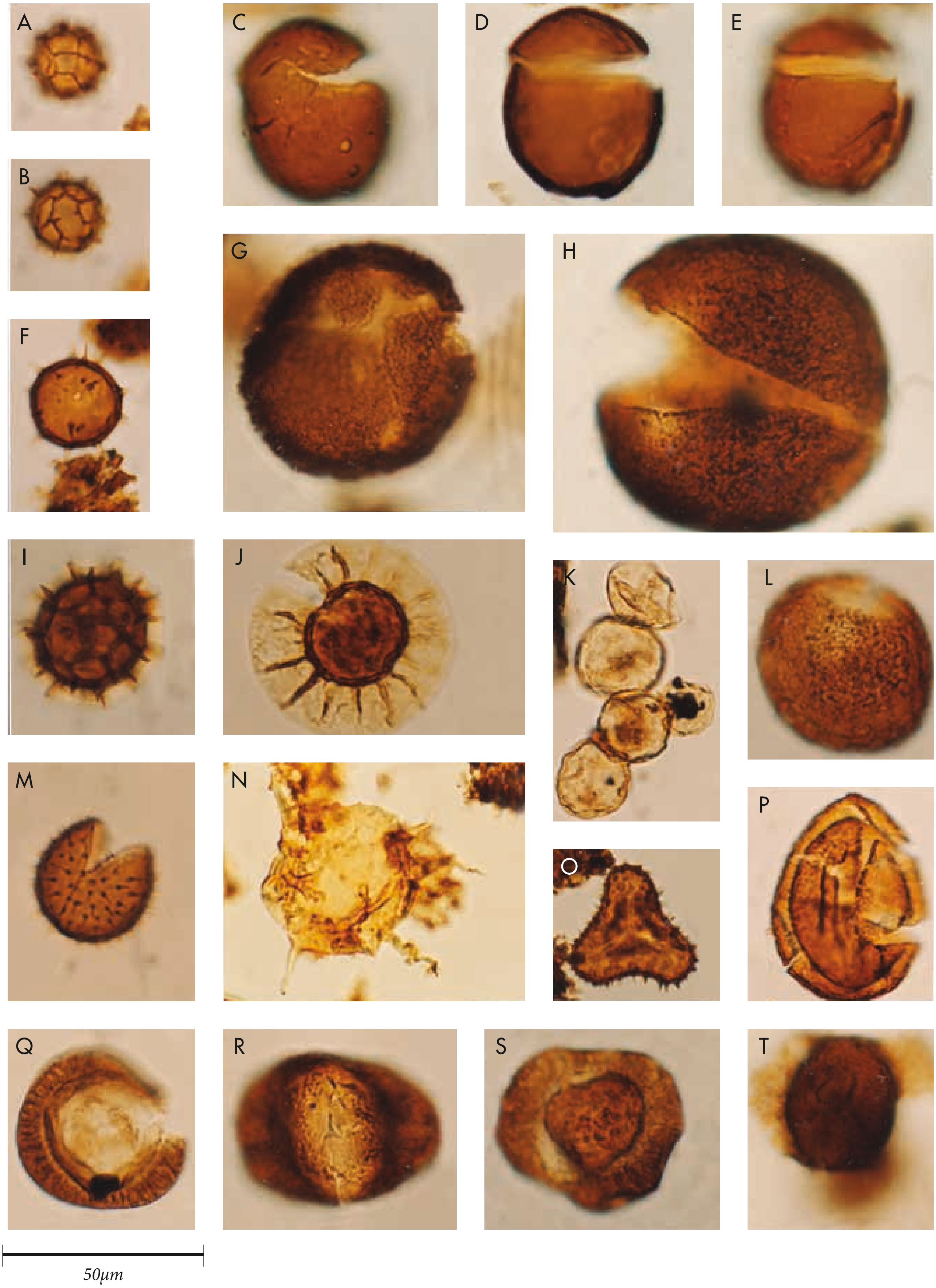
Illustrated specimens are enlarged according to the scale bar representing 50 μm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets.

Edgeøya, Skrukkefjellet (Locality No. 21): Botneheia Formation m (Table A.17, 72.0–149.5 m)

A. *Cymatiosphaera* sp. (119.0 m x2: F23/3).
B. *Cymatiosphaera* sp. (119.0 m x2: F23/3).
C. *Sentusidinium* sp. (119.0 m x: (L28).
D. *Sentusidinium* sp. (119.0 m x: (L28).
E. *Sentusidinium* sp. (119.0 m x: (L28).
F. *Micrhystridium* sp. (119.0 m x2: T14/4).
G. *Sentusidinium* sp. A (119.0 m x2: D28/2).
H. *Sentusidinium* sp. A (119.0 m si: Y17/1).
I. *Cymatiosphaera* sp. (119.0 m si: J27/3).
J. *Pterospermella* sp. (119.0 m si: J32).
K. Indeterminate plankton (119.0 m x2: H17/3).
L. *Sentusidinium* sp. (119.0 m x: Y33).
M. Indeterminate plankton (142.5 m x: C19).
O. *Neoraistrickia* sp. (119.0 m x2: C15/4).
P. *Aratrisporites* sp. (119.0 m x2: F23/1).
Q. *Kuglerina meieri* (119.0 m x2: O20/3).
R. *Triadispora obscura* (119.0 m x2: M20/1).
S. *Triadispora obscura* (119.0 m x: O35/1).
T. *Triadispora obscura*, degraded specimen illustrating partly loss of outer wall layer. (119.0 m x: F23/1).

Spitsbergen, Tschermakfjellet (Locality No. 9a): Botneheia Formation (Table A.5.1, 144.0–266.0 m)

N. *Solisphaeridium* sp. L (266.0 m x3: L25/4).


A
B
C
D
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G
H
I
J
K
L
M
N
O
P
Q
R
S
T
50μm

Plate 6: Middle Triassic palynomorphs from Svalbard

Illustrated specimens are enlarged according to the scale bar representing 50 µm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets.

Edgeøya, Skrukkefjellet (Locality No. 21): Botneheia Formation (Table A.17, 72.0–142.5 m)

A. *Eresinia spinellata* (119 m x2: Z27/3).
D. *Eresinia spinellata* (119 m x2: Z27/3).
E. *Eresinia spinellata* (119 m x2: Z27/3).
C. *Striatoabieites multistriatus* (119 m si: E31/4).
G. *Schizaeoisporites worsleyi* (119.0 m x3: Q30/3).
I. *Lunatisporites noviaulensis* (119.0 m x2: S19/1).
J. Alete folded body (142.5 m x: Z30/31).
L. *Podosporites* sp. (119.0 m x2: M21).
M. *Protohaploxypinus* sp. (119.0 m si: D–E29).

Barentsøya, Høgrinden (Locality. No. 20): Botneheia Formation (Table A.16, 125.0–200.0 m)

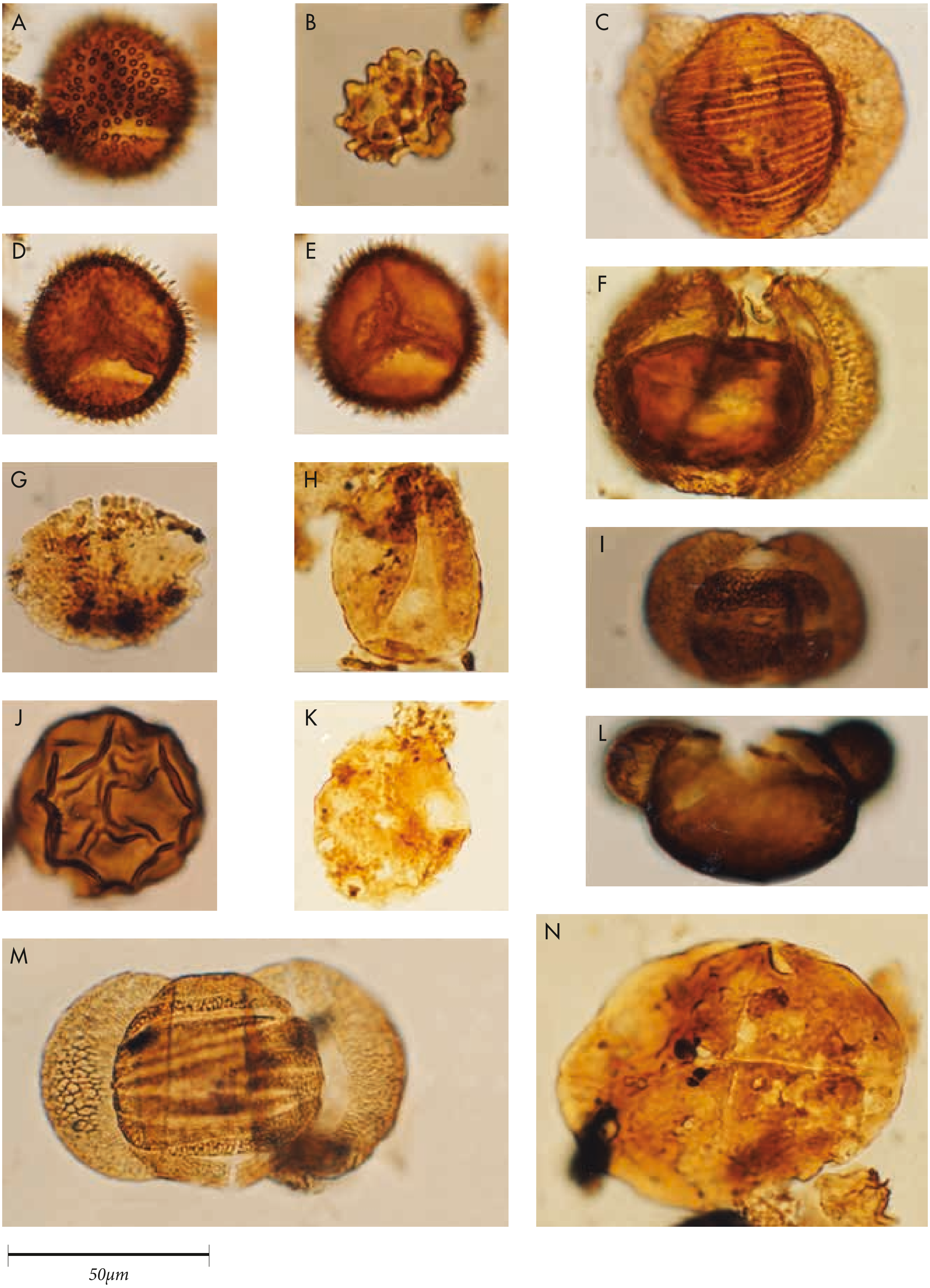
B. *Echinitosporites* sp. (200.0 m x2: V19/3).

Spitsbergen, Teistberget (Locality No. 18): Botneheia Formation (Table A.14, 146.0 m)

F. *Lunatisporites noviaulensis* (146.0 m x: P23).

Spitsbergen, Tschermakfjellet (Locality No. 9a): Botneheia Formation (Table A.5.1, 144.0–266.0) and (Table A.5.1, 372.0 m) De Geerdalen Formation

H. *Chasmatosporites* sp. A (372.0 m x3: P33/3).
K. *Ovalipollis pseudoalatus* (372.0 m x3: X17/4).
N. *Staurosaccites quadrifidus* (266.0 m x3: Q28/2).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50μm

Plate 7: Palynomorphs from the Late Triassic and from Triassic–Jurassic boundary strata on Svalbard

Illustrated specimens are enlarged according to the scale bars representing 50 µm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets. Note the shorter scale bar for Fig. E*.

Spitsbergen, Festningen (Locality No. 1d): Wilhelmøya Subgroup, Teistberget Member (Table A.1.2, 331.0–341.5 m)
A. *Cerebropollenites* sp. (336.0 m x: S18/4).
M. *Hystrichodinium* sp. (337.7 m x: Y29/2).

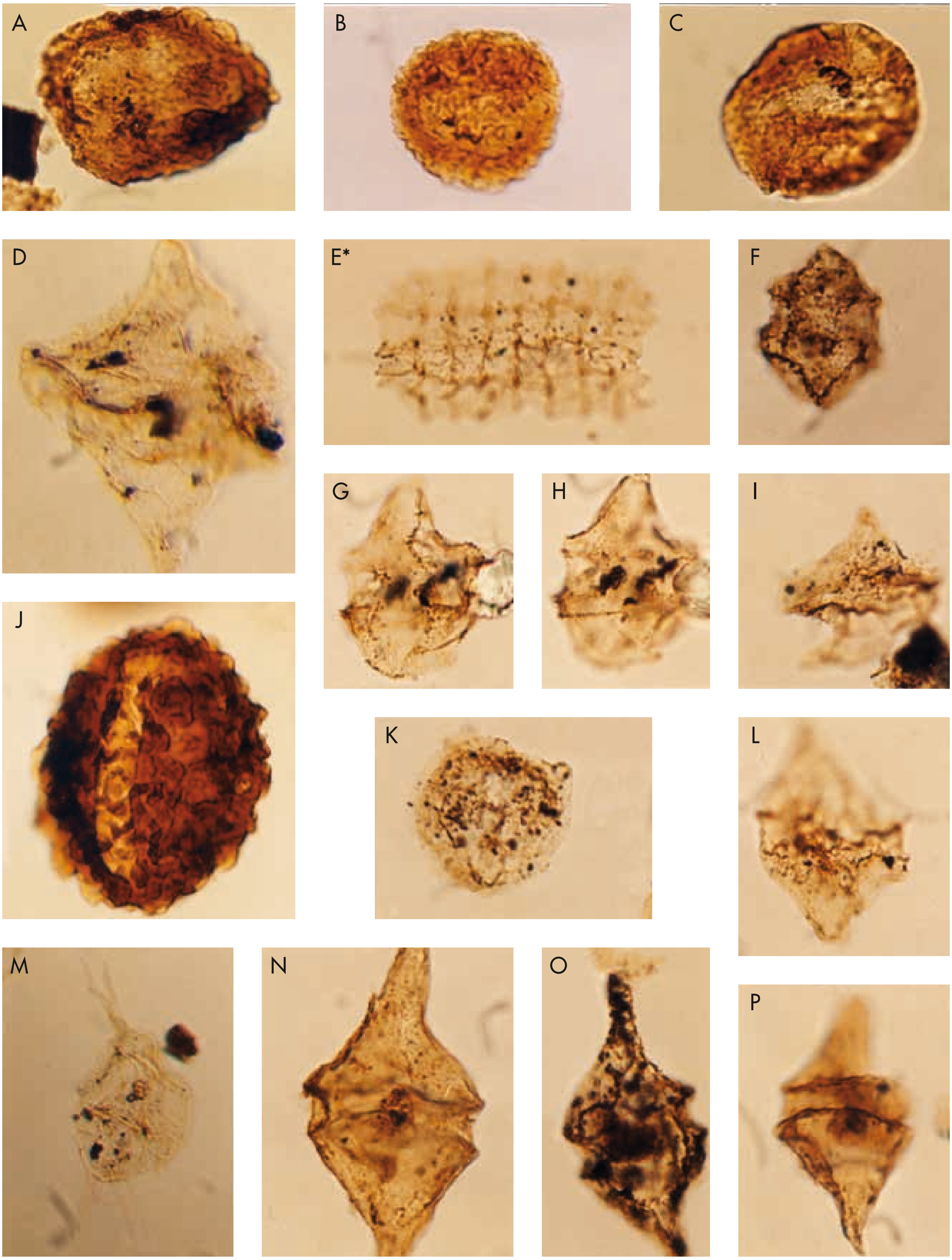
Spitsbergen, Festningen (Locality No. 1d): Wilhelmøya Subgroup, Tverrbekken Member (Table A.1.2, 325.3–330.0 m)
D. *Heibergella* sp. (329.0 m x: D14).
F. *Shublikodinium arcticum* (329.3 m x3: K25).
G. *Shublikodinium arcticum* (329.3 m x3: Q27).
H. *Shublikodinium arcticum* (329.3 m x3: Q27).
I. *Sverdrupiella* sp. (329.3 m x: R14/1).
K. *Noricysta* sp. (330.0 m x: F17/2).
L. *Rhaetogonyaulax rhaetica* (329.3 m x: R14/1).

Spitsbergen, Festningen (Locality No. 1d): Wilhelmøya Subgroup, Isfjorden Member
(Table A.1.2, 283.3–324.3 m)
E. *Plaesiodictyon* sp.* (283.3 m x: E14).
N. *Rhaetogonyaulax* sp. (324 m x3: S24/3).
O. *Rhaetogonyaulax* sp. (324 m x3: S21/3).
P. *Rhaetogonyaulax* sp. (324 m x3: V16).

Edgeøya, Blanknuten (Locality. No. 22c): Tschermakfjellet Formation (Table A.18, 120.0–193.0 m)
B. *Patinasporites densus* (123.0 m x: P17/2).

Spitsbergen, Eistraryggen (Locality No. 17): Wilhelmøya Subgroup (Table A.13, Samples 4–11 m)
C. *Vallasporites ignacii* (Sample No. 10 x: H35/3).

Spitsbergen, Tschermakfjellet (Locality No. 9b): Tschermakfjellet Formation, lowest part (Table A.5.2, Sample 2)
J. Bisaccate pollen. cf. *Verrucatosporites scabratus* in Bjærke and Manum 1977 (Sample No. 2 x: Y31/3).



50μm   *Fig. E* 50μm*

Plate 8: Palynomorphs from the Late Triassic and the Triassic–Jurassic boundary strata on Svalbard

Illustrated specimens are enlarged according to the scale bar representing 50 μm. Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets.

Edgeøya, Blanknuten South (Locality No. 22c): De Geerdalen Formation (Table A.18.2, 200.0–369.0 m)
A. *Dictyophyllidites mortoni* (369.0 m x: Y27/1).
C. *Camarozonosporites rudis* (369.0 m x: W21/4).
K. *Kraeuselisporites* sp. (369.0 m x: B23/3).
M. *Thomsonisporites undulatus* (342.0 m x: R12/4).
S. *Araucariacites* sp. (342.0 m x: P11).

Edgeøya, Blanknuten South: Tschermakfjellet Formation (Table A.18.2, 120.0–193.0 m)
O. *Chasmatosporites magnolioides* (123.0 m x: P17/3).
Q. *Schizaeoisporites worsleyi* (123.0 m x: L17).
R. *Triadispora verrucata* (123.0 m x: L17).

Spitsbergen, Festningen (Locality No. 1d): Teistberget Member (Table A.1.2, 331.0–341.5 m)
B. *Camarozonosporites laevigatus* (331.0 m x: V26/2).
D. *Kyrtomisporis laevigatus* (331.0 m x: K22/1).
E. *Kyrtomisporis speciosus* (331.0 m x: Y21/3).
F. *Zebrasporites laevigatus* (331.0 m x: F28).
G. *Zebrasporites interscriptus* (331.0 m x: C27/4).
H. *Annulispora folliculosa* (337.7/10.5 m x: F15/2).
I. *Rogalskaisporites cicatricosus* (331.0 m x: D21).
J. *Rogalskaisporites barentzii* (337.7: 10.5 m x: K16/4).
L. *Semiretisporis gothae* (338.0 m x: L13/1).
N. *Aratrisporites laevigatus* (331.0 m x: Y23).

Spitsbergen, Eistraryggen (Locality No. 17, Sample numbers 4–11): Wilhelmøya Subgroup (Table A.13)
P. *Podosporites* sp. B (Sample No.10 x: R31/4).

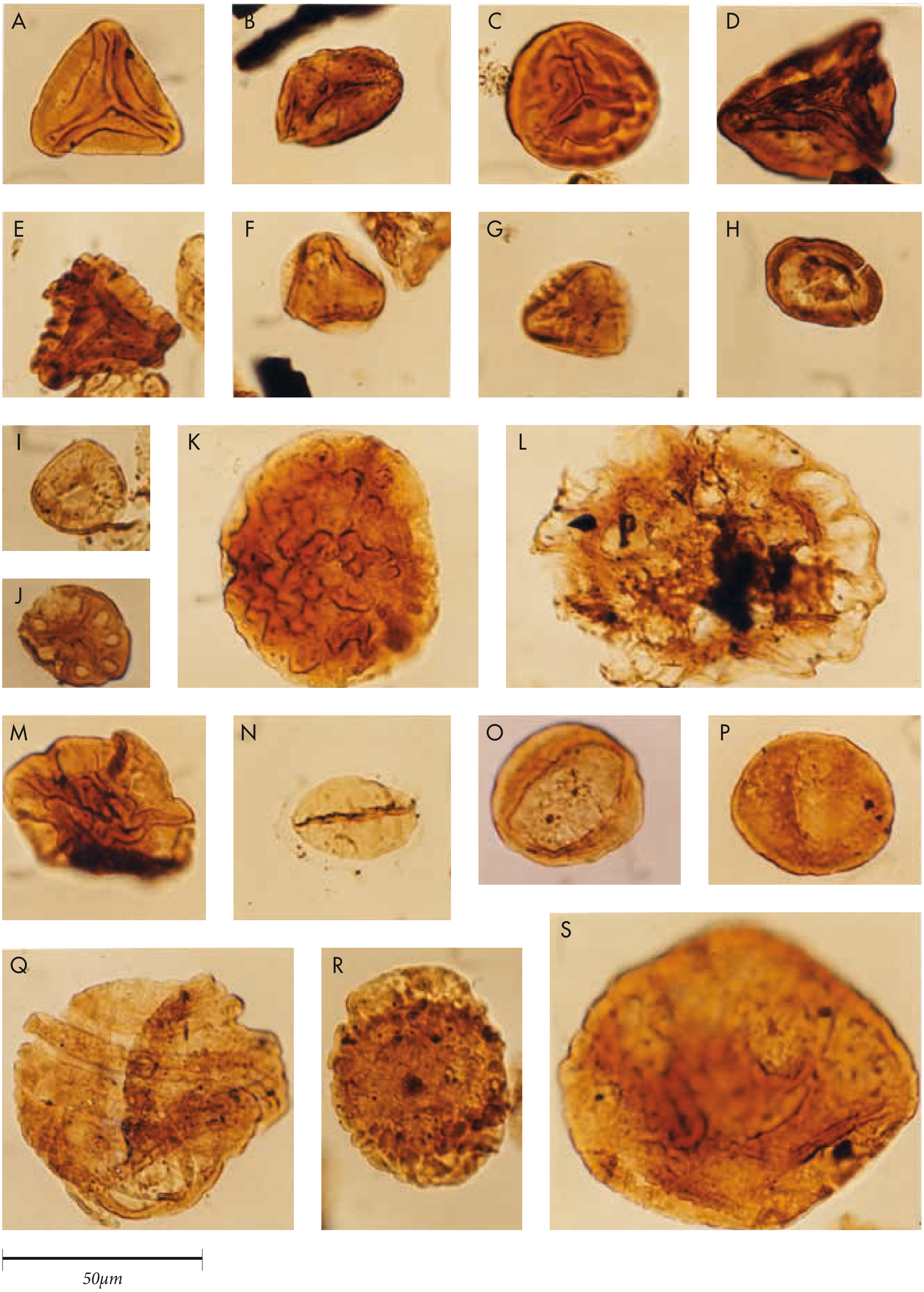

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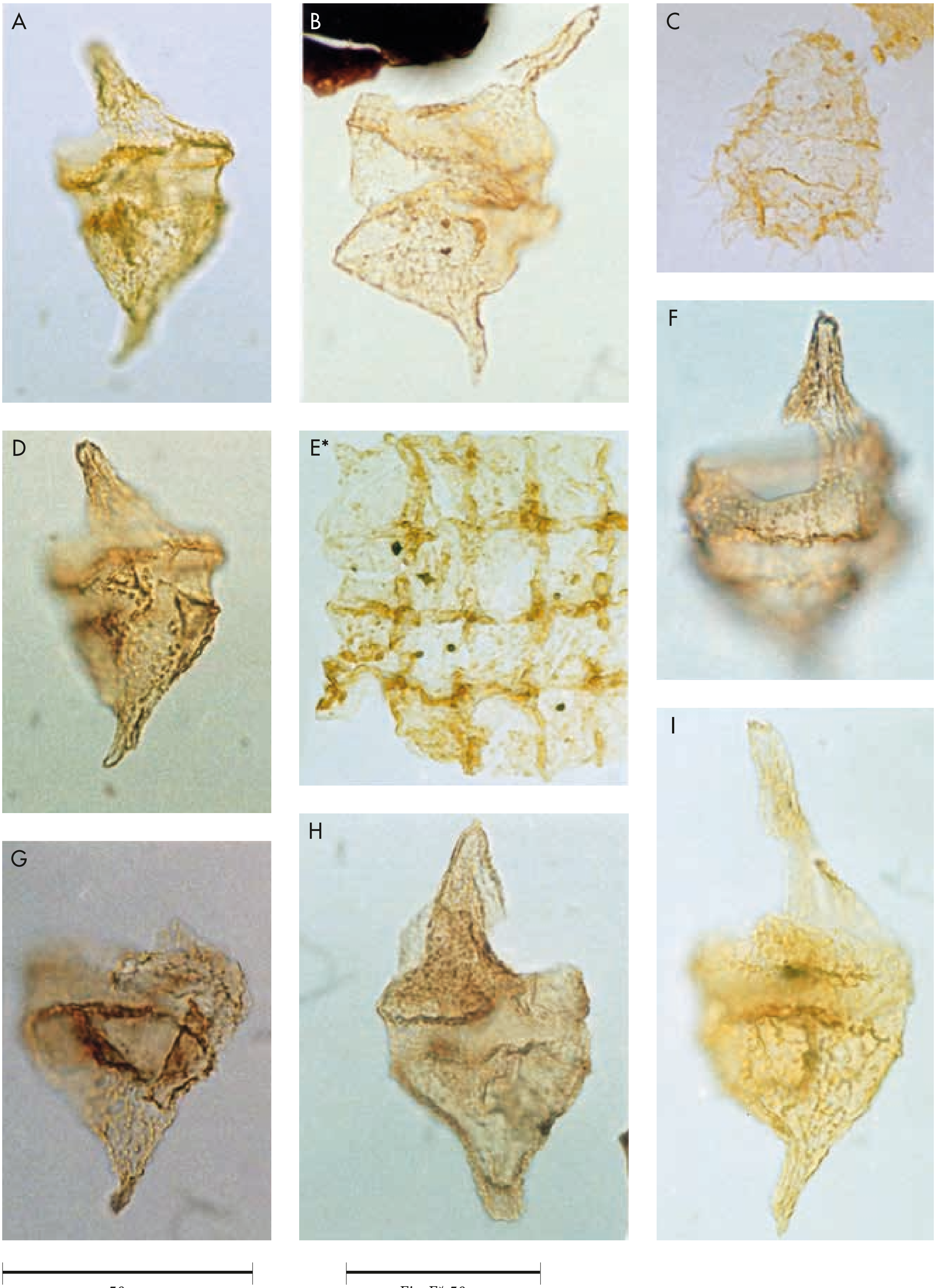
Plate 9: Palynomorphs from the Late Triassic on Hopen, Svalbard

Illustrated specimens are enlarged according to the scale bars representing 50 µm Taxa names are followed by sample height, slide type and coordinates by England Finder, in brackets. Note the shorter scale bar for Fig. E*.

Lyngefjellet West (Locality No. 32d): Flatsalen Formation (Table A.23, 170.0–200.8 m)

A. *Rhaetogonyaulax* sp. with double horn (LYN 6–1: V58/4).
D. *Rhaetogonyaulax* sp. with double horn (LYN 6–1: V58/4).
B. *Rhaetogonyaulax* sp. (LYN 6–1: U61/3).
C. Indeterminate dinocyst (LYN 6–1: S54).
E. *Plaesiodictyon mosellanum** (LYN 6–1: S66/1).
F. *Rhaetogonyaulax* sp. (LYN 6–1: V49).
G. *Rhaetogonyaulax* sp. (LYN 6–1: R55/2).
H. *Rhaetogonyaulax rhaetica* (LYN 4–1: Q46/2).
I. *Rhaetogonyaulax* sp. (LYN 6–1: T60/2).



50µm

Fig. E 50µm*

Plate 10: Palynomorphs from the Triassic deposits on Bjørnøya, Svalbard

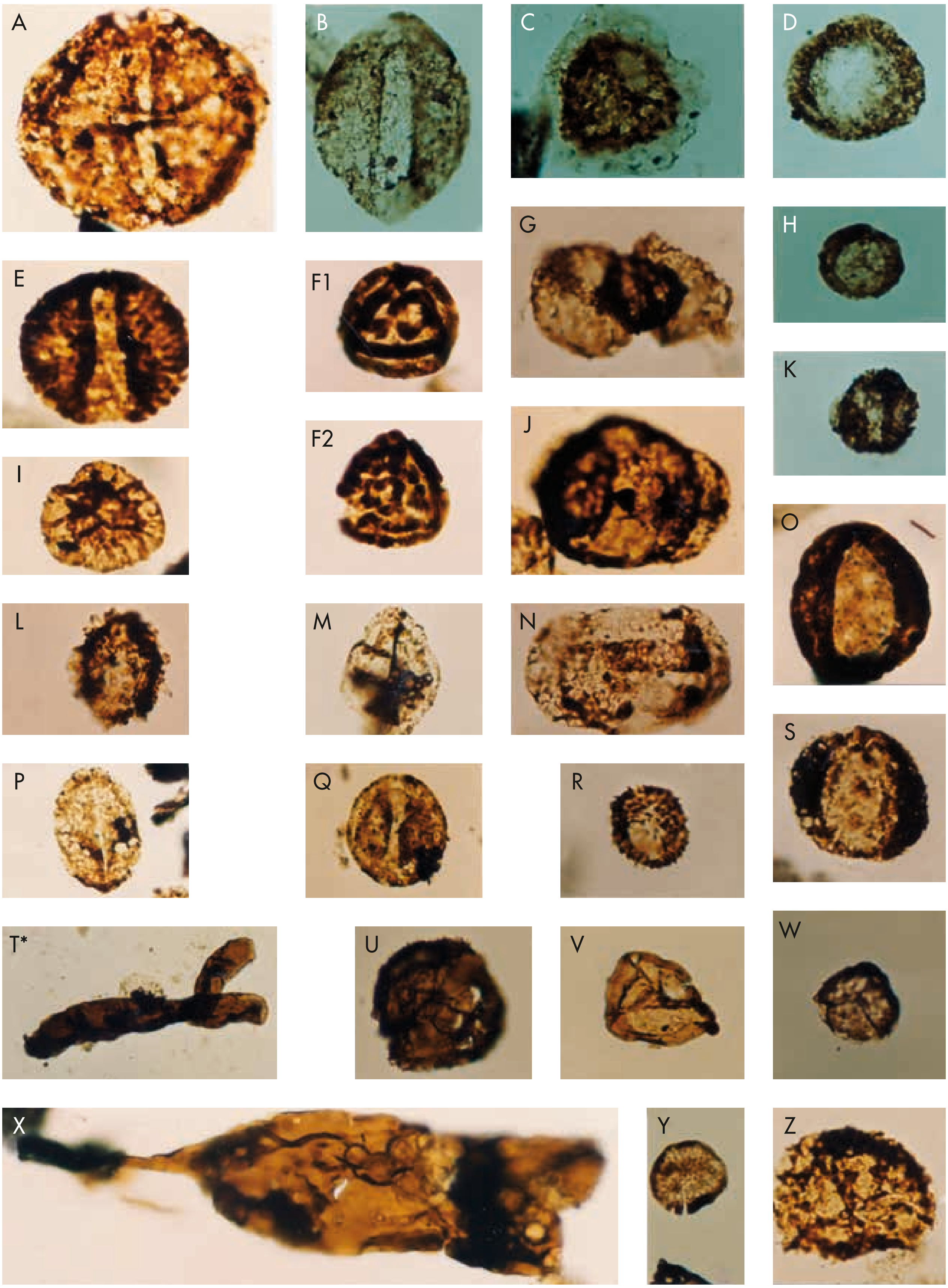
Illustrated specimens are enlarged according to the scale bars representing 50 µm. Taxa names are followed by sample height, slide type, PMO numbers and coordinates, in brackets. The PMO numbers refer to slides figured by Mørk et al. (1990) and belong to the collections of Paleontological Museum, University of Oslo. Note the shorter scale bar for Fig. T*.

Mountain Urd (Locality No. 28): Skuld Formation (Table A.24, 65.0–170.0 m)

A. *Staurosaccites quadrifidus* (94 m x, PMO 120 797: 30.0–107.8).
B. *Chasmatosporites magnolioides* (167.0 si, PMO 120 800: 22.7–113.1).
C. *Kraeuselisporites* sp. (170.0 m si: 27.3–106.4).
D. *Enzonalasporites vigens* (167 m si: 17.3–113.7).
E. *Schizaeoisporites worsleyi* (167 m x, PMO 120 799: 23.5–112.4).
F.1 *Striatella seebergensis* (80.0 m x: 28.6–98.2)
F.2. *Striatella seebergensis* (85.5 m x: 15.7–112.8).
G. *Podocarpidites* sp. (73 m si: 26.4–111.3).
H. *Corollina* sp. (167.0 m si: 28.1–112.8).
I. *Thomsonisporites undulatus* (94 m x, PMO 120 797: 21.4–92.6).
J. *Protodiploxypinus* sp. (J: 85.5 m x: 18.5–111.5).
K. *Protodiploxypinus* sp. (K: 167 m si: 37.7–114.7).
L. *Echinitosporites iliacoides* (85.0 m x, PMO 120 801: 12.2–111.2).
N. *Lunatisporites noviaulensis* (85.5 m x: 27.6–109.9).
O. *Chasmatosporites apertus* (85.5 m si: 27.0–95.5).
P. *Ovalipollis pseudoalatus* (67 m x: 23.7–112.3).
Q. *Eucommiidites microgranulatus* (67 m si: 38.2–106.3).
R. *Anapiculatisporites spiniger* (74 m si: 31.8–101.1).
S. *Triadispora obscura* (67.0 m x: 25.9–111.4).

Mountain Urd: Urd Formation (Table A.24, 1.2–49.0 m)

M. *Aratrisporites* sp. (4.1 m x, PMO 120 791: 24.7–98.6).
T. 'Fungal remain type 1' sensu Hochuli et al. 1989 (6.0 m si: 27.0–93.5).
U. *Densoisporites playfordi* (49.0 m x, PMO 120 793: 16.7–98.8).
V. *Densoisporites* sp. cf. *D. nejburgii* (2.0 m x: 32.8–110.3).
W. *Densoisporites nejburgii* (49.0 m x, PMO 120 793: 33.5–99.9).
X. Fungal remain of Mangerud 1991 (43.0 m x: 35.0–95.3).
Y. *Micrhystridium* sp. (1.2 m x, PMO 120 794: 25.0–110.0).
Z. *Kraeuselisporites apiculatus* (1.5 m x: 25.7–108.9).



50µm

Fig. T 50µm*

D.2 BARENTS SEA CORES

PLATES 11–18: SVALIS DOME

The individual plates from the stratigraphic core Dia–84–2 and Cores 7323/7–U–1 to –U–10 illustrate the content of the palynological Composite Assemblage Zones defined herein incorporating Svalis–1 to Svalis–8 from the Svalis Dome. The PMO numbers of the Paleontological Museum, University of Oslo, refer to slides where specimens were figured by Vigran et al. (1998).

Plate 11: The *Maculatasporites* spp. Composite Assemblage Zone (Svalis Dome)

The zone has been recognised from the stratigraphic core Dia–84–2 (Table A.33, 98.71–73.98 m) penetrating the Havert Formation at the Svalis Dome. It incorporates the late Griesbachian assemblage Svalis–1 of Vigran et al. (1998). The name of a taxon is followed by sample depth, slide type, PMO number and slide coordinates by England Finder. The scale bar represents 50 µm.

A. *Pechorosporites* sp. (87.56 m x2, PMO 163.150: Z25/1).
B. *Densoisporites nejburgii* (91.28 m x2, PMO 163: C14/3).
C. *Grebespora concentrica* (91.28 m x, PMO 163.152: Y37/1).
D. *Kraeuselisporites hoofddijkensis* (87.56 m x4, PMO 163.150: D37/2).
E. *Lunatisporites noviaulensis* (98.65 m x, PMO 163.157: C23).
F. *Aratrisporites tenuispinosus* (95.74 m x2, PMO 163.156: D31).
G. *Aratrisporites scabratus* (77.41 m x2, PMO 163.148: L30).
H. *Cycadopites* sp. (91.28 m/x2, PMO 163.153: E18/4).
I. *Proprisporites pocockii* (87.56 m x2, PMO 163.150: D22/3).
J. *Polycingulatisporites densatus* (91.28 m x2, PMO 163.153: W35/2).
K. *Densoisporites nejburgii* (90.43 m x2, PMO 163.151: U29/3).
L. *Proprisporites pocockii* (91.28 m x2, PMO 163.153: V29/3).
M. Indeterminate spore (98.65 m x2, PMO 163.158: D27).
N. *Proprisporites pocockii* (91.28 m x2, PMO 163.153: C27/4).
O. *Densoisporites nejburgii* (91.78 m x2, PMO 163.154: W29/3).
P. *Densoisporites* sp. (94.45 m x2, PMO 163.155: E22).
Q. *Lundbladispora brevicula* (86.56 m x, PMO 163.149: F18/2).
R. *Veryhachium* sp. (91.78 m x2, PMO 163.154: H24/3).
S. *Micrhystridium* sp. (91.28 m x2, PMO 163.153: 34/4).
T. *Kraeuselisporites* sp. (86.56 m x, PMO 163.149: G19).
U. *Reticulatisporites* sp. (87.56 m x2, PMO 163.150: Z21).

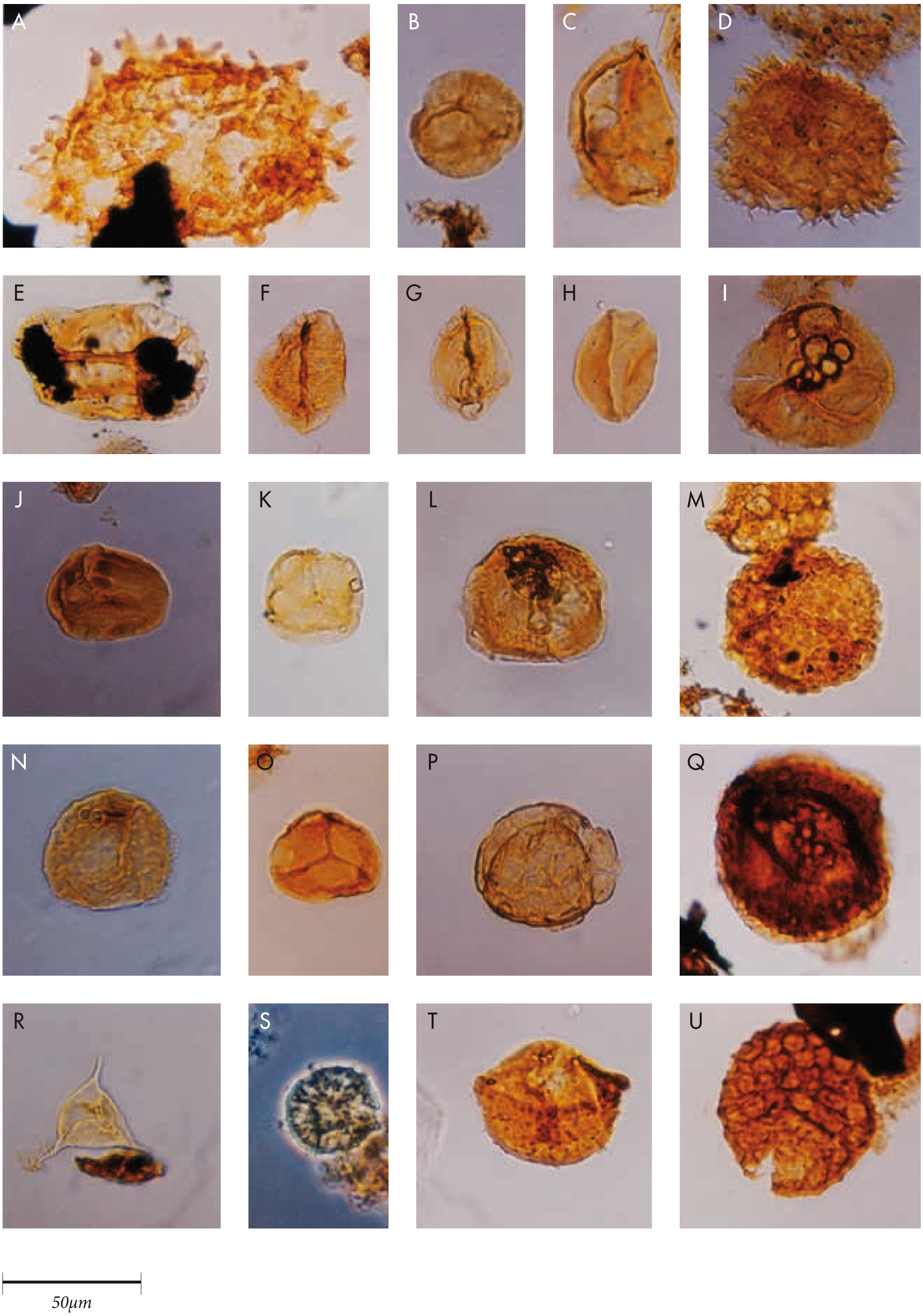

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Plate 12: The *Naumovaspora striata* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised in the stratigraphic cores 7323/7–U–8 and –U–6 penetrating the Klappmyss Formation at the Svalis Dome. It incorporates the late Smithian assemblage Svalis–2 of Vigran et al. (1998). The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

Core U–8 (Table A.33, 136.67–101.95 m)

A. *Punctatisporites* sp. (112.43 m x2, PMO 163.159: M23/2).
C. *Cyclotriletes triassicus* (112.43 m x2, PMO 163.159: H28).
D. *Kraeuselisporites echinoides* (114.20 m x, PMO 163.160: Z42).
E. *Pechorosporites disertus* (112.43 m x2, PMO 163.159: C23/1).
F. *Reticulatisporites bunteri* (112.43 m x2, PMO 163.159: F30/1).
G. *Kraeuselisporites* sp. (112.43 m x2, PMO 163.159: E31/1).
H. *Lundbladispora obsoleta* (112.43 m x2, PMO 163.159: W27).
I. 'Fungal remain' sensu Hochuli et al. 1989 (112.43 m x2, PMO 163.159: O32/2).
J. *Densoisporites complicatus* (112.43 m x2, PMO 163.159: D22/2).
K. *Densoisporites playfordi* (118.43 m x2, PMO 163.161: Y28/2).
L. Leech cocoon (112.43 m x2, L22/1) PMO 163.159: L22/1).
N. *Densoisporites nejburgii* (112.43 m x2, PMO 163.159: L22/1).
O. *Naumovaspora striata* (123.05 m x, PMO 163.162: J32/2).
P. *Densoisporites* sp., tetrad (112.43 m x2, PMO 163.159: E30/2).

Core U–6 (Table A.33, 133.74–99.05 m)

B. *Punctatisporites fungosus* (130.05 m x2, PMO 163.163: Z21/2).
M. *Proprisporites pocockii* (130.05 m x2, PMO 163.163: J31/3).

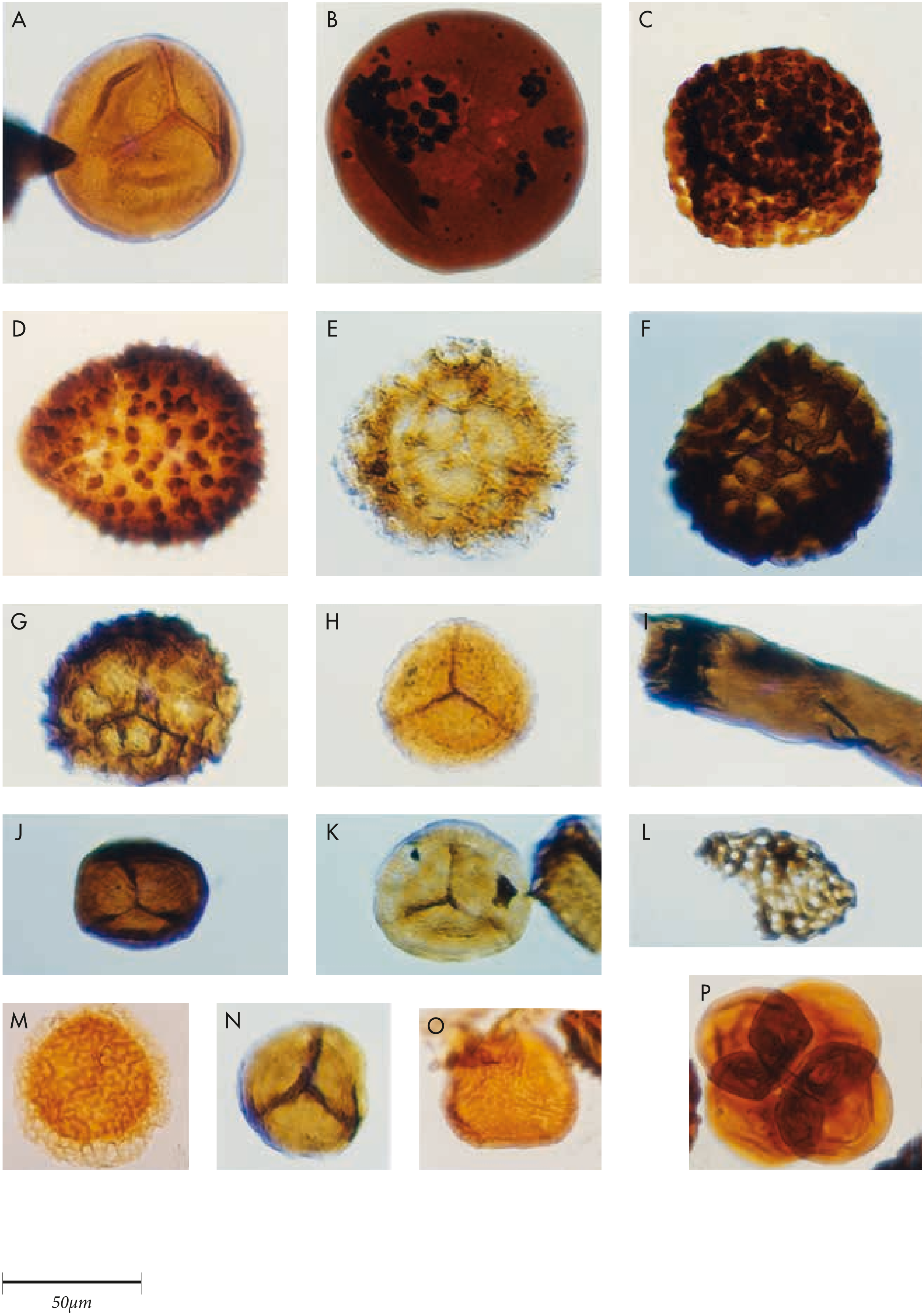
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Plate 13: The *Pechorosporites disertus* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised in the stratigraphic core 7323/7–U–3 (Table A.33, 132.02–99.01 m) penetrating the Klappmyss Formation. It incorporates the early Spathian assemblage Svalis–3 of Vigran et al. (1998). The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Pechorosporites disertus* (132.01 m x, PMO 163.167: G23/3).
B. *Pechorosporites disertus* (132.01 m x, PMO 163.167: F16/4).
C. *Protohaploxypinus* sp. (132.01 m x, PMO 163.167: H19/1).
D. *Tasmanites* sp. (132.01 m x, PMO 163.167: E24).
E. *Verrucosisporites remyanus* (101.01 m x2, PMO 163.164: O16).
F. *Perotrilites* sp. (119.93 m x, PMO 163.164: P20/1).
G. *Eresinia spinellata* (132.01 m x, PMO 163.167: O34).
H. Indeterminate bisaccate (132.01 m x, PMO 163.167: G20).
I. *Lunatisporites noviaulensis* (132.01 m x, PMO 163.167: E17/1).
J. *Polycingulatisporites densatus* (101.01 m x2, PMO 163.164: L30).
K. *Lunatisporites* sp. (132.01 m x, PMO 163.167: H19/1).
L. *Rewanispora foveolata* (132.01 m x, PMO 163.167: J18/3).
M. *Uvaesporites* sp. (132.01 m x, PMO 163.167: G15/1).
N. *Pretricolpipollenites* sp. (132.01 m x, PMO 163.167: G22/3).
O. *Lundbladispora obsoleta* (124.14 m x2, PMO 163.166: S20/3).

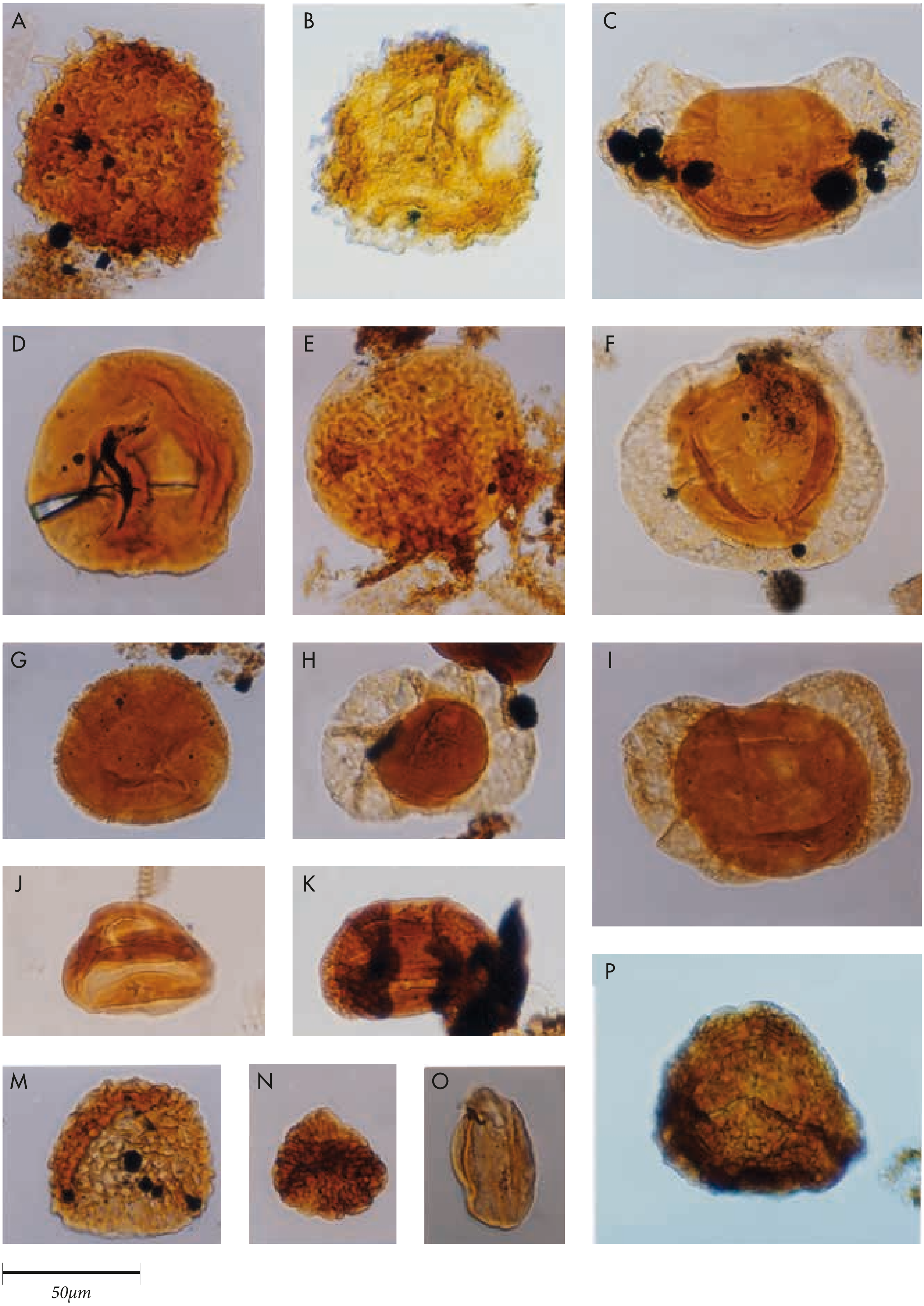
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Plate 14: The *Jerseyiaspora punctispinosa* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised in the stratigraphic core 7323/7–U–4 (Table A.33, 139.00–95.53 m,) penetrating the late Spathian to early Anisian deposits of the Steinkobbe Formation. It incorporates the palynomorphs of Svalis–4 of Vigran et al. (1998). The name of a taxon is followed by sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

A. *Jerseyiaspora punctispinosa* (123.01 m x2, PMO 163.168: T24/3).
B. *Jerseyiaspora* sp. (123.01 m x2, PMO 163.168: G18/3).
C. *Lunatisporites* sp. (124.01 m x, PMO 163.182: C17/2).
D. *Verrucosisporites morulae* (137.98 m x3, PMO 163.171: A22/3).
E. *Jerseyiaspora punctispinosa* (11.01 m x3, PMO 163.179: R24).
F. *Striatoabieites balmei* (104.01 m x4, PMO 163.178: Q22).
G. *Densoisporites* sp. cf. *D. playfordi* (123.01 m x2, PMO 163.168: C25/2).
H. *Densoisporites nejburgii* (123.01 m x2, PMO 163.181: D24).
I. *Pretricolpipollenites* sp. (123.01 m x2, PMO 163.168: K28/3).
J. cf. *Angustisulcites* sp. (124.01 m x2, PMO 163.168: D24).
K. *Kraeuselisporites* sp. (127.00 m x, PMO 163.170: F23).
L. *Lycopodiacidites* sp. (123.01 m x2, PMO 163.168: O12/2).
M. *Polycingulatisporites* sp. (123.01 m x2, PMO 163.168: K17/1).
N. *Concavisporites crassiexinius* (123.01 m x2, PMO 163.168: Q13).
O. *Lundbladispora* sp. cf. *L. obsoleta* (111.01 m x3, PMO 163.179: D18/3).
P. Alga, indeterminate (137.98 m x3, PMO 163.171: B26).
Q. *Punctatisporites* sp. (138.00 m x2, PMO 163.172: H27/4).

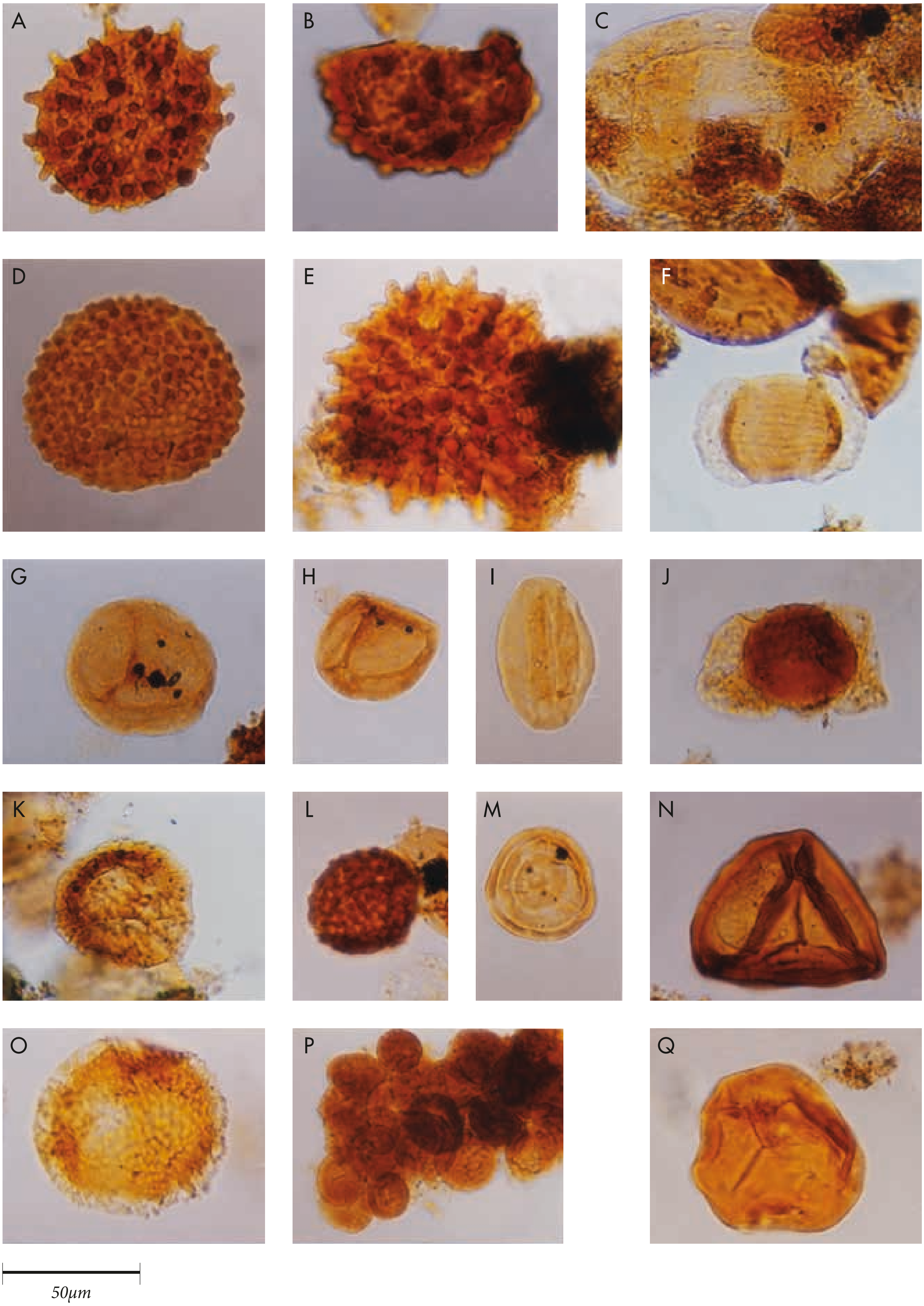
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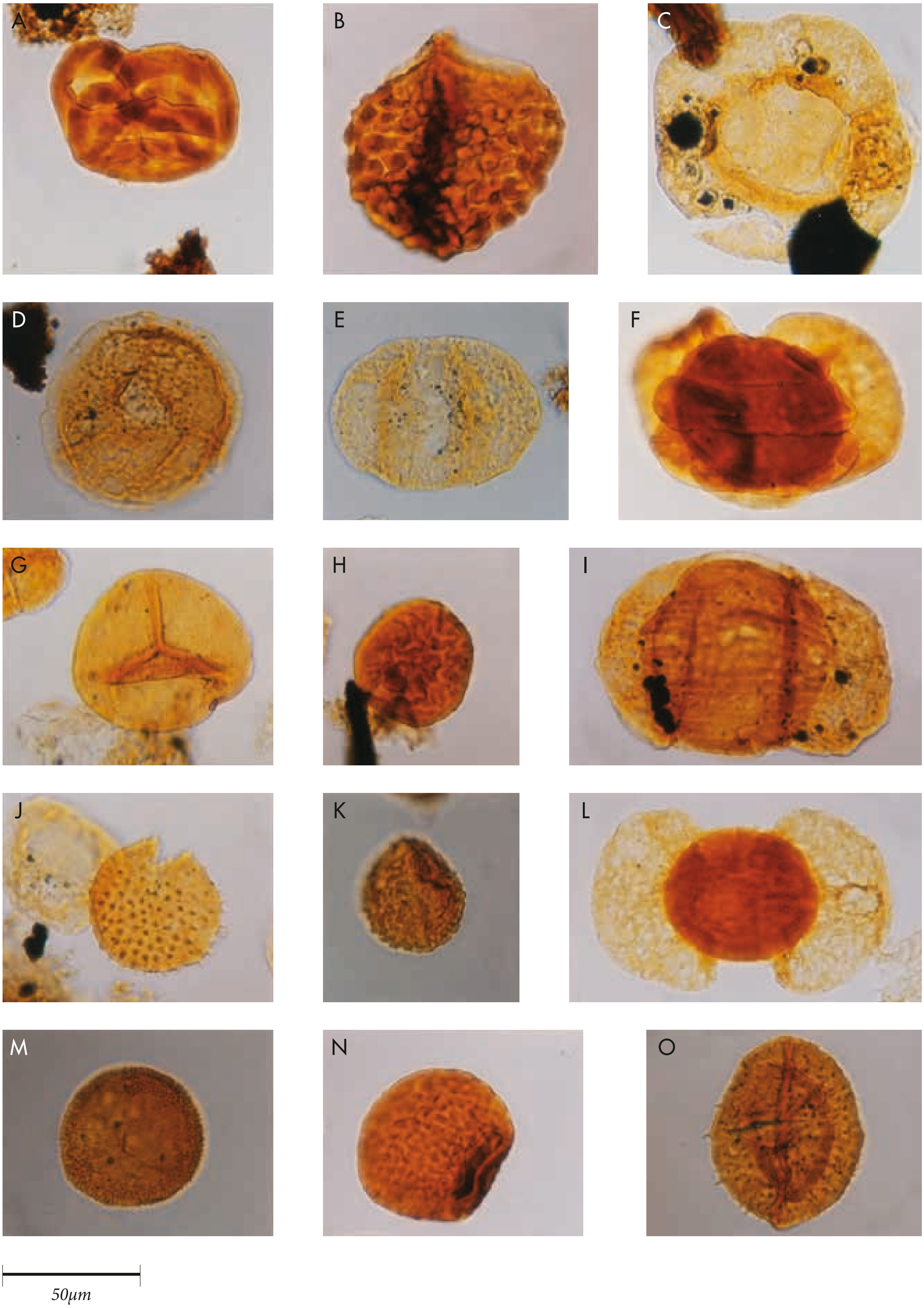
Plate 15: The *Anapiculatisporites spiniger* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised from the uppermost part of the stratigraphic core 7323/7–U–4 (Table A.33, 104.01–95.53 m) penetrating Lower Anisian deposits in Steinkobbe Formation. It incorporates Svalis–5 of Vigran et al. (1998). The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Striatella seebergensis* (104.01 m x4, PMO 163.185: P18/1).
B. *Verrucosisporites* sp. (100.01 m x3, PMO 163.184: O10).
C. *Accinctisporites circumdatus* (95.53 m x2, PMO 163.183: G23/3).
D. *Kraeuselisporites punctatus* (95.53 m x2, PMO 163.183: F13/3).
E. *Alisporites* sp. (95.53 m x2, PMO 163.174: G10).
F. *Lueckisporites junior* (100.01 m x3, PMO 163.184: F10).
G. *Osmundacidites senectus* (95.53 m x2, PMO 163.183: D18).
H. *Lycopodiacidites* sp. (100.01 m x3, PMO 163.184: F13).
I. *Striatoabieites multistriatus* (100.01 m x3, PMO 163.177: O12/3).
J. *Anapiculatisporites spiniger* (95.53 m x2, PMO 163.183: G14/4).
K. Indeterminate spore (95.53 m x2, PMO 163.183: T21).
L. *Striatodiploxypinus* sp. (98.01 m x5, PMO 163.176: D12).
M. *Cyclotriletes oligogranifer* (95.53 m x2, PMO 163.183: N16/3).
N. *Verrucosisporites* sp. (104.01 m x4, K28/4) PMO 163.185: L21/2).
O. *Aratrisporites palettae* (95.53 m x2, PMO 163.183: L21/2).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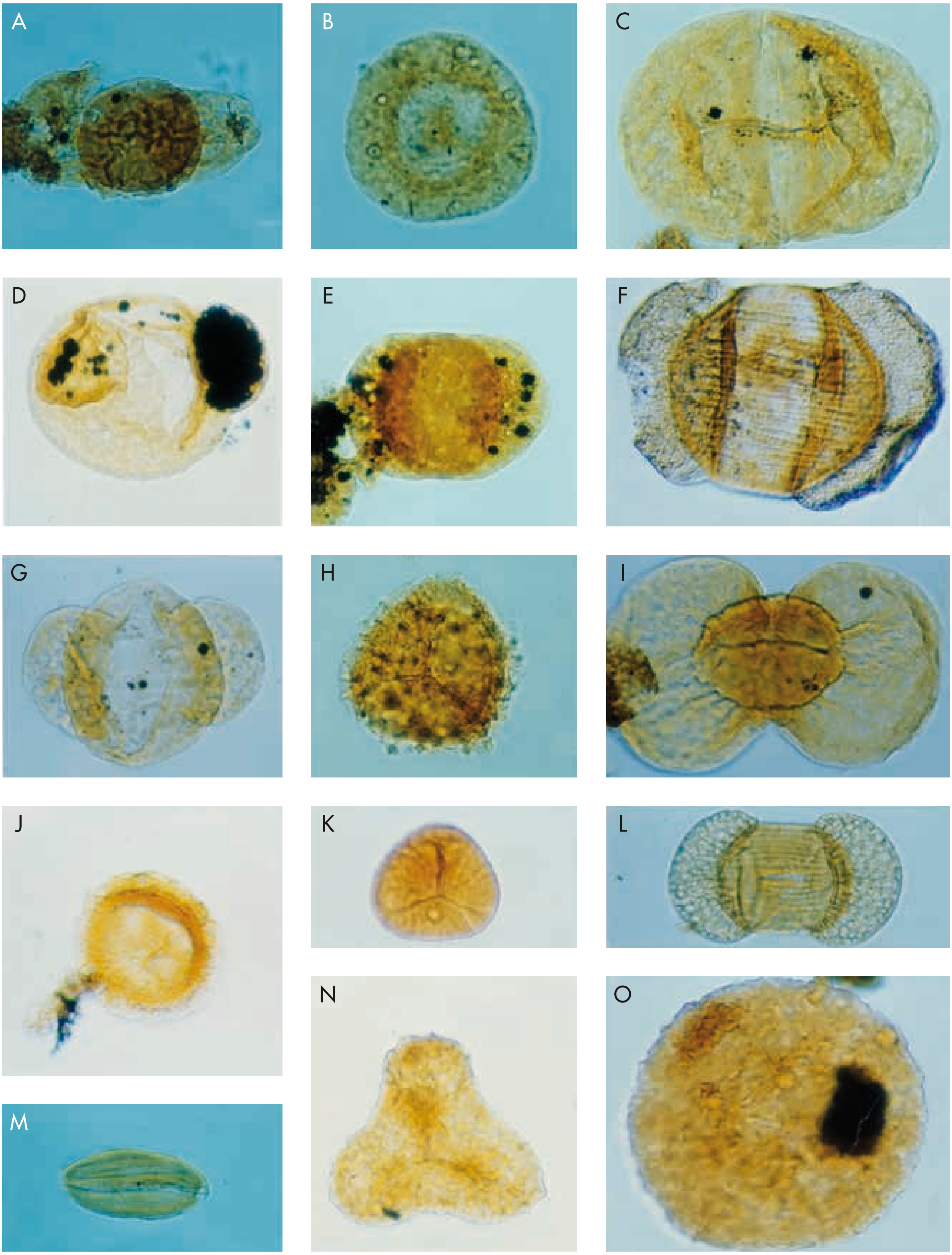
50µm

Plate 16: The *Triadispora obscura* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised in samples from core 7323/7–U–1 (Table A.33, 126.56–111.01 m) penetrating the middle Anisian deposits of Steinkobbe Formation at the Svalis Dome. It incorporates Svalis–6 of Vigran et al. (1998). The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

A. *Triadispora plicata* (121.06 m x2, PMO 163.191: W22/1).
B. *Cordaitina minor* (115.01 m x5, PMO 163.189: D29/4).
C. *Illinites chitonoides* (116.01 m x4, PMO 163.190: R26/3).
D. *Protodiploxypinus fastidioides* (126.59–60 m x, PMO 163.196: K31/3).
E. *Triadispora crassa* (121.06 m x2, PMO 163.191: M11/1).
F. *Striatoabieites multistriatus* (124.10 m x, PMO 163.194: S29).
G. *Podosporites amicus* (121.06 m x2, PMO 163.191: Y18).
H. *Kraeuselisporites apiculatus* (111.01 m x5, PMO 163.188: H26/1).
I. *Angustisulcites grandis* (116.01 m x4, PMO 163.190: W18/3).
J. Indeterminate pre pollen (122.48 m x5, PMO 163.192: D12/3).
K. *Densoisporites complicatus* (106.01 m x, PMO 163.187:Q11/3
L. *Striatoabieites balmei* (124.01 m x, PMO 163.193: W30/3).
M. *Pretricolpipollenites* sp. (126.59–60 m x, PMO 163.196: Q32/3).
N. *Converrucosisporites* sp. (126.59–60 m x, PMO 163.196: L19).
O. *Tasmanites* sp. (124.10 m x3, PMO 163.195: R24/3).



50μm

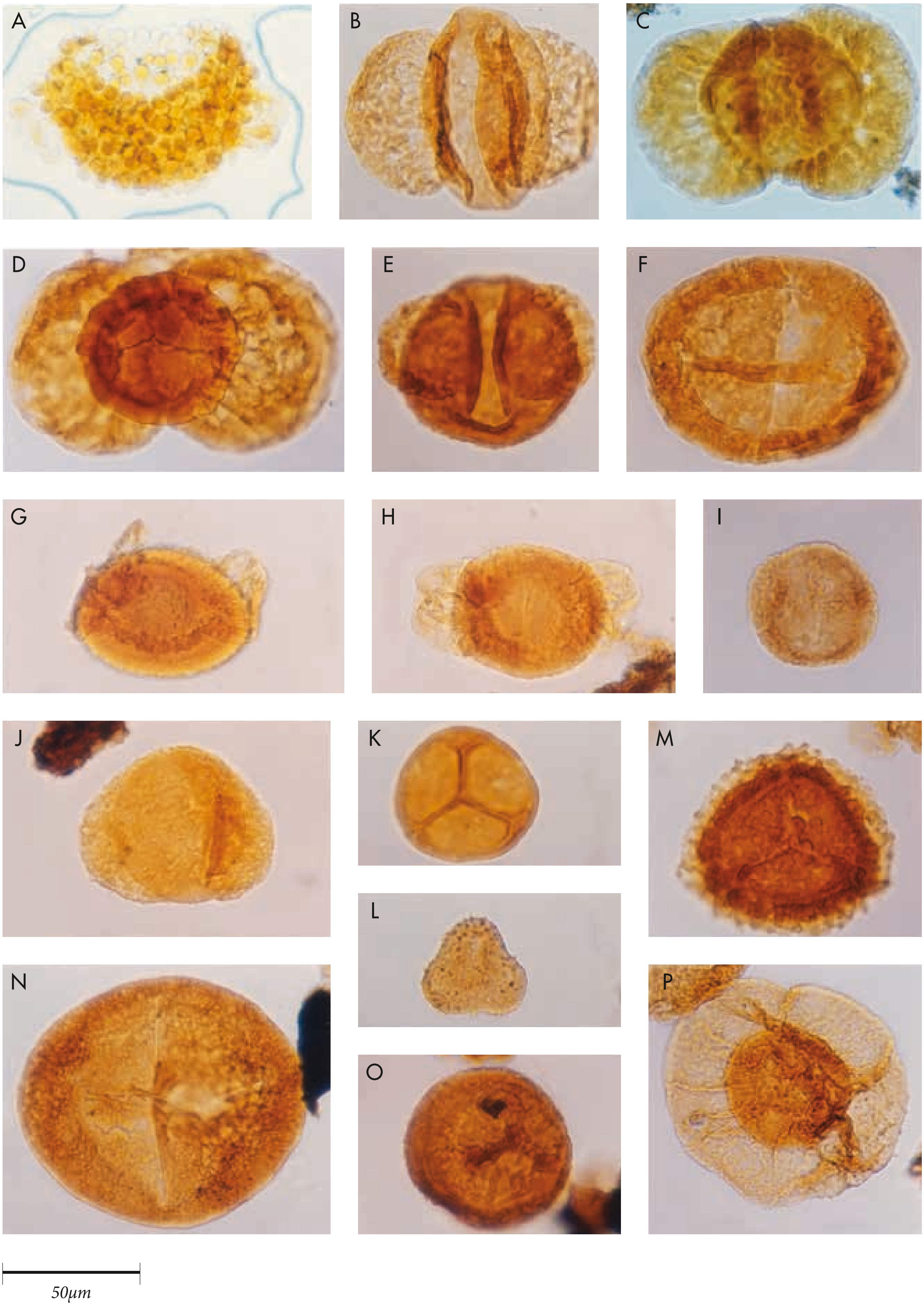
Plate 17: The *Protodiploxypinus decus* Composite Assemblage Zone (Svalis Dome)

The palynomorphs of this zone have been recognised in samples from cores 7323/7–U–7 and –U–9 penetrating the youngest deposits of Steinkobbe Formation at the Svalis Dome. The assemblage incorporates the late Anisian assemblage Svalis–7 of Vigran et al. (1998). The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

Core U–2 (Table A.33, 112.46–104.68 m)
A. *Protodiploxypinus decus* (106.15 m x3, PMO 163.200: G36/3).

Core U–7 (Table A.33, 102.10–98.45 m)
C. *Triadispora* sp. (101.55 m x3, PMO 163.197: (W55).

Core U–9 (Table A.33, 123.85–93.00 m)
B. *Protodiploxypinus* sp. (122.8 m x3, PMO 163.198: D37).
D. *Angustisulcites klausii* (122.8 m x3, PMO 163.198: W33).
E. *Protodiploxypinus* sp. (122.8 m x3, PMO 163.198: M27).
F. *Illinites chitonoides* (122.8 m x3, PMO 163.198: H27/4).
G. *Institisporites crispus* (100.7 m x3; G: C34).
This taxon name was not recorded in Table A.33.
H. *Institisporites crispus* (100.7 m x3; H: C36).
I. *Triadispora* sp. cf. *T. plicata* (122.8 m x2, J40/3) PMO 163.199.
J. *Triadispora obscura* (104.27 m x2: C35).
K. *Retusotriletes hercynicus* (122.8 m x3, PMO 163.198: H31/1).
L. *Conbaculatisporites* sp. (122.8 m x3, PMO 163.198: Q33).
M. *Kraeuselisporites apiculatus* (122.8 m x3, PMO 163.198: C36).
N. *Illinites chitonoides* (122.8 m x3, PMO 163.198: T29).
O. *Densoisporites complicatus* (122.8 m x3, PMO 163.198: P34).
P. *Aratrisporites macrocavatus* (122.8 m x3, PMO 163.198: U27/1).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50μm

Plate 18: The *Echinitosporites iliacoides* Composite Assemblage Zone (Svalis Dome)

The zone has been recognised in samples from cores 7323/7–U–10, –U–5, and –U–2, all penetrating the Snadd Formation at the Svalis Dome. It incorporates assemblage Svalis–8 of Vigran et al. (1998).

The name of a taxon is followed by the sample depth, slide type, PMO number and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

Core U–10 (Table A.33, 124.13–97.00 m)

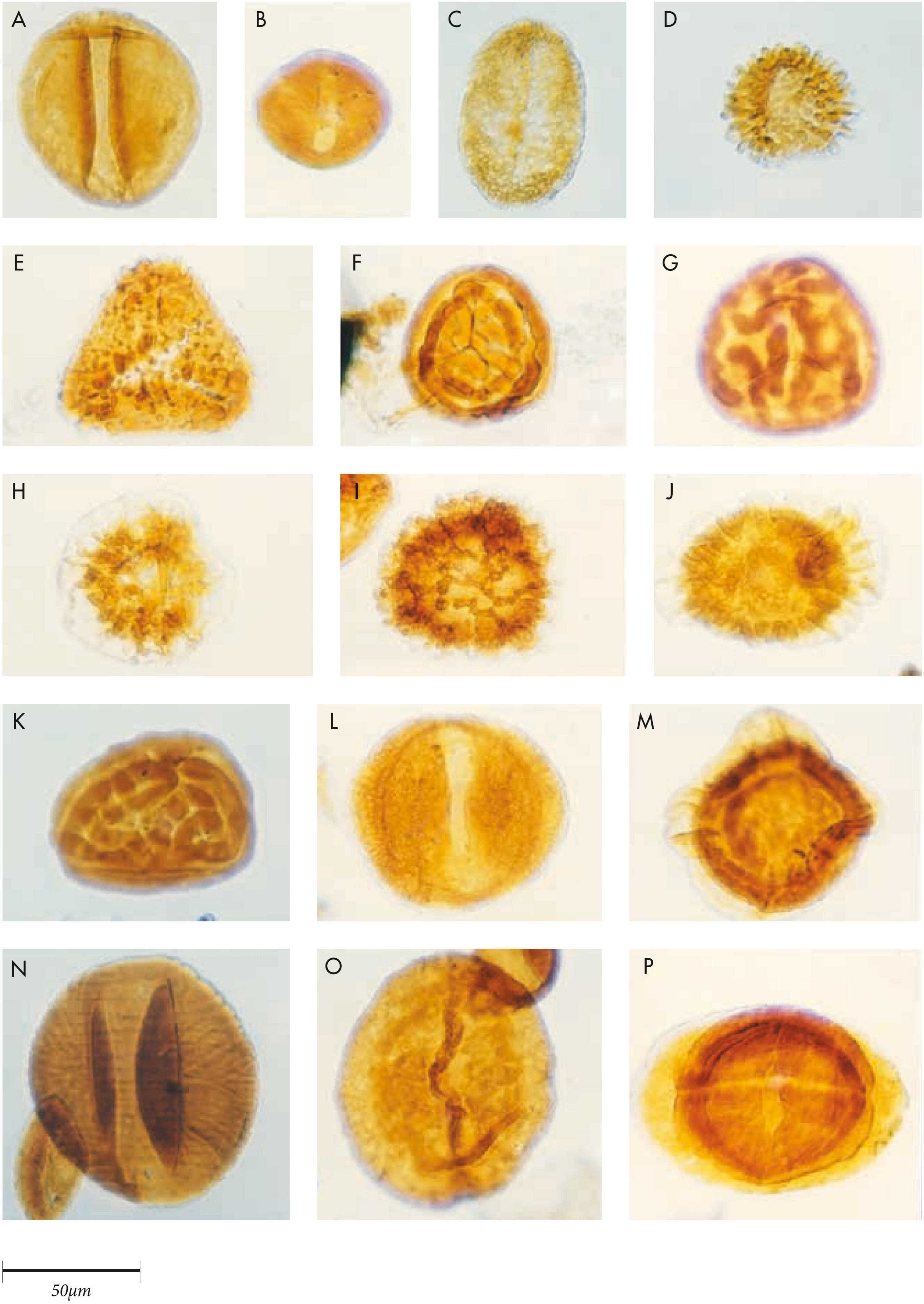
A. *Chasmatosporites* sp. A (97.02 m x3, PMO 163.201).
C. *Ovalipollis pseudoalatus* (97.02 m x3, PMO 163.201: C24/1).
D. *Echinitosporites iliacoides* (121.28 m, x3, PMO 163.205: C24/1).
E. *Conbaculatisporites hopensis* (101.2 m x2, PMO 163.202: O21).
F. *Striatella seebergensis* (97.02 m x3, PMO 163.201: T31).
H. *Kraeuselisporites dentatus* (97.02 m x3, PMO 163.201: K12).
J. *Institisporites crispus* (115.25 m x3, PMO 163.204: P32/1).
L. *Brachysaccus* sp. (97.02 m x3, PMO 163.201: L13).
M. *Accinctisporites circumdatus* (97.02 m x3, PMO 163.201: P26).
N. *Schizaeoisporites worsleyi* (97.02 m x3, PMO 163.201: T11/3).
O. *Aratrisporites palettae* (97.02 m x3, PMO 163.201: C25/1).
P. *Staurosaccites quadrifidus* (97.02 m x3, PMO 163.201: H16).

Core U–2 (Table A.33, 112.46–104.68 m)

B. *Podosporites* sp. B (104.70 m x3, PMO 163.208: T27/3).
K. *Striatella seebergensis* (104.70 m x3, PMO 163.208: V36/2).

Core U–5 (Table A.33, 137.87–97.01 m)

G. *Lycopodiacidites* sp. (131.03 m x, PMO 163.206: E10/2).
I. *Semiretisporis* sp. A. (127.10 m x2: S26/3).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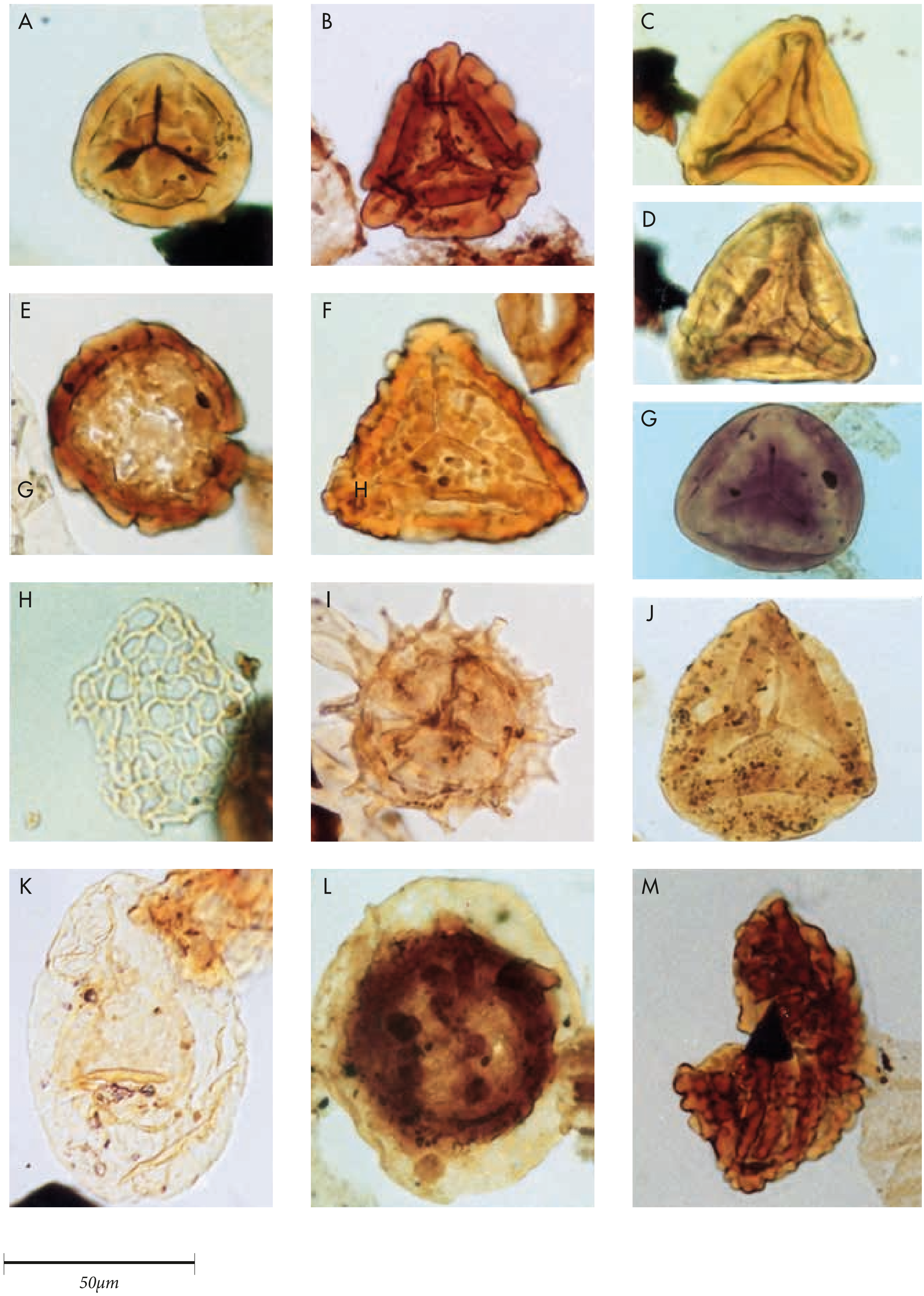
50μm

Plate 19: Core 7533/2–U–2, Sentralbanken

Illustrations from samples of Fruholmen Formation (Table A.38, 69.60–16.57 m), the slides belong to NPD.
The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets.
The scale bar represents 50 μm.

A. *Camarozonosporites rudis* (67.98 m x/sep: Q31).
B. *Kyrtomisporis gracilis* (69.60 m x/sep: N23).
C. *Kyrtomisporis speciosus* (22.65 m x: R27/3).
D. *Kyrtomisporis speciosus* (22.65 m x: R27/3).
E. Indeterminate spore (59.12 m x/sep: Q20).
F. *Kyrtomisporis gracilis* (22.65 m x: R30/3).
G. *Camarozonosporites laevigatus* (16.57 m x/sep: W25/26).
H. '*Retisulcites* sp. 2' sensu Hochuli et al. 1989 (52.62 m x/sep: N21/2)
I. *Kraeuselisporites reissingeri* (22.65 m x: R22/3).
J. *Kyrtomisporis niger* (16.57 m x: D38/4).
K. *Aratrisporites macrocavatus* (22.65 m sep: J25/2).
L. *Cingulizonates* sp. (16.57 m x/sep: T36).
M. *Ricciisporites tuberculatus* (16.57 m x/sep: W36/2).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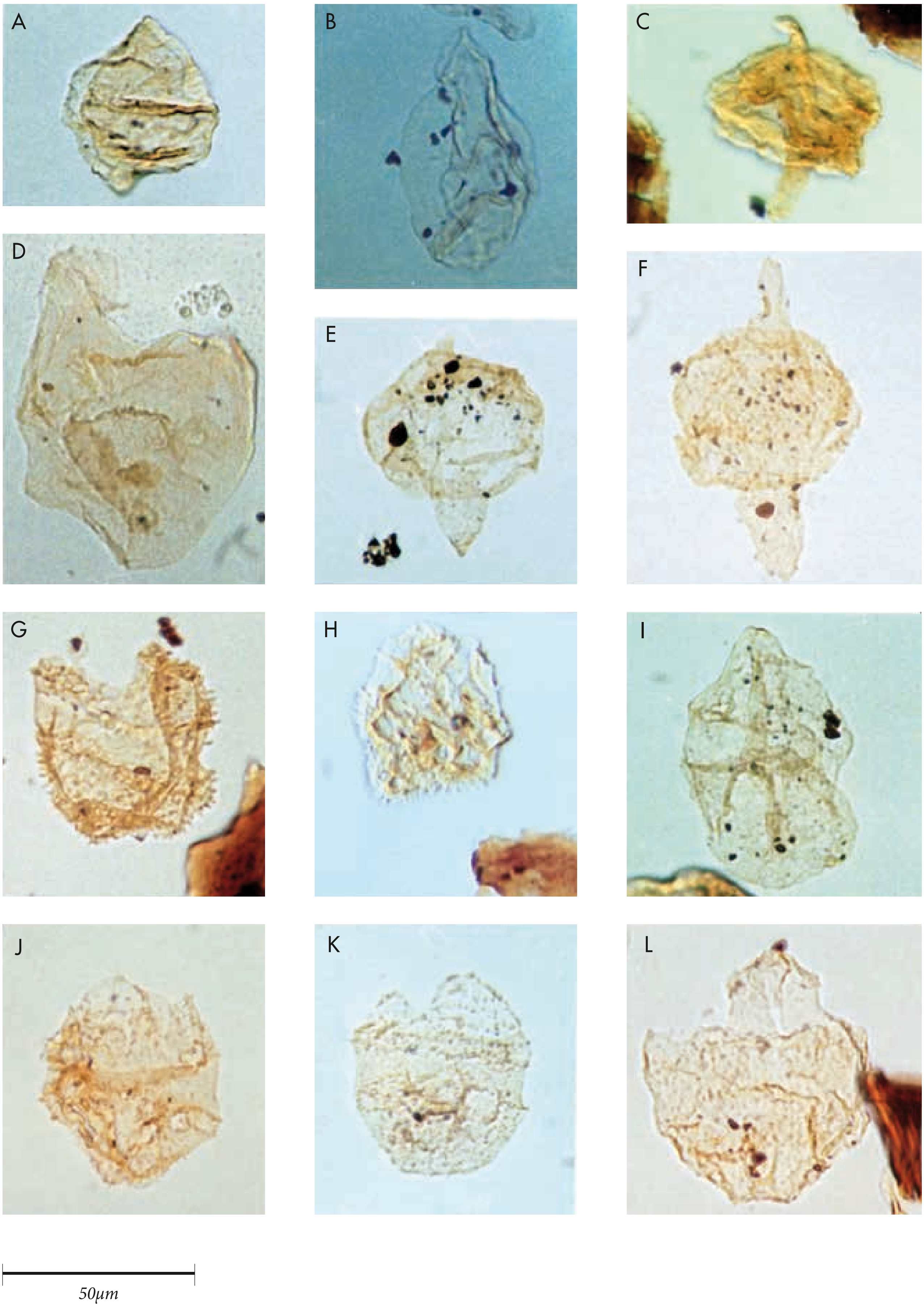
50µm

Plate 20: Core 7533/2–U–2, Sentralbanken

Illustrations from samples of Fruholmen Formation (Table A.38, 52.62–16.57 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Hebecysta brevicornuta* (22.65 m sep: H19/3).
B. *Hebecysta* sp. (22.65 m sep: G24).
C. *Sverdrupiella usitata* (16.57 m x: H39/2).
D. Indeterminate dinocyst (17.5 m sep2: J/K25).
E. *Sverdrupiella* cf. *usitata* (16.57 m x/sep: U38/1).
F. *Sverdrupiella mutabilis* (16.57 m x: F27/2)
G. *Shublikodinium setigerum* (17.5 m sep2: N30/3).
H. *Shublikodinium setigerum* (22.65 m sep: G24/3).
I. *Sverdrupiella* cf. *mutabilis* (52.62 m sch/sep: N18/4).
J. *Shublikodinium arcticum* (22.65 m sch: P36/37)
K. *Shublikodinium arcticum* (42.88 m sch: L29/4).
L. cf. *Shublikodinium arcticum* (22.65 m sch: P29/3).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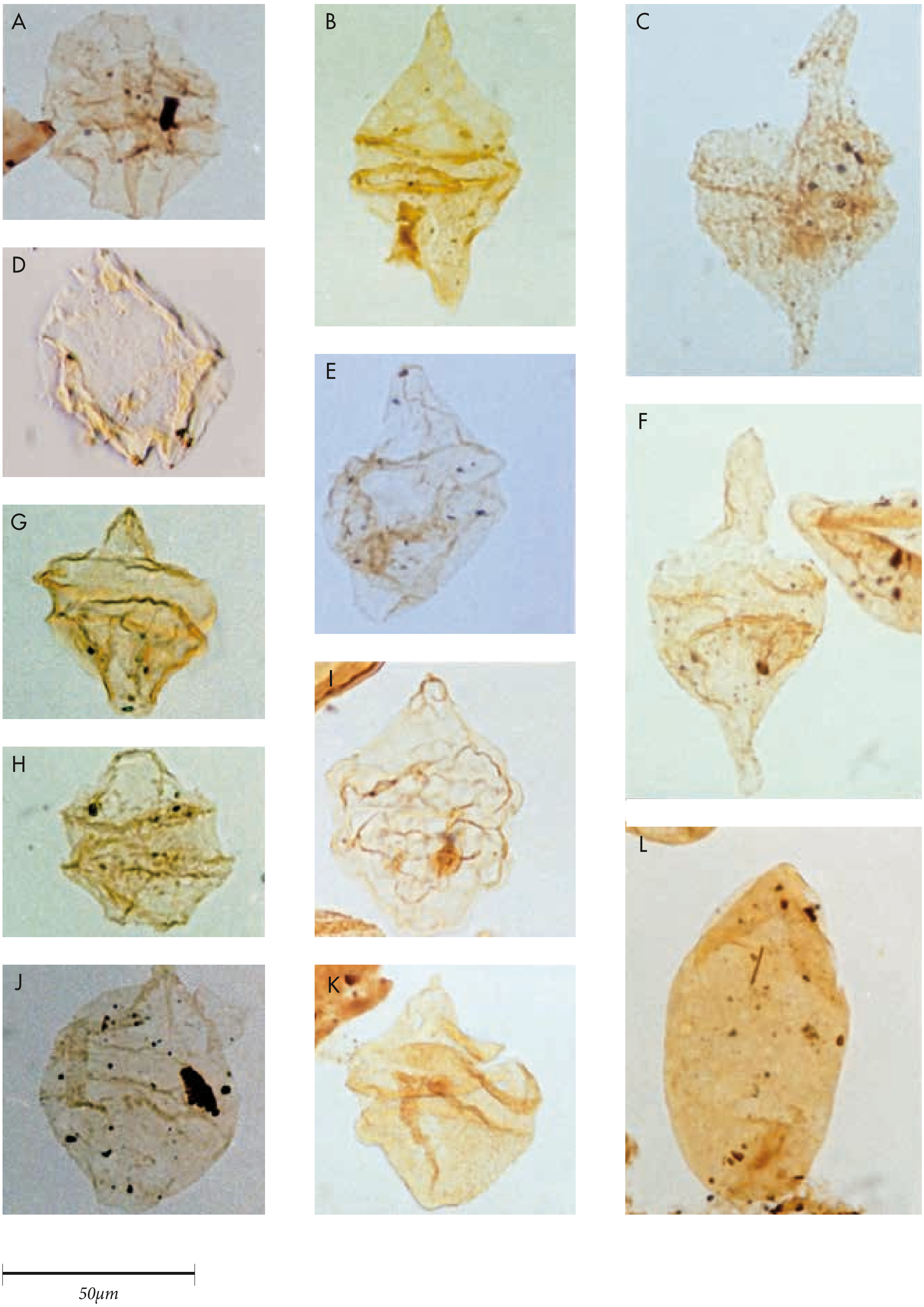
50μm

Plate 21: Core 7533/2–U–2, Sentralbanken

Illustrations from samples of Fruholmen Formation (Table A.38, 69.79–9.07 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Noricysta fimbriata* (16.57 m x/sep: X33/4).
B. *Rhaetogonyaulax rhaetica* (16.57 m x/sep: X38/4).
C. *Rhaetogonyaulax* sp. (16.57 m x/sep: T39/3).
D. Indeterminate dinocyst (22.65 m sep: G24/3).
E. *Heibergella asymmetrica* (16.57 m x/sep: V/W25).
F. *Rhaetogonyaulax* sp. (16.57 m x/sep: S34/4).
G. *Heibergella asymmetrica* (22.71 m x/sep: P37/1).
H. *Heibergella asymmetrica* (52.62 m x/sep: N/O18).
I. *Heibergella asymmetrica* (22.65 m sep: J17/1).
J. *Heibergella asymmetrica* (16.57 m x: D31/2).
K. *Heibergella* sp. (16.57 m x/sep: S26/2).
L. *Psophosphaera* sp. (22.65 m sep: T23/2).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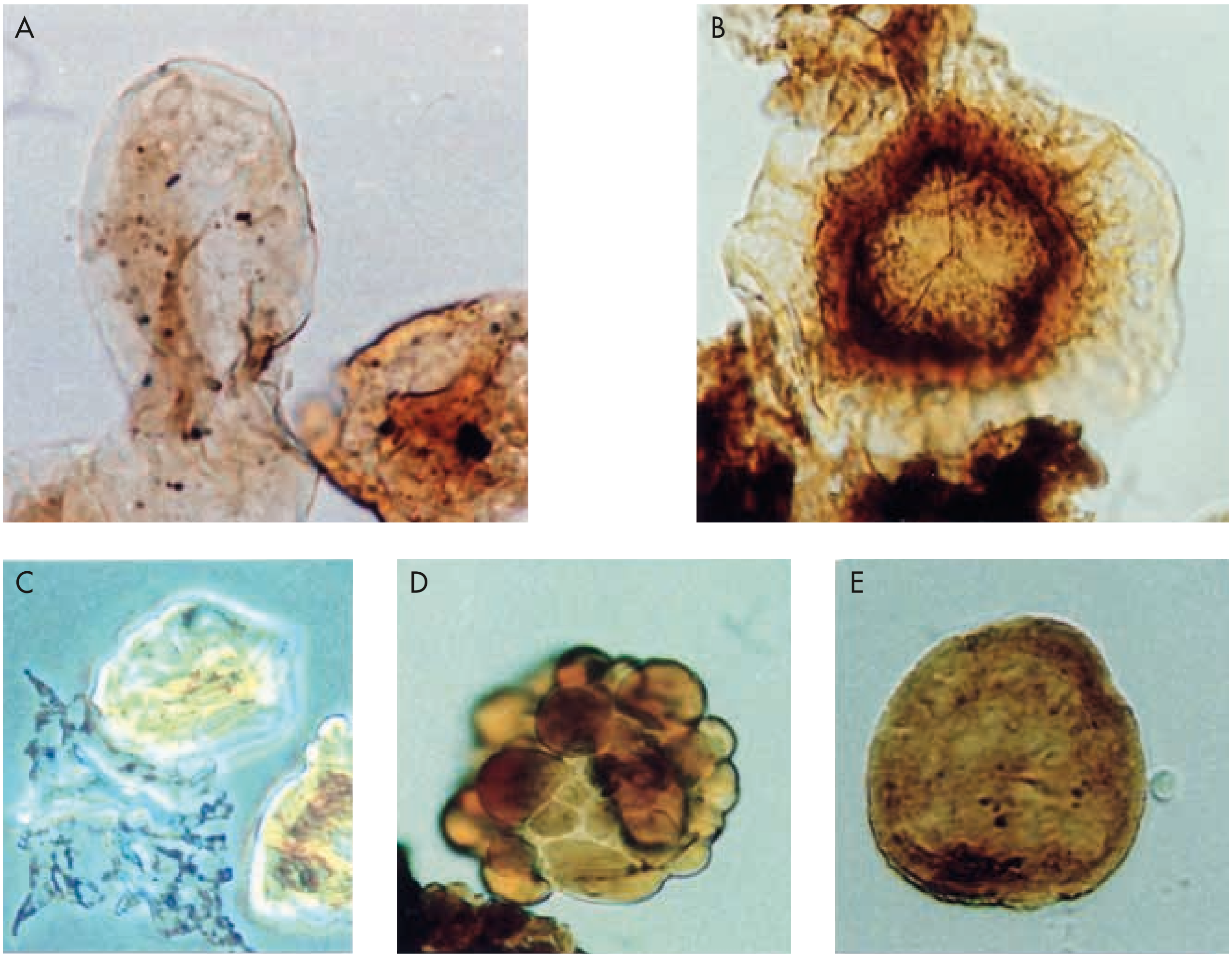
50μm

Plate 22: Core 7533/3–U–7, Hopendjupet, Sentralbanken

The illustrated specimens represent De Geerdalen Formation (Table A.39, 200.31–113.94 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Concentrisporites pseudosulcatus* (113.94 m sep3: L39/2).
B. *Cingulizonates rhaeticus* (200.31 m sep2: O41).
C. *Plaesiodictyon* sp. (141.71 m sep4: N33). Each cell has one strong horn.
D. *Leptolepidites macroverrucosus* (200.31 m sep2: M43).
E. *Duplicisporites* sp. (141.71 m sep4: N28/2).

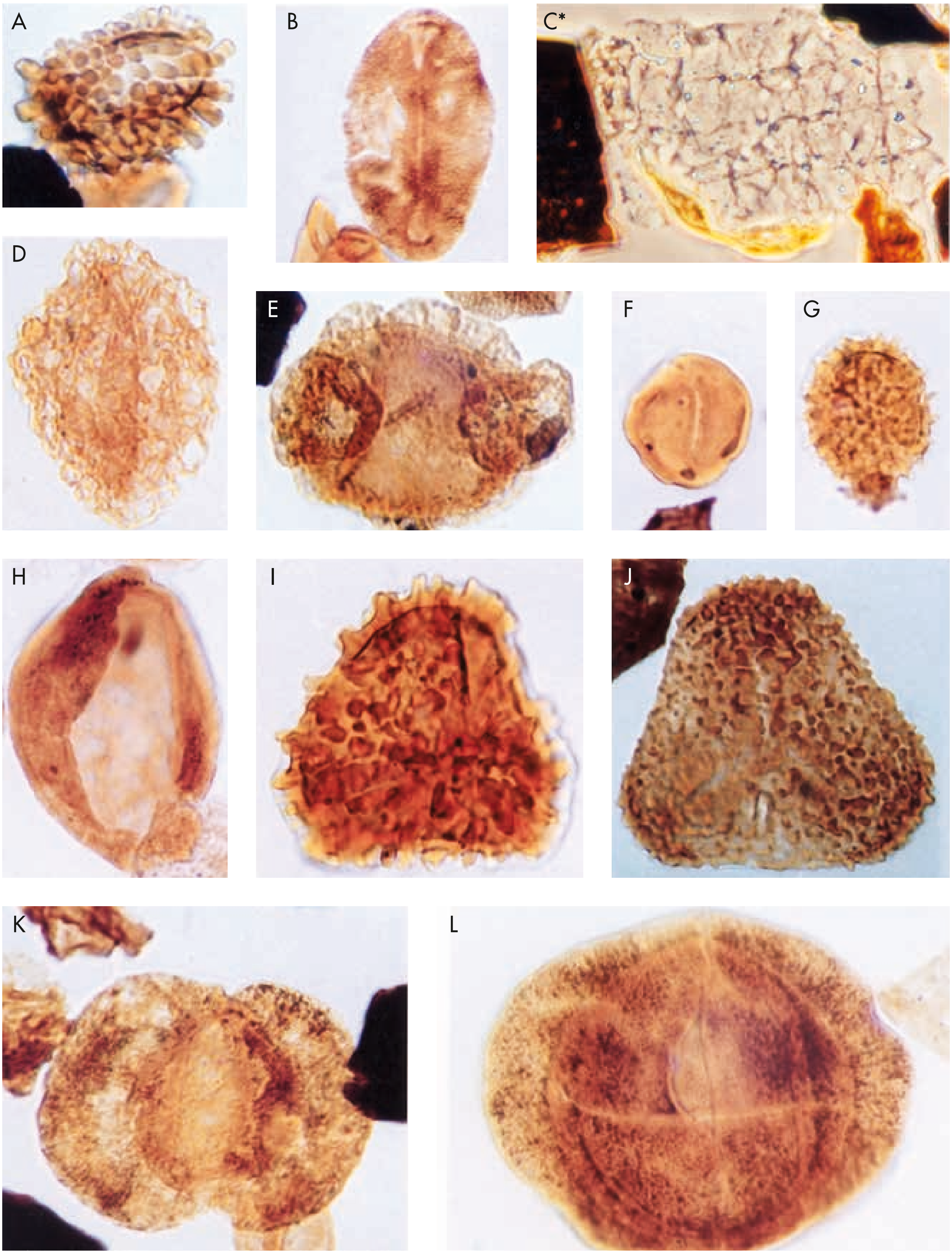


50µm

Plate 23: Core 7534/4–U–1, Sentralbanken

Illustrations from samples of Snadd Formation (Table A.40, 233.0–94.29 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bars represent 50 µm. Note the shorter scale bar for Fig. C*.

A. *Echinitosporites iliacoides* (233.0 m x2: H30/4).
B. *Ovalipollis pseudoalatus* (179.33 m x: O24).
C. *Plaesiodictyon mosellanum** (171.83 m x: D18–19).
D. *Retisulcites* sp. (179.33 m x: R19).
E. *Institisporites crispus* (94.29 m x: Q32/2).
F. *Eucommiidites minor* (179.33 m x: Q15–16).
G. *Polypodiisporites* sp. (171.83 m x: O17/1).
H. *Chasmatosporites magnolioides* (171.83 m x: O15/4).
I. *Conbaculatisporites* sp. (171.83 m x: C15/2).
J. *Conbaculatisporites hopensis* (179.33 m x: N14–15).
K. *Angustisulcites klausii* (171. 83 m x: T13).
L. *Staurosaccites quadrifidus* (194.53 m x: K28–29).



50µm

Fig. C: 50µm*

Plate 24: Core 7534/4–U–1, Sentralbanken

Illustrations from samples of Snadd Formation (Table A.40, 179.33–42.49 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Densosporites* sp. (42.49 m x: O16/4).
B. *Kraeuselisporites cooksonae* (42.49 m x: O24/3).
C. *Camarozonosporites rudis* (179.33 m x: P20–21).
D. *Lycopodiacidites kuepperi* (179.33 m x: Q28–29).
E. *Kraeuselisporites* sp. (53.27 m x2: P31).
F. *Semiretisporis* sp. A (179.33 m x: N16).
G. *Kraeuselisporites* sp. (83.97 m x: M28).
H. *Velosporites* sp. (74.11 m x2: S48).

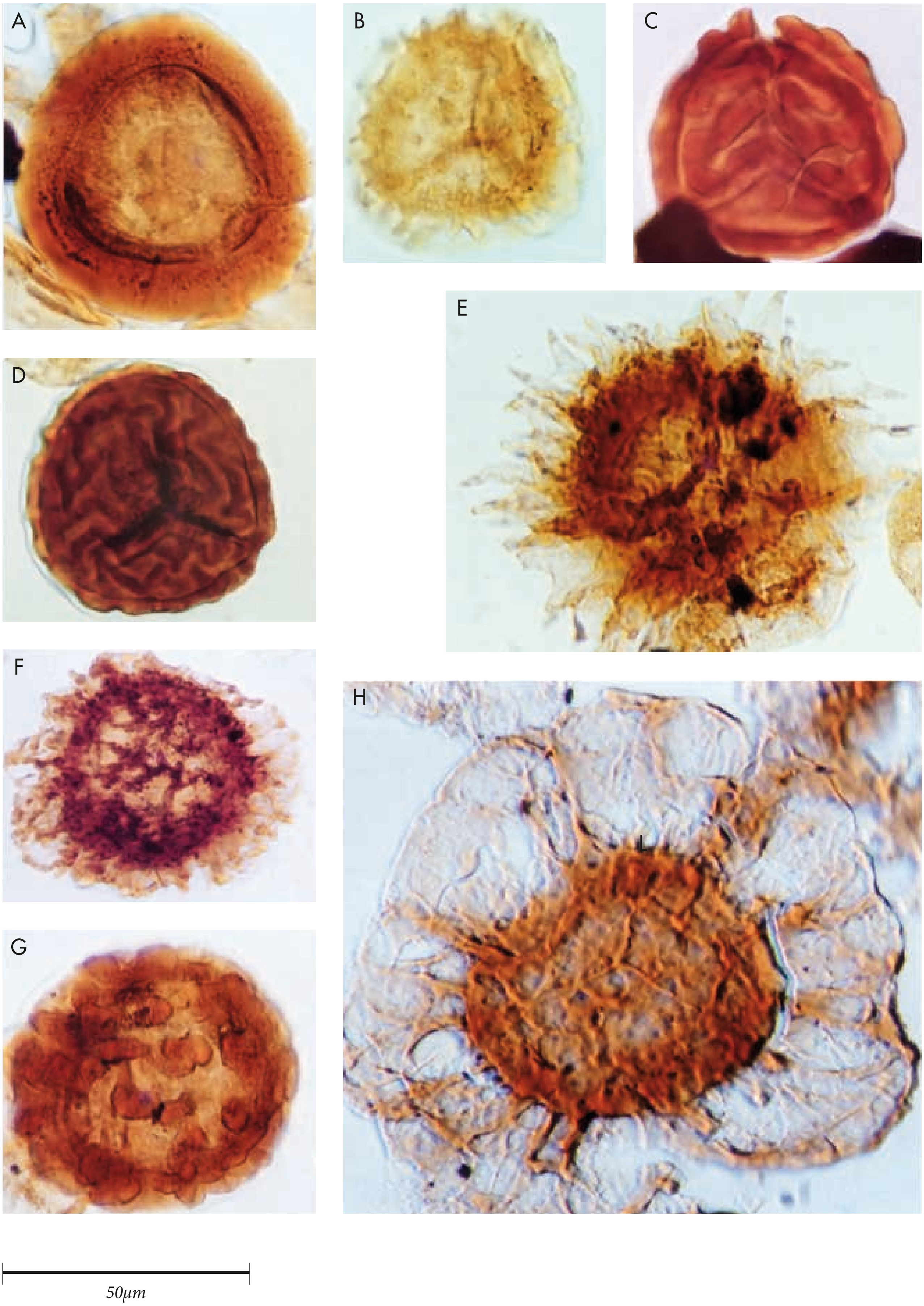

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Plate 25: Core 7534/6–U–1, Sentralbanken

Illustrations from samples of Klappmyss Formation (Table A.41, 119.42–84.80 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

A. *Staplinisporites caminus* (95.13 m x2: V29–30).
B. *Grebespora concentrica* (119.42 m x2: L32/4).
C. *Ephedripites* sp. (84.8 m x2: Z27–28).
D. *Cyclotriletes pustulatus* (107.34 m p: P–Q39).
E. *Cyclotriletes oligogranifer* (84.8 m x2: Q32/2).
F. *Verrucosisporites* sp. (107.34 m p: P–O21).
G. *Bocciaspora blackstonensis* (107.34 m p: Q36).
H. *Striatella seebergensis* (95.13 m x2: T28).
I. *Aratrisporites scabratus* (107.34 m p: F27–28).
J. *Lunatisporites* sp. (95.13 m x2: V26).
K. *Aratrisporites* sp. (107.34 m x: V35).

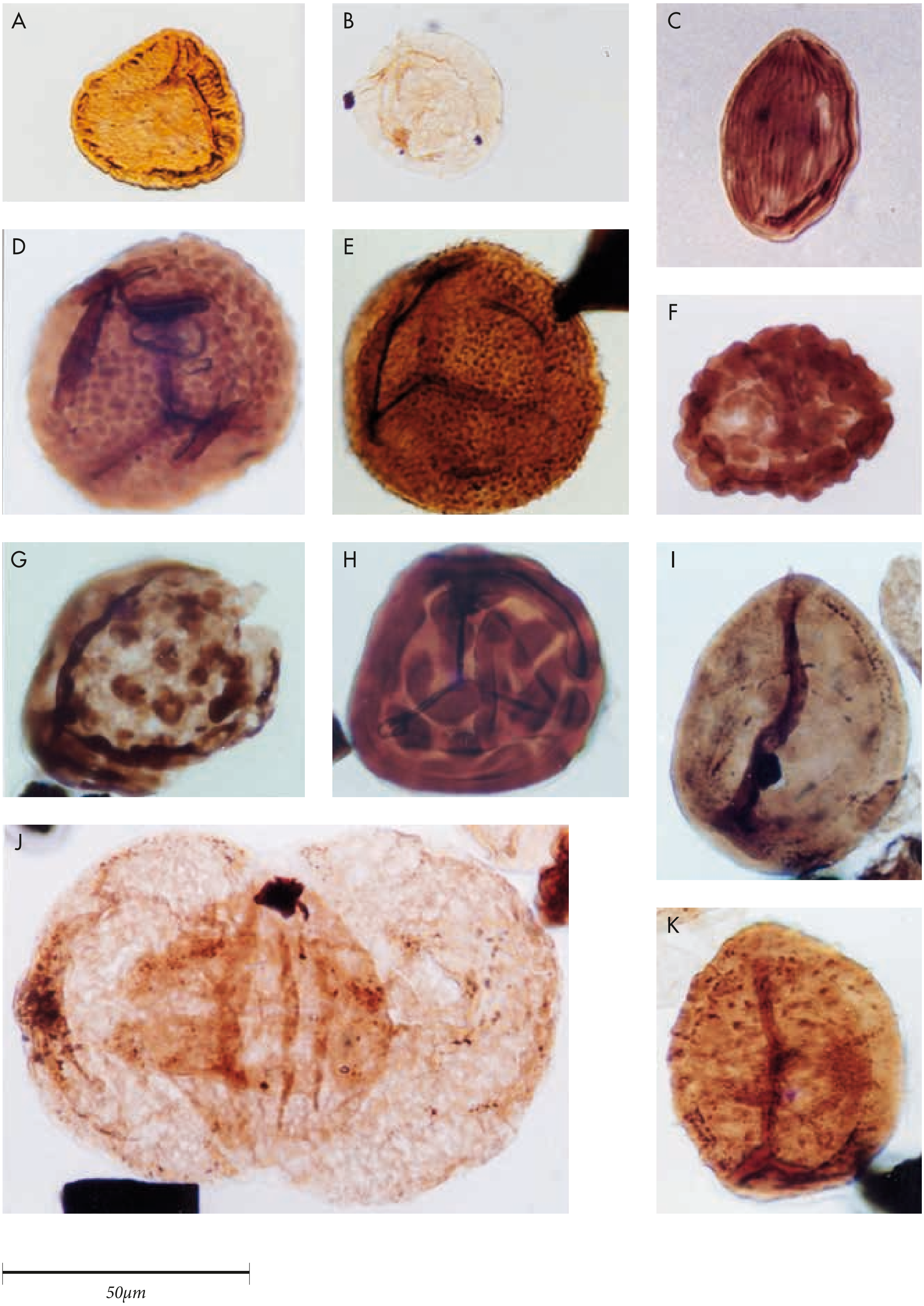
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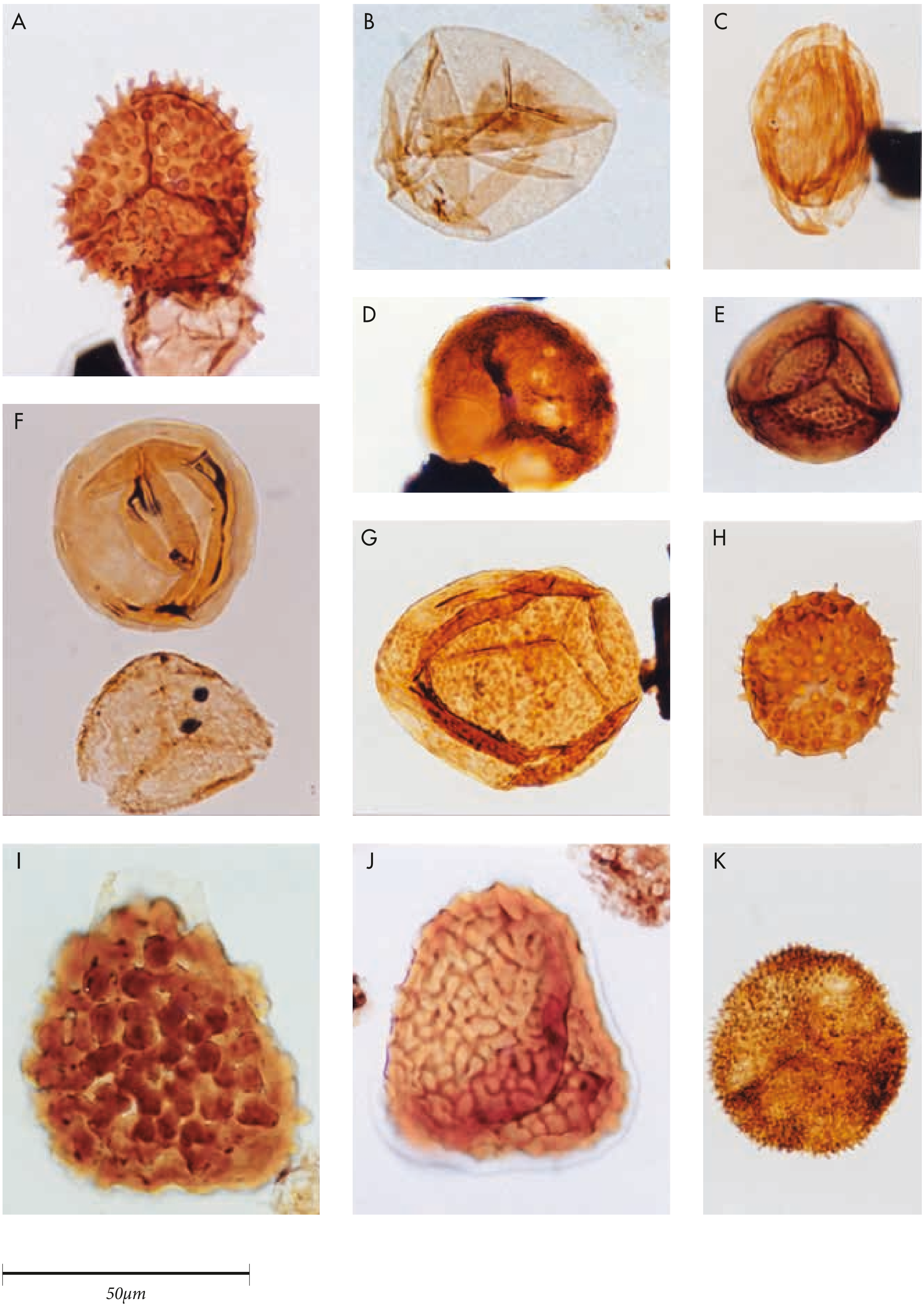
Plate 26: Core 7534/6–U–1, Sentralbanken

Illustrations from samples of Klappmyss (Table A.41, 84.80 m) and Kobbe formations (Table A.41, 75.25–65.59 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Acanthotriletes* sp. (75.25m x: P29).
B. *Calamospora impexa* (65.59 m x3: U30–31).
C. *Ephedripites* sp. (84.8 m x2: Z27–28).
D. *Densoisporites nejburgii* (75.25 m p: P22–23).
E. *Gordonispora fossulata* (75.25 m x: Q25).
F. Leiosphere and indeterminate trilete spore (65.59 m x3: N–O24).
G. *Cyclotriletes oligogranifer* (75.25 m x: L–M28).
H. *Anapiculatisporites spiniger* (75.25 m x: Q30–31).
I. *Uvaesporites* sp. (65.59 m x3: L30–31).
J. Microreticulate spore (65.59 m x3: Q17).
K. *Eresinia spinellata* (75.25 m x: Q25).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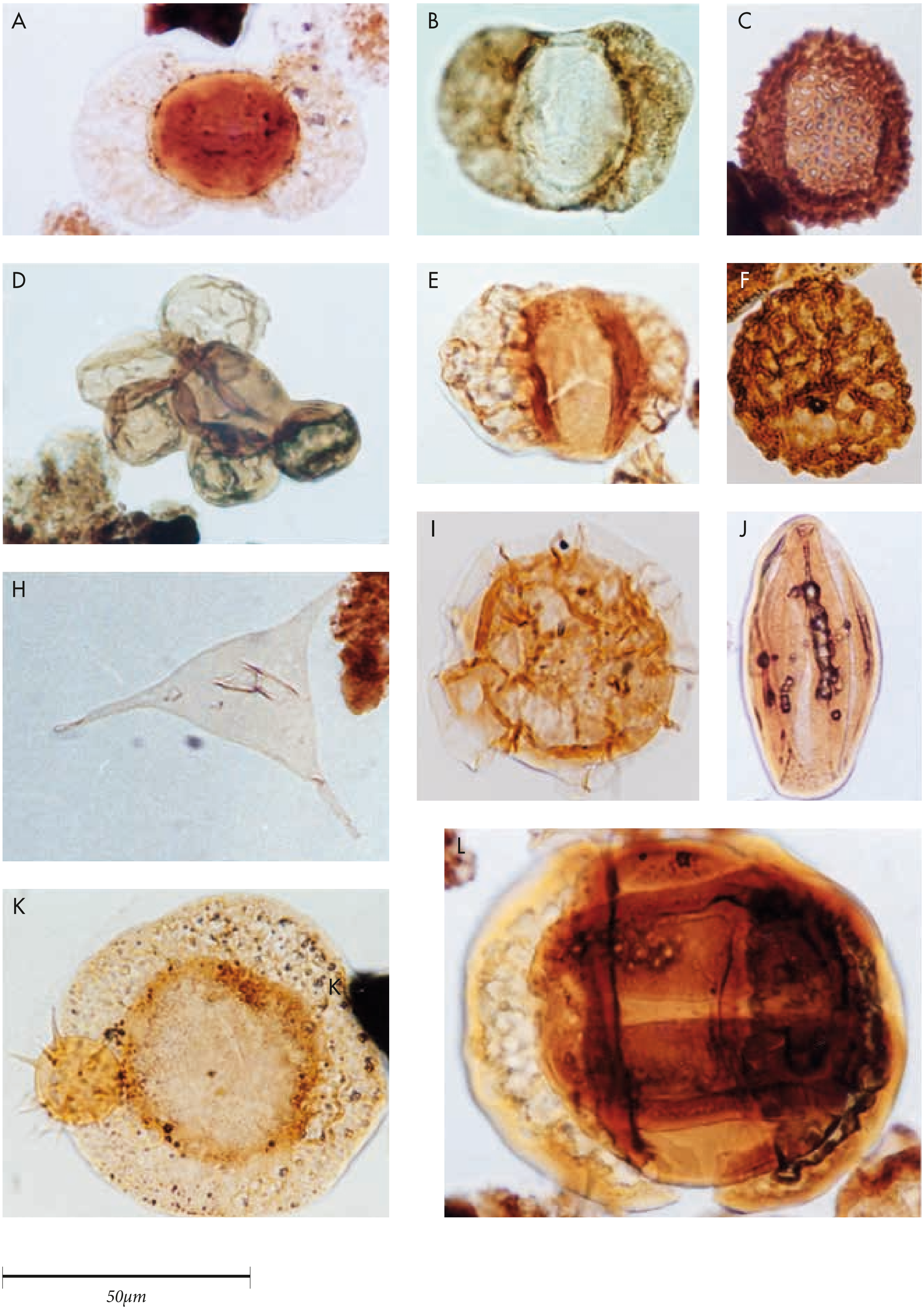
K
50µm

Plate 27: Core 7534/6–U–1, Sentralbanken

Illustrations from samples lowest in Kobbe Formation (Table A.41, 75.25–65.59 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm.

A. Indeterminate taeniate pollen (65.59 m x3: N29/2).
B. *Triadispora obscura* (65.59 m x3: N21).
C. Indeterminate spore (65.59 m x3: P29/2).
D. Foraminiferal lining (65.59 m x3: O31).
E. *Triadispora crassa* (65.59 m x3: N–O24).
F. *Rewanispora foveolata* (75.25 m x: M38).
G. *Veryhachium* sp. (65.59 m x3: M28).
H. *Cymatiosphaera* sp. 1 (75.25m x: P22).
I. *Pretricolpipollenites* sp. (65.59 m x3: N32).
J. *Cordaitina minor* (65.59 m x3: O23–24).
K. *Lueckisporites junior* (65.59 m x3: D30).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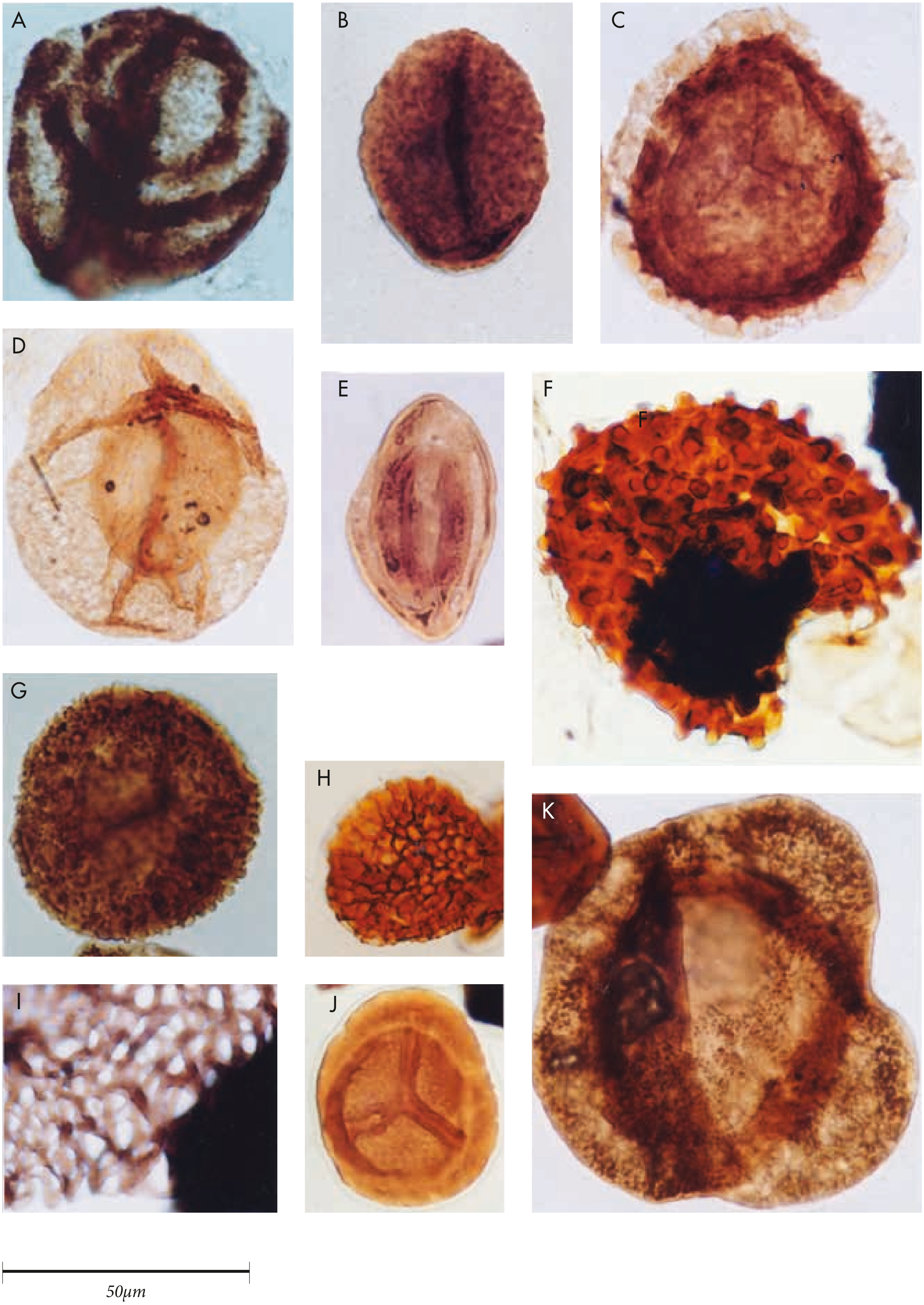
50μm

Plate 28: Core 7534/6–U–1, Sentralbanken

Illustrations from samples of Kobbe Formation (Table A.41, 55.94–12.49 m), the slides belong to NPD. The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Concentricisporites plurianulatus* (18.50 m x2: G28/3).
B. *Aratrisporites paenulatus* (29.82 m x: P–Q30).
C. *Kraeuselisporites apiculatus* (29.82 m x2: S21–22).
D. *Aratrisporites macrocavatus* (29.82 m x2: S38–39).
E. *Pretricolpipollenites* sp. (55.94 m x: M36–37).
F. *Jerseyiaspora punctispinosa* (55.94 m x: S28–29).
G. *Cyclotriletes* sp. A (18.50 m x2: O37/3).
H. *Rewanispora foveolata* (12.49 m x2: U21/2).
I. Leech cocoon (18.50 m P: E–F25).
J. *Gordonispora fossulata* (29.82 m x2: U32).
K. *Accinctisporites circumdatus* (35.89 m x2: O27–28).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50µm

D.3 BARENTS SEA EXPLORATION WELLS

Plate 29: Well 7121/1–1R, Finnmark Platform, Hammerfest Basin

Most of the illustrated specimens are from the Snadd Formation (Table A.46, 1164 m conventional core, cc). Fig. C is from the Kobbe Formation (Table A.46, 2210–15 m cuttings, cu). The name of a taxon is followed by the sample depth, slide type and slide coordinates by England Finder, in brackets. The scale bar represents 50 μm. Note the shorter scale bar Fig. E*.

A. Taeniate bisaccate pollen (1164 m cc: N43/4).
B. *Chasmatosporites magnolioides* (1164 m cc: O23–24).
C. *Angustisulcites klausii* (Cuttings 2210–15 m cu: P51–52).
D. *Protodiploxypinus* sp. (1164 m cc: L24–25).
E. *Triadispora verrucata** (1164 m cc: M36–37).
F. *Eucommiidites microgranulatus* (1164 m cc: L37/1).
G. Indeterminate ornamented spore (1164 m cc: M48/1).

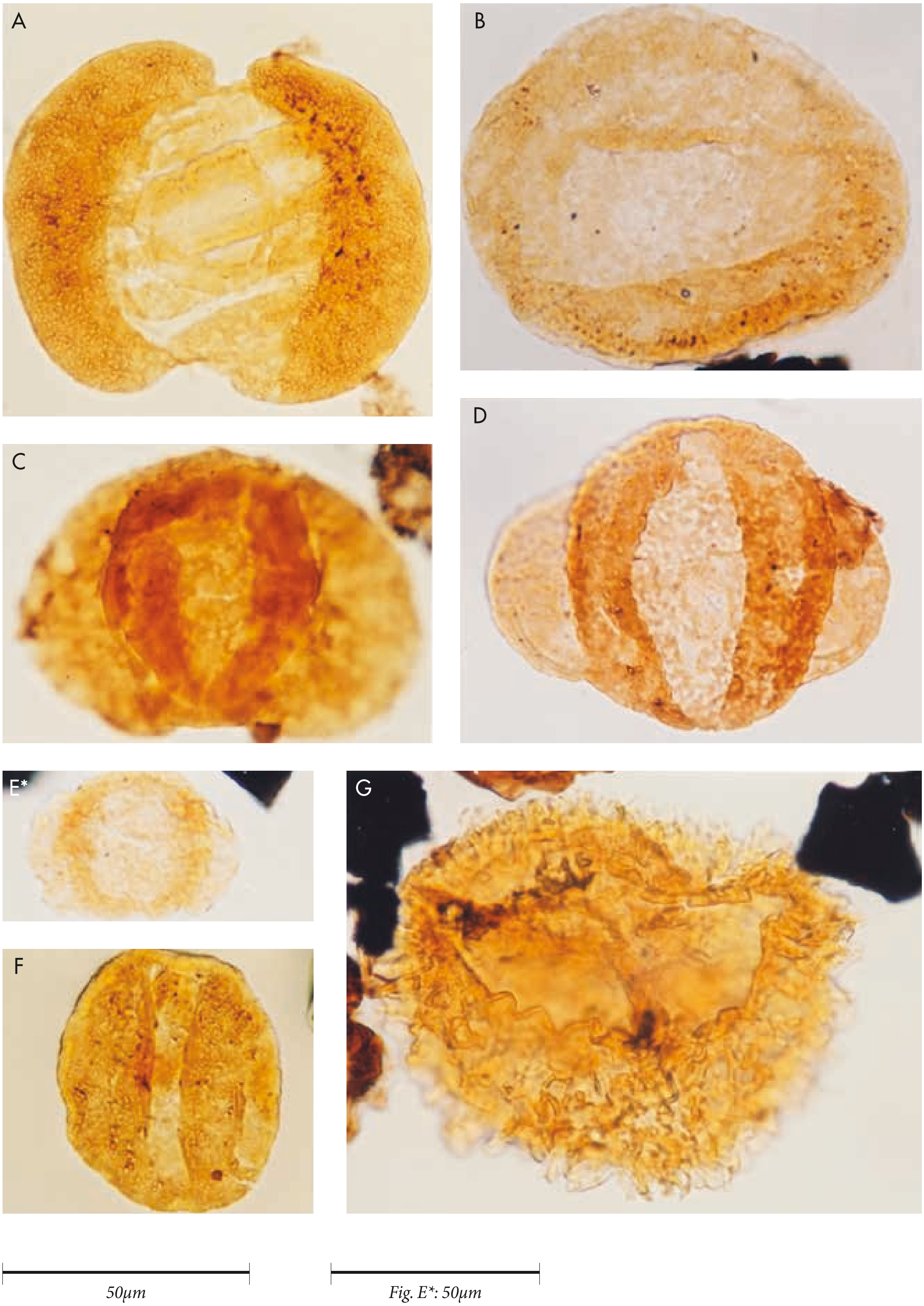
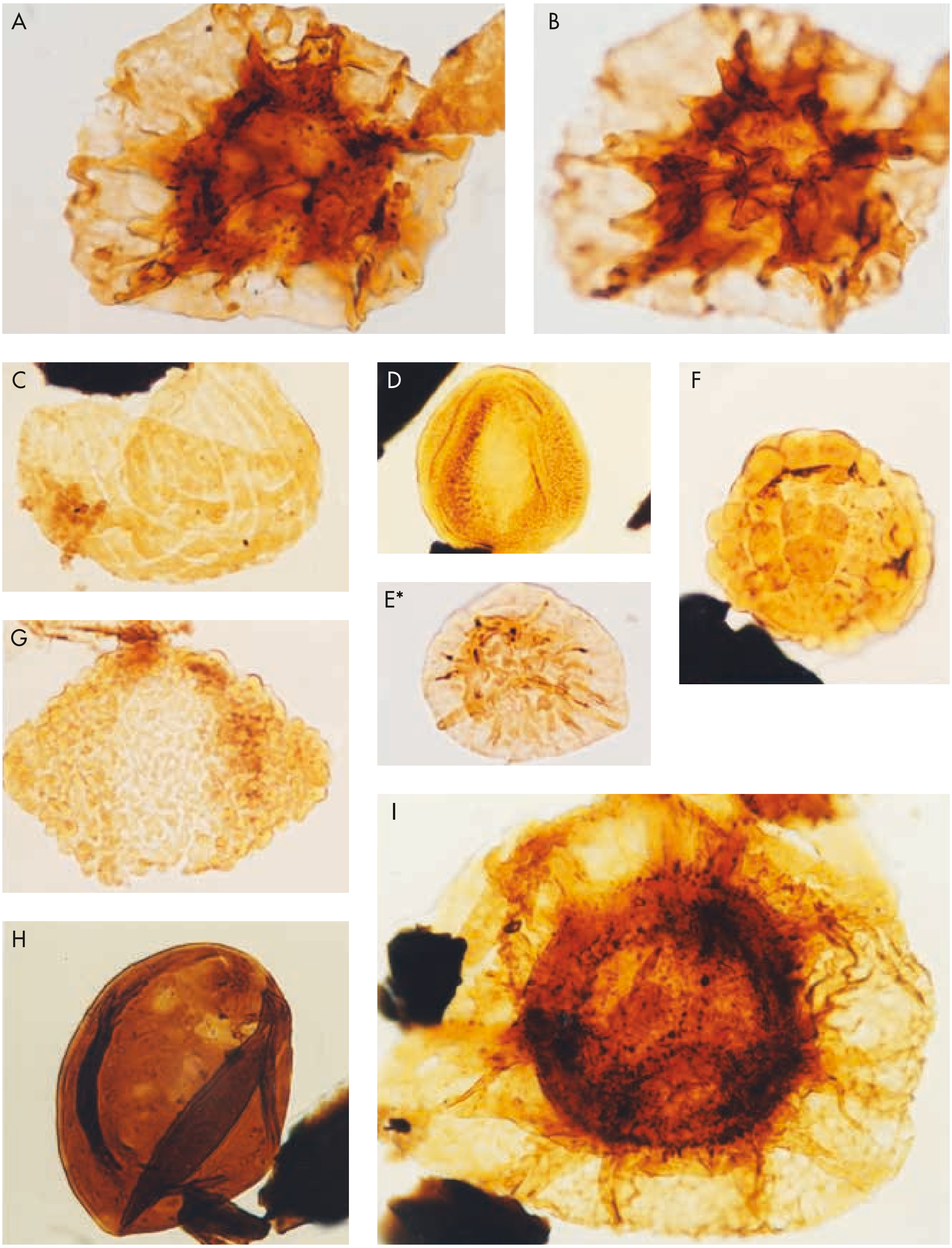

A
B
C
D
E*
F
G
50μm
Fig. E*: 50μm

Plate 30: Well 7121/1–1R, Finnmark Platform, Hammerfest Basin

The illustrated specimens are from the Snadd Formation (Table A.46, 1905 m cuttings, cu, 1164 and 1043 m conventional cores, cc), the slides belong to Statoil. The name of a taxon is followed by the sample-depth and -type and slide coordinates by England Finder, in brackets. The scale bars represent 50 μm. Note the shorter scale bar for Fig. E*.

A. *Kraeuselisporites dentatus* (1905 m cu: M41/2).
B. *Kraeuselisporites dentatus* (1905 m cu: M41/2).
C. *Schizaeoisporites worsleyi* (1164 m cc: N41/4).
D. *Corollina* sp. (1164 m cc: P50).
E. *Thomsonisporites undulatus** (1164 m cc: L–M40).
F. *Leptolepidites* sp. (1164 m cc: L33/4).
G. *Protodiploxypinus macroverrucosus* (1164 m cc: M37/1).
H. *Aulisporites astigmosus* (1043 m cc: N35).
I. *Velosporites* sp. (1164 m cc: O37–38).



50µm

Fig. E: 50µm*

Plate 31: Well 7224/7–1B, Bjarmeland Platform, Loppa Ridge

The illustrated specimens represent the *Aulisporites astigmosus* Composite Assemblage Zone in the Snadd Formation (Table A.48, 1419.5–1029 m cu), the slides belong to Statoil. The name of a taxon is followed by the depth of the cuttings sample (cu) and slide coordinates by England Finder, in brackets. The scale bar represents 50 µm.

A. *Rewanispora* sp. (1185.0 m cu, Q45/3).
B. *Rewanispora* sp. (1185.0 m cu, E15).
C. Indeterminate ornamented spore (1185.0 m cu: D16/1).
D. *Lycopodiacidites* sp. (1185.0 m cu: L17/3).
E. *Porcellispora longdonensis* (1185.0 m cu: B12/13).
F. Ornamented zonate spore (1185.0 m cu: H10).
G. *Corollina meyeriana* (1215.0 m cu: N10/3).
H. *Angustisulcites klausii* (1215.0 m cu: O25/3).
I. Ornamented zonate spore (1185.0 m cu: H10).
J. *Kuglerina meieri* (1215.0 m cu: H26/3).
K. *Doubingerispora filamentosa* (1246.0 m cu: W61/2).
L. Ornamented zonate spore (1215.0 m cu: O8/1).

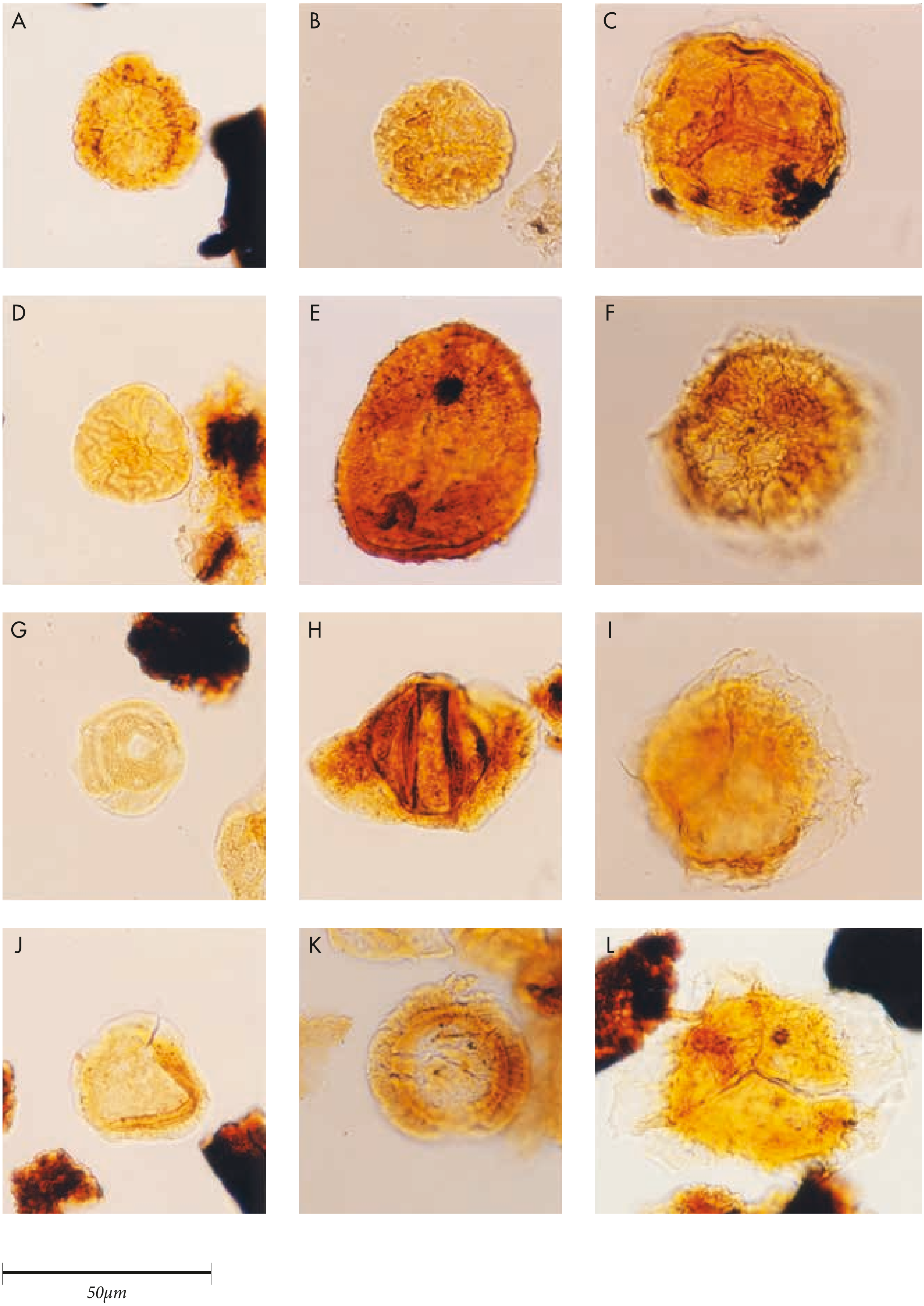

A
B
C
D
E
F
G
H
I
J
K
L
50µm

Plate 32: Well 7224/7–1B, Bjarmeland Platform, Loppa Ridge

Figures A–I illustrate specimens representing the *Limbosporites lundbladii* Composite Assemblage Zone in Fruholmen Formation (Table A.48, 973.0–929.6 m cc). Figures J–L illustrate the *Aulisporites astigmosus* Composite Assemblage Zone in Snadd Formation (Table A.48, 1419.5–1029.0 m). The slides belong to Statoil.

The name of a taxon is followed by the depth of the conventional core (cc), sidewall core (swc) or cuttings (cu) and the slide coordinates by England Finder, in brackets. The scale bars represent 50 µm. Note the shorter scale bar for Fig. J*.

A. *Ricciisporites umbonatus* (929.6 m cc: G48/3).
B. *Protodiploxypinus microsaccus* (929.6 m cc: J54/4).
C. *Polycingulatisporites crenulatus* (930.9 m cc: G56).
D. *Duplicisporites granulatus* (962.5 m cc: J60/1).
E. *Fossapollenites moderatus* (930.9 m cc: S63/2).
F. *Fossapollenites moderatus* (930.9 m cc: I: K69).
G. *Kyrtomisporis laevigatus* (962.5 m cc: H58).
H. *Praecirculina* sp. (962.5 m cc: L60/1).
I. *Zebrasporites interscriptus* (962.5 m cc: S57).
J. *Leschikisporis* acme (1176.9 m swc: J55/4).*
K. *Aulisporites astigmosus* (1073.0 m cu: A57).
L. *Franconisporites laevigata* (1058.0 m cu: K56/4).

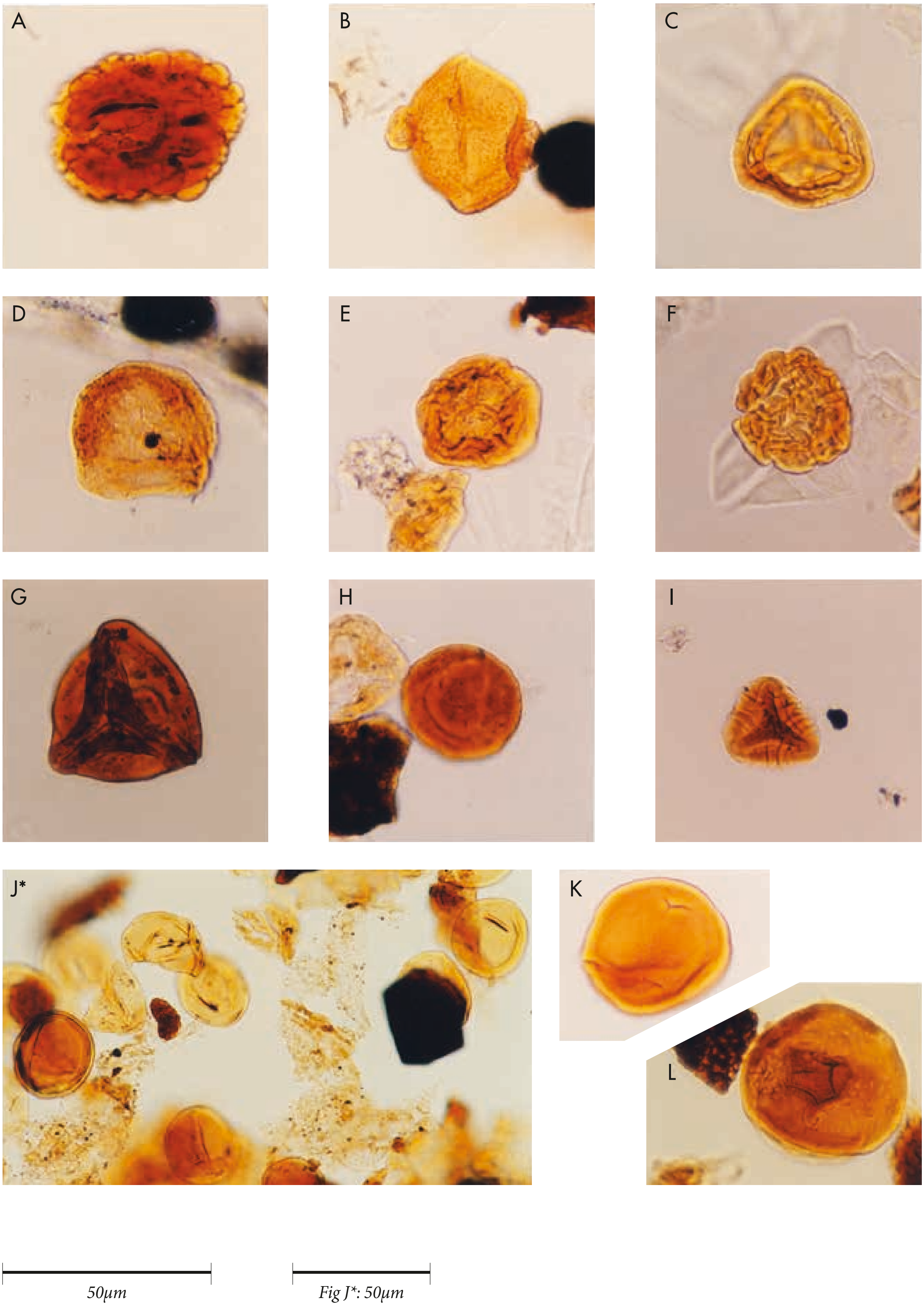
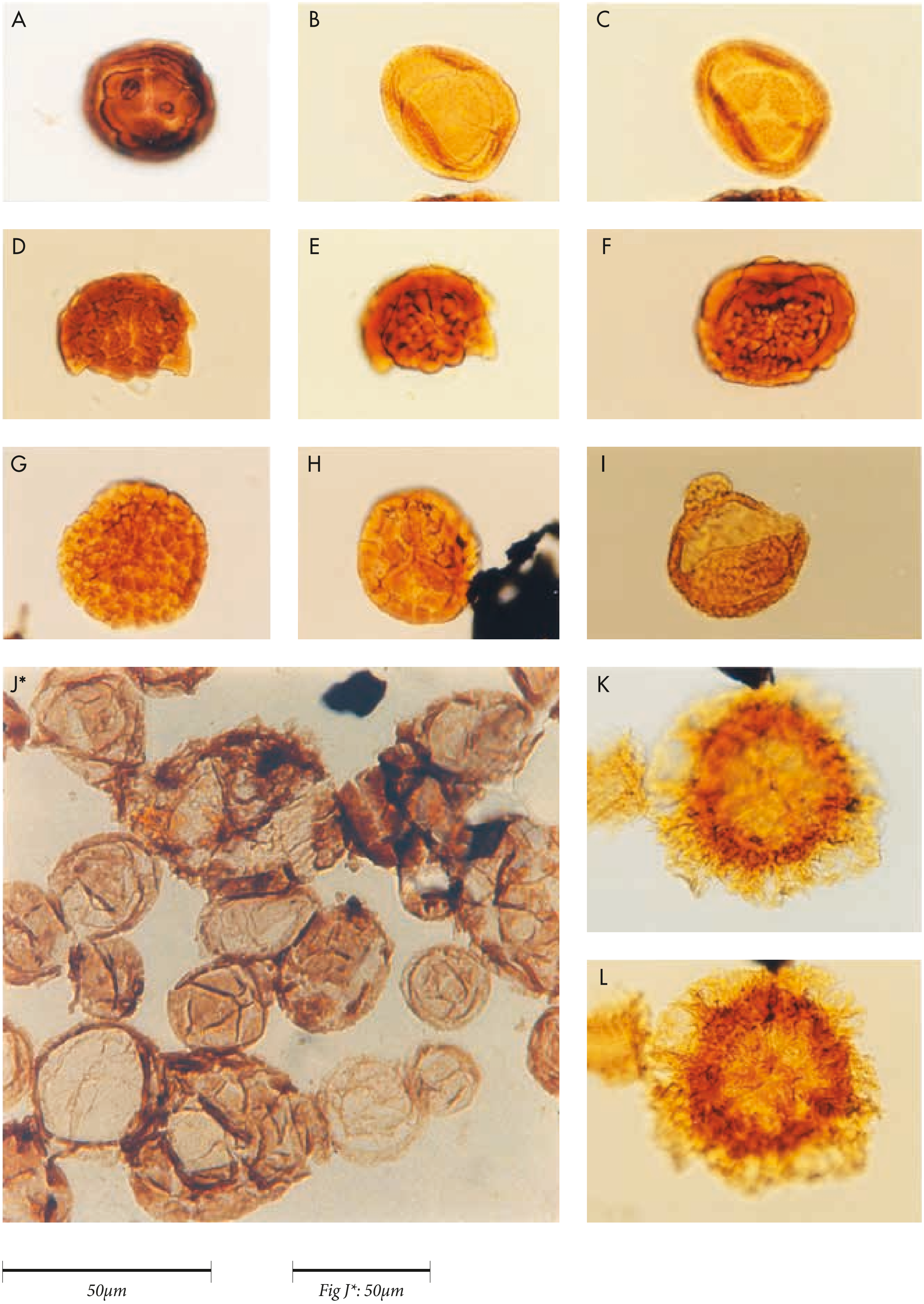

A
B
C
D
E
F
G
H
I
J*
K
L
50µm
Fig J*: 50µm

Plate 33: Well 7324/10–1 Bjarmeland Platform, Maud Basin

The illustrated specimens represent the *Echinitosporites iliacoides* Composite Assemblage Zone of the Snadd Formation (Table A.49, 1587.00–1399.00 m and the Aulisporites astigmosus Composite Assemblage Zone above, 1360.00 m upwards to 676.50 m which is outside the range chart). The slides belong to Statoil. The name of a taxon is followed by the depth of the sidewall core (swc) and the slide coordinates by England Finder, in brackets. The scale bars represent 50 μm. Note the shorter scale bar for Fig. J*.

A. *Sellaspora rugoverrucata* (676.5 m swc: P32).
B. *Discisporites* sp. (676.5 m swc: V12).
C. *Discisporites* sp. (676.5 m swc: V12).
D. *Sellaspora rugoverrucata* (676.5 m swc: T26).
E. *Sellaspora rugoverrucata* (676.5 m swc: T26).
F. *Sellaspora* sp. (676.5 m swc: J6/7).
G. *Verrucosisporites* sp. (676.5 m swc: N44/2).
H. *Verrucosisporites* sp. (676.5 m swc: O37/1).
I. *Protodiploxypinus microsaccus* (676.5 m swc: K37-38).
J. *Aulisporites* palynofacies* (1168 m swc: M27).
K. *Semiretisporis* sp. (676.5 m swc: N32/2).
L. *Semiretisporis* sp. (676.5 m swc: N32/2).


A
B
C
D
E
F
G
H
I
J*
K
L
50µm
Fig J*: 50µm

Taxa list

Explanation

1 Brackets (*Concentrisporites* sp. A and sp. B) *Concentrisporites pseudosulcatus* mark informal or invalid names that may appear in the distribution charts and are followed by the accepted taxon name.
2 {**Bold text in brackets**} marks plates figuring a species/specimen: {**Plates 1.H; 10.V, W; 11.B, K, O; 12.N; 14.H; 26.D.**}
3 The taxon accepted for use is followed by author names. Brackets mark taxa used under an equivalent name.

POLLEN

Accinctisporites circumdatus (Leschik in Kräusel and Leschik 1955) Jain 1968 {**Plates 15.C; 18.M; 28.K**}
Accinctisporites ligatus Leschik 1955 in Kraeusel and Leschik 1955
Alisporites grauvogeli Klaus 1964
Alisporites microreticulatus Reinhardt 1964
Alisporites microsaccus (Couper 1958) Pocock 1962
Alisporites nuthallensis Clarke 1965
Angustisulcites grandis (Freudenthal 1964) Visscher 1966 {**Plate 16.I**}
Angustisulcites klausii (Freudenthal 1964) Visscher 1966 *{Plates 17D; 23.K; 29.C; 31.H}*
Araucariacites australis Cookson 1947
Aulisporites astigmosus (Leschik 1955) Klaus 1960 {**Plates 30.H; 32.K**}
Bharadwajispora labichensis Jansonius 1962
Brachysaccus neomundanus (Leschik 1955) Mädler 1964
Callialasporites dampieri (Balme 1957) Sukh Dev 1959
Camerosporites pseudoverrucatus Scheuring 1970
Camerosporites secatus (Leschik 1956) Scheuring 1978
Cerebropollenites macroverrucosus (Thiergart 1949) Schulz 1967
Cerebropollenites thiergartii Schulz 1967
Chasmatosporites apertus (Rogalska 1954) Pocock and Jansonius 1969 {**Plate 10.O**}
Chasmatosporites magnolioides (Erdtman 1948) Nilsson 1958 {**Plates 8.O; 10.B; 23.H; 29.B**}
(*Chasmatosporites major* Nilsson 1958) *C. magnolioides*
Chasmatosporites sp.A, informal name {**Plate 6.H; 18.A**}
Chordasporites cingulichorda Klaus 1966
Chordasporites voltziaformis Visscher 1966
(*Classopollis classoides* (Pflug) Pocock and Jansonius 1962) *Corollina meyeriana*
(*Classopollis harrisii* Muir and van Konijnenburg-van Zittert 1970) *Corollina harrisii*
Colpectipollis ellipsoideus Visscher 1966
Concentrisporites hallei (Nilsson 1958) Wall 1965
Concentrisporites pseudosulcatus (Briche, Danzé-Corsin and Laveine 1963) Pocock 1970 {**Plate 22.A**}
(*Concentrisporites* sp.A and sp. S) *Concentrisporites pseudosulcatus*
Concentrisporites sulcatus (Rogalska 1945) Pocock 1970
Cordaitina gunyalensis (Pant and Srivastava 1964) Balme 1970
Cordaitina minor (Pautsch 1971) Pautsch 1973 {**Plates 16.B; 27.J**}
Corollina harrisii (Muir and van Konijnenburg-van Zittert 1970) Cornet and Traverse 1977
Corollina meyeriana (Klaus 1960) Venkatachala and Goczan 1964 (*Classopollis classoides*) {**Plate 31.G**}
Corollina (*Classopollis, Geopollis, Gliscopollis*)
Cristatisaccus cristatus Mädler 1964
Crustaesporites globosus Leschik 1956 {Plate 2.A}
Crybelosporites vectensis Kemp 1971
Cycadopites nitidus (Balme 1957) Norris 1969
Camerosporites pseudoverrucatus Scheuring 1970
Camerosporites secatus (Leschik 1955) Scheuring 1978
Cycadopites nitidus (Balme 1957) Norris 1969
(*Decussatisporites delineatus* Leschik 1955) *Lagenella martini*
Doubingerispora filamentosa Scheuring 1978 {Plate 31.K}
Duplicisporites granulatus (Leschik 1955) Scheuring 1970 {**Plate 32D**}
Dyupetalum vicentinense Brugman 1983
Echinitosporites iliacoides Schulz and Krutzsch 1961 {**Plates 6.B; 10.L; 18.D; 23.A**}
Enzonalasporites densus (Leschik 1955) Dolby 1976
Enzonalasporites vigens Leschik 1955 {**Plate 10.D**}
Ephedripites spp. (multistriated forms of *Gnetaceaepollenites*)
Ephedripites steevesii (Jansonius 1962) de Jersey and Hamilton 1967
(*Eucommiidites granulatus*) misprint for *Eucommiidites microgranulatus*
Eucommiidites granulosus Schulz 1967
Eucommiidites intrareticulatus Bjærke and Manum1977
Eucommiidites major Schulz 1967
Eucommiidites microgranulatus Scheuring 1970 {**Plates 10.Q; 29.F**}
Eucommiidites minor Groot and Penny 1960 {**Plate 23.F**}
Eucommiidites troedsonii Erdtmann 1958
Exesipollenites scabratus (Couper 1958) Pocock 1970
Falcisporites keuperianus Pautsch 1971
Falcisporites snopkovae Visscher 1966
Falcisporites stabilis Balme 1970
Falcisporites zapfei (Potonié and Klaus 1954) Leschik 1956
Florinites luberae Samoilovich 1953
Fossapollenites moderatus Scheuring 1970 {**Plates 32.E, F**}

Franconisporites laevigata Heunisch 1986 {**Plate 32.L**}
(*Gnetaceaepollenites multistriatus* Jansonius 1962) *Ephedripites*
Granasporites magnus Quian Lijun, Zao Cenghua and Wu Jinjun 1983
(*Granuloperculatipollis operculatus*) *Granuloperculatipollis rudis*
Granuloperculatipollis rudis Venkatachala and Goczan 1964
Haberkornia gudati Scheuring 1978
Haberkornia parva Scheuring 1978
Illinites chitonoides Klaus 1964 {**Plates 16.C; 17.F, N**}
Illinites trivisus Visscher 1966
Inaperturopollenites nebulosus Balme 1970
Infernopollenites schaubergeri (Klaus 1953) Potonie and Klaus 1954
Infernopollenites sulcatus (Pautsch 1958) Scheuring 1970
Institisporites crispus Pautsch 1971 {**Plates 17.G, H; 18.J; 23.E**}
Jugasporites conmilvinus Klaus 1964
Klausipollenites schaubergeri (Potonie and Klaus 1954) Jansonius 1962
Klausipollenites staplinii Jansonius 1962
Kuglerina meieri Scheuring 1978 {**Plates 5.Q; 31.I, J**}
Lagenella delineatus (Leschik 1956) Klaus 1960
Lagenella martini (Leschik) Klaus 1960
Laricoidites magnus (Potonie 1933) Potonie et al. 1950
Laricoidites sp. *sensu* Bjærke and Manum 1977
Libumella spp.
Lueckisporites junior Klaus 1960 {**Plates 15.F; 27.K**}
Lueckisporites sp.A *sensu* Mangerud 1994
Lueckisporites virkkiae (Potonié and Klaus 1959) Clarke 1965
Lunatisporites acutus (Leschik 1955) Scheuring 1970
Lunatisporites noviaulensis (Leschik 1956) Scheuring 1970 {**Plates 6.F, I; 10.M; 11.E; 13.I**}
Lunatisporites obex Balme 1963
Lunatisporites pellucidus (Goubin 1965) Balme 1970
Lunatisporites rhaeticus (Schulz 1967) Warrington 1974
Lunatisporites sp. U (*Taeniaesporites* sp. U sensu Jansonius 1962)
Lunatisporites transversundatus (Jansonius 1962) Mangerud 1994
Maculatasporites spp. aff. '*Reticulina bilateralis*' Koloda sensu Mangerud 1994
Monosulcites granulosus informal name
Ovalipollis pseudoalatus (Thiergart 1949) Schuurmann 1976 {**Plates 6.K; 10.P; 18.C; 23.E**}
Pallidosporites minimus Schaarschmidt 1963
(*Paracirculina tenebrosa* Scheuring 1970) *Partitisporites*
Partitisporites tenebrosus (Schulz 1970) van der Eem 1983
Parvisaccites radiatus Couper 1958
Perinopollenites elatoides Couper 1958
Piceapollenites sp. B *sensu* Mangerud 1994
Pinuspollenites minimus (Couper 1958) Kemp 1971
Pityosporites scaurus (Nilsson 1958) Schulz 1967
Platysaccus papilionis Potonié and Klaus 1954
Podocarpidites langii Pocock 1970
Podocarpidites rousei Pocock 1970
Podosporites amicus Scheuring 1970 {Plate 16.G}
(*Podosporites doubingeri* Klaus 1964) *Protodiploxypinus doubingeri*
Podosporites sp.A, sensu Vigran et al. 1998
Podosporites sp.B, sensu Vigran et al. 1998 {**Plate 8.P**}
Porcellispora longdonensis (Clarke 1965) Scheuring 1970 {**Plate 31.E**}
Praecirculina granifer (Leschik 1955) Klaus 1960
Protodiploxypinus decus Scheuring 1970 {**Plate 17.B**}
Protodiploxypinus doubingeri (Klaus 1964) Warrington 1974
Protodiploxypinus fastidioides (Jansonius 1962) Warrington 1974 {**Plate 16.D**}
Protodiploxypinus gracilis Scheuring 1970
Protodiploxypinus macroverrucosus Bjærke and Manum 1977 {**Plate 30.G**}
Protodiploxypinus microsaccus Bjærke and Manum 1977 {**Plates 32.B; 33.I**}
Protodiploxypinus minor Bjærke and Manum 1977
Protodiploxypinus ornatus (Pautsch 1973) Bjærke and Manum 1977
Protodiploxypinus sittleri (Klaus 1960) Scheuring 1970
Protodiploxypinus sivaki Scheuring 1978
Protohaploxypinus amplus (Balmeand Hennelly 1955) Hart 1964
Protohaploxypinus chaloneri Clarke 1965
Protohaploxypinus globus (Hart 1960) Hart 1964
Protohaploxypinus limpidus (Balmeand Hennelly 1955) Balme and Playford 1968
Protohaploxypinus microcorpus (Schaarschmidt 1963) Clarke 1965
Protohaploxypinus minor (Klaus 1963) Clarke 1965
Protohaploxypinus perfectus (Naumova ex K-Murza 1952) Samoilovich 1953
Protohaploxypinus samoilovichii (Jansonius 1962) Hart 1964
Protohaploxypinus varius (Bharadwaj 1962) Balme 1970
Pseudenzonalasporites summus Scheuring 1970
Quadraeculina anellaeformis Maljavkina 1949
Retisulcites perforatus (Mädler 1964) Scheuring 1970
'*Retisulcites* sp. 1' sensu Hochuli et al. 1989
'*Retisulcites* sp. 2' sensu Hochuli et al. 1989 {Plate 19.H}
Rhaetipollis germanicus Schulz 1967
Ricciisporites tuberculatus Lundblad 1954 {Plate 19.M}
Ricciisporites umbonatus Felix and Burbridge 1977 {**Plate 32.A**}
Schizaeoisporites worsleyi Bjærke and Manum 1977 {**Plates 6.G; 8.Q; 10.E; 18.N; 30.C**}
Scutasporites sp. cf. *S. unicus* Klaus 1963
Staurosaccites quadrifidus Dolby in Dolby and Balme 1976 {**Plates 6.N; 10.A; 18.P; 23.R**}
Striatoabieites aytugii (Visscher 1966) Scheuring 1970
Striatoabieites balmei (Klaus 1964) Scheuring 1978 {**Plates 14.F; 16.L**}
Striatoabieites multistriatus (Balme and Henelly 1955) Hart 1964 {**Plates 6.C; 15.I; 16.F**}
Striatoabieites richteri (Klaus 1955) Hart 1964
Striatopodocarpites cancellatus (Balme and Henelly 1955) Hart 1964
Striatopodocarpites pantii (Jansonius 1962) Balme 1970
Striatopodocarpites varius (Leschik 1955) Hart 1964
Succinctisporites grandior Leschik 1955
(*Sulcatisporites nilssoni*) *Alisporites* spp.
Tetrasaccus Pant 1954

Triadispora aurea Scheuring 1970
Triadispora bölchii Scheuring 1970
Triadispora crassa Klaus 1964 {**Plates 16.E; 27.E**}
(*Triadispora labichensis*) *Bharadwajispora*
Triadispora modesta Scheuring 1970
Triadispora obscura Scheuring 1970 {**Plates 10.S; 17.J; 27.B**}
Triadispora plicata Klaus 1964 {**Plates 16.A; 17.I**}
Triadispora stabilis Scheuring (1970) emend. 1978
Triadispora verrucata (Schulz 1966) Scheuring 1970 {**Plates 8.R; 29.E**}
Vallasporites ignacii Leschik 1956) Scheuring 1970 {**Plate 7.C**}
Vesicaspora schemelii Klaus 1963
Verrucatosporites scabratus Bjærke and Manum 1977 {**Plate 7.J**}
Vitreisporites pallidus (Reissinger 1938) Nilsson 1958
Vitreisporites signatus Leschik 1956
Vittatina costabilis Wilson 1962
Vittatina minima Jansonius 1962
Vittatina saccata (Hart 1960) Jansonius 1962
Vittatina simplex Jansonius 1962
Vittatina striata (Luber 1940) Jansonius 1962
Vittatina subsaccata Samoilovich 1953
Vittatina vittifera (Luber and Walz 1941) Samoilovich 1953
Voltziaceaesporites heteromorpha Klaus 1964

SPORES

(*Acanthotriletes* sp. F sensu Vigran et al. 1998) *Eresinia spinellata*
Acanthotriletes tereteangulatus Balme and Hennelly 1956
Acanthotriletes varispinosus Pocock 1962
Acanthotriletes variabilis (Nilsson 1958) Schuurman 1977
(*Acanthotriletes varius*) *Acanthotriletes variabilis*
Anapiculatisporites dawsonensis Reiser and Williams 1969
Anapiculatisporites spiniger (Leschik 1955) Reinhardt 1961 {**Plates 10.R; 15.J; 26.H**}
Anaplanisporite stipulatus Jansonius 1962
Annulispora bicollateralis (Rogalska 1954) Bjærke and Manum 1977
Annulispora cicatricosa (Rogalska 1954) Morbey 1975
Annulispora folliculosa (Rogalska 1954) de Jersey 1959 {**Plate 8.H**}
Annulispora sp. A (Bjærke and Manum 19077)
Annulispora sp. B (Bjærke and Manum 19077)
Apiculatisporis lanjouwii Jansonius 1962
Apiculatisporis ovalis (Nilsson 1958) Norris 1964
Apiculatisporis parvispinosus (Leschik 1955) Schulz 1962
Aratrisporites baculatus, informal name
Aratrisporites centratus Leschik 1955
Aratrisporites fimbriatus (Klaus 1960) Mädler 1964
Aratrisporites laevigatus Bjærke and Manum 1977 {**Plate 8.N**}
Aratrisporites macrocavatus Bjærke and Manum 1977 {**Plates 17.P; 19.K; 28.D**}
Aratrisporites minimus Schultz 1967
(*Aratrisporites 'minor'* informal) *Aratrisporites minimus*
Aratrisporites paenulatus Playford and Dettmann 1965 {**Plate 28.B**}
Aratrisporites palettae (Klaus 1960) Schulz 1967 {**Plates 15.O; 18.O**}
Aratrisporites parvispinosus (Leschik 1955) Playford 1965
Aratrisporites plicatus deJersey and Hamilton 1967
Aratrisporites robustus Yaroshenko and Golubeva 1989
Aratrisporites saturni (Thiergart 1949) Playford and Dettmann 1965
Aratrisporites scabratus Klaus 1960 {**Plates 11.G; 25.I**}
Aratrisporites tenuispinosus Playford 1965 {**Plate 11.F**}
(*Asseretosporites seebergensis*) *Striatella*
(*Auritulinasporites intrastriatus* Nilsson 1958) *Concavisporites juriensis*
(*Auritulinasporites scanicus*) *Concavisporites juriensis*
Auritulinasporites triclavis Nilsson 1958
Baculatisporites comaumensis (Cookson 1953) Potonié 1956
Baculatisporites wellmannii (Couper 1953) Krutzsch 1959
Biretisporites potoniei Delcourt and Sprumont 1955 *sensu* Bjærke and Manum
Bocciasporites blackstonensis van der Eem 1983 {**Plate 25.G**}
Calamospora breviradiata Kosanke 1950
Calamospora impexa Playford 1965 {**Plate 26.B**}
Calamospora mesozoica Couper 1958
Calamospora tener (Leschik 1955) Mädler 1964
Camarozonosporites laevigatus Schulz 1967 {**Plate 19.G**}
Camarozonosporites rudis (Leschik 1955) Klaus 1960 {**Plates 8.C; 19.A; 24.C**}
Cavatoretisporites obvius Bjærke & Manum 1977
Cibotiumspora (Balme 1957) Filatoff 1975
Cingulizonates rhaeticus (Reinhardt 1962) Schulz 1967 **Plate 22.B**}
Conbaculatisporites hopensis Bjærke & Manum 1977 {**Plates 18.E; 23.J**}
Conbaculatisporites sp.1, informal taxon
Conbaculatisporites mesozoicus Klaus 1960
Concavisporites crassiexinius Nilsson 1958 {**Plate 14.N**}
Concavisporites intrastriatus (Nilsson 1958) Arjang 1975
Concavisporites juriensis Balme 1957
Concavisporites scabratus Bjærke and Manum 1977
(*Concavisporites* sp.A) *Concavisporites juriensis*
Concentricisporites insignis (Pautsch 1971) Pautsch 1973
Concentricisporites plurianulatus Antonescu 1969 {**Plate 28.A**}
Converrucosisporites cameroni (de Jersey 1962) Playford and Dettmann 1965
Convolutispora klukiforma Schultz 1967
Convolutispora microfoveolata Schultz 1967
Convolutispora microrugulata Schulz 1967
(*Corrugatisporites amplectiformis*) *Striatella seebergensis*
(*Cosmosporites elegans* Nilsson 1958) *Concavisporites juriensis*
Cyclogranisporites arenosus Mädler 1964
Cyclogranisporites orbicularis (Kosanke 1950) *Potonié* and Kremp 1955
Cyclotriletes microgranifer Mädler 1964
Cyclotriletes oligogranifer Mädler 1964 {**Plates 15.M; 25.E; 26.G**}
Cyclotriletes orbicularis Mädler 1964
Cyclotriletes pustulatus (Kosanke 1950) Potonie and Kremp 1955 {**Plates 2.O, 25.D**}
Cyclotriletes triassicus Mädler 1968 {**Plates 3.I; 12.C**}
Cycloverrutriletes presselensis Schulz 1964
Decisporis reticulatus Kar 1970

Decisporis variabilis Kar 1970
Deltoidospora australis (Couper 1953) Pocock 1970
Deltoidospora concavus (Bolkhovitina 1953) Dettmann 1963
Deltoidospora juncta (Kara-Murza 1956) Singh 1964
Deltoidospora minor (Couper 1953) Pocock 1970
Deltoidaspora mortoni (Leschik 1955) Lund 1978
Deltoidospora neddeni (Potonie 1931) Orbell 1973
(*Deltoidospora toralis* Leschik 1955) *D. mortoni*
Densoisporites cavernatus Orlowska-Zwolinska 1966
Densoisporites complicatus Balme 1970 {**Plates 12.J; 16.K; 17.O**}
Densoisporites nejburgii (Schulz 1964) Balme 1970 {**Plates 1.H; 10.V and W; 11.B, K and O; 12.N; 14.H; 26.D.**}
Densoisporites playfordi (Balme 1963) Dettmann 1963 {**Plates 2.D; 10.U; 12.K; 14.G**}
Densoisporites velatus (Weyland and Krieger 1953) Krasnova 1961
Densosporites cingulatus Schulz 1966
Densosporites fissus (Reinhardt 1964) Schulz 1967
Densosporites foveocingulatus Schulz 1966
Densosporites spp. Bjærke and Manum 1977, pl. 5
Dictyophyllidites harrisii Couper 1958
Dictyophyllidites mortoni (de Jersey 1959) Playford and Dettmann 1965 {**Plate 8.A**}
Discisporites niger Leschik 1956
Discisporites psilatus de Jersey
Endosporites papillatus Jansonius 1962
Equisetosporites steevesii de Jersey
Eresinia spinellata Maljavkina 1949 {**Plates 4.H; 6.A, D, E; 13.G; 26.K**}
Foraminisporis jurassicus Schulz 1967
Foveosporites sp.A, informal taxon
(*Gibeosporites*) *Polypodiisporites*
(*Gibeosporites lativerrucosus*) *Polypodiisporites ipsviciensis*
Gleicheniidites senonicus Ross 1949
Gordonispora fossulata (Balme 1970) van der Eem 1983 {**Plates 2.P; 3.H; 4.K; 26.E; 28.J**}
Gordonispora lubrica (Orlowska-Zwolinska 1972) van der Eem 1983
(*Gordonispora nevesi*) *Gordonispora lubrica* (Orlowska-Zwolinska 1972) van der Eem 1983)
(*Iraquispora*) *Kyrtomisporis*
Ischyosporites variegatus (Couper 1958) Schulz 1967
Jerseyiaspora punctispinosa Kar, Kieser and Jain 1972 {**Plates 2.M; 14.A, E; 28.F**}
(*Keuperisporites baculatus* Schulz 1965) *Jerseyiaspora punctispinosa*
Kraeuselisporites apiculatus Jansonius 1962 {**Plates 1.E; 2.R; 10.Z; 15.D; 16.H; 17.M; 28.C**}
Kraeuselisporites cooksonae (Klaus 1962) Dettmann 1963 {**Plate 24.B**}
Kraeuselisporites cuspidus Balme 1963 {**Plate 4.O**}
Kraeuselisporites dentatus Leschik 1956 {**Plates 18.H; 30.A; 30.B**}
Kraeuselisporites echinoides (Mädler 1964) Vijaya and Tiwari 1988 {**Plate 12.D**}
Kraeuselisporites hoofddijkensis Visscher 1966 {**Plate 11.D**}
Kraeuselisporites punctatus Jansonius 1962
Kraeuselisporites reissingeri (Harris 1957) Morbey 1975 {**Plate 19.I**}
(*Kraeuselisporites rhaeticus* Reinhardt) *Cingulizonates*
Kraeuselisporites saeptatus Balme 1963
Kraeuselisporites spinosus Jansonius 1962 {**Plate 2.I**}
Kraeuselisporites splendens, informal species
Kyrtomisporis gracilis Bjærke and Manum 1977 {**Plates 19.B; 19.F**}
Kyrtomisporis laevigatus Mädler 1964 {**Plates 8.D; 32.G**}
Kyrtomisporis niger Bjærke and Manum 1977 {**Plate 19.J**}
Kyrtomisporis speciosus Mädler 1964 {**Plates 8.E; 19.C; 19.D**}
(*Kraeuselisporites* sp.A with a thin flange) *Cingulizonates rhaeticus*
Laevigatosporites callosus Balme 1970
Lapposisporites loricatus Visscher 1966
Leptolepidites bossus Tralau 1968
Leptolepidites equatibossus (Couper 1958) Tralau 1968
Leptolepidites jonkeri (Jansonius 1962) Yaroshenko and Golubeva 1991
Leptolepidites macroverrucosus Schulz 1967 {Plate 22.D}
Leschikisporis aduncus (Leschik 1955) Potonié 1958 {**Plate 32.J**}
Limatulasporites limatulus (Playford 1965) Helby and Foster 1979
Limbosporites lundbladii Nilsson 1958
Lophotriletes novicus Singh 1964
Lundbladispora brevicula Balme 1963 {**Plate 11.Q**}
Lundbladispora obsoleta Balme 1970 {**Plates 12.H; 13.O**}
(*Lundbladispora playfordi* Balme 1963) *Densoisporites*
Lundbladispora willmotti Balme 1963
Lycopodiacidites kokenii van der Eem 1983
Lycopodiacidites kuepperi Klaus 1960 {**Plates 2.Q; 24.D**}
(*Lycopodiacidites rhaeticus*) *Lycopodiacidites* spp.
Lycopodiacidites rugulatus (Couper 1958) Schulz 1967
(*Lycopodiacidites* sp. smooth surface) *Camarozonosporites laevigatus* Schulz 1967
Lycopodiumsporites austroclavatidites (Cookson 1953) Potonié 1956s
(*Lycopodiumsporites microreticulatus*) *L.reticulumsporites*
Lycopodiumsporites reticulumsporites (Rouse) Dettmann 1963
Lycopodiumsporites semimuris Danze-Corsin and Laveine 1963) Mc Kellar 1974
Lycospora imperialis (Jansonius 1962) Utting 1994 (*Uveaesporites*) {**Plate 1.N**}
Microreticulatisporites asper (Nilsson 1958) (Trachysporites)
Microreticulatisporites fuscus (Nilsson 1958) Morbey 1975 (*Trachysporites*)
Naumovaspora striata Jansonius 1962 {**Plate 12.O**}
Neoraistrickia cornutus (Andreyeva) Hart 1965
Neoraistrickia taylorii Playford and Dettmann 1965
(*Nevesisporites limatulus* Playford 1965) *Limatulasporites*
Nevesisporites vallatus de Jersey and Paten 1964
Osmundacidites senectus Balme 1963 {**Plate 15.G**}
(*Osmundacidites wellmannii* Couper 1958) *Baculatisporites*
Patinasporites densus Leschik 1955 {**Plate 7.B**}
Pechorosporites coronatus Yaroshenko and Golubeva 1984
Pechorosporites disertus Yaroshenko and Golubeva 1989 {**Plates 12.E; 13.A, B**}
Pechorosporites intermedius Yaroshenko and Golubeva 1989 {**Plate 2.B**}
Perotrilites minor (Mädler 1964) Antoniescu and Taugourdeau-Lantz 1973
Perotrilites sp. {**Plate 13.F**}

Polycingulatisporites crenulatus Playford and Dettmann 1965 **{Plate 32.C}**
Polycingulatisporites densatus (de Jersey 1959) Playford and Dettmann 1965 **{Plates 11.J; 13.J}**
Polypodiisporites ipsviciensis (de Jersey 1962) Playford and Dettmann 1965
Polypodiisporites mutabilis Balme 1970
Polypodiisporites spp. (*Gibeosporites, Thymospora*)
Proprisporites pocockii Jansonius 1962 **{Plates 1.K; 2.G; 3.N; 11.J, L, N; 12.M}**
Punctatisporites fungosus Balme 1963 **{Plate 12.B}**
Punctatisporites globosus (Leschik 1955) Lund 1977
(*Punctatisporites scabratus* (Couper 1958) *Todisporites*
Punctatosporites walcomii de Jersey 1962
(*Raistrickia* sp.A) *Jerseyispora punctispinosa*
Reticulatisporites bunteri Mädler 1964 **{Plate 12.F}**
(*Retitriletes austroclavatidites* (Cookson 1953) Döring et al. 1963) *Lycopodiumsporites*
Retusotriletes hercynicus (Mädler 1964) Schuurmann 1977 **{Plate 17.K}**
Retusotriletes mesozoicus Klaus 1960
Rewanispora foveolata de Jersey 1970 **{Plates 2.H; 13.L; 27.F; 28.H}**
Rewanispora vermiculata Antonescu and Taugourdeau-Lantz 1973
Rogalskaisporites barentzii Bakken 1990 **{Plate 8.J}**
Rogalskaisporites cicatricosus (Rogalska 1954) Danzé-Corsin and Laveine 1963 **{Plate 8.I}**
Rugulatisporites ramosus de Jersey 1959
(*Rugulatisporites* sp.A) *Thomsonisporites undulatus*
Scabratisporites scabratus Visscher 1966
Selagosporis mesozoicus Schulz 1967
Sellaspora foveorugulata van der Eem 1983
Sellaspora rugoverrucata van der Eem 1983 **{Plates 33.A; 33.D; 33.E}**
Semiretisporis 'barentzii' informal taxon
(*Semiretisporis* sp. A) *S.'barentzii'* **{Plate 18.I}**
Semiretisporis sp. 1
Semiretisporis gothae Reinhardt 1962 **{Plate 8.L}**
Semiretisporis maljavkinae Schulz 1967
Simeonospora minuta (Jansonius 1962) Utting 1994
Staplinisporites caminus (Balme 1957) Pocock 1962 **{Plates 10.I; 25.A}**
(*Stereisporites annulosus*) *S. aulosensis*
Stereisporites aulosensis (Schulz) Schulz 1966
Stereisporites perforatus Leschik 1955
(*Stereisporites psilatus* Orlowska-Zwolinska 1972) *G. lubrica*
Striatella seebergensis Mädler 1964 **{Plates 10.F.1, F.2; 15.A; 18.F, K; 25.H}**
Striatella sp.1, informal taxon
Taurocusporites segmentatus (Stover 1962) Playford and Dettmann 1965
Thomsonisporites toralis Leschik 1955
Thomsonisporites undulatus Leschik 1955 **{Plates 8.M; 30.E}**
(*Thymospora canaliculatus*) *Polypodiisporites* spp.
(*Thymospora ipsviciensis* de Jersey 1962) *Polypodiisporites ipsviciensis*
(*Thymospora*) *Polypodiisporites*
Tigrisporites halleinis Klaus 1960
(*Tigrisporites playfordii* de Jersey and Hamilton 1967) *Triplexisporites*
Todisporites cinctus (Maljavkina 1949) Orlowska-Zwolinska 1971
Todisporites major Couper 1958
Todisporites marginales Bharadwaj and Singh 1964
Todisporites minor Couper 1958
Todisporites scabratus Couper 1958
(*Trachysporites fuscus* Nilsson 1958) *Microreticulatisporites*
Triancoraesporites ancora (Reinhardt 1962) Schulz 1967
Triplexisporites playfordii (de Jersey and Hamilton 1967) Foster 1979
Uvaesporites argenteaeformis (Bolkhovitina 1953) Schulz 1967
Uvaesporites gadensis Praehauser-Enzenberg 1970
(*Uvaesporites imperialis* Jansonius 1962) *Lycospora imperialis*
Velosporites cavatus Bjærke and Manum 1977
Verrucosisporites applanatus Mädler 1964
Verrucosisporites jenensis Reinhardt and Schmitz 1965
Verrucosisporites morulae Klaus 1960 **{Plate 14.D}**
Verrucosisporites narmianus Balme 1970
Verrucosisporites pseudomorulae Klaus 1960
(*Verrucosisporites pustulatus*) *Cyclotriletes*
Verrucosisporites remyanus Mädler 1964 **{Plate 13.E}**
Verrucosisporites thuringiacus Mädler 1968
(*Verrucosisporites triassicus*) *Cyclotriletes*
Zebrasporites fimbriatus Klaus 1960
Zebrasporites interscriptus Klaus 1960 **{Plates 8.G; 32.I}**
Zebrasporites kahleri Klaus 1960
Zebrasporites laevigatus (Schulz 1962) Schulz 1967 **{Plate 8.F}**

PLANKTON AND VARIA

(*Chordecystia chalasta* Foster 1979) *Reduviasporonites chalastus*
Chytroeisphaeridia chytroeides (Sarj.1962) Downie and Sarjeant 1965
Ctenidodinium ornatum (Eisenack 1935) Deflandre 1938
Dapcodinium priscum Evitt 1961
Dictyotidium reticulatum Schulz 1965
Dictyotidium tenuiornatum Eisenack 1955
Dinoflagellate sp. B Bjærke 1980
Eyachia prisca Gocht 1979
Facetodinium faustum Bjærke 1980
Filisphaeridium setasessitante (Jansonius 1962) Staplin et al. 1965
('Fungal remain sp. B' sensu Mangerud 1994) *Reduviasporonites chalastus* **{Plate 10.X}**
'Fungal remain type 1' sensu Hochuli et al. 1989 {Plates 1.G; 2.E; 12.I}
Gonyaulacysta jurassica (Deflandre 1938) Norris and Sarjeant 1965
Grebespora concentrica Jansonius 1962 {Plates 11.C; 25.B}
Hebecysta brevicornuta Bujak and Fisher 1976 **{Plate 20.A}**
Heibergella aculeata Bujak and Fisher 1976
Heibergella asymmetrica Bujak and Fisher 1976 **{Plate 21.E, G, H, I, J}**
Heibergella salebrosacea Bujak and Fisher 1976
Kalyptea diceras Cookson and Eisenack 1965

Lacrynodinium warrenii Alberti et al. 1986
Mancodinium semitabulatum Morgenroth 1970
Maturodinium inornatum Morgenroth 1970
Mendicodinium reticulatum Morgenroth 1970
Micrhystridium setasessitante Jansonius 1962
Micrhystridium sp. F (informal species figured by Staplin 1979, pl. 3, figs.8-9)
(*Micrhystridium tenuispinosum*) *Filisphaeridium setasessitante*
Nannoceratopsis gracilis (Alberti 1961) Evitt 1962
Nannoceratopsis pellucida (Deflandre 1938) Evitt 1961
(*Noricysta aculeata*) *Heibergella aculeata* Bujak and Fisher 1976
Noricysta fimbriata Bujak and Fisher 197**6** {**Plate 21.A**}
Noricysta pannucea Bujak and Fisher 1976
Noricysta varivallata Bujak and Fisher 1976
Ovalicysta hiata Bjærke 1980
Paleospongiosporis europaeus Schulz 1965
Parvocysta barbata Bjærke 1980
Parvocysta bullula Bjærke 1980
Parvocysta contracta Bjærke 1980
Parvocysta cracens Bjærke 1980
Parvocysta nasuta Bjærke 1980
Phallocysta eumekes Dörhöfer and Davies 1978
Plaesiodictyon mosellanum Wille 1970 {**Plates 9.E; 23.C**}
('Planktonic alga type A' sensu Mørk et al.1999b) *Veryhachium ellesmerense* {**Plates 2.J, K; 3.F**}
Reduviasporonites chalastus (Foster 1979) Elsik 1999 {**Plates 1.P; 2.C; 10.X**}
Rhaetogonyaulax arctica (Wiggins) Stover and Evitt 1978
Rhaetogonyaulax rhaetica (Sarjeant 1963) Loeblich and Loeblich 1968 {**Plates 7.L; 9.H; 21.B**}
(*Rhaetogonyaulax* sp.A) *Rhaetogonyaulax* sp. Fisher, B., and F. 1976 pl.9, figs 18-20
(*Rhaetogonyaulax* sp. B with a short horn) *Shublikodinium arcticum*
Rhaetogonyaulax sp. (specimen with 'double horn') {**Plate 9.A, D**}
Rhynchodiniopsis chladophora (Deflandre 1938) Below 1981
Scriniocassus weberi Gocht 1964
Sentusidinium sp.A {**Plates 5.H, I**}
Shublikodinium arcticum Wiggins 1973 {**Plates 7.F, G, H; 20.J, K, L**}
Shublikodinium setigerum Wiggins 1973 {**Plate 20.G, H**}
Suessia swabiana Morbey 1975
Sverdrupiella downii Bujak and Fisher 1976
Sverdrupiella manicata Bujak and Fisher 1976
Sverdrupiella mutabilis Bujak and Fisher 1976 {**Plates 20.F, I**}
Sverdrupiella septentrionalis Bujak and Fisher 1976
(*Tympanicysta stoschiana* Balme 1980) *Reduviasporonites chalastus*
Sverdrupiella usitata Bujak and Fisher 1976 {**Plate 20.C, E**}
Tetraporina horologica (Staplin 1962) Playford 1963
Valvaeodinium cf. *armatum* Morgenroth 1970
Veryhachium ellesmerense Staplin 1978 {**Plate 2.J**}
Veryhachium reductum (Deunff) Jechowsky 1961 **(Plate 3)**

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