POLISH POLAR RESEARCH
vol. 24, no. 1, pp. 61–72, 2003

Overthrust Carboniferous strata (Sergeijevfjellet Formation) at Lidfjellet, NW Sørkapp Land, Spitsbergen

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ABSTRACT: The Lidfjellet thrust is the most prominent tectonic structure in the Lidfjellet-Øyrlandsodden fold zone, which stretches NNW-SSE along the western coast of Sørkapp Land in Spitsbergen. This paper provides a reinterpretation of the Lidfjellet structure, with particular reference to lithostratigraphy of the autochthonous and overthrust sequences involved, and to the position of the thrust surface. Geological and palynologicalal data indicate that the sequence attributed previously to the Lower Cretaceous Helvetiafjellet Formation of the autochthonous cover represents in fact the Carboniferous (Viséan) Sergeijevfjellet Formation forming the lower part of the overthrust unit. The youngest deposits involved in tectonic structures of the Lidfjellet-Øyrlandsodden fold zone are of Upper Jurassic age.

Key words: Arctic, Spitsbergen, Sørkapp Land, Carboniferous, tectonics, palynology.

Introduction

The Lidfjellet-Øyrlandsodden fold zone is a tectonic belt stretching NNW-SSE along the western coast of Sørkapp Land in Spitsbergen (Fig. 1). It shows compressional structures with trends and vergences corresponding to those of the West Spitsbergen Thrust and Fold Belt, though it is not certain whether the two belts were formed during the same tectonic phase (Dallmann *et al.* 1993, Harland 1997). Onland outcrops of the Lidfjellet-Øyrlandsodden fold zone embrace exposures in NW Sørkapp Land (Hohenlohefjellet, Sergeijevfjellet, Lidfjellet) and the ones at Øyrlandsodden, Tokrossøya, Stiernøya, and Sørkappøya in S Sørkapp Land. It was suggested that the youngest deposits involved in tectonic structures of the fold zone represent the Lower Cretaceous Helvetiafjellet Formation. The Formation is depicted on the Geological Map of Sørkapp Land 1:100 000 (Sheet

Fig. 1. Sketch map of the Svalbard archipelago showing location of Lidfjellet in NW Sørkapp Land in Spitsbergen.

C13G) at the top of the autochthonous sequence at Lidfjellet, where it is overthrust by Triassic strata (Winsnes *et al.* 1993).

This paper documents that the sequence attributed to the autochthonous Helvetiafjellet Formation (Lower Cretaceous) at Lidfjellet represents in fact the

Carboniferous (Viséan) Sergeijevfjellet Formation, which is thrust over a tectonically reduced Agardhfjellet Formation (Upper Jurassic), the latter being the youngest known sedimentary formation in the Lidfjellet-Øyrlandsodden fold zone. Lithostratigraphic names used in the paper follow definitions presented in the *Lithostratigraphic Lexicon of Svalbard* (Dallmann 1999).

The Lidfjellet structure

The low-angle thrust exposed at Lidfjellet is the most prominent tectonic structure in the Lidfjellet-Øyrlandsodden fold zone (Fig. 2A). It shows eastward vergence, with a minimum estimated displacement of 1.8 km (Dallmann *et al.* 1993).

The thrust surface is well visible on the western slope of Lidfjellet where it separates the autochthonous sequence, forming the lower third of the slope, from the overthrust one, forming its middle and upper parts (Figs 2, 3).

The autochthonous sequence embraces sedimentary formations classified into the Lower–Middle Triassic Sassendalen Group (Tvillingodden and Bravaisberget formations) and the Upper Triassic–Lower Jurassic Kapp Toscana Group (De Geerdalen and Smalegga formations). Distinct morphologic bench at the top of the Smalegga sandstone is covered by the Brentskardhaugen Bed, which in turn is overlain by the Upper Jurassic Agardhfjellet Formation (Fig. 2B). The Agardhfjellet Formation is strongly tectonically reduced and cut by the overthrust (Fig. 3B), though its thickness increases south- and eastwards at the expense of thickness of the overthrust sequence.

The overthrust sequence consists of the Carboniferous Sergeijevfjellet Formation overlain by the Triassic Sassendalen Group (Fig. 2A). Prominent morphologic bench beneath the summit dome of Lidfjellet marks the contact between the two (Fig. 3A). The contact is sedimentary, encompassing a broad stratigraphic gap related to uplift of the Sørkapp-Hornsund High during Late Carboniferous and Permian (Harland 1997). The Sassendalen Group sequence starts with a few metres thick basal conglomerate unit (Kistefjellet Member of the Vardebukta Formation), and embraces the Tvillingodden and Bravaisberget formations. The summit of Lidfjellet shows sandstones of the upper part of the Bravaisberget Formation (Somovbreen Member).

A downfallen block of the overthrust sequence forms an isolated hill in the NW slope of Lidfjellet (Fig. 2A). It consists of the Sassendalen Group sequence, and contains a scale of resistant sandstones of the Sergeijevfjellet Formation at bottom. Its origin owes most probably to Quaternary rockslip movement.

Detailed geological map and interpretation of the Lidfjellet structure is under elaboration and will be subject of a separate publication.

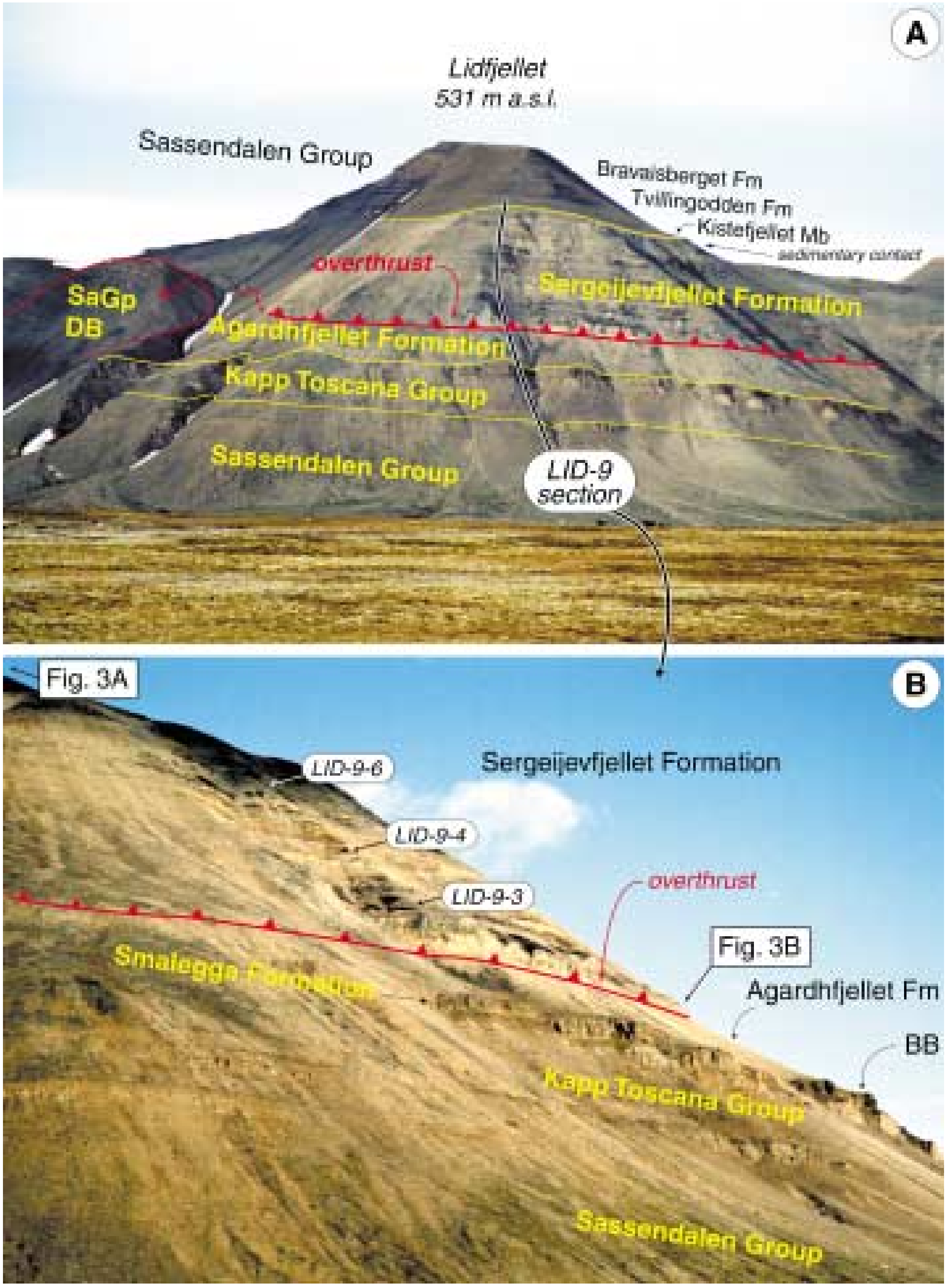

Fig. 2. **A**. Lidfjellet tectonic structure seen from the west, and location of the studied section of the Sergeijevfjellet Formation (LID-9). SaGp DB is a downfallen block of the overthrust Sassendalen Group. **B**. Exposures of the overthrust Sergeijevfjellet Formation along the LID-9 section and the location of palynological samples. BB is the Brentskardhaugen Bed.

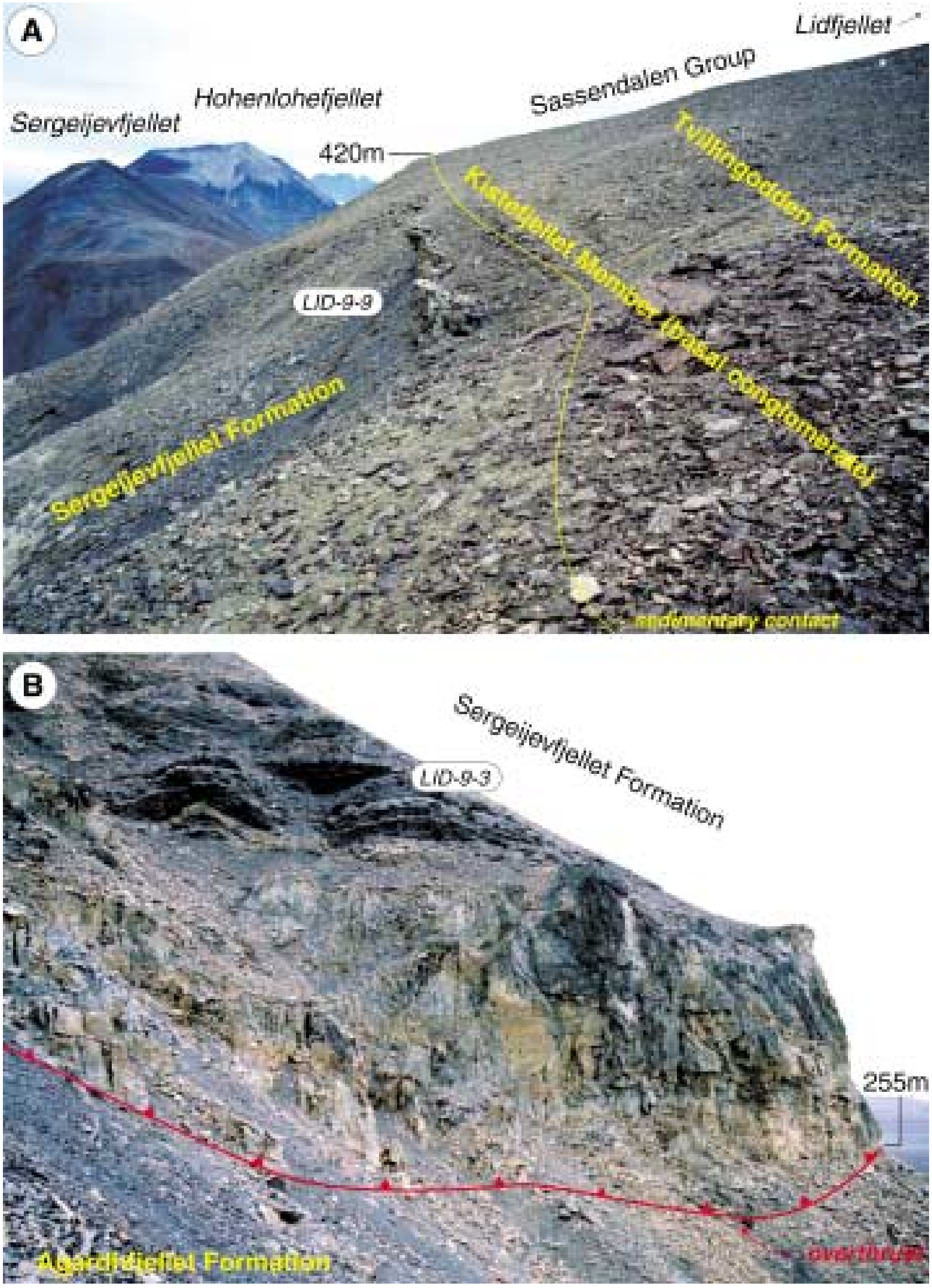

Fig. 3. **A**. Sedimentary contact between the Sergeijevfjellet Formation and the Sassendalen Group in the overthrust sequence at Lidfjellet. **B**. Thrust tectonic contact of the Sergeijevfjellet Formation with the underlying autochthonous Agardhfjellet Formation at Lidfjellet. LID-9-3 and LID-9-9 are locations of palynological samples.

Overthrust Sergeijevfjellet Formation

The overthrust Sergeijevfjellet Formation at Lidfjellet shows facies development and lithologic sequence strikingly similar to those observed in the autochthonous cover at Sergeijevfjellet (Siedlecki 1960, Siedlecki and Turnau 1964, Liparski and Ćmiel 1984, Wendorff 1985). This provides additional evidence of a rather small tectonic displacement associated with the Lidfjellet thrust. Maximum thickness of the overthrust Sergeijevfjellet Formation reaches 170 m, *i.e.* noticeably less than the thickness of this formation in the underlying autochthonous cover (approx. 260 m). This suggests that only upper part of the sequence has been involved in the thrust structure.

The overthrust sequence of the Sergeijevfjellet Formation consists of continental deposits, and embraces seven horizons of light sandstone separated by intervals dominated by siltstone and shale (Fig. 4). The sandstone horizons form recurrent rocky walls (4–20 m high) up the western slope of Lidfjellet, and can be traced over a lateral distance of one kilometre. They are usually medium grained, with common cross-bedding typical of fluvial depositional regime. Fine-grained intervals consist of dark to black shale, mudstone and siltstone, with subordinate sandstone beds, some of which are iron-rich and rusty in colour. Flora remains are common throughout. A few horizons of coaly shale occur in the lower part of the sequence. Diagenetic carbonate (siderite) bands and concretions tend to concentrate in the shaly units. The sedimentary features indicate wetland environment with braided rivers and floodplains, and are consistent with previous interpretation of the Sergeijevfjellet Formation (Wendorff 1985).

Palynology

Materials and methods. — Palynological samples were collected along the LID-9 section located on the western slope of Lidfjellet (Fig. 2A). Four samples of dark grey and black shales and argillaceous bands (LID-9-3, LID-9-4, LID-9-6, and LID-9-9) were subjected to standard laboratory treatment, and all yielded determinable spores. Detailed location of the samples is shown in Figs 2B, 3, and 4. The palynological slides are housed at the Institute of Geological Sciences of the Polish Academy of Sciences in Warsaw.

The dominant palynological matter found in the samples is unstructured. Determinable spores constitute a minor admixture. Their state of preservation varies from very good to very poor. The dimensions of miospores are mainly in the range between 25 μm and 37 μm, only occasionally reaching 40–50 mm. Representation of many forms is poor, hence several taxa have been determined to generic level only.

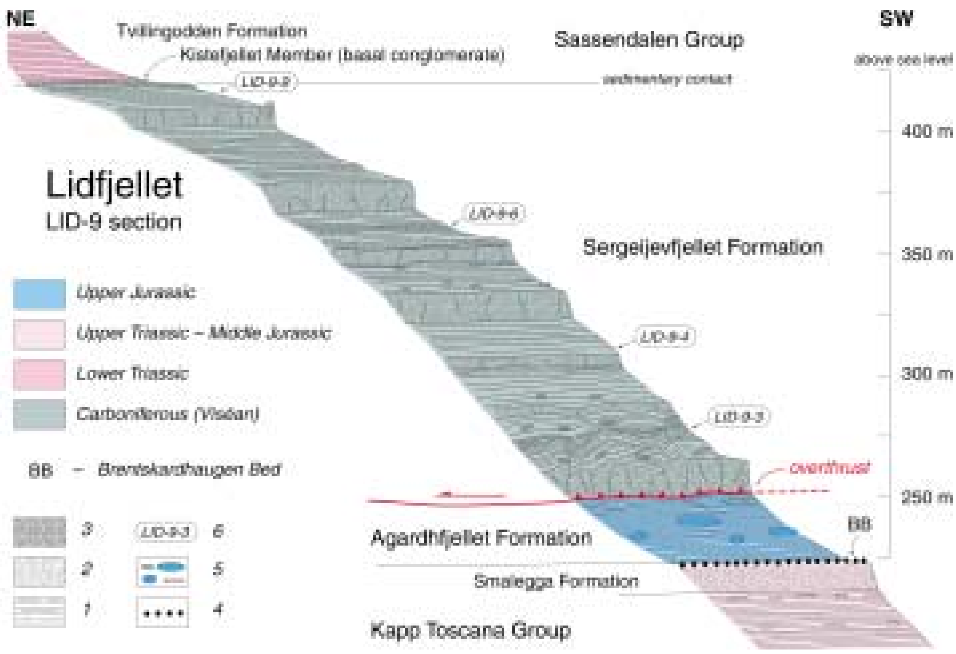

Fig. 4. Geological section of the overthrust Sergeijevfjellet Formation along the western slope of Lidfjellet (LID-9 section). 1 – shale dominated intervals; 2 – sandstone dominated intervals; 3 – conglomeratic intervals; 4 – phosphorite conglomerate; 5 – diagenetic carbonate concretions and bands; 6 – location of palynologicalal samples.

Palynostratigraphy. — Distribution of the miospore taxa in the samples studied is shown in Table 1, and selected, relatively well represented taxa are illustrated in Fig. 5. The stratigraphically useful taxa are as follows:

Sample LID-9-3	*Lycospora pusilla*
Sample LID-9-4	*Cingulizonates bialatus*, *Lophotriletes tribulosus, Lycospora pusilla* and *Waltzispora planiangulata*
Sample LID-9-6	*Lycospora pusilla* and *Triquitrites piramidalis*
Sample LID-9-9	*Lophotriletes tribulosus, Lycospora pusilla* and *Waltzispora planiangulata*

Other characteristic components of the assemblage are: *Auroraspora macra, Calamospora breviradiata, Convolutispora* cf. *crassa, Densosporites* cf. *brevispinosus, Dictyotriletes* cf. *castanaeformis, Microreticulatisporites densus, Microreticulatisporites* cf. *nobilis, Schulzospora* cf. *ocellata* and *Tricidarisporites* cf. *dumosus.*

The stratigraphical distribution of the useful species is as follows:

Table 1

Distribution of miospore taxa in the overthrust Sergeijevfjellet Formation at Lidfjellet.

Miospore taxa	Lidfjellet, LID-9 section			
	LID-9-3	LID-9-4	LID-9-6	LID-9-9
Lycospora pusilla (Ibrahim) Somers 1972	×	×	×	×
Dictyotriletes cf. *castanaeformis* (Horst) Sullivan 1964	×		×	
Grandispora sp.	×			
Auroraspora macra Sullivan 1968		×		×
Calamospora breviradiata Kosanke 1950		×		
Cingulizonates bialatus (Waltz) Smith *et* Butterworth 1967		×		
Lophotriletes tribulosus Sullivan 1964		×		×
Waltzispora planiangulata Sullivan 1964		×		×
Densosporites cf. *brevispinosus* Hoffmeister, Staplin *et* Malloy 1955		×		
Tricidarisporites cf. *dumosus* (Staplin) Smith *et* Butterworth 1967		×		
Cirratriradites sp.		×		
Crassispora sp.		×	×	
Murospora sp.		×		
Triquitrites sp.		×		
Triquitrites piramidalis (Kedo *et* Jushko) Stempień and Turnau 1988			×	
Convolutispora cf. *crassa* Playford 1962			×	
Microreticulatisporites cf. *nobilis* (Wicher) Knox 1955			×	
Corbulispora sp.			×	
Pilosisporites sp.			×	
Microreticulatisporites densus (Love) Sullivan 1964				×
Schulzospora cf. *ocellata* (Horst) Potonié *et* Kremp, 1956				×
Endosporites sp.				×

Cingulizonates bialatus (Waltz) Smith and Butterworth 1967
Fig. 5I

Occurrence: Viséan, Russia, (Ishchenko 1956); Upper Viséan possibly to Namurian A, Spitsbergen (Playford 1963); Viséan and Namurian, Great Britain (Smith and Butterworth 1967); Viséan, *Tripartites vetustus–Rotaspora fracta* (VF) Biozone, Western Europe (Clayton *et al.* 1977); Upper Viséan and Lower Namurian, *Perotrilites tessellatus–Schulzospora campyloptera* (TC) – *Stenozonotriletes triangulus–Rotaspora knoxi* (TK) Biozones, Ireland (Higgs 1984); Upper Viséan, Brigantian, *Tripartites vetustus–Rotaspora fracta* (VF) Biozone, Poland (Stempień and Turnau 1988); Viséan, Arctic Canada (Utting *et al.* 1989).

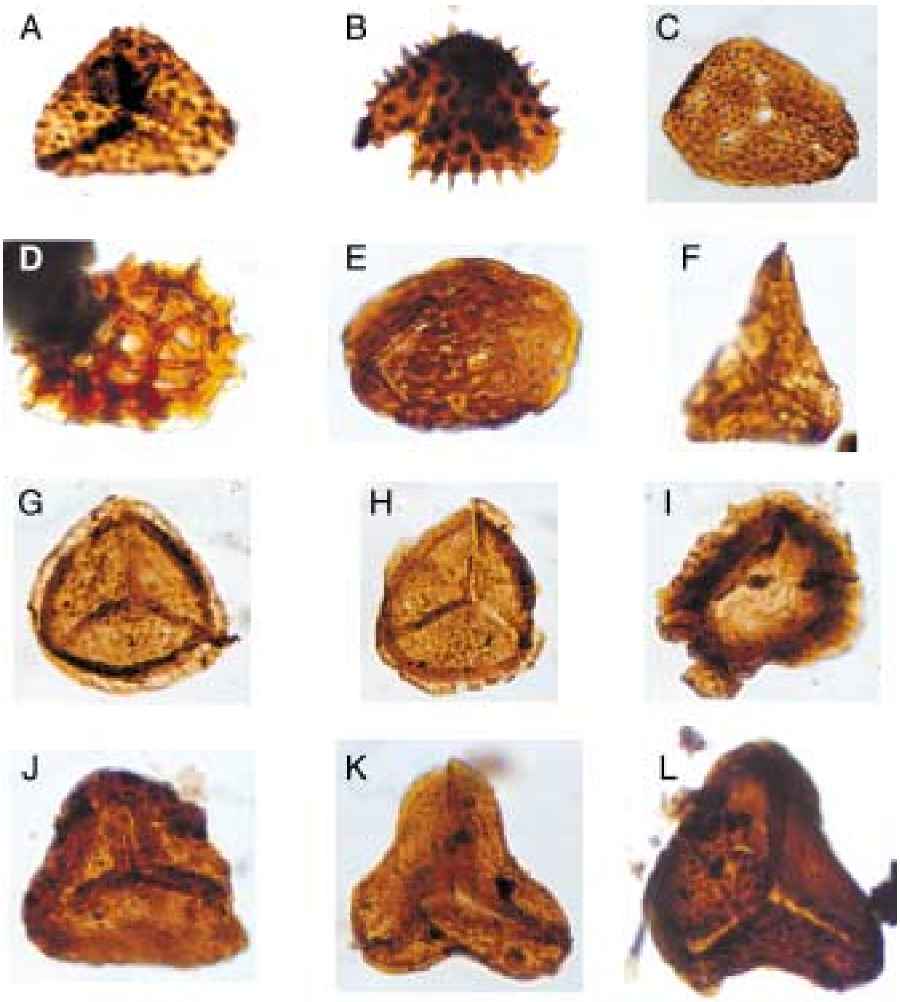

Fig. 5. Selected miospore taxa from the overthrust Sergeijevfjellet Formation at Lidfjellet (LID-9 section). **A**. *Lophosporites tribulosus* Sullivan 1964, LID-9-4. **B**. *Tricidarisporites* cf. *dumosus* (Staplin) Smith and Butterworth 1967, LID-9-4. **C**. *Microreticulatisporites* cf. *nobilis* (Wicher) Knox 1955, LID-9-6. **D**. *Dictyotriletes* cf. *castanaeformis* (Horst) Sullivan 1964, LID-9-6. **E**. *Convolutispora* cf. *crassa* Playford, 1962, LID-9-6. **F**. *Triquitrites piramidalis* (Kedo and Jushko) Stempień and Turnau 1988, LID-9-6. **G**, **H**. *Lycospora pusilla* (Ibrahim) Somers 1972, LID-9-6. **I**. *Cingulizonates bialatus* (Waltz) Smith and Butterworth 1967, LID-9-4. **J**. *Murospora* sp., LID-9-4. **K**, **L**. *Waltzispora planiangulata* Sullivan 1964, LID-9-4. A–L magnification × 700.

Lophotriletes tribulosus Sullivan 1964
Fig. 5A

Occurrence: Upper Viséan, Scotland (Sullivan 1964); Upper Viséan, Poland (Turnau 1979); Upper Viséan and Lower Namurian, *Raistrickia nigra–Triquitrites marginatus* (NM) – *Stenozonotriletes triangulus–Rotaspora knoxi* (TK) Biozones, Ireland (Higgs 1984); Upper Viséan, Brigantian, *Tripartites vetustus–Rotaspora fracta* (VF) Biozone, Poland (Stempień and Turnau, 1988).

Lycospora pusilla (Ibrahim) Somers 1972
Fig. 5G, H

Occurrence: The species is common in Western Europe from Viséan to Westphalian.

Triquitrites piramidalis (Kedo *et* Jushko) Stempień and Turnau 1988
Fig. 5F

Occurrence: Lower Carboniferous, Russia (Kedo 1966); Upper Viséan, Brigantian, *Tripartites vetustus–Rotaspora fracta* (VF) Biozone, Poland (Stempień and Turnau, 1988); Viséan, Romania (Beju 1967).

Waltzispora planiangulata Sullivan 1964
Fig. 5K, L

Occurrence: Upper Viséan, Scotland (Sullivan 1964); first appearance in Upper Viséan, in *Perotrilites tessellatus–Schulzospora campyloptera* (TC) Biozone, characteristic species of *Perotrilites tessellatus–Schulzospora campyloptera* (TC) and *Tripartites vetustus–Rotaspora fracta* (VF) Biozones, Western Europe (Clayton *et al.* 1977); Upper Viséan, *Perotrilites tessellatus–Schulzospora campyloptera* (TC) and *Tripartites vetustus–Rotaspora fracta* (VF) Biozones, Ireland (Higgs 1984); Upper Viséan, Brigantian *Tripartites vetustus –Rotaspora fracta* (VF) Biozone, Poland (Stempień and Turnau 1988); Lower Namurian (N_1–N_7), Upper Silesia Coal Basin, Poland (Jachowicz 1972); Upper Viséan, *Raistrickia nigra–Triquitrites marginatus* (NM) – *Tripartites vetustus–Rotaspora fracta* (VF) biozones, Arctic Canada (Utting *et al.* 1989).

Previous palynological study of the autochthonous Sergeijevfjellet Formation in Sørkapp Land is that by Siedlecki and Turnau (1964). It concerns a section located on the NW slope of Sergeijevfjellet. On the basis of poorly preserved miospore assemblage, these authors suggested that the formation is probably of Namurian age. This age determination seems now invalid, and the Viséan age is accepted in recent stratigraphic compilations (Harland 1997, Dallmann 1999).

The palynological data that can be used for age determination of the overthrust Sergeijevfjellet Formation at Lidfjellet are limited. *Lycospora pusilla* appears at the base of the Viséan, in the *Lycospora pusilla* (Pu) Biozone of the western European miospore division for the Carboniferous (Clayton *et al*. 1977), and disappears in the Stephanian. *Waltzispora planiangulata* appears in the Upper Viséan, in the lower part of the *Perotrilites tessellatus–Schulzospora campyloptera* (TC) Biozone, and is considered to be characteristic species of assemblages representing the *Perotrilites tessellatus–Schulzospora campyloptera* (TC), *Raistrickia nigra–Triquitrites marginatus* (NM) and *Tripartites vetustus–Rotaspora fracta* (VF) biozones. In the miospore assemblage studied, no taxa that are considered diagnostic of the uppermost Viséan and lowermost Namurian, such as *Tripartites vetustus* Schemel, *Rotaspora fracta* Schemel and *R. knoxi* Butterworth et Williams (Clayton *et al*. 1977), have been encountered.

This indicates that the studied assemblage is not older than the Viséan, and a part of the sequence from LID-9-4 upwards is probably of late Viséan (V_3) age.

Conclusions

The Lidfjellet thrust is the most prominent tectonic structure in the Lidfjellet-Øyrlandsodden fold zone that stretches along the western coast of Sørkapp Land in Spitsbergen. The structure consists of the autochthonous and overthrust units. Geological and palynological investigation of a part of sedimentary sequence attributed so far to the autochthonous Lower Cretaceous Helvetiafjellet Formation (see Dallmann *et al.* 1993) indicates that in fact it represents the Carboniferous (Viséan) Sergeijevfjellet Formation forming base of the overthrust unit. The youngest deposits involved in tectonic structures of the Lidfjellet-Øyrlandsodden fold zone are of Upper Jurassic age.

Aknowledgements. — The geological fieldwork in Sørkapp Land (summer 2001) was supported by a research project No. 6PO4D04120 of the State Commitee for Scientific Research. Tomasz Nowicki MSc is thanked for assistance during the fieldwork, and Andrzej Prejbisz MSc for preparation of palynological samples. The paper benefited from reviews by Professor Elżbieta Turnau and Professor Krzysztof Birkenmajer.

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Received November 5, 2002
Accepted February 27, 2003