Permian stratigraphy of the Svalis Dome, south-western Barents Sea

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Upper Palaeozoic strata drilled at the Svalis Dome, south-western Barents Sea, contain sedimentary rocks which closely resemble the succession of the Gipsdalen and Tempelfjorden groups in the Svalbard Archipelago. The Gipsdalen Group cores are dominated by fossiliferous grainstones and packstones deposited on a carbonate shelf. Two distinctive different fusulinid faunas show close affinities to fusulinids elswhere in the present Arctic region. The lower *Schwagerina parva* assemblage indicates a late Asselian to earliest Sakmarian age while beds with *Schwagerina kolviensis* give a late Artinskian age. The Tempelfjorden Group cores are dominated by silicified, often fossiliferous, wackestones and fragmented siliciclastics of more basinal setting. A palynological assemblage including *Scutasporites nanuki*, *Lueckisporites virkkiae* and *Lunatisporites* spp. indicates a Kazanian age for this unit. The recorded palynomorphs resemble Upper Permian assemblages elsewhere in the present Arctic region. At the top of the succession (below the Triassic shales), a fossiliferous packstone with productids resembles the Miseryfjellet Formation, Bjørnøya. No age diagnostic fossils are, however, recorded in this part of the succession.

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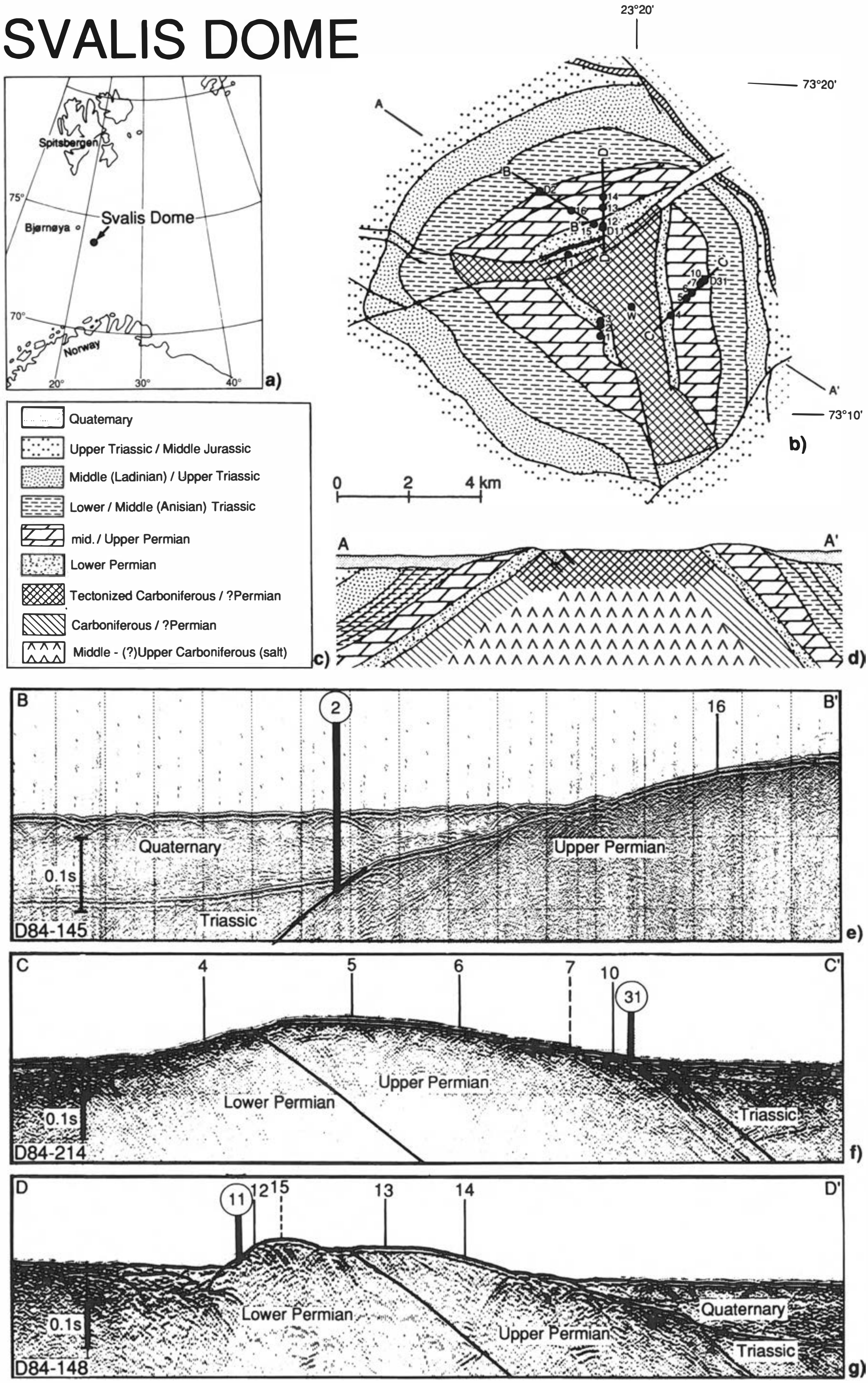
The Svalis Dome is a subcircular structure situated on the north-eastern margin of the Loppa High in the south-western Barents Sea (Fig. 1). The structure, first described by Sundvor (1974) and later by Kristoffersen & Elverhøi (1978), rises approximately 80 m above the surrounding sea floor, and is interpreted as being a salt dome (Gabrielsen et al. 1990; Bugge & Fanavoll 1995). In 1984 IKU started the long-term Barents Sea Mapping Program and extensive investigations were carried out in the Svalis Dome area due to the fact that sedimentary rocks are subcropping around the dome. From 1984 to 1986, 14 minicores and 3 shallow drilling cores were taken from the Upper Palaeozoic rocks in the centre of the dome. Almost no Quaternary cover is present (Fig. 1). Based on biostratigraphy and lithology it has been possible to place the Upper Palaeozoic cores and minicores from the Svalis Dome in ascending stratigraphical order relative to each other (Table 1). These data from the Barents Shelf demonstrate clearly the close similarity to the Permian succession on Svalbard.

Upper Palaeozoic rocks outcrop in several land areas surrounding the Barents Shelf, including the Svalbard Archipelago, Greenland and Arctic Russia. On Svalbard this succession belongs to the continental Billefjorden Group, the carbonate dominated Gipsdalen Group and the siliciclastic/cherty dominated Tempelfjorden Group (Cutbill & Challinor 1965; Steel & Worsley 1984). The closest land exposure to the Svalis Dome is Bjørnøya situated 140 km to the north-west. During the Late Carboniferous–Permian period a carbonate shelf was established there. The general pattern of carbonate deposition is, however, interrupted by several hiati, episodes of clastic input, tectonic disturbance and erosion (Worsley & Edwards 1976; Worsley et al. 1990).

In the Barents Sea area, including Spitsbergen and Bjørnøya, restricted marine and lagoonal carbonates with *Palaeoaplysina* buildups were deposited over most of the platform areas during the Gzhelian and Asselian (Skaug et al. 1982; Lønøy 1988; Bugge et al. 1995). More open marine carbonate deposition characterized the Sakmarian-Artinskian succession, which also reveals *Tubiphytes*/bryozoan dominated shelf-margin buildups along the Finnmark Platform, Loppa High and Nordkapp Basin margins (Bruce & Toomey 1993; Cecchi 1993). The mid-upper Permian succession on the Barents Shelf reveals a marked change to clastic-dominated sediments, coincident with the final phases of the Uralian fusion. The facies change is a result of a regional transgression, accompanied by a change in water circulation as well as change to cooler climate in the whole Barents Sea area (Stemmerik & Worsley 1989). Deposition of basinal siliceous shales and more marginal carbonates and clastics dominate this succession, as also seen in the mid-upper Permian Kapp Starostin Formation on Spitsbergen. In south-western Barents Sea, buildups are locally developed (Gérard & Buhring 1990; Bruce & Toomey 1993; Nilsen et al. 1993). These buildups are thought to be similar to those described in Upper Permian succession of East Greenland (Surlyk et al. 1986; Hurst et al. 1989; Stemmerik & Worsley, 1989, 1994). More locally, along the Senja-Hornsund alignment, major sandstone units are developed (Stemmerik & Worsley 1989), both on Spitsbergen and on the Barents Shelf, bearing evidence of activity along this north–south trend (Doré 1991).



SVALIS DOME
Spitsbergen
75°
Svalis Dome
Bjørnøya
70°
Norway
20°
30°
40°
a)
23°20'
73°20'
73°10'
A
A'
B
B'
C
C'
D
D'
b)
0
2
4 km
Quaternary
Upper Triassic / Middle Jurassic
Middle (Ladinian) / Upper Triassic
Lower / Middle (Anisian) Triassic
mid. / Upper Permian
Lower Permian
Tectonized Carboniferous / ?Permian
Carboniferous / ?Permian
Middle - (?)Upper Carboniferous (salt)
c)
d)
2
16
Quaternary
Upper Permian
0.1s
Triassic
D84-145
e)
4
5
6
7
10
31
Upper Permian
Lower Permian
Triassic
0.1s
D84-214
f)
11
12
15
13
14
Lower Permian
Upper Permian
Quaternary
Triassic
0.1s
D84-148
g)

Material

Three shallow stratigraphic drilling cores up to 26 metres long and with 91% core recovery give the most important information from the Svalis Dome. In addition, 14 minicores varying in length from 0.1 to 2.6 m give important mapping, facies and dating material (Table 1).

The fusulinid study is based on 25 samples from cores Dia84-11 (10.4 m long) and 7323/10-U-01 (D85-W), and minicores D84-12/3, D84-11/1 and D84-15/1. Although none of the investigated samples is rich in fusulinids, the recorded shells have proved to be age-diagnostic. Approximately 75 oriented thin-sections were prepared for this study.

The palynomorph study is based on approximately 30 samples from core Dia84-31 (21.5 m long). In addition, about 15 samples from core Dia84-11 and minicores D84-2/1, -4/1, -5/1, 11/1, -12/3, 13/1, -14/1, -15/1 and -16/1 were studied. Preservation varied from very poor to fairly good and, as a result, identification to species level was often difficult. In the most productive samples from core D84-31, 200 palynomorphs were counted. No identifiable macrofossils were recorded, but shell fragments and coquina of productids occur in the basal bed of core Dia84-2.

Gipsdalen Group

Core Dia84-11 (Fig. 2) and 5 minicores are regarded as belonging to the same seismic unit of Early Permian age (Fig. 1e, f, g). The thickness of this Lower Permian seismic unit is ca. 500 m (Bugge & Fanavoll 1995). In addition, a short, fragmented core 7323/10-U-01 was drilled in the fractured central part of the dome. Based on biostratigraphy and lithology, these cores are correlated to the Gipsdalen Group of Svalbard.

Core 7323/10-U-01 (D85-W)

This core was drilled to obtain a single datapoint in the central area of the Svalis Dome (Fig. 1b). However, only 20 cm of rock fragments were recovered. These fragments consist of micritic carbonate fragments in a groundmass of gypsum, but no gypsum fragments were present. This may indicate that gypsum was reached where drilling terminated.

Biostratigraphy. – Only fragments of Schwagerinidae were identified in this core, but species of this fusulinid family are common in Upper Carboniferous and Lower Permian strata worldwide.

Core Dia84-11

This core was drilled into the lower part of the Lower Permian seismic unit with almost no internal reflections (Fig. 1g). The core consists of fossiliferous packstone and grainstone, and subordinate wackestones (Fig. 2). Silt-sized quartz grains are abundant in the upper part of the core, and minor chert nodules occur occasionally. A diverse fauna is seen in thin-sections (Figs. 2, 3). It is dominated by crinoid debris, brachiopod and bryozoan fragments, but foraminifers (including fusulinids), ostracods, gastropods, pelycypods, *Tubiphytes* and fragments of algae, corals and trilobites are also present. Micritization is abundant throughout the core. A calcite cemented breccia consisting of slightly rounded fragments of the same lithology as below occurs at 11.8 m. Below this thin breccia, crinoidal packstone dominates. Stylolitization is abundant throughout the core.

Biostratigraphy. – The following fusulinid species are identified in this core: *Schwagerina* aff. *parafecunda*, *S. parva*, *S.* aff. *idelbajevica*, *Zigarella* ex. gr. *lutuginiformis*, *Zigarella lutuginiformis*, *Schubertella kingi*, *Pseudofusulinella* sp., *Pseudoendothyra* sp. and *Pseudofusulinella* aff. *valkenburgae* (Fig. 4).

Schwagerina parafecunda occurs in middle Asselian (*Sphaeroschwagerina moelleri*-*Schwagerina fecunda* Zone) and upper Asselian (*Sphaeroschwagerina sphaerica*-*Schwagerina firma* Zone) strata of the Urals (Shamov & Scherbovich 1949) (Fig. 5). *Schwagerina parva* and *S. idelbajevica* are both identified in the uppermost Asselian (Nehetskyi Horizon) in the Timan-Pechora Basin (Grozdilova & Lebedeva 1961), but *S. parva* is also present in lower Sakmarian (*Schwagerina moelleri* Zone) strata of the Urals (Beljaev & Rauser-Chernousova 1938; Shamov 1958; Mikhailova 1966, 1974) and the Russian Platform (Rauser-Chernousova & Scherbovich 1958). On Spitsbergen *S. parva* occurs in upper Asselian (*Schwagerina sphaerica* Zone) as well as in lower Sakmarian (*Eoparafusulina paralinearis* Zone) beds (Nilsson 1993). *Zigarella lutuginiformis* is common in upper Asselian–lower Sakmarian strata of the Urals (e.g. Mikhailova 1974). This species occurs in upper Asselian–lower Sakmarian beds on Spitsbergen while it is only recovered in lower Sakmarian (*Schwagerina blochini*–*Zigarella lutuginiformis* Zone) beds in the Sverdrup Basin of Arctic

Fig. 1. Maps and sections of the Svalis Dome. (a) Index map. (b) A subcrop map of the Svalis Dome with numbered core localities, seismic lines (B-B', C-C', D-D') and the cross-section of the dome (A-A') (from Bugge & Fanavoll 1995). (c) Legend. (d) Section along line A-A' (see Fig. 1b). (e) Seismic section B-B' (Fig. 1b) with localization of core Dia84-2 (circulated) and minicore D84-16/1. (f) Seismic section C-C' with localization of core Dia84-31 (circulated) and minicores D84-4/1 (=4), D84-5/1 (=5), D84-6/1 (=6), D84-7/1 (=7) (relative position) and D84-10/3. (g) Seismic section with localization of core Dia84-11 (circulated) and minicores D84-12/3 (=12), D84-15/1 (=15; in relative position), D84-13/1 (=13) and D84-14/1 (=14).

Table 1. Summary of core data. Penetr. (=depth of penetration in bedrock). Core length excludes 'core loss'.

Core type No	Penetrat. m	Core length m	Core diam mm	Main Lithology	Fossil content	Facies	Key biostratigraphy	Age	Equivalent units	Latit N	Long E	Seismic line shot point
Core Dia84-2	Approx. 25m	23.5m (total) 0.26m (Permian)	54	Triassic: Shale and siltstone Permian: Packstone	Triassic: Ammonoids Bivalves Palynomorphs Permian: Bryozoans Echinoderms Brachiopods	Triassic: Shelf Permian: Carbonate shelf	Triassic: Ammonoids Permian: Indet. Macrofossils	Triassic: Late Griesbachian Permian: Late Permian	Triassic: Havert Formation Permian: Miseryfjellet Formation	73°16' 41.33"	23°09' 29.57"	D84-145 1708.4
Core Dia84-31	Approx. 21.5m	21.4	54	Dark grey siliceous siltstone	Sponges Sponge spicules Palynomorphs Zoophycos	Basinal clastics	Palynomorphs: Scutas. unicus Lunatisporites Luecki. virkkiae	Kazanian	Kapp Starostin Formation	73°13' 59.95"	23°27' 00.04"	D84-214 112.2
Minicore D84-10/3	1.8	0.45	25	Silicified wackestone some clastic grains	Echin Bryozo Brach Foraminifera Sponge spicules	Shelf Basin			Tempelfjorden Group	73°13' 57.37"	23°26 49.72"	D84-214 122
Minicore D84-7/1	0.56	0.26	25	Wackestone Clastic grains Glauconite	Echin Bryozo Brach Sponge spicules	Shelf			Tempelfjorden Group	73°13' 52.49"	23°26' 31.94"	D84-214 143
Minicore D84-6/1	0.99	0.3	25	Spiculitic chert	Bryozoans Brachiopods Sponge spicules	Shelf Basin			Tempelfjorden Group	73°13' 36.25"	23°25' 35.67"	D84-214 206
Minicore D84-16/1	1.45	0.05	25	Silicified siltstone	Sponge spicules Brachiopods Palynomorphs	Shelf Basin	Palynomorphs: Vittatina Unellium	Late Permian	Kapp Starostin Formation	73°16' 09.90"	23°12' 48.11"	D84-145 1653
Minicore D84-14/1	1.18	0.35	25	Silicified wackestone	Echinoderms Sponge spicules Foraminifera Bryozoans Palynomorphs	Shelf Basin	Palynomorphs: Vittatina	Permian	Kapp Statostin Formation	73°16' 33.95"	23°16' 10.21"	D84-148 2020
Minicore D84-5/1	1.68	0.9	25	Silty biomicrite silicified	Echinoderms Brachiopods Sponge spicules Foraminifera Ostracods Palynomorphs	Shelf Basin	Palynomorphs: Vittatina Krauselisporites spinosus	Late Permian	Kapp Starostin Formation	73°13' 25.58"	23°25' 08.69"	D84-214 262
Minicore D84-13/1	2.3	1.3	25	Silicified siltstone	Palynomorphs Zoophycos	Shelf Basin	Palynomorphs: Vittatina Unellium	Late Parmian	Kapp Starostin Formation	73°16' 14.38"	23°16' 08.68"	D84-148 1976
Minicore D84-1/1	3.71	2.6	25	Sillicified wackestone	Echin Bryozo Brach Sponge spicules Foraminifera	Shelf Basin			Kapp Starostin Formation	73°12' 17.38"	23°15' 54.09"	D84-148 1642
Minicore D84-2/1	5.4	0.17	25	Not *in situ* Pack-wackestone, silicified	Echin Bryozo Brach Sponge spicules Palynomorphs	Shelf	Palynomorphs: Vittatina	Permian	?Kapp Starostin Formation	73°12' 36.97"	23°15' 54.92"	D84-148 1487
Minicore D84-4/1	5.1	0.9	25	Very-fine sandstone Gypsum laminae	Palynomorphs	Evaporitic			Gipsdalen Group	73°12' 57.11"	23°23' 19.58"	D84-214 343
Minicore D84-15/1	2.28	1.93	25	Wackestone/ Finegr.sandstone/ Siltstone silicified	Echin Bryozo Brach Sponge spicules Foraminifera Palynomorphs	Shelf	Fusulinids: Schwagerina kolviensis Palynomorphs: Vittatina	Late Artinskian	Hambergfjellet Formation	73°15' 43.58"	23°15' 11.29"	D84-145 1642
Minicore D84-12/3	1.79	1.02	25	Grainstone/ Packstone	Echin Bryozo Brach Tubiphytes Foraminifera Bryozoans	Carbonate Shelf	Fusulinids: Schwagerina parva	Early Sakmarian Late Asselian	Gipsdalen Group	73°15' 42.67"	23°16' 04.61"	D84-148 1906
Minicore D84-3/2	2.21	Fragments	25	Silicified carbonate					?Gipsdalen Group	73°12' 15.18"	23°15' 55.23"	D84-148 1501
Core Dia84-11	14.3	10.4	44	Dark grey limestone fossiliferous grainstone Micritization	Echin Bryozo Brach Tubiphytes Foraminifera Bivalves Gastropods Ostracods Algae Palynomorphs	Carbonate Shelf	Fusulinids: Schwagerina parva Palynomorphs: Vittatina	Early Sakmarian Late Asselian	Gipsdalen Group	73°15' 41.33"	23°16' 07.01"	D84-148 .1902
Minicore D84-11/1	2.71	1.1	25	Packstone vains with barite	Echin Bryozo Brach Tubiphytes Sponge spicules	Carbonate Shelf	Fusulinids: Schwagerina Sp.A	Early Sakmarian Late Asselian	Gipsdalen Group	73°14' 51.29"	23°12' 42.52"	D84-144 1395
7323/ 10-U-01 (D85-W)	0.2	Fragments	75	Micritic limestone fragments Gypsum	Foraminifera	Evaporitic	Fusulinids: Schwagerinidae	Early Permian Late Carb.	Gipsdalen Group	73°13' 15.87"	23°18' 42.72"	D84-215 1037

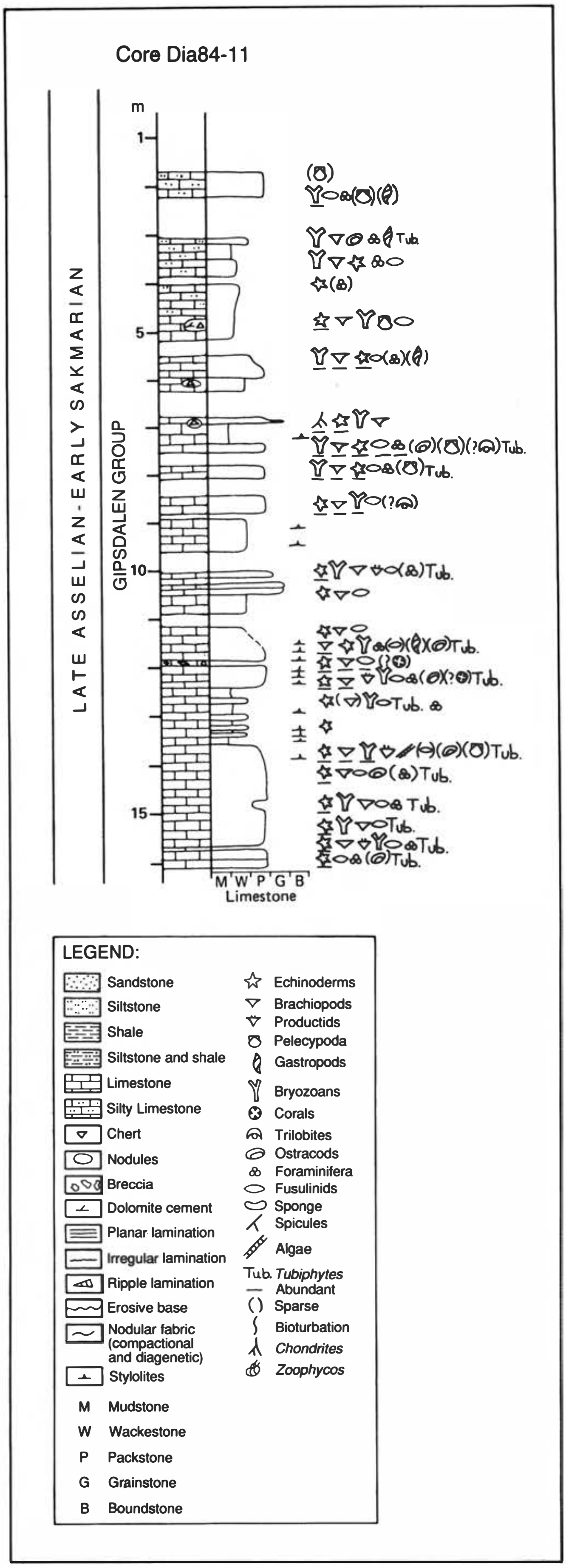


Fig. 2. Core Dia84-11 with thin-section observations and explanatory legend.

Canada (Nilsson 1993). Based on comparison with faunas from adjacent areas, this local *Schwagerina parva* assemblage is suggested to belong to transition layers between typical late Asselian and early Sakmarian fusulinid faunas. Consequently, a latest Asselian to earliest Sakmarian age is suggested for core Dia84-11.

The palynological samples in this core were nearly barren, with only a few poorly preserved *Vittatina* present, indicating a general Permian age.

Minicores

Minicore D84-11/1. – This core (Fig. 1b) consists of strongly fractured wackestone/packstone (Table 1). Abundant fragments of open marine fossils including bryozoans, brachiopods, echinoderms and foraminifera (including fusulinids) dominate together with *Tubiphytes*. Fractures are filled with barite.

Only one fusulinid species, *Schwagerina* sp. A, is identified in this core (Fig. 4). It resembles species common in upper Asselian to lower Sakmarian strata in Russia (e.g. Rauser-Chernousova 1940; Shamov 1958; Grozdilova & Lebedeva 1961), and indicates a similar age to that recorded from cores Dia84-11 and D84-12/3. No palynomorphs are recorded.

Minicore D84-12/3. – This core (Fig. 1g) consists of grainstone dominated by echinoderm debris, but fragments of bryozoans, brachiopods, fusulinids and small foraminifers are also present. Silicification is mainly restricted to some echinoderm fragments.

This core comprises *Schubertella kingi*, *Pseudofusulinella* aff. *valkenburghae*, *Schwagerina thorsteinssoni* and *S. parva*. The recorded fusulinid assemblage shows close similarities to the *Schwagerina parva* assemblage of core Dia84-11, indicating a latest Asselian–earliest Sakmarian age for minicore D84-12/3. No palynomorphs are recorded from this core.

Minicore D84-15/1. – This core (Fig. 1g) consists of a mixture of wackestones and very fine-grained sandstones and siltstones. All lithologies are partly silicified with abundant fragments of brachiopods, bryozoans, echinoderms and fusulinids.

The presence of *Schwagerina kolviensis* indicates a late Artinskian age in comparison with fusulinid faunas of the Timan-Pechora Basin (Konovalova 1991). In Arctic Russia this species occurs in the same assemblage as *Schwagerina jenkinsi*, and that species is common in the Hambergfjellet Formation of Bjørnøya (Simonsen 1988) and IKU shallow cores 7129/10-U-01 and 7128/12-U-01 on the Finnmark Platform (Nilsson 1993; Bugge et al. 1995). The bed with *Schwagerina kolviensis* tentatively corresponds to the *Schwagerina jenkinsi* assemblage on Bjørnøya and Finnmark Platform. Palynological analysis revealed only a few poorly presented *Vittatina*, indicating a general Permian age.

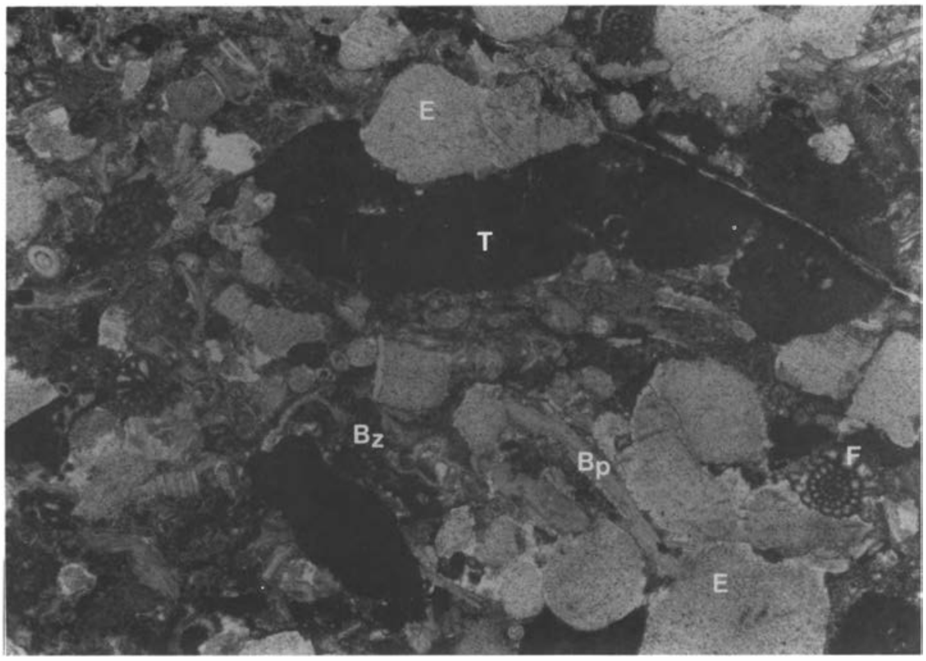


Fig. 3. Thin-section photo from Dia84-11, 11.2 m, showing packstone dominated by *Tubiphytes* (T) and echinoderms (E) debris, but also with fragments of bryozoans (Bz), barchipods (Bp) and fusulinids (F). Width of photo ~ 1 cm.

Minicore D84-4/1. – The core (Fig. 1f) consists of very fine-grained sandstone with mud and gypsum laminae. Planar lamination and small-scale ripple cross lamination are present. The gypsum laminae are deformed. Fragments of wood, cuticle and poorly preserved, unidentifiable palynomorphs are present. Fusulinids are not recorded.

Tempelfjorden Group

Core Dia84-31 and 9 minicores have been assigned to the same seismic unit of late Early Permian to Late Permian age (Fig. 1, Table 1). The thickness of this seismic unit is ca. 600 m (Bugge & Fanavoll 1995). In addition, core Dia84-2 penetrated the Triassic–Permian contact (Fig. 1e). Based on biostratigraphy and lithology, these cores are correlated with the Tempelfjorden Group of Svalbard.

Core Dia84-31

The core consists of dark grey chert-cemented bioturbated siltstones (Fig. 6). Bedding can be recognized throughout the core and flaser and lenticular lamination is present in some beds. Extensive bioturbation has destroyed many of the sedimentary structures. Most abundant is *Zoophycos* and *Chondrites*, but other trace fossils are also present. Silica cementation is extensive and below 13 m the core consists of 'spiculite'. One silica sponge was the only macrofossil observed. The core has a 'nodular' appearance due to compaction and diagenetic effects. This results in a lithological appearance similar to what is observed in the Kapp Starostin Formation on Spitsbergen.

Material from this part of the succession shows a consistent organic carbon content of 0.4–0.9 wt% (IKU data). The cluster of Tmax values around 438°C indicates that the kerogen is of moderate thermal maturity. RockEval hydrogen indices from 50 to 88 suggests that the organic matter consists of hydrogen-poor type III kerogen which also is reflected in the terrestrially dominated palynofacies (Fig. 7). Palynofacies in core Dia84-31 is characterized by equal proportions of small equidimensional charcoal, structureless amorphous material and pale unstructured debris probably derived from cuticula. Degraded wood, spores, pollen and acritarchs are present in smaller amounts. The variation in the quantitative composition of the palynomorphs, probably reflects the alternating facies change between dominantly shales and minor siltstones. Concerning the relative distribution of palynomorphs, the acritarchs dominate the samples and represent as much as 90% of the palynomorphs. This type of palynofacies is characteristic for a low energy offshore setting.

Biostratigraphy. – Palynomorphs are the only age-diagnostic fossils recorded from this unit. Most of the studied samples yielded dominance of marine microplankton (Fig. 7), basically with a low diversity assemblage of the genus *Micrhystridium*. Other acritarch genera include rare *Unellium*, *Cymatiosphaerae* and *Veryhachium* spp. Terrestrial palynomorphs are dominated by striate and non-striate bisaccate and polyplicate pollen.

The stratigraphically most important species recorded in core Dia84-31 is *Scutasporites nanuki*, appearing as it does together with *Lueckisporites virkkiae* and *Lunatisporties* spp. (Fig. 8). Utting (1994) reports *S. nanuki* from the Sverdrup Basin, Canada, in beds dated as Kazanian or younger Permian based on conodonts, brachiopods

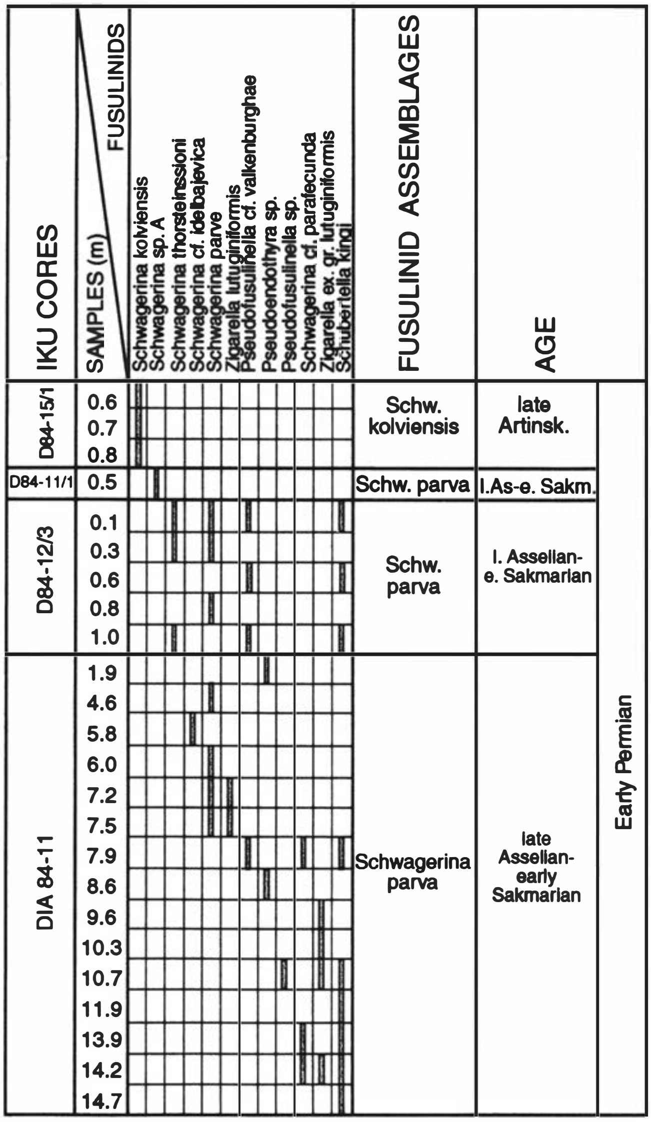


Fig. 4. Composite distribution-chart for fusulinids in the Svalis Dome.

and ammonoids. Utting (1994) regards *S. nanuki* as synonymous to *Scutasporites* sp. cf. *S. unicus* reported by Balme (1980) from East Greenland. Consequently records of *Scutasporites* sp. cf. *S. unicus* reported from Kazanian–? Tatarian succession on the Finnmark Platform, Barents Sea (Mangerud 1994) should be assigned to the new species *Scutasporites nanuki*.

The presence of *Lueckisporites virkkiae* is also indicative of a Late Permian, possibly Kazanian or younger age. The species is recorded together with *Scutasporites nanuki* on East Greenland (Balme 1980) as well as on the Finnmark Platform (Mangerud 1994). In Arctic Russia *Lueckisporites virkkiae* is reported to be restricted to the Tatarian (Varyukhina 1971; Molin & Koloda 1972). In contrast to the Zechstein sediments of western Europe, where *Lueckisporites virkkiae* dominate certain levels (Visscher 1971), *L. virkkiae* always appear rare, but regular, in the upper part of the Upper Permian succession in the Arctic area. It is worthwhile to mention that *L. virkkiae* was not reported from the Sverdrup Basin by Utting (1994).

The assemblages recorded in core Dia84-31 at the Svalis Dome (Figs. 9 & 10) can be correlated with the *Ahrensisporites thorsteinssonii–Scutasporites nanuki* Concurrent Range Zone recorded in the Trold Fiord and Degerbols Formations in the Sverdrup Basin (Utting 1994). It also correlates with the *Scutaporites* sp. cf. *S. unicus* (*syn. Scutasporites nanuki*)–*Lunatisporites* sp. Concurrent Range Zone from the upper part of the Kapp Starostin Formation equivalent on the Finnmark Platform (Mangerud 1994). The assemblages from core Dia84-31 show close similarites with the *Vittatina* and *Protohaploxypinus* assemblages recorded from the Upper Permian succession in East Greenland. These assemblages also contain *Scutasporites nanuki* and *Lueckisporites virkkiae* (Balme 1980), but both these species seem to be more common in East Greenland compared to further north. The association of abundant spinose, acritarchs and varied assemblages of trilete spores, bisaccate pollen and common polyplicate pollen recorded from Dia84-31 is also a characteristic feature of various assemblages described from basinal facies elsewhere in the Upper Permian succession of the present Arctic area (Utting 1989, 1994; Mangerud & Konieczny 1991, 1993).

Core Dia84-2

Only the lowermost 26 cm of this 25 m long core can be assigned to the Permian while the overlying siltstones are of Early Triassic age. A lower 10 cm thick light grey-brown limestone with a small amount of silica is separated by a shaly parting from the overlying fossiliferous packstone. The lower boundary of the packstone is erosional. The packstone consists of fragments of echinoderms, bryozoans and brachiopods (mainly productids) (Fig. 11). On top of the limestone surface, encrusting fenestrate bryozoans occur, and in the basal beds of the overlying siltstone, crinoidal debris is present, indicating reworking of the underlying sediment. The thin bedding of packstone with shaly parting and the erosional surface is common in the mid-upper Permian Miseryfjellet Formation (Tempelfjorden Group) of Bjørnøya. No age-diagnostic microfossils or palynomorphs have been recorded from the limestone, but macrofossil fragments including productids and bryozoans clearly resemble faunas seen in the mid-upper Permian Tempelfjorden Group of Svalbard.

Minicores

Minicore D84-1/1. – This core (Fig. 1b) consists of strongly silicified pack- to wackestone (Table 1). The core contains abundant bryozoans, echinoderms and brachiopods as well as scattered foraminifera. Abundant sponge spicules indicate a source of the silification. This

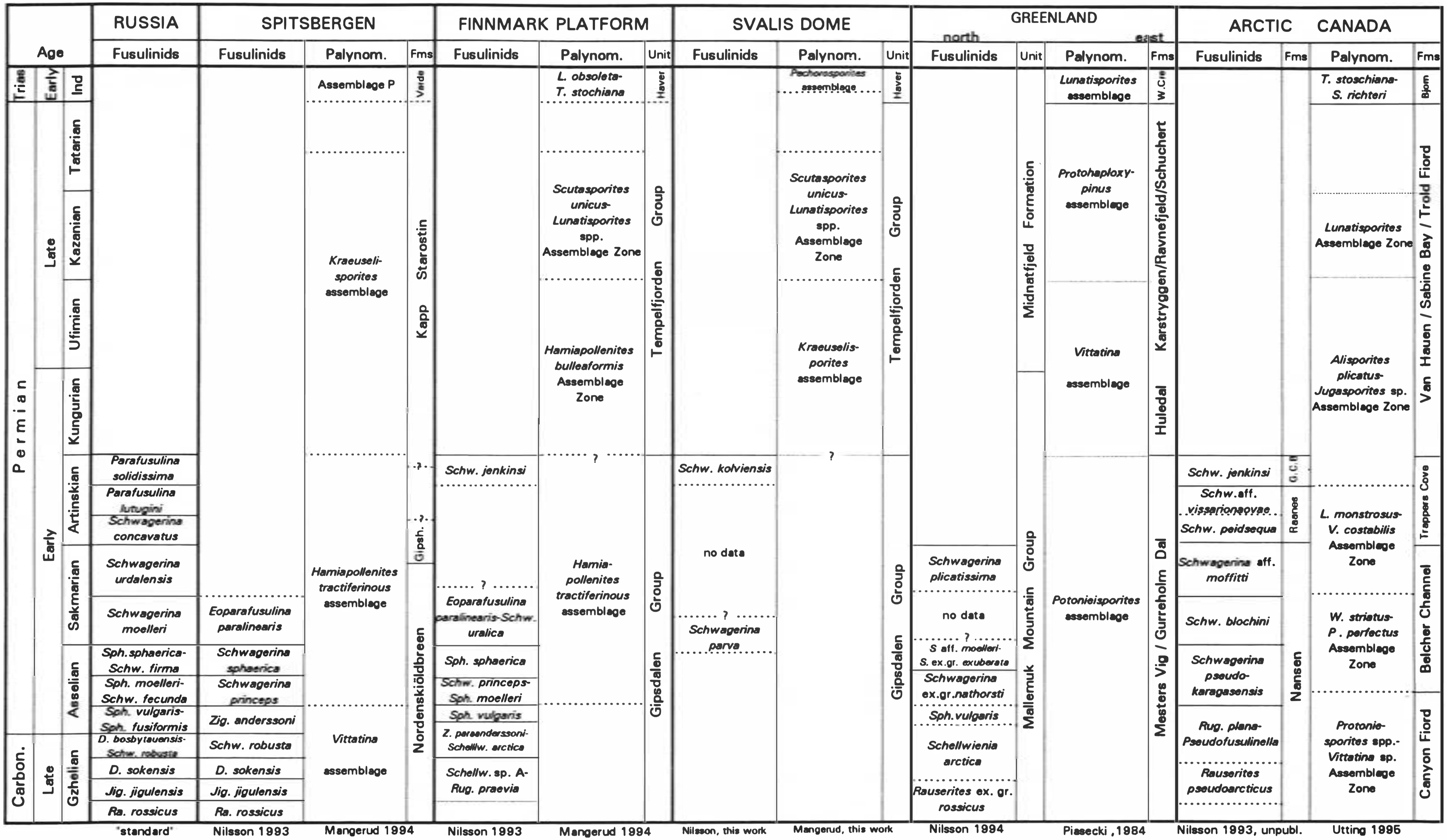


Fig. 5. Biostratigraphical correlations of the Svalis Dome with adjacent Arctic areas. The fusulinid zonation of the Russian Platform and/or the Urals (e.g. Shamov 1940; Rauser-Chernousova 1949; Rosovskaya 1950, 1958; Rauser-Chernousova et al. 1979; Davydov et al. 1990) is commonly used as reference ('standard') zonation for fusulinids recorded from the present northern areas.

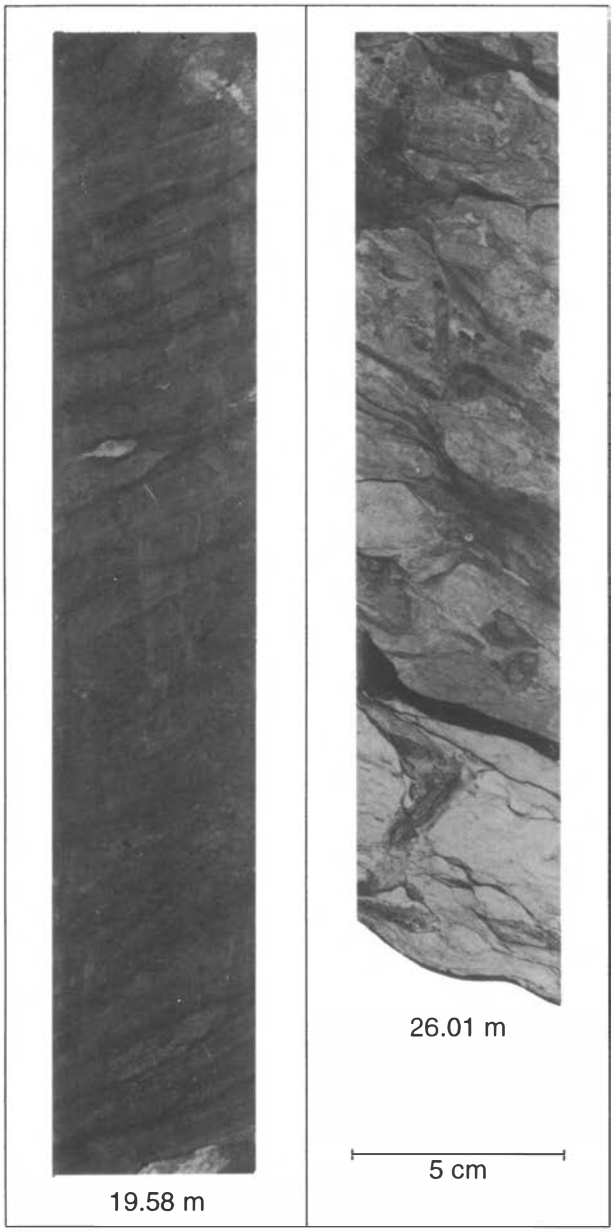


Fig. 6. Typical lithologies of core Dia84-31. Left: dark grey cherty mudstone with oblique darker *Zoophycos* traces. Right: nodular bioturbated cherty limestone.

type of facies indicates a correlation to the Kapp Starostin Formation in Svalbard.

Minicore D84-2/1. – This core (Fig. 1b) consists of strongly silicified pack- to wackestones with abundant fossil fragments including sponge spicules reflecting an open marine affinity (Table 1). Although it may not be *in situ*, the lithology indicates correlation to typical 'Kapp-Starostin-facies'. Poorly preserved palynomorphs include only *Vittatina* spp., indicating a latest Carboniferous-Permian age.

Minicore D84-13/1. – This core (Fig. 1g) consists of chert-cemented siltstone. A palynomorph-assemblage including *Vittatina* together with abundant acritarchs (*Veryhachium*, *Unellium* and *Micrhystridium* spp.) is recorded (Fig. 8). The assemblages are similar to the *Kraeuselisporites* assemblage of the Kapp Starostin Formation on Svalbard (Mangerud & Konieczny 1993; Fig. 5), indicating a late Early to Late Permian age.

Minicore D84-5/1. – This core (Fig. 1f) consists of silty biomicrite with a rich marine fauna. Echinoderm and brachiopod fragments dominate and sponge spicules have contributed to the silicification. There is some bioturbation. The palynomorph assemblage includes *Vittatina* spp., *V. costabilis*, *Weylandites striatus*, *Protohaploxypinus*, *Kraeuselisporites spinosus* and *Micrhystridium* spp. (Fig. 8). The assemblage is similar to the *Kraeuselisporites* assemblage recorded in the Kapp Starostin Formation on Spitsbergen (Mangerud & Konieczny 1993; Fig. 5), indicating a late Early to Late Permian age.

Minicore D84-14/1. – This core (Fig. 1g) consists of dark grey silicified wackestone with muddy clastic material and siltgrains. There was well-preserved bryozoan fragments, abundant sponge spicules and some echinoderm fragments and foraminifera. The palynomorphs assemblage contains microplankton in addition to *Vittatina*, resembling other Late Permian assemblages from Svalbard and the Barents Shelf.

Minicore D84-16/1. – This core (Fig. 1e) consists of partly silicified siltstones with sponge spicules and brachiopod fragments. The palynological composition includes *Vittatina*, *Protohaploxypinus* spp. and a diverse acitarch assemblage including *Micrhystridium*, *Unellium* and *Veryhachium*. This correlates with the *Kraeuselisporites* assemblages recorded in the Kapp Starostin Formation on Svalbard (Mangerud & Konieczny 1993), indicating late Early to Late Permian age.

Minicores D84-6/1, -7/1 and -10/3. – No age-diagnostic fossils are recorded from these minicores, but the lithology characterized by silicified wackestone and strongly silicified spiculitic chert with bryozoan, brachiopods and sponge spicules indicate a correlation to the Tempelfjorden Group.

Regional correlations

The investigated material demonstrates two main depositional environments: Lower Permian shelf carbonates of the Gipsdalen Group and mid-upper Permian basinal siliciclastics of the Tempelfjorden Group (Fig. 12). No cores of salt were obtained on the Svalis Dome. The age of the salt can therefore only be inferred from dating of younger units. The oldest core 7323/10-U-01, drilled into the centre of the dome, comprises fragments of fusulinid shells that indicate a general Late Carboniferous-Early Permian age. Although the recorded carbonate rocks are suggested to represent collapsed *in situ* sedimentary rocks

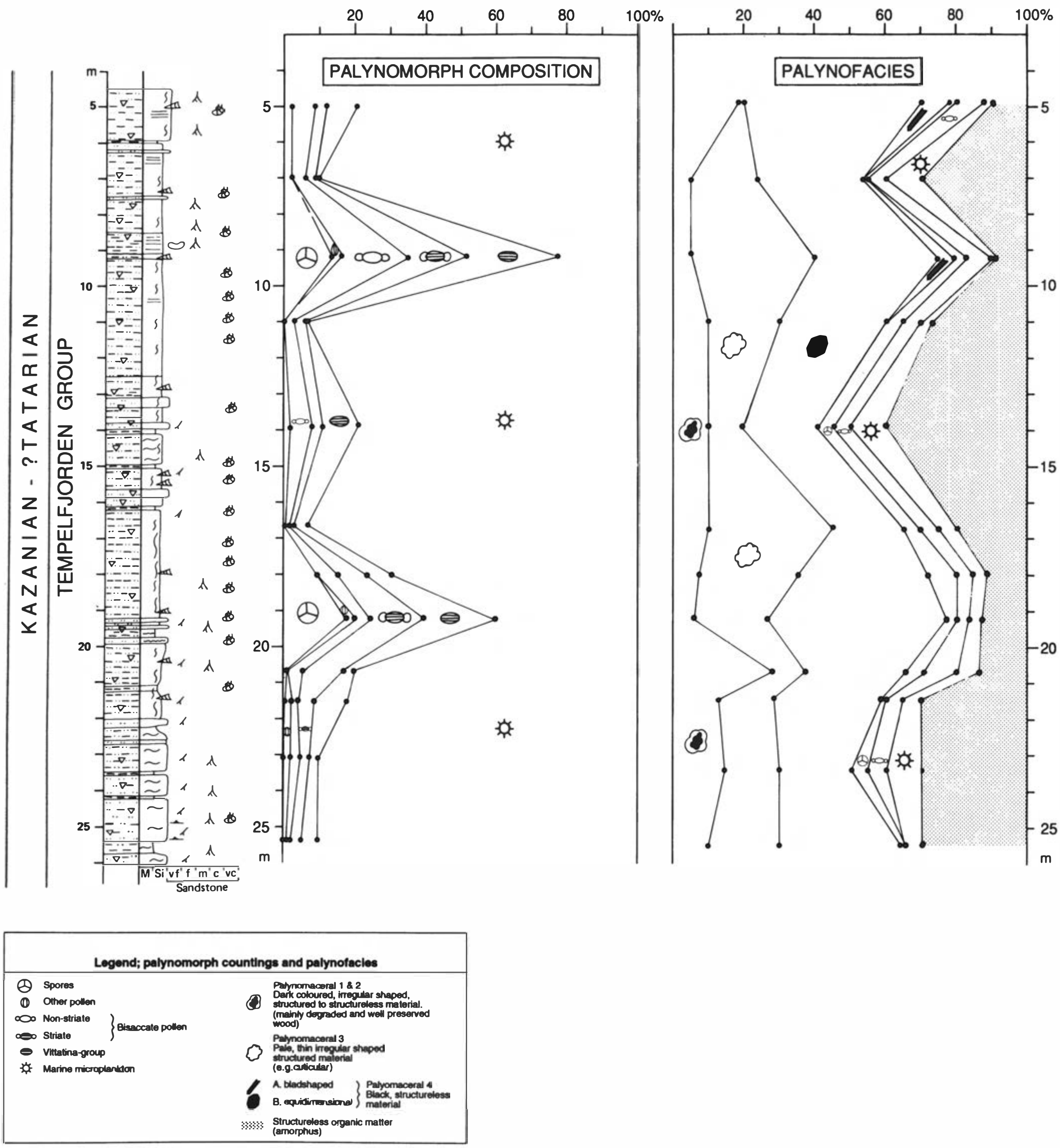


Fig. 7. Core Dia84-31. Lithological section (legend in Fig. 2), palynomorph composition and palynofacies.

above the salt, they may have been glacially transported from outside the centre (Bugge & Fanavoll 1995). The salt is tentatively correlated to the middle Carboniferous Ebbadalen Formation on Spitsbergen. The evaporite deposits in the Nordkapp and Tromsø basins are also suggested to correlate to these middle Carboniferous evoporites on Spitsbergen (Nøttvedt et al. 1993).

The oldest sedimentary rocks exposed at the Svalis Dome are of latest Asselian–earliest Sakmarian age (*Schwagerina parva* assemblage). The fossiliferous packstones/grainstones in core Dia84-11 and minicores D84-11/1 and D84-12/3 represent shallow marine carbonate shelf similar to those seen in the Nordenskiöldbreen Formation of Spitsbergen. On Bjørnøya these strata may correspond to the topmost beds of the Kapp Duner Formation which contain fusulinids of late Asselian age (Simonsen 1988). Shallow marine conditions, including several levels with *Palaeoaplysina* buildups, are also seen

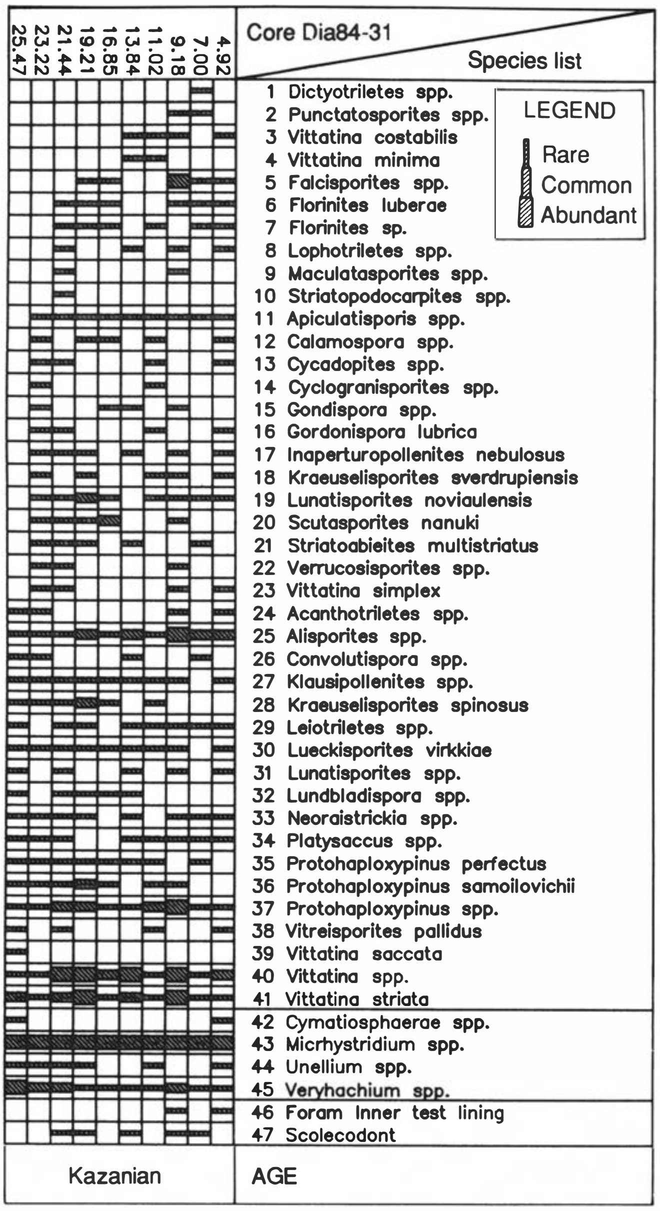


Fig. 8. Distribution-chart of selected palynomorphs in core Dia84-31. The samples correspond to metre levels in core.

in the Gzhelian-Asselian succession of the Finnmark Platform (Bugge et al. 1995).

The presence of *Schwagerina kolviensis* in minicore D84-15/1 indicates a late Artinskian age. Similar fusulinid fauna (*Schwagerina jenkinsi* Zone) occurs in the upper part of the Hambergfjellet Formation on Bjørnøya (Simonsen 1988) and on the Finnmark Platform (Nilsson 1993; Bugge et al. 1995). Lithologically, this core also resembles the open marine sediments of the Hambergfjellet Formation (Worsley & Edwards 1976). On the Finnmark Platform this unit corresponds to a major carbonate platform development where *Tubiphytes*-bryozoan cementstone reefs are widespread (Bruce & Toomey 1993; Cecchi 1993; Nilsen et al. 1993). Time equivalent deposits may be missing on Spitsbergen.

The dark grey siliceous siltstone with sponge spicules and abundant trace fossils, including *Zoophycos* and *Chondrites* in core Dia84-31, indicates deeper calm water in dysaerobic (cf. Bromley 1990, p. 195) environments in the Svalis Dome area during deposition of these sediments. This is also indicated by the moderate TOC values (0.4–0.9%), as well as by the low content of amorphous organic material (Fig. 7). The dominating silica cementation and presence of silica sponges led Siedlecka (1970) to use the term 'spiculite' for basinal parts of the Kapp Starostin Formation. The palynomorphs *Scutasporites* and *Lunatisporites* indicate a Late Permian (Kazanian–? Tatarian) age for these sediments and allow a correlation with the upper part of the Kapp Starostin Formation (Fig. 12).

The 9 minicores (Fig. 1, Table 1) drilled through similar sediments to those found in core Dia84-31 are of late Early Permian to Late Permian age, thus supporting a correlation with the Kapp Starostin Formation. In addition, similar sediments are reported from wells (7120/1-1 and 7121/1-1) on the Loppa High (Stemmerik & Larssen 1992). On Bjørnøya sandy limestones and well-sorted sandstones appear at this time, indicating a shallower depositional environment of the Miseryfjellet Formation. This was caused by a positive feature resulting from Early Permian faulting and is also seen in the Upper Permian Tokrossøya Formation in south-western Spitsbergen where a sand-dominated succession was developed due to fault activity along the Hornsund–Sørkapp trend (Siedlecka 1970; Steel & Worsley 1984). More marginal marine conditions are demonstrated from IKU shallow cores in the southern parts of the Finnmark Platform (Fig. 12) where a clastic dominated unit of Kungurian–Ufimian age is overlain by an upper limestone unit of Kazanian–? Tatarian age (Mangerud 1994). The Upper Permian succession on the Svalis Dome probably represents a depositional environment somewhere between the development reflected in the Miseryfjellet Formation on Bjørnøya and the deeper water spiculite shales/siltstone facies recorded in the Kapp Starostin Formation on Spitsbergen. The depositional pattern developed during the Late Palaeozoic in the Svalis Dome area was probably a result of activation of the generally NE–SW striking Hoop Fault Complex, which created a half-graben in the Svalis Dome area on the northwestern down-faulted side (Bugge & Fanavoll 1995).

Fusulinid taxonomy

Genus *Schubertella* Staff & Wedekind 1910
Schubertella kingi Dunbar & Skinner 1937
Fig. 13A, B

Type species. – *Schubertella kingi* Dunbar & Skinner 1937; pp. 610–611, pl. 45, figs. 10–15.

Description. – Elongate fusiform to subcylindrical shell with bluntly pointed poles. Specimens of 5 to 6 volutions reaching a length of approximately 0.9 mm, a diameter

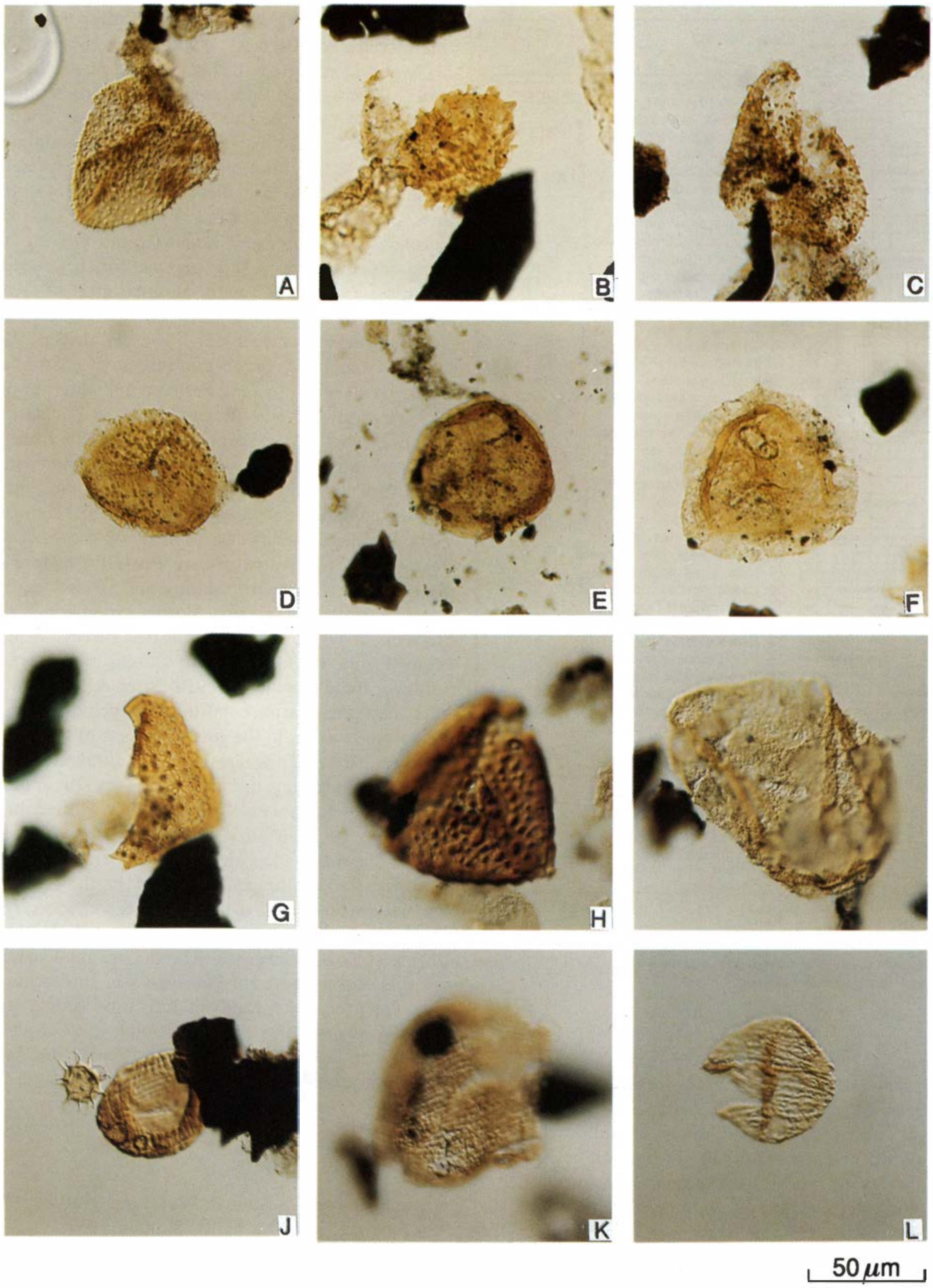


Fig. 9. Selected spores and pollen from indicated levels of core Dia84-31. Specimens deposited in Palaeontological Museum, Oslo (PMO) and catalogued by slide number followed by England Finder. Scale is added. A. *Apiculatisporis* sp., 4.92 m, PMO 139.102, C51. B. *Neoraistrickia* sp., 9.18 m, PMO 103, C47/3. C. *Acanthotriletes* sp., 4.92 m, PMO 139.102, M66/3. D. *Kraeuselisporites apiculatus* Jansonius 1962, 9.18 m, PMO 139.103, K46/3. E. *Kraeuselisporites*, 7.00 m, PMO 139.104, D44. F. *Kraeuselisporites sverdrupiensis* Utting 1994, 9.18 m, PMO 139.103, B49/1. G. Unidentified spore, 9.18 m, PMO 139.103, Y48/2. H. Unidentified spore 23.22 m PMO 139.105, M56. I. *Inaperturopollenites nebulosus* Balme 1970, 9.18 m, PMO 139.103, P47/1. J. *Weylandites striata* (Luber) Samoilovich, 11.02 m, PMO 139.106, R55/3. K. *Vittatina* sp., 13.84 m, PMO 139.107, V49/4. L. *Vittatina costabilis* Wilson 1962, 11.02 m, PMO 139.106, E54/3.

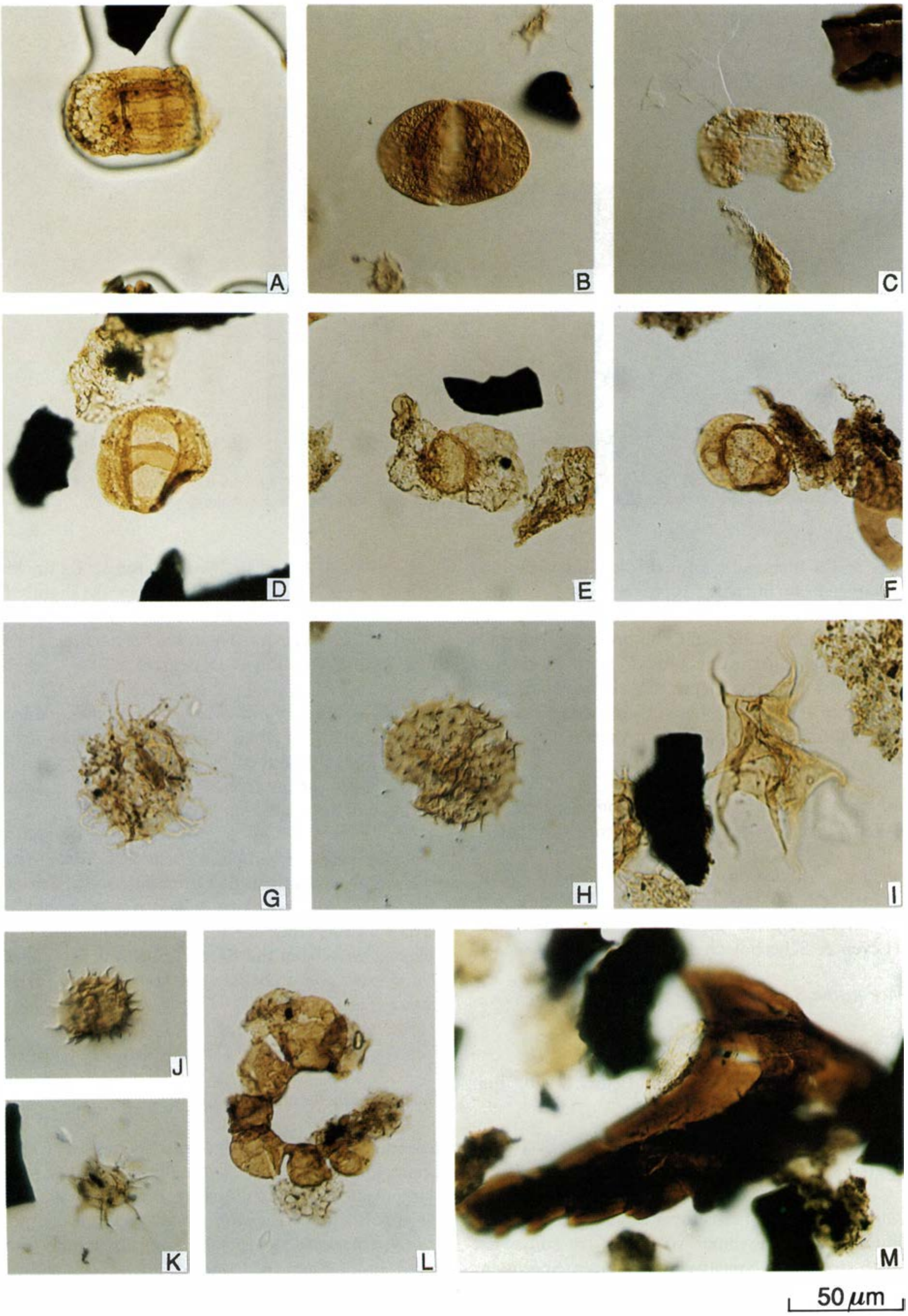


Fig. 10. Selected pollen (A-F), acritarchs (G-K) and other acid resistant fossils (L & M) from core Dia84-31. See explanation in Fig. 9. A. *Lunatisporites noviaulensis* (Leschik 1956) Foster 1979, 19.21 m, PMO 139.108, T51/4. B. *Protohaploxypinus samoilovichii* Hart 1964, 23.22 m, PMO 139.105, Z52/4. C. *Lueckisporites virkkiae* Potonié & Klaus 1954, 11.02 m, PMO 139.106, D40. D. *Scutasporites nanuki* Utting 1994, 9.18 m, PMO 139.103, H56/1. E. *Platysaccus papilionis*, 4.92 m, PMO 139.102, R57. F. *Florites* sp., 4.92 m, PMO 139.102, L50. G. *Micrhystridium* sp., 4.92 m, PMO 139.109, F47/3. H. *Micrhystridium* sp., 25.47 m, PMO 139.109, C45/4. I. *Unellium* sp., 4.92 m, PMO 139.102, R56. J. *Micrhystridium* sp., 25.47 m, PMO 139.109, M51/4. K. *Micrhystridium* sp., 25.47 m, PMO 139.109, H53/2. L. Foraminifera inner lining, 4.92 m, PMO 139.102, G54. M. Scolecodont, 9.18 m, PMO 139.103, W43.

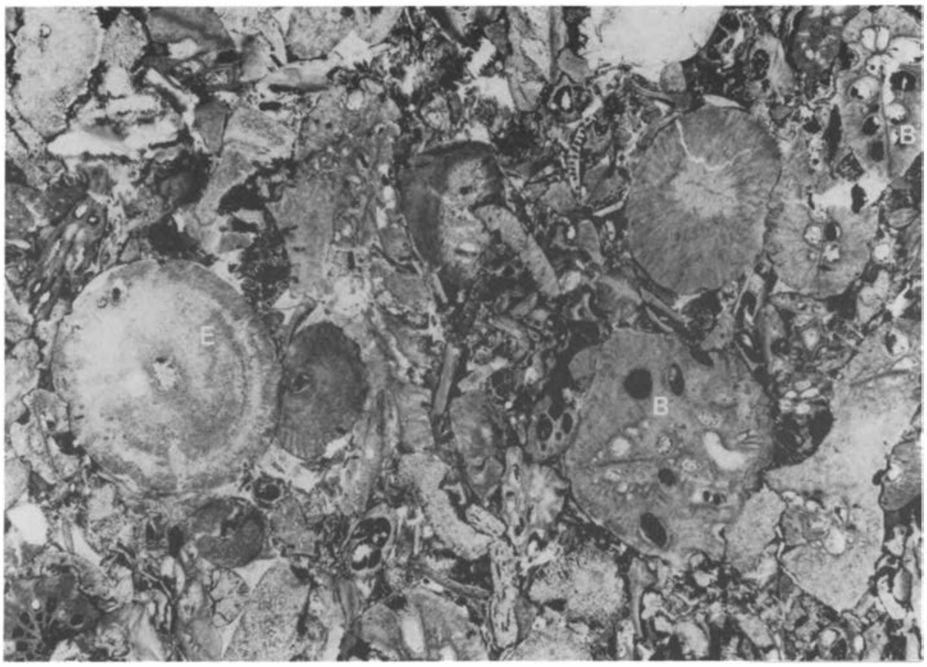


Fig. 11. Photograph of thin section from core Dia84-2, 98.63 m. Rock is a packstone with debris of echinoderms (E) and bryozoa (B). Width of photo ~1 cm.

of 0.3 mm and a form ratio of 3. Proloculus is minute; outside diameter 40 microns. First to second volution represents an endothyroid juviarium, which is coiled about 'pependicular' to the adult volutions. Spirotheca is extremely thin, reaching a thickness of 10 to 15 microns in the outermost volution. Septa are almost plane with gentle folding in the polar regions. Chomata are lacking in the juvinarium, but conspicuous in the adult fusiform volutions.

Remarks. – Schubertella kingi differs from *S. transitoria* Staff & Wedekind in being larger and more slender.

Stratigraphical distribution. – Lower Permian (Wolfcampian) in North America (e.g. Skinner & Wilde 1965), Canadian Arctic (Harker & Thorsteinsson 1960) and Russia (Leven & Scherbovich 1978).

Occurrence in the Svalis Dome. – Core Dia84-11.

Genus *Pseudofusulinella* Thompson 1951

Pseudofusulinella aff. *valkenburghae* Petocz 1970, Fig. 13C, D

Type species. – Pseudofusulinella valkenburghae Petocz 1970; pp. 35–38, pl. 1, Figs. 3–11.

Description. – The shell is fusiform to elongate fusiform with pointed poles. The inner volutions are somewhat ovoidal with straight to concave lateral slopes. Specimens of 6 to 6.5 volutions reach an approximate length of 3.2 to 3.6 mm, a diameter of 1.0 to 1.2 mm and a form ratio of 2.9 to 3.2. The outside diameter of proloculus is 90 to 140 microns. The spirotheca is composed of tectum and diaphanotheca. Epithecal deposits present on spirotheca in all volutions except the two outermost. Its thickness in sixth whorl is 20 to 30 microns. Septa are slightly fluting in the polar regions. The chomata attain about half the height of the chambers. The tunnel is narrow. The tunnel angle in fifth volution is 15 degrees.

Remarks. – Pseudofusulinella aff. *valkenburghae* from the Barents Shelf resembles the type specimens from the Alaska Range described by Petocz (1970), but differs in having more heavy epithecal deposits on spirotheca throughout the shell.

Stratigraphical distribution. – Pseudofusulinella valkenburghae was orginally described from the zone of *Schwagerina whartoni*, considered to be of late Asselian–middle Sakmarian age (Petocz 1970). The specimens of *P.* aff. *valkenburghae* from the Barents Shelf are associated with *Schwagerina parva* (Beljaev) of late Asselian–early Sakmarian age.

Occurrence in the Svalis Dome. – Minicore D84-12/3.

Pseudofusulinella sp. Fig. 13E

Remarks. – Only one shell of this species was found. The specimen differs from *P. valkenburghae* Petocz in having a larger number of volutions and a more inflated fusiform test. The shells of *Pseudofusulinella* sp. are composed of 8 or 9 volutions and measure approximately 5 mm in length and 1.7 mm in diameter. The species shows some similarities with *Pseudofusulinella acuminata* Skinner & Wilde, which occurs in the McCloud Limestone (Lower Permian) of California (Skinner & Wilde 1965) as well as in the Nansen Formation (Lower Permian) of Arctic Canada (Nassichuk & Wilde 1977).

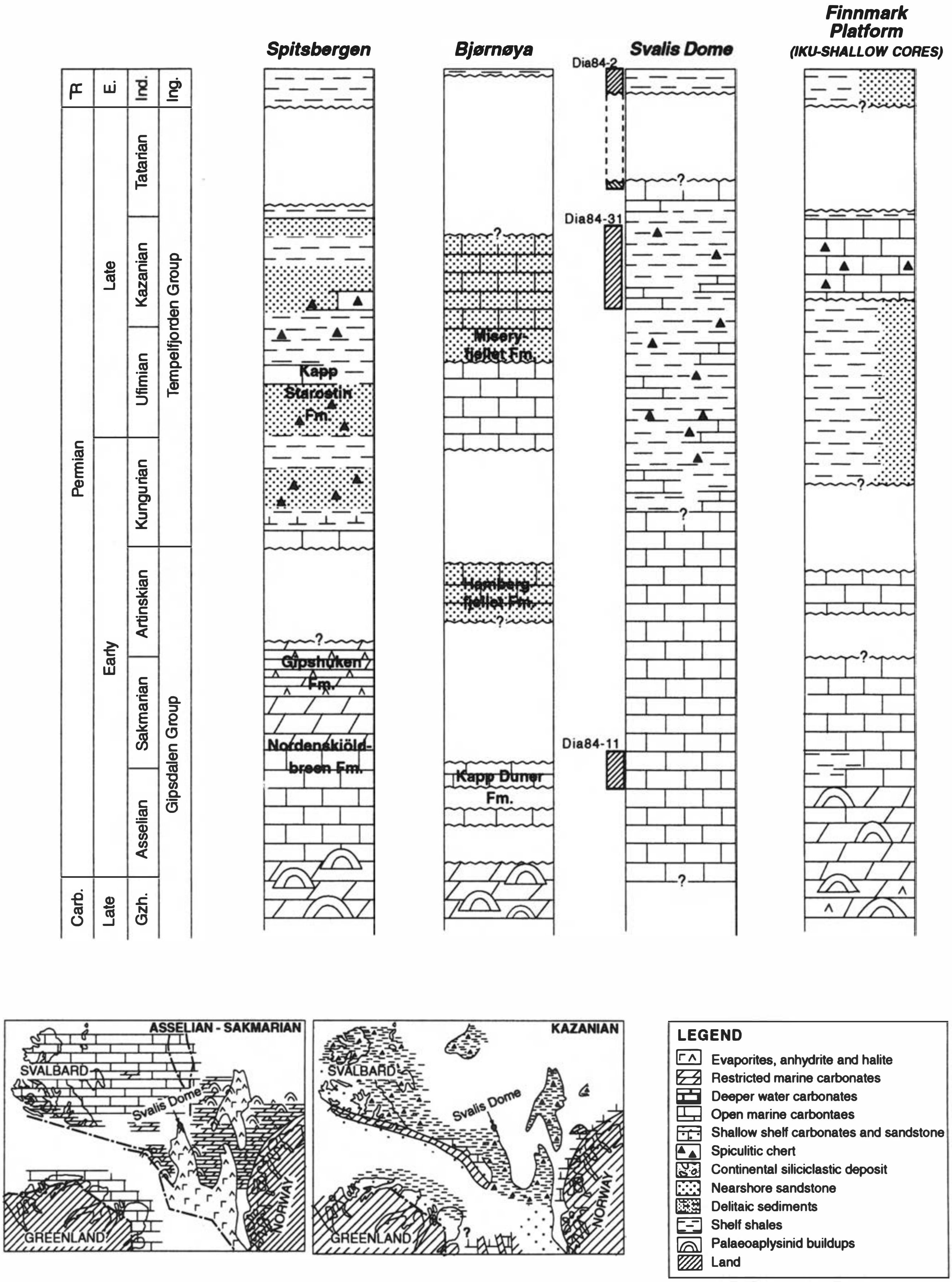


Fig. 12. Lithological sections from the Svalis Dome and adjacent areas of the Barents Shelf. Palaeogeographic maps slightly modified from Stemmerik & Worsley (1994).

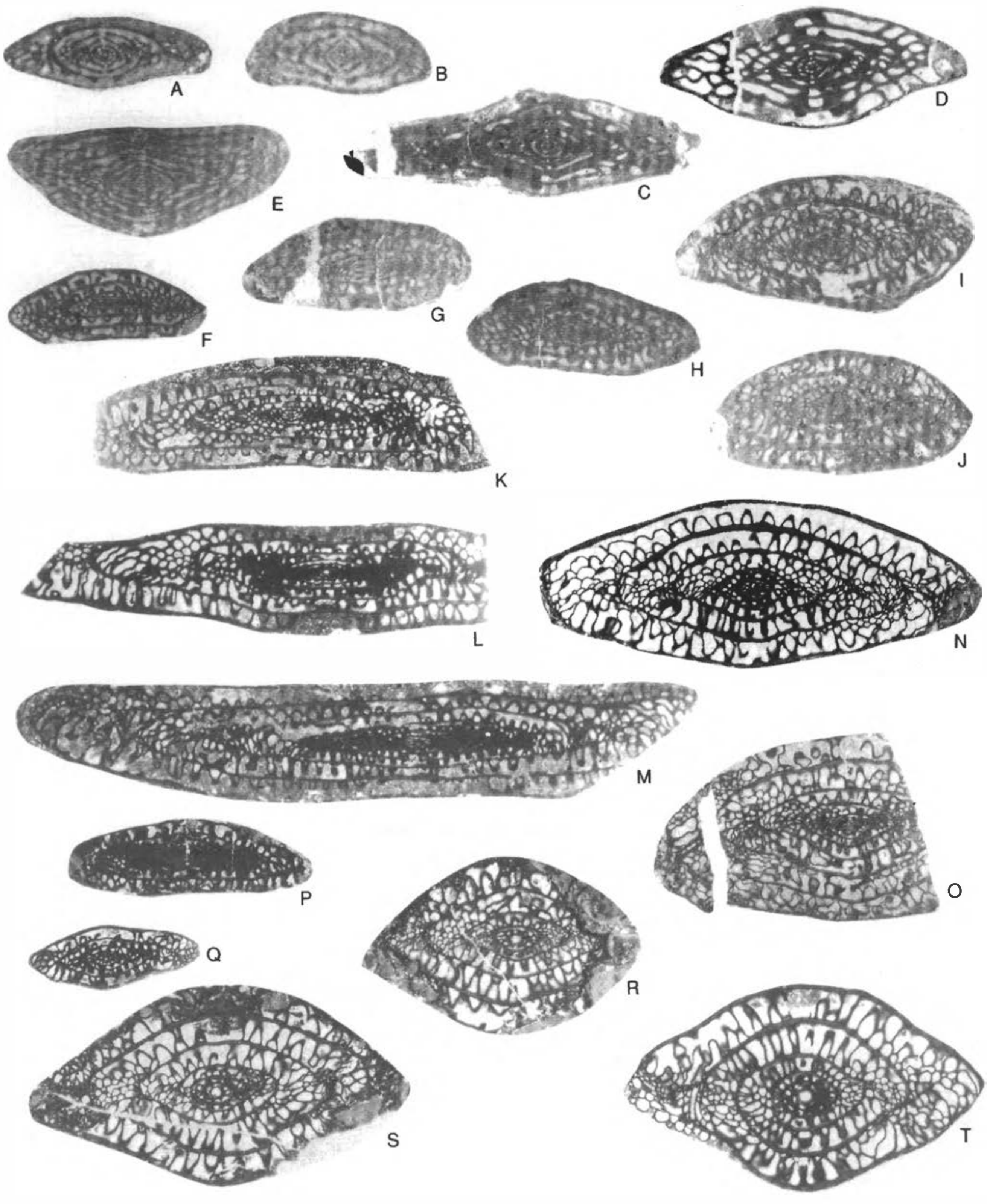


Fig. 13. Selected fusulinids from indicated levels of core Dia84-11, and minicores D84-11/1, D84-12/3 and D84-15/1. Specimens deposited in Palaeontological Museum, Oslo (PMO). A, B: *Schubertella kingi* Dunbar & Skinner × 40, A, Dia84-11-7.9, PMO 139.118; B, D84-12/3-1.0, PMO 139.125. C, D: *Pseudofusulinella valkenburghae* Petocz × 20, C, D84-12/3-0.1, PMO 139.129; D, D84-12/3-1.0, PMO 139.125. E: *Pseudofusulinella* sp. × , Dia84-11-11.9, PMO 139.114. F, G, H: *Zigarella* ex. gr. *lutuginiformis* × 10, F, Dia84-11-11.9, PMO 139.114: G, Dia84-11-10.3, PMO 139.115; H, Dia84-11-9.6, PMO 139.116. I, J: *Schwagerina parafecunda* (Shamov) × 10, I, Dia84-11-14.2, PMO 139.111; J, Dia84-11-7.9, PMO 139.118. K, L, M: *Schwagerina kolviensis* (Grozdilova & Lebedeva) × 10, K, D84-15/1-0.8, PMO 139.130; L, D84-15/1-0.8, PMO 139.131; D84-15/1-0.6, PMO 139.132. N: *Schwagerina* aff. *idelbajevica* (Shamov) × 10, Dia84-11-7.5, PMO 139.119. O: *Schwagerina* sp. A × 10, Dia84-11/1-0.5, PMO 139.133. P: *Zigarella lutuginiformis* (Rauser-Chernousova) × 10, Dia84-11-7.5, PMO 139.119. Q: *Schwagerina thorsteinssoni* Wilde × 10, Dia84-12/3-1.0, PMO 139.125. R, S, T: *Schwagerina parva* (Beljaev) × 10, R, Dia84-11-7.5, PMO 139.119; S, Dia84-11-7.5, PMO 139.119; D84-12/3-0.8, PMO 139.126.

Occurrence in the Svalis Dome. – Core Dia84-11.

Genus *Schwagerina* von Möller 1877 *Schwagerina* aff. *idelbajevica* Shamov 1958, Fig. 13N

Type species. – *Schwagerina idelbajevica* Shamov 1958; pp. 145–146, pl. 2, fig. 3.

Description. – Fusiform shell with bluntly pointed poles. Specimen of 5 volutions reaches a length of 7.9 mm, a diameter of 3.0 mm and a form ratio of 2.6. The outside diameter of proloculus is about 250 microns. The thickness of spirotheca is 100 microns in fifth volution. The septa are intensely and regularly fluted throughout the shell.

Remarks. – The specimens from Dia84-11 are similar to the type specimens of *Schwagerina idelbajevica* in shape, size and several internal features, but the septa are more regularly fluted throughout the shell.

Stratigraphical distribution. – Specimens of *S. idelbajevica* are reported from the upper Asselian strata in the Timan-Pechora Basin (Grozdilova & Lebedeva 1961) and the Urals (Konovalova 1991).

Occurrence in the Svalis Dome. – Core Dia84-11.

Schwagerina kolviensis (Grozdilova & Lebedeva 1986). Fig. 13K, L, M

Type species. – *Pseudofusulina kolviensis* Grozdilova & Lebedeva 1986: no description, pl. XX.

Description. – The fusiform to elongate specimens of 6 to 6.5 volutions reach a length of approximately 11.7 to 14.0 mm, a diameter of 1.7 to 2.1 mm and a form ratio of 6.7. Outside diameter of the proloculus is 160 to 220 microns. Spirotheca thin in the inner volutions, reaching a thickness of 60 to 80 microns in outmost volution. The septa are regularly fluted throughout the central part of the shell, but higher and more irregularly fluted towards the pole regions. Rudimentary chomata are observed on proloculus and inner two volutions. The tunnel is irregular. Some axial fillings are present in the three inner volutions. Development of cuniculi is not observed.

Stratigraphical distribution. – Upper lower Artinskian to upper Artinskian (*Parafusulina lutugini* zone) in the Timan-Pechora Basin and the Urals (Konovalova 1991).

Occurrence in the Svalis Dome. – Minicore D84-15/1.

Schwagerina aff. *parafecunda* (Shamov & Scherbovich 1949). Fig. 13I, J

Type species. – *Schwagerina parafecunda* Shamov & Scherbovich 1949; pp. 166–167, pl. 1, figs. 8, 9.

Description. – The shape of the shell is fusiform with broadly rounded to bluntly pointed poles with loose coiling. The number of whorls is 5 to 5.5. The specimens reach a length of 5 to 5.4 mm and a diameter of 2.1 to 2.6 mm; a form ratio of 2.2 to 2.4. The proloculus measure 160 microns in outside diameter. The spirotheca is thin in inner volution, reaching a thickness of 100 microns in outmost volution. The septa are intensively and irregularly fluted throughout the shell. Chomata are present only on the proloculus.

Stratigraphical distribution. – Middle to upper Asselian strata in Russia (Shamov 1958).

Occurrence in the Svalis Dome. – Core Dia84-11.

Schwagerina parva (Beljaev 1936). Fig. 13R–T

Type species. – *Pseudofusulina uralica* var. *parva* Beljaev in Rauser-Chernousova, Beljaev & Reitlinger 1936, p. 197 (no pictures).

Description. – Shell with inflated fusiform shape with bluntly pointed poles. Specimens of 4 to 6 volutions measure about 5.8 to 6.5 mm in length and 3.2 to 3.7 mm in diameter which indicates form ratio of 1.8. Outside diameter of the proloculus is 200 to 340 microns. The spirotheca reach 100 to 115 microns in outmost volution. Septa are high and intensely fluted throughout the shell.

Remarks. – *Schwagerina parva* differs from *S. princeps* in having larger proloculus, higher and more regularly septal fluting and the form ratio is slightly greater. *S. parva* belong to the *S. uralica* group, but is commonly smaller, more tightly coiled and the septal folding is less intensive than the principal form.

Stratigraphical distribution. – *Schwagerina parva* is reported from the upper Asselian (Nenetskiy) beds in the Timan-Pechora Basin (Grozdilova & Lebedeva 1961), but ranges into the lower Sakmarian in the Urals (Beljaev & Rauser-Chernousova 1938; Shamov 1958; Mikhailova 1966, 1974) and the Russian Platform (Rauser-Chernousova & Scherbovich 1958).

Occurrence in the Svalis Dome. – Core Dia84-11.

Schwagerina thorsteinssoni Wilde 1977. Fig. 13Q

Type species. – *Schwagerina thorsteinssoni* Wilde in Nassichuk & Wilde 1977; p. 28, pl. 4, figs. 1–5.

Description. – The shell is fusiform with bluntly pointed poles. The inner two or three volutions are globose to inflated fusiform with rounded poles. The specimens of 5 volutions measures 3.0 mm in length, 1.2 mm in diameter and have a form ratio of 2.5. The proloculus is minute;

it measure 100 microns in outside diameter. The spirotheca is very thin in innermost volution; reaching a thickness of 50 microns in outermost volution. The septa are moderately fluting throughout the test. Minute chomata occur on the proloculus; pseudochomata are present in the succeeding whorls except in the outermost one. The tunnel is narrow.

Stratigraphical distribution. – *Schwagerina thorsteinssoni* occurs in the *S. whartoni* assemblage zone, which is considered to be of Asselian–early Sakmarian age by Nassichuk & Wilde (1977).

Occurrence in the Svalis Dome. – Minicore D84-12/3.

Schwagerina sp. A. Fig. 13D

Description. – The shell is fusiform to inflated fusiform with broadly rounded poles. The specimen consists of 5.5 whorls which are loosely coiled. The length of the shell is 6.8 mm, the diameter 3.4 mm and the form ratio 2. The thickness of the spirotheca is 80 microns in outer volution. Septal folding is high and narrow in inner two or three volutions, but intensely and irregularly folded in outermost.

Remarks. – This species resembles *Schwagerina moelleri* (Schellwien) in the shape and size of the shell, but the septal folding appears to be more irregularly fluted throughout the outer volutions. A closer identification is, however, impossible as the investigated shell is slightly tangentially orientated.

Occurrence in the Svalis Dome. – Minicore D84-11/1.

Genus *Zigarella* Davydov 1982. *Zigarella lutuginiformis* (Rauser-Chernousova 1940). Fig. 13P

Type species. – *Pseudofusulina lutuginiformis* Rauser-Chernousova 1940; pp. 83–85, pl. 2, figs. 11, 12, pl. 3, figs. 1–6.

Description. – The shell is elongate fusiform to subcylindrical with bluntly rounded poles. Specimens of 4 to 5 volutions measure about 4.3 to 4.8 mm in length and 1.2 to 1.4 mm in diameter, which give a form ratio of 3.2 to 3.6. The proloculus is minute; outside diameter of 100 to 120 microns. The spirotheca is thin; reaching a thickness of 50 microns in outer volution. The septa are intensively and regularly folded throughout the shell except for the one or two innermost volutions where the septa are plane in the middle part of the shell. No chomata observed. The tunnel is narrow. Secondary depositions in the pole areas are common.

Stratigraphical distribution. – Upper Asselian to lower Sakmarian strata in the Urals and Russian Platform (e.g. Mikhailova 1974).

Occurrence in the Svalis Dome. – Core Dia84-11.

Zigarella ex. gr. *lutuginiformis* (Rauser-Chernousova 1940). Fig. 13F, G, H

Description. – The shape of shell is fusiform with pointed poles. Number of whorls is more than five. Specimens reach an approximate length of 3.5 to 4.5 mm and a diameter of 1.2 to 1.6 mm. Proloculus appears to be minute. Spirotheca is extremely thin in inner two or three volutions, but it reaches a thickness of about 100 microns in outer volution. The septafolding is regularly fluted throughout test. No chomata observed.

Remarks. – This species is rather characterisic with the extremely thin spirotheca in the inner volutions. It shows close affinities to *Schwagerina lutuginiformis* (Rauser-Chernousova 1940) from the upper Asselian–lower Sakmarian beds of the Urals, but it is different in having no axial deposits.

Occurrence in the Svalis Dome. – Core Dia84-11.

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