NORSK POLARINSTITUTT
MEDDELELSER NR. 100

B. FLOOD, J. NAGY, T. S. WINSNES

The Triassic succession of Barentsøya, Edgeøya, and Hopen (Svalbard)

NORSK POLARINSTITUTT
OSLO 1971

DET KONGELIGE DEPARTEMENT FOR INDUSTRI OG HÅNDVERK

NORSK POLARINSTITUTT

Middelthuns gate 29, Oslo 3, *Norway*

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Manuscript received August 1970

Printed February 1971

Contents

Abstract

This paper is a preliminary account of the Triassic stratigraphy of Barentsøya, Edgeøya, and Hopen, based on observations and collections resulting from Norsk Polarinstitutt's field work in eastern Svalbard in 1969.

The Triassic of Barentsøya and Edgeøya is a shale-siltstone-sandstone sequence; its stratigraphy corresponds mainly to the Triassic of Spitsbergen but is generally more simple. In this paper the Triassic of Barentøya and Edgeøya is divided into four formations, the distribution of which is shown on a geological map. A short lithological description of the formations is given, illustrated by columnar sections. The depositional environment of the continental De Geerdalen Formation (Upper Triassic and possibly Lower Liassic) is discussed in more detail.

Based on a preliminary determination of fossils, the age relationships are briefly discussed. On the basis of lithological and faunal evidence the rock sequence of Hopen (previously regarded as Cretaceous) is correlated with the De Geerdalen Formation.

Introduction

Edgeøya and Barentsøya form the south-eastern part of Svalbard and cover an area of 6 400 km^2, i.e. about 10% of the total area of the archipelago. Although the first geologist who visited Svalbard (the Norwegian B. M. KEILHAU in 1827) landed in Edgeøya, both these islands were mainly bypassed by the later and usually much more extensive geological expeditions to Svalbard.

The occurrence of Triassic sediments in Edgeøya was first suggested by LINDSTRÖM (1865) on the basis of samples collected by NORDENSKIÖLD from Kvalpynten. This age was later confirmed by WITTENBURG (1910) who described the material collected by the Swedish-Russian "Arc of meridian expeditions" in 1899–1902. The results of the British expeditions to Storfjorden in 1919 and 1920 were published by TYRRELL (1933), who described four sections from the west coast of Barentsøya and from Kapp Lee in Edgeøya. A short description of the western part of Edgeøya was given by FALCON (1928), who acted as geologist to the Cambridge expedition to Edgeøya in 1927. Based on the observations published in these papers, Barentsøya and Edgeøya were marked as Triassic on the geological maps published by NATHORST (1910) and ORVIN (1940). The latter map also shows the distribution of the dolerite intrusions, and the occurrence of Jurassic rocks in four small patches in the southern part of Edgeøya.

In the early 1960's a wide interest was shown for the eastern part of Svalbard by Russian and American oil-companies, and several claims were staked both in Barentsøya and Edgeøya. As a result of the Russian field work some sections were published from the Triassic of Edgeøya (KLUBOV 1965a), and Permian rocks were described from the north-eastern part of Barentsøya (KLUBOV 1965b).

In the summer 1969 Norsk Polarinstitutt sent an expedition to the eastern part of Svalbard. With logistic support from a strong sealer and helicopters, the present authors visited c. 100 localities where about 50 stratigraphic sections were measured with Paulin altimeters, and numerous rock samples and fossils were collected. The geological map shown in Pl. 4 is compiled from these field data and supplementary photogeological observations obtained from oblique aerial photographs.

The present paper is a modified version of a lecture delivered in January 1970 at The IX Nordic Geological Winter Meeting in Lyngby, Denmark.

The authors wish to thank Mr. M. GALÅEN for final drafting of the illustrations; cand. mag. P. HAGEVOLD for translation of the English abstract into Russian; P. KLOUMANN, B. Sc., for microscoping the majority of the thin sections; and Dr. D. WORSLEY for correcting the English of the manuscript. The editorial work has been carried out by Mrs. E. HOLMSEN.

Stratigraphic subdivision

The oldest stratigraphic unit observed in the investigated area is the Permian Kapp Starostin Formation which is exposed in a small field in the north-eastern part of Barentsøya (see Pl. 4). Apart from this field only Triassic rocks were observed by us, although Permian inliers have been reported from Edgeøya by KING (1964). The Triassic succession is divided into four formations (in ascending order): Vardebukta, Kongressfjellet, Tschermakfjellet, and De Geerdalen. The lithology of the formations is shown by columnar sections on Pl. 5.

As mentioned above, the geological map of ORVIN (1940) shows occurrence of Jurassic strata on Kvalpynten and Negerpynten. We visited the highest parts of these two peninsulas, but did not succeed in finding rocks other than siltstones and sandstones of the De Geerdalen Formation. It must be borne in mind, however, that by Jurassic rocks we mean dark shales of marine facies correlative with the Agardhfjellet Formation in Spitsbergen. A Jurassic age for the upper part of the De Geerdalen Formation is still an open question both in Spitsbergen, Barentsøya, and Edgeøya.

A lithostratigraphic scheme for the Triassic succession of Spitsbergen was introduced in a paper by BUCHAN *et al.* (1965), and BUCHAN suggested that this scheme might also be valid for Edgeøya. Our investigations support this view, but also show the necessity of certain modifications within the scheme when it is used in Barentsøya and Edgeøya. As shown in Fig. 1, the modifications proposed in the present paper consist in that six lithostratigraphic units are changed in rank. These changes are discussed in the following:

1) The shale-siltstone sequence superjacent to the Vardebukta Formation is recognized as the Kongressfjellet Subgroup in Spitsbergen where it is subdivided into two formations: The Sticky Keep Formation (below) consists of harder shales and siltstones, while the Botneheia Formation (above) consists mainly of soft black shales. In Barentsøya and Edgeøya the siltstone beds are not always distinct in the lower part of the unit, neither are they solely confined to this part; consequently the whole unit seems more uniform than in Spitsbergen. We therefore regard the Kongressfjellet Subgroup as only a single formation in the Barentsøya—Edgeøya region and call it the Kongressfjellet Formation.

2) Because of this change, the Sticky Keep and the Botneheia Formations must be given a lower rank than formation in the Barentsøya—Edgeøya region. For the present they are classed as two members of our Kongressfjellet Formation, although it is questionable whether or not this can be justified. The lithological difference between these two units is not very conspicuous, and it is often difficult to recognize a definite boundary between them.

3) The upper part of the Triassic succession in Spitsbergen was de-

<table>
<tr><td colspan="4">SPITSBERGEN
(BUCHAN et al. 1965)</td><td colspan="3">BARENTSØYA and
EDGEØYA (This paper)</td></tr>
<tr><td colspan="3" rowspan="2">Kapp Toscana Formation</td><td>De Geerdalen Member</td><td rowspan="2">Kapp Toscana Group</td><td colspan="2">De Geerdalen Formation</td></tr>
<tr><td>Tschermakfj. Member</td><td colspan="2">Tschermakfjellet Formation</td></tr>
<tr><td rowspan="5">Sassendalen Group</td><td rowspan="3">Kongressfjellet Subgroup</td><td colspan="2">Botneheia Formation</td><td rowspan="5">Sassendalen Group</td><td rowspan="3">Kongressfjellet Formation</td><td>Botneheia Member</td></tr>
<tr><td rowspan="2">Sticky Keep Formation</td><td>Kaosfjellet Member</td><td rowspan="2">Sticky Keep Member</td></tr>
<tr><td>Iskletten Member</td></tr>
<tr><td colspan="2" rowspan="2">Vardebukta Formation</td><td>Siksaken Member</td><td colspan="2" rowspan="2">Vardebukta Formation</td></tr>
<tr><td>Selmaneset Member</td></tr>
</table>

Fig. 1. *Stratigraphical table showing names of Triassic rock units established for Spitsbergen and proposed for Barentsøya and Edgeøya.*

scribed by BUCHAN *et al.* (1965) as the Kapp Toscana Formation, subdivided into two members: The Tschermakfjellet Member (below) with shales and siltstones deposited under marine conditions, and the De Geerdalen Member (above) with siltstones and sandstones mainly of continental origin. In Barentsøya and Edgeøya these two members are classed as formations, a change in rank which is justified by the great thickness, facies difference, and ease of recognition of these units. As a consequence of the change described above, the Kapp Toscana Formation of BUCHAN *et al.* is classed as a group in Barentsøya and Edgeøya.

Description of the formations

1. THE VARDEBUKTA FORMATION

This formation is only exposed in Barentsøya, where it has been observed south of Kapp Ziehen (in the north-east), and in Freemansundet (in the south-west). South of Kapp Ziehen the unit rests on highly fossiliferous Permian strata belonging to the Kapp Starostin Formation and the contact is probably disconformable. The Vardebukta Formation is here represented mainly by light, poorly consolidated, silty claystones, weathering yellow-brown. About 40 m above its base there appear more massive fossiliferous sandstones; the upper 20 m of the formation consist chiefly of sandy siltsones. The observed thickness is c. 60 m.

2. THE KONGRESSFJELLET FORMATION

The lower part of this formation, the Sticky Keep Member, consists of dark grey shales and silty shales interbedded with characteristic, 20–40 cm thick, yellow-brown weathering silty marls and subordinate limestones. A varying content of large (c. 1 m across) lime concretions are frequently observed. They usually show a marked concentration along certain stratigraphic horizons.

The upper part of the formation, the Botneheia Member, consists mainly of papery black shales, often carbonaceous and with numerous phosphorite nodules (average diameter 2–3 cm). This shale is typically cliff-forming and is the most characteristic horizon to be traced both in the field and on aerial photographs (Pl. 1, fig. 1). In this region usually two levels of large calcarous concretions (diameter up to 2 m) are found in the upper part of the member. These concretions yield a characteristic smell of petroleum when hit with a hammer. The base of the Botneheia Member is placed arbitrarily at the top of the highest, laterally traceable marl bed of the Sticky Keep Member. The top of the Botneheia Member is a well-marked stratigraphic horizon which consists of one to four grey-brown beds of calcareous siltstone (c. 50 cm thick) containing numerous light weathering marl concretions (diameter 2–4 cm). The total thickness of the Kongressfjellet Formation is 162 m.

3. THE TSCHERMAKFJELLET FORMATION

According to Russian observations there was a considerable erosion of the Botneheia Member before the deposition of the Tschermakfjellet

Formation. This assumption is based on observations in the northern part of Edgeøya where paleontological evidence indicates increasing erosion from west to east (KLUBOV 1965a).

The lower part of the Tschermakfjellet Formation consists of grey shales, with frequent concretions and thin intercalations of distinctive red clay-ironstone containing a relatively rich bivalve fauna. Upwards the shales turn more grey-greenish and become more silty. In the upper part of the formation sandy intercalations are quite common while clay-ironstone is rare. The thickness of the formation varies from 64 to 143 m.

4. THE DE GEERDALEN FORMATION

The lower boundary of this formation is defined as the base of the first resistant bed of sandstone. The formation is generally of continental origin and is characterized by grey to grey-green, mainly calcareous sandstones which weather yellow-brown or red-brown. The thickness of the sandstone beds vary from a few dm to more than 20 m. Lateral changes in thickness of the individual beds are also quite distinct. Interbedded with the sandstones are black and grey shales, and yellow-brown or red-brown often calcareous siltstones. The shales and siltstones usually dominate quantitatively. Cyclic sedimentation is common with the following succession in ascending order: 1) sandstone, 2) thin black shale, 3) grey shale, 4) siltstone, 1) new sandstone. Above the sandstone beds, within the black shale, thin seams (c. 20 cm) of coal or highly carbonaceous shale are often found. The individual cycles are around 4 to 10 m thick.

Short periods of marine sedimentation are recognizable especially in the upper part of the formation. These periods are represented by thin (50–200 cm) yellow-brown marls with numerous bivalves, as well as by dark shales with red clay-ironstone concretions containing some bivalves. Echinoderms have also been found in a sandstone bed at one locality.

Ripplemarks, cross-bedding, and cone-in-cone structure occur frequently within the formation. Strikes of ripplemarks have been measured at 12 localities where the following directions were observed:

6	localities:	NE–SW
3	»	E–W
3	»	NNW–SSE

As can be seen from Pl. 4, this formation caps the mountains in the whole map area and is the best exposed unit in this region. Its observed thickness reaches 370 m, but an upper boundary has not been recorded.

Composition and texture of the sandstones: Study of 34 thin sections of the sandstones in the De Geerdalen Formation has yielded more detailed sedimentological information. The samples used were selected from the whole map area and represent different levels within the formation. The material investigated does not indicate any marked regional variation either in composition or texture. The composition of the sandstones is tabulated below.

Detrital grains:			
	Rock fragments:	Average 27%	Range 6–50%
	Quartz:	» 24 »	» 5–55 »
	Plagioclase:	» <5 »	
	Mica and chlorite:	» <2 »	
	Microcline:	Present (not counted)	
	Orthoclase:	Present (not counted)	
	Calcite:	Present (not counted)	
	Organodetrital material:		» 0–40 »
	Accessories: Opaques, tourmaline, apatite, zircon, garnet, and probably sillimanite.		
Detrital grains total:		Average 56%	Range 15–90%
Matrix total:		» 44 »	» 10–85 »

In most thin sections the matrix is dominated by calcite, but in a few cases quartz, sericite, and probable siderite occur. The two former are prominent when the compaction is good, i.e. when the amount of matrix is subordinate. The calcite matrix often appears as large patches or subparallel zones of simultaneous extinction within the thin sections. One of the sections displays an oolitic texture with carbonate rim on quartz, feldspars, calcite, rock fragments, and organodetrital fragments.

The size of the detrital grains is mainly of the same order within the same thin section, and varies from 40 μ to 300 μ, with c. 150 μ as most usual.

A minority of the rock fragments consists of fine-grained quartzites, but grains of a submicroscopic, probably siliceous aggregate are most common. The latter carry opaque dust and sericite or chlorite in varying amounts, and strongly resemble the groundmass found both in the Kapp Hansteen Formation volcanics and the quartz-porphyry from the Lower Hecla Hoek succession in Nordaustlandet (FLOOD *et al.* 1969). Probably as a result of their fine-grained texture, these grains show a much higher grade of sphericity and roundness than the other detrital grains.

Quartz usually occurs as subangular, often elongated grains. Variation in roundness is however most distinct in this mineral, and both angular and rounded grains may be found within the same thin section. Subhedral (and in extreme cases euhedral) quartz grains are noticeable. There is no doubt that in some cases these textures are a result of authigenic growth (Pl. 2, fig. 1); mainly, however, there is no sign of any nucleus (Pl. 2, fig. 2), and the crystal outline of the quartz grains might be regarded as a primary feature. These subhedral (and euhedral) grains are non-undulatory and are reminiscent of the metamorphic regions in Nordaustlandet where non-undulatory quartz phenocrysts are frequent in the quartz-porphyries mentioned above. In general, however, the quartz shows all variations from non to strong undulatory extinction, indicating different sources of material. To obtain an idea of the relative amounts of undulatory grains and those with straight extinction, the quartz grains from 8 thin sections (selected at random from tbe whole region) were counted:

Undulatory extinction (noticeable to strong):	Average 66%	Range 45–75%
Straight extinction:	» 34 »	» 25–55 »

One of these thin sections is from Hopen and showed a deviation of only 1% from the average.

Feldspars occur in varying amounts, but plagioclase almost always dominates over microcline and probable orthoclase. Apparently the plagioclase is mainly of acid composition with a refractive index close to that of canada balsam. The shape of the plagioclases are generally determined hy their cleavage-planes and the rounding is poorer than that observed in the potassium feldspars. The plagioclase appears both unaltered and strongly sericitized, and quartz myrmekites were observed in a couple of grains.

Micas (both biotite and muscovite) occur in laths, often bent and with a wavy extinction. The chlorite (grass-green pleochroic) usually bas a more flaky shape.

It is difficult to distinguish clastic grains of calcite from the carbonate groundmass, but proof of their presence is shown by the oolitic sample where calcite grains display the pre-diagenetic dark carbonate rim.

The organodetrital material consists both of plant remains and fragments of bivalves (Pl. 3, figs. 1 and 2). Small fragments of echinoderm ossicles probably occur in one thin section. Plant fragments are the most common element and appear as opaque or semiopaque spots, often 'impregnated' by carbonate.

A few thin sections studied from the Kapp Toscana Formation north of Hornsund, Spitsbergen, differ from those described above mainly by a much higher quartz content; the grains are mostly larger, are partly recrystallized, and show sutured boundaries; tbe amount of groundmass varies from 10 to 30% and is mainly siliceous.

The age of the sequence

BARENTSØYA AND EDGEØYA

The age relationships within the Triassic succession of Barentsøya and Edgeøya are elucidated by correlation with the standard scheme for the Triassic introduced by TOZER (1967). Our correlations (Fig. 2) are based on a provisional examination of the fossil material; both the identifications of fossils and the correlations must therefore be regarded as pre-

Series	Stages	Sub-stages	Barentsøya and Edgeøya		
			Faunas and flora	Lithostratigraphical units	
UPPER TRIASSIC	RHAETIAN		Pterophyllum sp. Todites sp. Macrotaeniopteris sp. Taeniopteris sp. Podozamites sp.	DE GEERDALEN FORMATION	
UPPER TRIASSIC	NORIAN	UPPER		DE GEERDALEN FORMATION	
UPPER TRIASSIC	NORIAN	MIDDLE		DE GEERDALEN FORMATION	
UPPER TRIASSIC	NORIAN	LOWER	Lingula cf. polaris Pentacrinus (?) sp. Estheria cf. minuta	DE GEERDALEN FORMATION	
UPPER TRIASSIC	KARNIAN	UPPER	?	?	
UPPER TRIASSIC	KARNIAN	LOWER	Halobia zitteli Nathorstites gibbosus–(Ladinan ?)	TSCHERMAK-FJELLET FORMATION	
MIDDLE TRIASSIC	LADINIAN	UPPER	Nathorstites mcconnelli Nathorstites tenuis Nathorstites aff. gibbosus Procladiscites cf. martini	TSCHERMAK-FJELLET FORMATION	
MIDDLE TRIASSIC	LADINIAN	UPPER	Ptychites cf. trochlaeformis	BOTNEHEIA MEMBER	KONGRESSFJELLET FORMATION
MIDDLE TRIASSIC	LADINIAN	LOWER		BOTNEHEIA MEMBER	KONGRESSFJELLET FORMATION
MIDDLE TRIASSIC	ANISIAN	UPPER	Gymnotoceras cf. laqueatum Parapopanoceras verneuili Ptychites trochlaeformis Ptychites sp.	BOTNEHEIA MEMBER	KONGRESSFJELLET FORMATION
MIDDLE TRIASSIC	ANISIAN	MIDDLE		BOTNEHEIA MEMBER	KONGRESSFJELLET FORMATION
MIDDLE TRIASSIC	ANISIAN	LOWER		BOTNEHEIA MEMBER	KONGRESSFJELLET FORMATION
LOWER TRIASSIC	SPATHIAN		Svalbardiceras (?) cf. spitzbergense Posidonia aranea Keyserlingites cf. subrobustus	STICKY KEEP MEMBER	KONGRESSFJELLET FORMATION
LOWER TRIASSIC	SMITHIAN		«Pseudomonotis» occidentalis Arctoprionites nodosus Posidonia mimer	STICKY KEEP MEMBER	KONGRESSFJELLET FORMATION
LOWER TRIASSIC	DIENERIAN			STICKY KEEP MEMBER	KONGRESSFJELLET FORMATION
LOWER TRIASSIC	GRIES-BACHIAN	UPPER	Claraia stachei Ophiceras (?) sp.	VARDEBUKTA FORMATION	
LOWER TRIASSIC	GRIES-BACHIAN	LOWER		VARDEBUKTA FORMATION	

Fig. 2. *Correlation table showing the age of Triassic rock units recognized in Barentsøya and Edgeøya.*

liminary. A correlation of the Triassic succession of Spitsbergen with the standard scheme has already been done by TOZER & PARKER (1968). Our correlation scheme from Barentsøya and Edgeøya agrees generally with the scheme presented by these authors but differs from it on the following main points:

1) The upper boundary of the Vardebukta Formation in Spitsbergen is correlated with the top of Dienerian by TOZER & PARKER (1968). Our investigations in Barentsøya show that this boundary here is older, and must be correlated with the top of the Griesbachian. This correlation is based mainly on the occurrence of *Claraia stachei* BITTNER in the uppermost part of the Vardebukta Formation. In the Arctic islands of Canada *C. stachei* is characteristic of the Upper Griesbachian. In Spitsbergen the Vardebukta Formation has a considerably greater thickness than in Barentsøya. This decrease in thickness towards the east, and the mentioned difference in age indicate that the sandstones in the upper part of the Vardebukta Formation in Spitsbergen gradually become more and more shaly towards the east. If that is so, these shales in Barentsøya form the lower part of the Kongressfjellet Formation.

2) The upper boundary of the Botneheia Formation in Spitsbergen is correlated with the top of the Lower Ladinian. In Barentsøya and Edgeøya this boundary is considered to be younger, and we have placed it in the Upper Ladinian. This opinion is based on the occurrence of *Nathorstites mcconnelli* (WHITEAVES) in the Nathorstites fauna found immediately above the upper boundary of the Botneheia Member. In Canada *N. mcconnelli* is apparently confined to the upper part of the Upper Ladinian (TOZER 1967).

The exact age of the upper boundary of the Tschermakfjellet Formation is difficult to determine as this part of the succession is very poor in fossils of age significance.

HOPEN

This island is situated outside the main routes to Svalbard, and even in the summer time it is often inaccessible owing to ice and fog. The age of the rocks forming the island is therefore a matter of controversy or ignorance even today. Since the geological maps of FREBOLD (1935) and ORVIN (1940) were published, the island has been regarded as consisting of Cretaceous sediments. In the older literature, however,

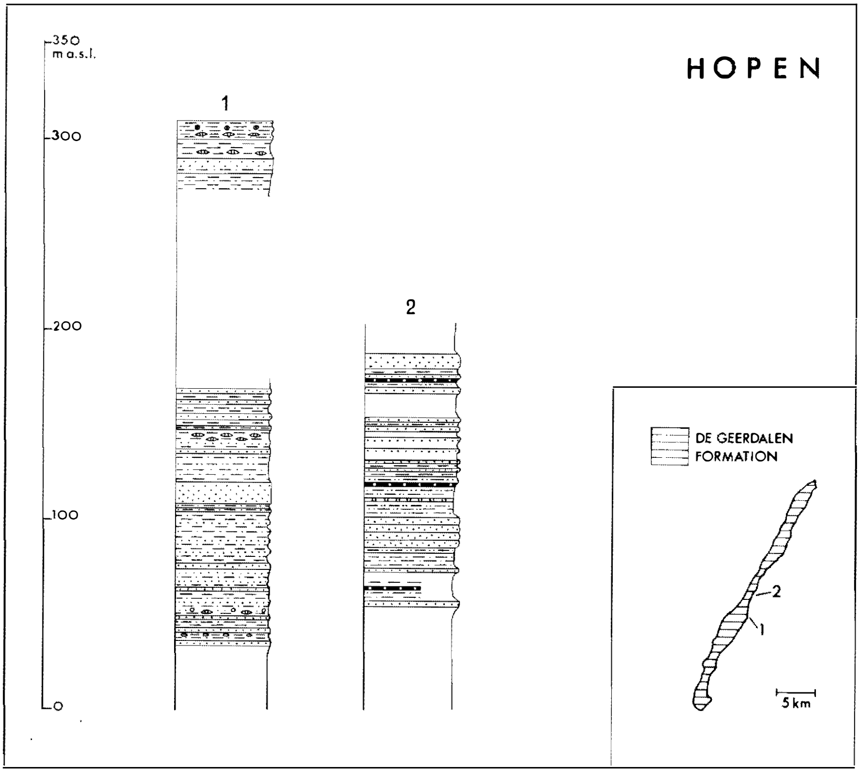

Fig. 3. *Stratigraphical sections from Hopen.*
The sections are located on Johan Hjortfjellet (1) and Småhumpen (2).

NATHORST (1894) published a geological map showing a Triassic age for the rocks of Hopen, while on a later map of NATHORST (1910) the island remained without any colour.

ORVIN (1940) apparently based his map of Hopen on the results from THOR IVERSEN's expedition in 1924 (IVERSEN 1926). In this publication W. WERENSKIOLD pointed out the great similarity between the continental Lower Cretaceous in Spitsbergen and the investigated sediments on Hopen. A few bivalves and gastropods were preliminarily determined, and also these were considered to indicate a Cretaceous age. However, in the same publication O. A. HØEG suggested a Triassic age based on his collection of plant fossils.

The sedimentary succession of Hopen (Fig. 3 and Pl. 1, fig. 2) shows a great similarity to the De Geerdalen Formation of Barentsøya and Edgeøya, both in facies and lithology. This fact led us, while still in the field, to regard the sediments of Hopen as correlative with the De Geerdalen Formation. The fossil material collected from the island supports this assumption as shown below.

According to O. A. HØEG (pers. comm.), *Pterophyllum* is represented among the plant-fossils we brought back. This genus occurs both in the continental sandstones of Hopen and in the De Geerdalen Formation of Edgeøya. Of particular interest are, however, a few bivalves and one ammonite which were found in sediments of a more marine facies in the uppermost part of the sequence exposed on Hopen. The bivalves have been determined as *Halobia zitteli* LINDSTRÖM and "*Gryphaea*" sp., while the ammonite probably belongs to the genus *Arctosirenites*. Both the presence of *H. zitteli* and the possible occurrence of *Arctosirenites* indicate an Upper Triassic age.

Concluding remarks

It is of particular interest to consider our observations with regard to the paleogeography of the Svalbard Triassic and the position of the source areas for these Triassic sediments. We admit the weakness of our material in this respect, as systematic observations on sedimentary structures are lacking. The conclusions reached are based on the variations in thickness in the different sections, on the age relationships, and on the study of thin sections from the De Geerdalen Formation.

The continental Upper Triassic sediments decrease in thickness from 327 m on the west coast of Spitsbergen to 190 m in the central part of that island. In Edgeøya, Barentsøya, and Hopen the thickness has again increased to more than 370 m. This conspicuous increase towards the east indicates a source area to the east or north-east at least for the continental Upper Triassic sediments in the eastern part of Svalbard. This view is supported by the decrease in thickness of the underlying marine Tschermakfjellet Formation from west to east in Barentsøya (Fig. 4), and by the presumed deeper erosion of the Botneheia Formation on the east

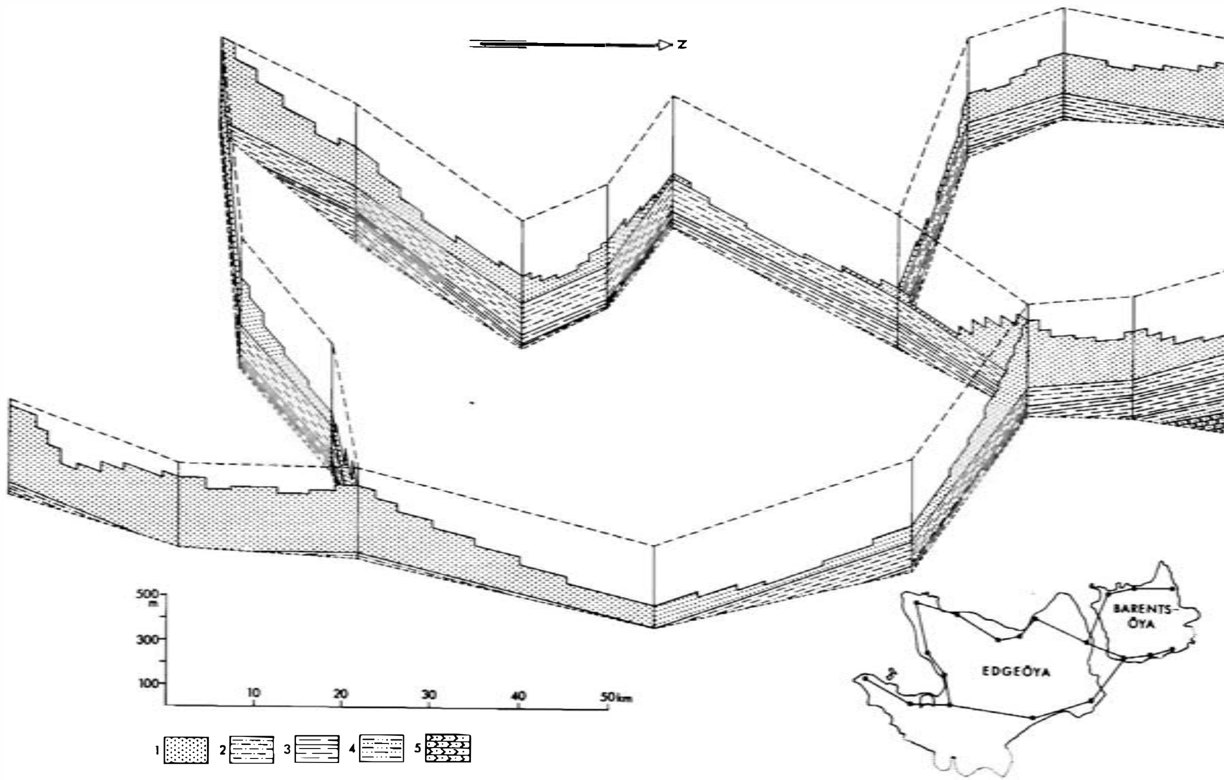

Fig. 4. *Fence diagram showing the lateral variation within the Triassic succession in Edgeøya and Barentsøya. 1 – the De Geerdalen Formation, 2 – the Tschermakfjellet Formation, 3 – the Kongressfjellet Formation, 4 – the Vardebukta Formation, 5 – the Kapp Starostin Formation (Permian).*

side of Edgeøya pointed out by KLUBOV (1965a). However, the large thickness of the continental Upper Triassic on the west coast of Spitsbergen (Grønfjorden, Van Keulenfjorden) probably indicates a western or north-western source area for that region.

Noticeable features of the De Geerdalen sandstones (p. 11) are: the high proportion of mainly calcitic matrix, the rock fragments as the dominant detritus, the dominance of plagioclase over potash feldspars, and the generally poorly rounded detrital grains.

The climatic conditions during the deposition of these continental sediments must have been fairly humid as thin coal seams are found at many different levels within the De Geerdalen Formation. Fossil leaves and wood trunks occur at several localities. The largest measured diameter of the trunks is 43 cm.

The rather low content of feldspars in the De Geerdalen sandstones agrees with the climatic conditions indicated by the coals and plant remains. According to PETTIJOHN (1957), Mesozoic sandstones contain on average 19% feldspar. The relatively small quantities found by us indicate slow erosion in a low relief, especially as the generally poor roundness of the detrital grains suggests transport over only a short distance.

If we regard the proportions of undulose and non undulatory quartz as indicative of the relation between metamorphic, igneous and sedimentary provenances, there is no marked variation from north to south. The average proportion is close to that usual for sandstones (KRYNINE in PETTIJOHN 1957). The special features of the rock fragments (p. 11), the dominance of plagioclase over potash feldspars, and the possibility that some of the quartz grains are detrital phenocrysts rather than euhedras formed by authigenic growth, indicate that a considerable proportion of the material was derived from a volcanic source. Such a source is seen today in the Hecla Hoek succession of the northern and central part of Nordaustlandet.

The assumption of a provenance from the east and north-east (p. 16), and the regional homogeneity of the material investigated, indicate that the metamorphic and igneous rocks now found in northern Svalbard were exposed much farther to the south-east in Upper Triassic time.

The deposition of the De Geerdalen Formation must have taken place mainly on a low coastal plain and/or in deltas. The proximity of the sea is indicated by the occurrence of thin layers carrying marine fossils within the terrestrial succession. These layers mainly contain bivalves, usually in great quantities, but at one locality (Schneiderberget) there were also found well preserved remains of crinoids, ophiuroids, and asteroids.

It is interesting to note that the sandstones of the De Geerdalen Formation in Barentsøya, Edgeøya, and Hopen are less well consolidated than the corresponding sandstones along the western coast of Spitsbergen. In the latter area the sandstones are partly recrystallized and resemble quartzite, while in the eastern part of Svalbard they can be characterized as normal sandstones. If the main reason for the higher grade of diagenesis in Spitsbergen is the fact that the Mesozoic succession here was (and partly is) covered by at least 1 500 m of Tertiary sediments, the low grade of diagenesis in the east may indicate that such a thick Tertiary succession was never deposited on the eastern islands of Svalbard. This theory is supported by the fact that Jurassic and Cretaceous sediments on Kong Karls Land are almost completely unconsolidated. However, the Tertiary folding which was most active along the west coast of Spitsbergen and decreased eastwards may in part have contributed to the higher grade of diagenesis in the westernmost regions of Svalbard.

Аннотация

[Триасовая толща островов Barentsøya (Баренца), Edgeøya (Эдж) и Hopen (Надежды) на архипелаге Свальбард]

Настоящий доклад является предварительным отчетом о триасовой стратиграфии островов Barentsøya (Баренца), Edgeøya (Эдж) и Hopen (Надежды), основанным на материалах, собранных авторами во время полевой работы экспедиции Норвежского Полярного Института (Norsk Polarinstitutt) на восточном Свальбарде в 1969 г.

Триас островов Barentsøya и Edgeøya представлен толщей сланцев, алевролитов и песчаников, стратиграфия которой соответствует, главным образом, триасу Шпицбергена, но чаще она более простая. В этом докладе триас островов Barentsøya и Edgeøya подразделен на четыре формации, распространение которых показано на геологической карте. Дается краткое литологическое описание этих формаций, иллюстрированное колонкой. Более подробно обсуждаются условия осадконакопления континентальной де-ердаленской (De Geerdalen) формации (верхнетриасового, либо нижнелейасового возраста).

На основе предварительного определения ископаемых остатков, кратко обсуждаются возрастные соотношения, а на основе литологических и фаунистических данных, толща пород острова Hopen (раньше рассматривавшаяся как меловая) коррелируется с де-ердаленской формацией.

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Fig. 1. *Aerial view of the region south of Meodden (Freemansundet). The slope in the foreground is formed by the Kongressfjellet Formation (K), with the cliff-forming papery shales of the Botneheia Member (B) uppermost. The latter is overlain by the less resistant shales and siltstones of the Tschermakfjellet Formation (T). The plateaus and the uppermost parts of the slopes are formed by the De Geerdalen Formation (D).*

Photo: B. LUNCKE.

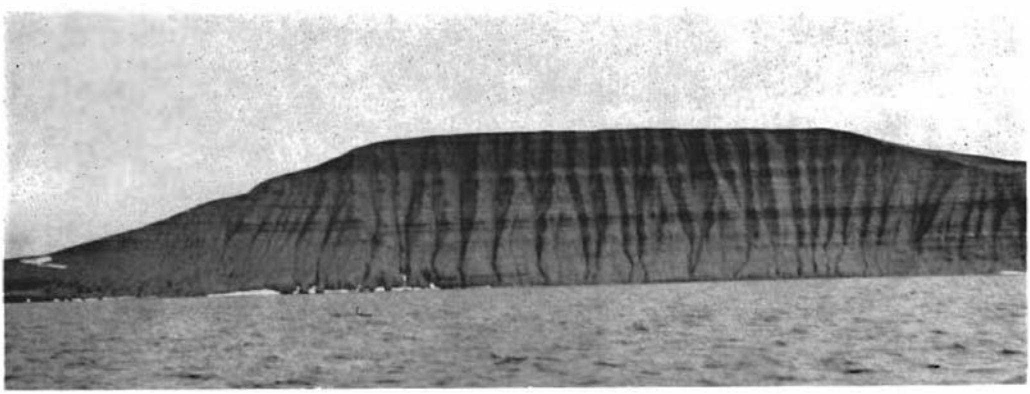

Fig. 2. *Johan Hjortfjellet on Hopen seen from west. The mountain consists of a sandstone-siltstone-shale sequence correlated with the De Geerdalen Formation.*

Photo: T. S. WINSNES.

Micro photographs of sandstones from the
De Geerdalen Formation in Edgeøya

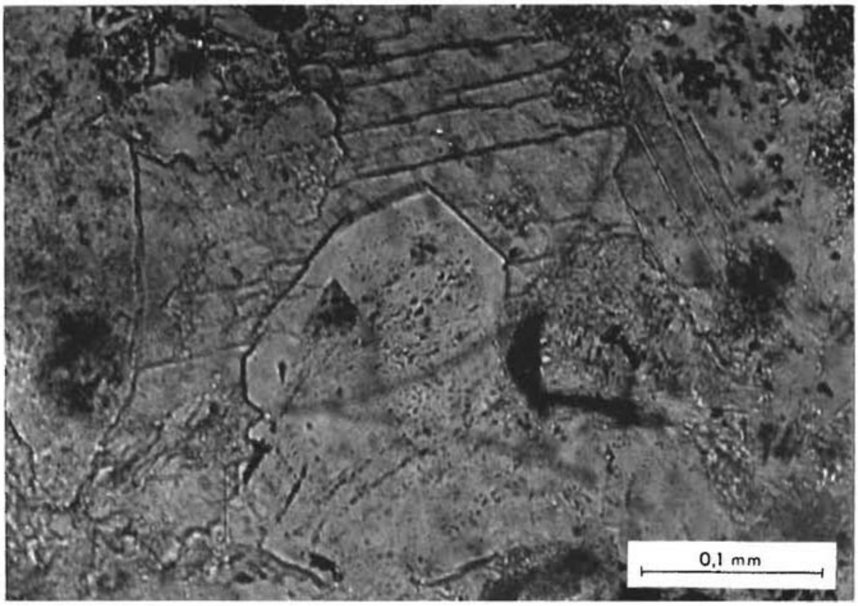

Fig. 1. *Subhedral quartz grain partly formed by authigenic growth towards calcite (69–Ng–22–S6).*

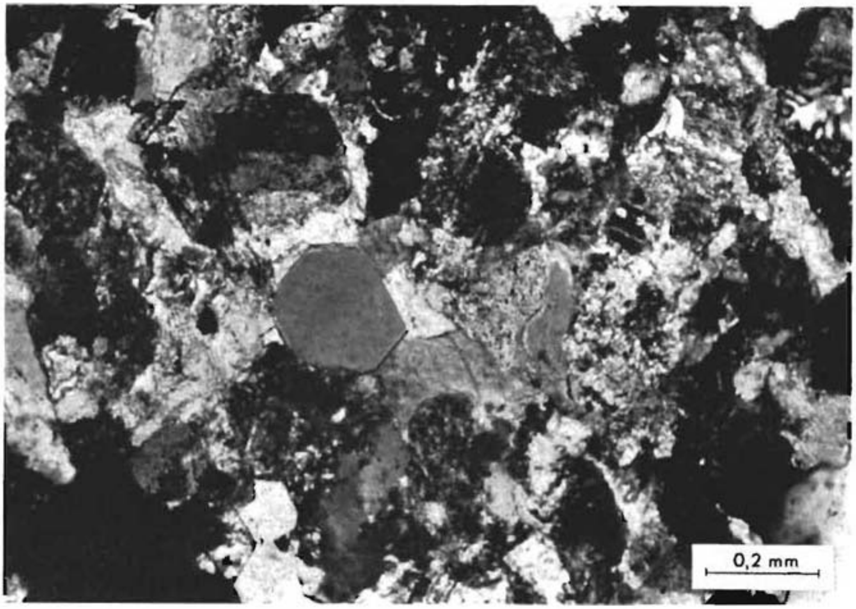

Fig. 2. *Euhedral quartz grain, probably a detrital phenocryst,* $\times N$, *(69–BF–77).*

Micro photographs of sandstones from the De Geerdalen Formation in Edgeøya

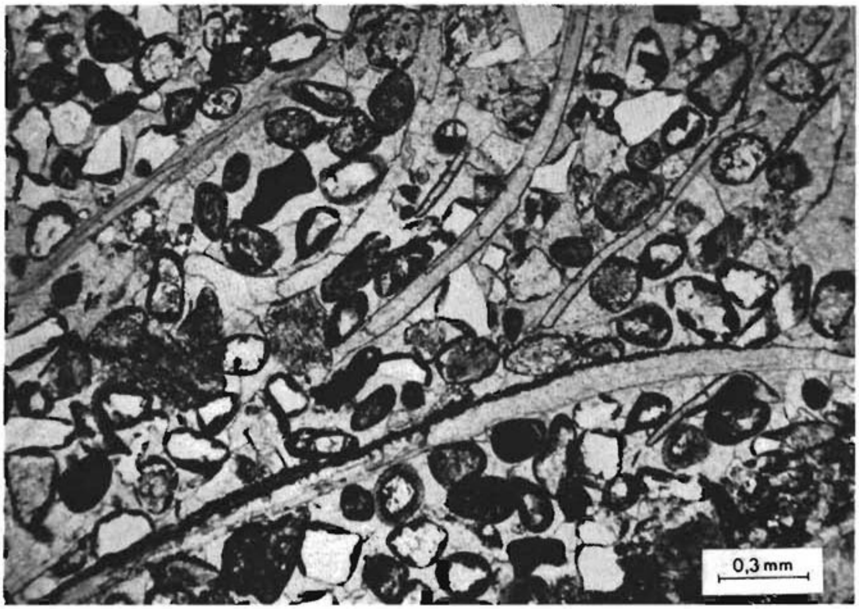

Fig. 1. *Angular to rounded quartz grains and calcitic shell fragments of bivalves. Dark grains are rock fragments (69–BF–125).*

Fig. 2. *Angular and rounded grains of quartz and rounded grains of plagioclase. Dark grains are mainly rock fragments, while rod shaped debris are fragments of bivalve shells,* $\times N$, *(69–BF–125).*

GEOLOGICAL MAP OF EDGEÖYA AND BARENTSÖYA

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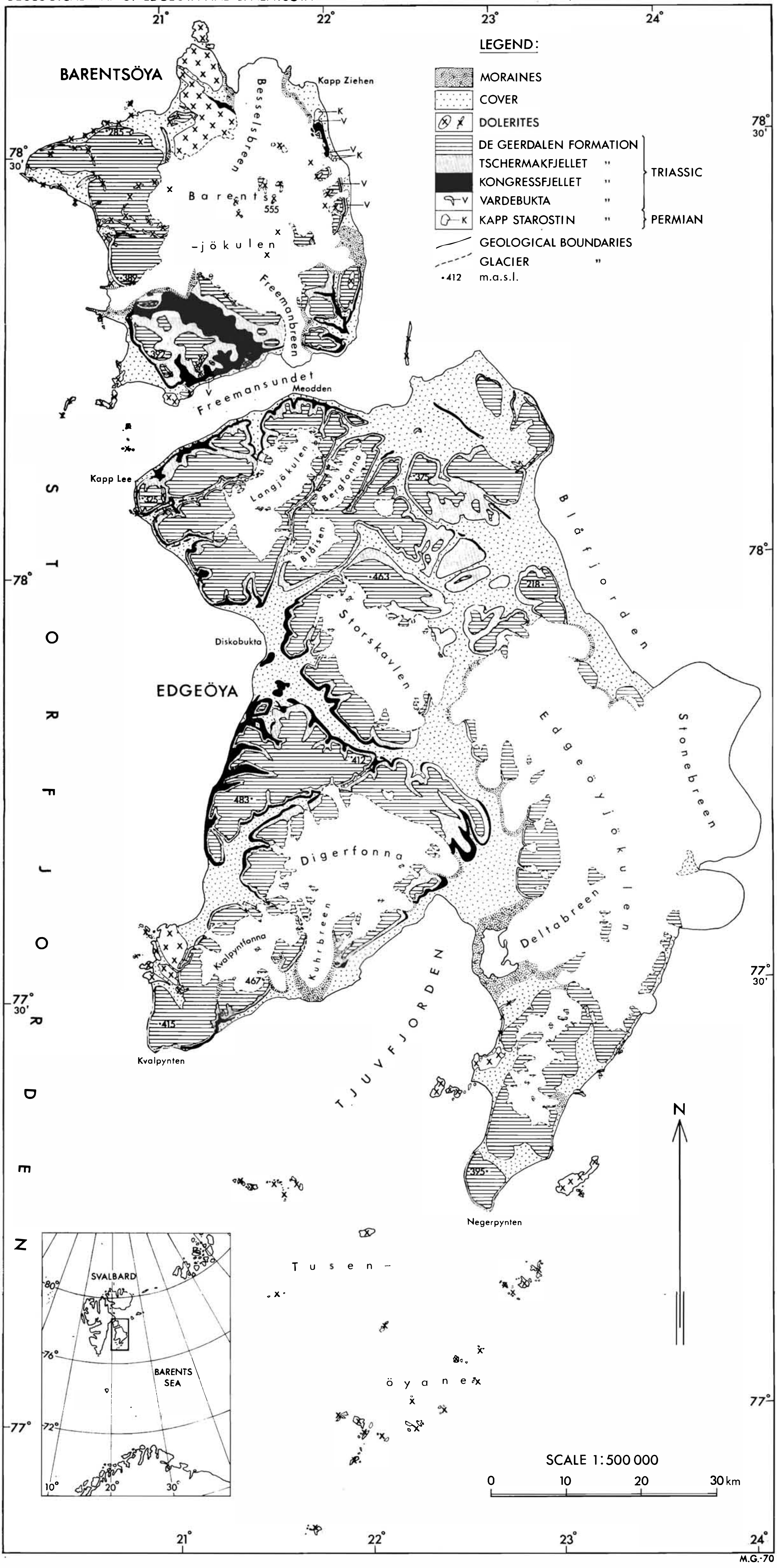

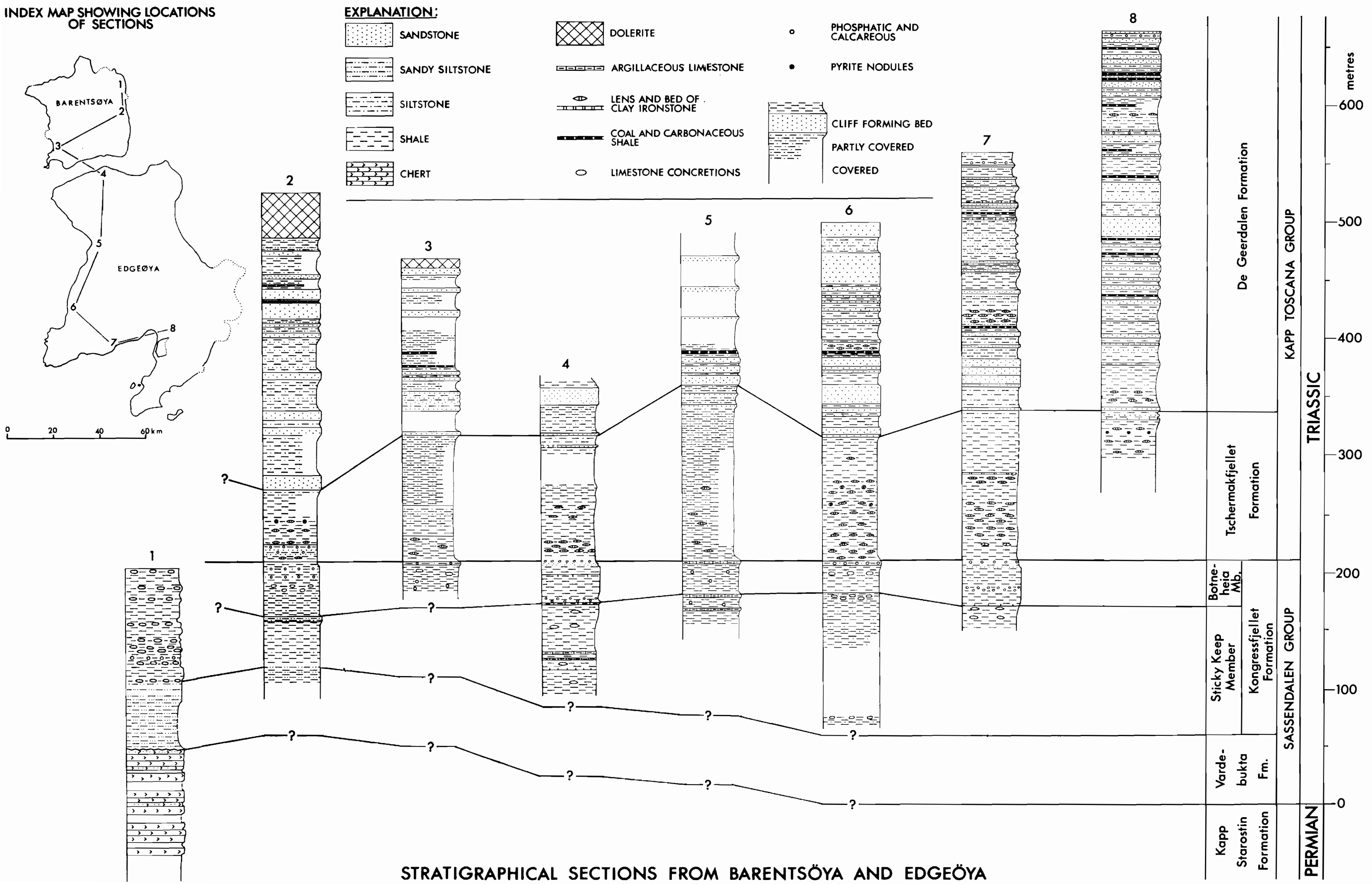

STRATIGRAPHICAL SECTIONS FROM BARENTSÖYA AND EDGEÖYA

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