Some new aspects of the geology of Varanger peninsula (Northern Norway)

Preliminary report
by
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Abstract

The authors have established that Varanger Peninsula consists of two different geological regions divided from each other by a large thrust fault trending in NW-SE direction. The south-western, Tanafjord-Varangerfjord region, consists of rocks of the Vestertana Group (Reading, 1965) and of the "Older Sandstone Series" (Føyn, 1937). The north-eastern, Barents Sea region, consists of thick sedimentary sequences which are quite dissimilar to the sedimentary sequences present in the Tanafjord - Varangerfjord region. New groups and formations are described in the Barents Sea region, in which the rock assemblages are considered to have been deposited in a miogeosyncline.

The age of the sedimentary rocks of the Barents Sea region is uncertain; they presumably represent a time period earlier than Cambrian. The Barents Sea region is tentatively regarded as belonging to the Timanian orogenic belt.

Introduction

Thanks to the inspiration of Rektor S. Føyn, and to the organisation and financial assistance of Norges geologiske undersøkelse and Norges Teknisk-Naturvitenskapelige Forskningsråd, geological investigations have been carried out on the Varanger Peninsula during parts of the 1966 and 1967 field seasons. The main object of the investigations has been the study of the stratigraphy and structural geology in those areas of the Varanger Peninsula underlain by unmetamorphosed sedimentary rocks of the "Older Sandstone Series" (Føyn, 1937) and its presumed equivalents. The investigations carried out for 3 weeks in August 1966 during rather inclement weather conditions were necessarily of only a reconnaissance nature. In 1967 more systematic field-studies were undertaken during a period from the end of June until the beginning of Sep-

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tember. The following descriptions are based mainly on observations made during this time.

With the help of a car, local post-boat, fishing boats and a small boat with an outboard-motor, more or less detailed geological observations along the costal sections of the Varanger Peninsula were eventually completed, with the exception of limited area between Store Molvik, Tanahorn and Skonsvik (in the northernmost part of the peninsula).

In the inner part of the peninsula investigations were at first concentrated along the road crossing the central highland and later in land-areas to the north-west and south-east of this road, especially the area surrounding the big lakes Buevannet, Gednjevannet and Hjordvannet.[1]) The eastern coast of Tanafjord between Leirpollen and Trollfjorden, together with the land-area stretching inland from this coast, has been mapped in detail.

In all, an area of about 600 sq.km. of the inner part of the Varanger Peninsula and of its coastline has been mapped on the scale 1:50.000. Because of lack of time other areas in the interior of Varanger Peninsula were studied in less detail, but the localities thought to be of greater importance to a general understanding of the geology of the peninsula were visited by us during reconnaissance trips.

At the present, however, our field investigations and petrological studies of collected samples are still in the preliminary stage; future studies will supply many details to supplement our present-day knowledge of the geology of the Varanger Peninsula. Consequently only the broad outlines of some new aspects of the geology of this area will be presented here.

Acknowledgements

We wish to express our thanks to Norges geologiske undersøkelse, Trondheim, for defraying the expences of our investigations, and to Norges Teknisk-Naturvitenskapelige Forskningsråd, for providing a fellowship for one of us (A.S.).

We are especially indebted to Rektor S. Føyn, Oslo, for the proposing the present investigations of the "Older Sandstone Series" on Varanger Peninsula, and for his constant advice and valuable discussions.

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1) Geographical nomenclature on Varanger Peninsula is based partly on Lappish tradition and partly on Norwegian introduced names. To avoid possible confusion the names used here are those appearing on the "Topografisk kart over Norge", 1:100,000, ed. Norges geografiske oppmåling, 1956-1962. These have been rewritten to conform with modern orthography.

Mr. W. Czajkowski, Mr. T. Dobrowolski and Mr. D. Myklebust were our field-assistants in the summer of 1967.

Dr. D. Roberts, NGU, Trondheim, and Prof. F. C. Vokes, NTH, Trondheim, have kindly corrected the English manuscript.

Summary of previous investigations

Varanger Peninsula and adjacent areas of the eastern Finnmark have been investigated by numerous geologists, the Eocambrian sediments of glacial origin generally attracting the most attention. (Eocambrian is considered by the present authors as a chronostratigraphical term including the time-period between the beginning of deposition of tillites and the first beds containing Cambrian fossils.) Other sediments, particularly those older than the tillites, were not often studied in this part of eastern Finnmark and the monographic paper of Holtedahl (1918) can be regarded as the first and still most important source of information concerning the "pre-tillitic" rock-sequence of the Varanger Peninsula.

The present authors, both during the field investigations and while establishing their stratigraphical and tectonic conceptions, have based their work mainly on the papers of Reusch (1891-b), Holtedahl (1918, 1919, 1932, 1953, 1960-a, 1960-b, 1961), Føyn (1937, 1960, 1964), Rosendahl (1945) and Reading (1965, 1966). In preparing the new stratigraphical scheme (see Fig. 1) account has been taken, as far as possible, of the terminology which have previously been either introduced or suggested by the writers mentioned above.

New data concerning the geology of the Varanger Peninsula

Field investigations carried out by the present authors in 1967 show that a large thrust fault divides Varanger Peninsula into two different geological regions. The thrustfault (or set of parallel faults) runs in an approximate NW-SE direction along Trollfjorden, Trollfjordelven valley, Gednjevannet and Hjordvannet lakes, the NE slopes of the Skipskjølen mountain and along the Komagelven valley (see map, Fig. 2). There is no lithostratigraphical correlation between the two different regions. The region situated SW of the thrust will here be called the Tanafjord - Varangerfjord region and that which extends NE of the thrust the Barents Sea region.

The precise nature of the thrust is not yet known; data collected during the mapping have permitted us only to establish the occurrence of this structure, its direction and extent. Stresses which initiated the thrusting have been directed approximately from NE to SW, causing the rock sequences of the

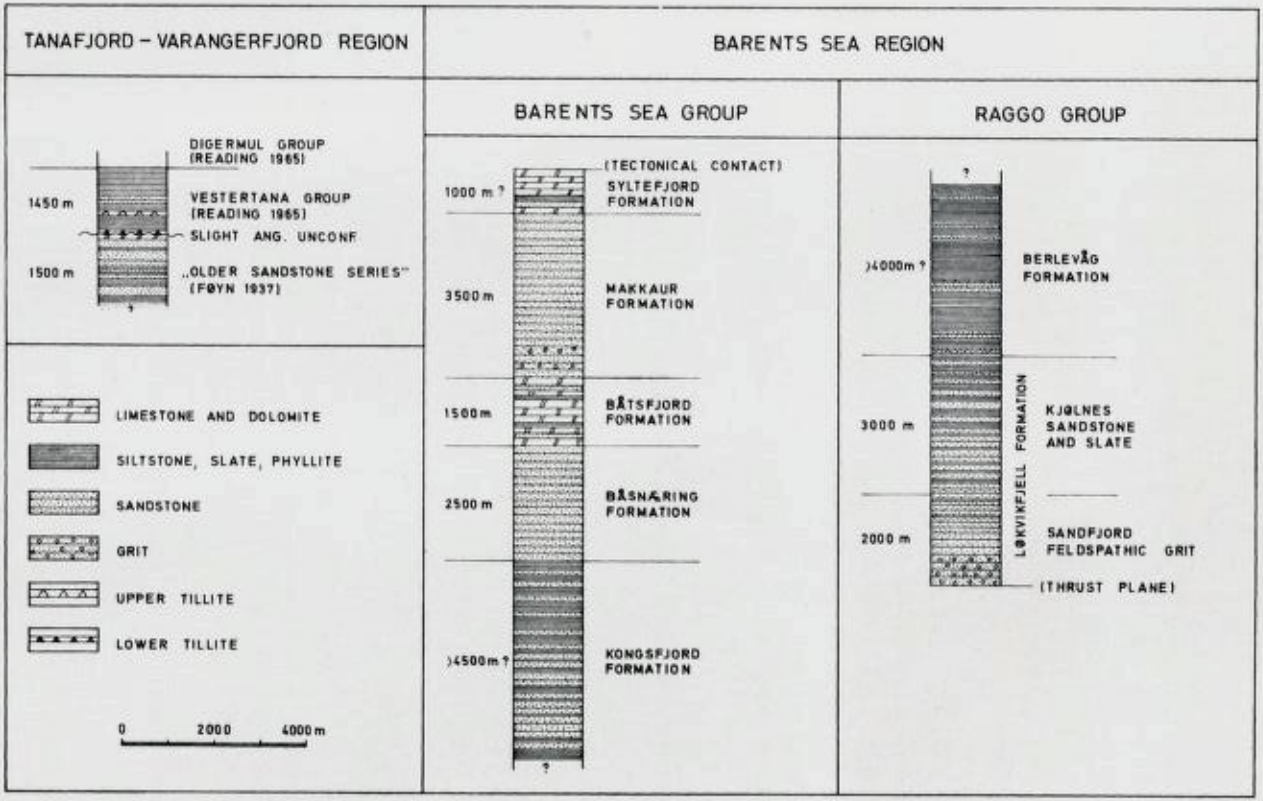

Fig. 1. Lithostratigraphical sections of the rock sequences of the Varanger Peninsula.

Barents Sea region to be thrust over those of the Tanafjord - Varangerfjord region. The thrust will here be called the Trollford - Komagelv thrust.

Short descriptions of the rock sequences observed in the above-mentioned regions follow immediately below.

Tanafjord - Varangerfjord region

The total known thickness of the entire sequence of sedimentary rocks of Hyperborean age (term introduced and defined by Sederholm, 1932) reaches ca. 3000 m. in this region. An Eocambrian succession (ca. 1450 m.), discribed by Føyn (1937) and Reading (1965) from an adjacent area on the Digermul Peninsula, has been termed the Vestertana Group (Reading, 1965). The oldest beds of this group are tillites which, together with slates and sandstones of the Nyborg Formation, represent sediments of Varangian (Varegian) Ice Age. The youngest strata of the Vestertana Group, Breivik Formation, are of Lower Cambrian age (Føyn, 1967). The sedimentary rock sequence underlying the Vestertana Group is that of the "Older Sandstone Series" of Føyn (1937). This reaches ca. 1500 m in thickness, but the base of the series is not known. The main area on the Varanger Peninsula underlain by the "Older Sandstone Series" is the eastern shore of Tanafjord (between Leirpollen and the southern coast of Trollfjord) and the territory to the east of Tanafjord, extending up to Trollfjordelven valley and to the western shores of the Gednjevannet lake. The Trollfjord - Komagelv thrust fault forms the north-eastern border of this area. Toward the SE, along a line running approximately up the Čabmaelven valley and south of Hanglečerro, the "Older Sandstone Series" dips beneath the Vestertana Group. Along the northern shores of Varangerfjord the rocks of the "Older Sandstone Series" crop out again, so that the whole area between the heads of Tanafjord and Varangerfjord can be regarded as a large syncline with Eocambrian and Cambrian sediments of the Vestertana Group in its core and with the limbs composed of sediments of the "Older Sandstone Series" (see cross-section, Fig. 2). The axial plane of the syncline trends approximately in a WSW-ENE direction. The syncline is assymetrical, the north-western (NNW) limb being steeper and more distinctly folded than the strata of the south-eastern (SSE) limb. In addition, evidence of strong deformation is present at the NE side of the syncline, near the plane of the Trollfjord - Komagelv thrust. Outcrops of rocks of the "Older Sandstone Series" in the area near Varangerfjord are not so extensive as in the sections around the Tanafjord area. Problems of detailed stratigraphy and of facial changes which may occur within the rocks of the "Older Sandstone Series" in the Varangerfjord area, i.e. in the vicinity of the border of the Baltic shield, require further investigation.

An examination of the lithologies of the "Older Sandstone Series" in the Tanafjord - Varangerfjord region, and of the preserved sedimentary markings, show that the sediments are mostly shallow water deposits, in part of marine and in part presumably of continental origin. Within these sediments occur thick strata of quartzitic sandstones interbedded with sandy and silty shales. Siltstones often appear in the lower parts of the rock-sequence (e.g. Stangenes shale) while sandstones (quartzites) prevail in its upper part. Some sandstones contain feldspar; typical "sparagmite", rich in coarse grains of feldspar is, however, very rare. Dolomite layers, interbedded with shale and mudstone, are known only from the uppermost part of the rock-sequence. In some places they were eroded before the deposition of tillites. The dolomite occurring in the Tanafjord - Varangerfjord region contains stromatolitic structures and displays many lithological similarities to the Porsanger dolomite, with which it can almost certainly be correlated.

The Tanafjord - Varangerfjord region on Varanger Peninsula should be regarded as the easternmost part of a large area of East Finnmark over which sediments correlated with the "Older Sandstone Series" and Vestertana Group are extensive. Stratigraphical and palaeogeographical correlations within these rock sequences have been discussed by several authors (see Holtedahl, 1918, 1932, 1960; Føyn, 1937, 1964, 1967).

Igneous rocks (occurring in great quantity in the Barents Sea region) are rare in the Tanafjord - Varangerfjord region. They are absent around the inner part of Tanafjord and in the southern part of the Varanger Peninsula (Føyn, 1945). A few diabase dykes have been observed by Holtedahl (1918) along the N coast of the outer Varangerfjord at Krampenes, on Store Ekkerøy and at Kvalneset. The latter locality has been recorded also by Mr. O. Jøsang, Oslo (personal communication).

Barents Sea region

Two different successions of sedimentary rocks occur in this region, the boundary between them being a plane of tectonic disconformity. They will be described below as:

1. Barents Sea Group, and
2. Raggo Group.

1. Barents Sea Group

The sedimentary sequence of the Barents Sea Group crops out most conveniently for observation, in large coastal sections along the north-eastern shore of Varanger Peninsula, approximately between Sandfjordbukten (NW of

Kongsfjord) and Komagvær (S of Vardø). The group reaches a thickness of about 13 000 m and consists of sandstones, siltstones, slates and carbonate rocks; no tillites or tillite-like rocks have been observed. The beds show a constant general strike NE-SW between Kongsfjord and Syltefjord; this direction is followed by the fjords occurring in NE part of the Varanger Peninsula. In the south-east the beds dip mainly 15-30° SE, but northwestwards the dips steepens to about 60-70° SE.

Preliminary geological observations concerning some sediments now referred to the Barents Sea Group were reported by Keilhau (1844) and Reusch (1891 b). More detailed descriptions are to be found in Holtedahl's (1918) monograph, where sediments of the Barents Sea Group have been mostly included in the "Older, dolomite-bearing sandstone division".

The present authors differentiate five formations within the Barents Sea Group using in their descriptions, as far as possible, lithostratigraphical terms introduced by Holtedahl (1918).

Kongsfjord Formation

Holtedahl (1918, pp. 188, 223) introduced term "Kongsfjord skifer" for this assemblage. The "Naalnesets sandstensrække" of Holtedahl (1918, p. 184) is also included here by the present authors.

The Kongsfjord Formation is the oldest in the Barents Sea Group and occurs mainly in the area situated close to Kongsfjord. It consists of dark-grey and blackish mudstones, slates and dark-grey sandstones. The latter, usually fine-grained, become in some places coarse-grained, feldspathic, and contain intercalations of conglomerates. Although the lithology of the Kongsfjord Formation is apparently monotonous, a lot of sedimentary markings have been recorded. Graded bedding, load casts, intraformational conglomerates and indistinct ripple marks are those most commonly observed in this formation.

The base of the Kongsfjord Formation is not known; its contact with the Raggo Group is a thrust surface. At the top, towards the south-east, the Kongsfjord Formation grades into the next, Båsnæring Formation.

The apparent thickness of the Kongsfjord Formation, computed from the geological map approximate 7500 m. However, in reality, the true thickness is much lower; the numerous disharmonic folds occurring in the incompetent slaty beds have resulted in an apparent enlargement. The real thickness of the Kongsfjord Formation may be established, tentatively, as about 4500 m. It seems that in the future it will be possible to differentiate minor lithostratigraphical units within Kongsfjord Formation.

Båsnæring Formation

"Baasnæringens sandstensserie" of Holtedahl (1918, p. 187).

The Båsnæring Formation occurs above the Kongsfjord Formation and there is a transition between these two units. This transition has been recorded by Holtedahl (1918, p. 188) at the SE side of Kongsfjord.

The Båsnæring Formation consists of thick beds of quartzitic sandstones and underlies a peninsula between Kongsfjord and Båtsfjord. In the lower part of the formation medium-grained, grey, massive sandstones are dominant; grey slates are subordinate and disappear gradually upwards. The upper part of the formation consists mostly of red, coarse-grained sandstones, commonly exhibiting cross-bedding, while the uppermost part is characterized by interbedding of red siltstones with beds of medium- and coarse-grained, red sandstones. Then, light-grey sandstones and dark-grey arenaceous shales with interbedded carbonate layers appear. The proportion of the latter increases upwards. These rocks will be regarded as the lowermost beds of Båtsfjord Formation.

Thickness on the Båsnæring Formation is ca. 2500 m (according to Holtedahl, 1918, p. 187 - ca. 2000 m).

Båtsfjord Formation

"Baasfjord dolomit-skifer-sandstensserie" of Holtedahl (1918, pp. 188, 223).

The Båtsfjord Formation underlies the area close to Båtsfjord and the valley forming the SW prolongation of the latter. The formation consists of interbedded dolomitic and clayey limestones, shales, mudstones and sandstones. The dolomitic limestones are grey or light-grey and become yellowish on weathered surfaces. Clastic rocks associated with carbonate rocks are grey, blackish, red, green and yellow. Ripple marks and mud-cracks are common on the bedding surfaces of the clastic rocks; these structures have been described in detail by Holtedahl (1918). In the lower and upper parts of the formation the clastic rocks seem to be dominant while carbonate rocks prevail in the middle. The base of the formation is marked by light-grey sandstones and dark-grey arenaceous shales appearing above the red coarse-grained quartzitic sandstones of the subjacent Båsnæring Formation. At the top of the Båtsfjord Formation the carbonate rocks are interbedded with light-grey or red coarse-grained calcareous sandstones and red silstones. Then, the carbonate rocks gradually disappear and the Båtsfjord Formation grades into the next formation beginning with red, coarse-grained cross-bedded sandstones and conglomerates. This transition from Båtsfjord Formation to the Makkaur Formation has been previously observed by Reusch (1891, p. 41) and by Holtedahl (1918, p. 190, Pl. XI).

Thickness of the Båtsfjord Formation may be established as ca. 1500 m.

Makkaur Formation

"Makurs sandstensserie" of Holtedahl (1918, p. 192).

The Makkaur Formation underlies a large peninsula occurring between Båtsfjord and Syltefjord. This formation consists of mainly medium- and coarse-grained sandstones forming thick layers (1 meter and more) and exhibiting cross-bedding. The sandstones are red-violet or reddish-grey; on the weathered surfaces they are more intensively red stained. The sandstones are feldspathic, especially in the lower part of the formation where quartz-conglomerate layers also appear. These conglomerates and associated sandstones have been observed by Reusch (1891 b, pp. 40-41) at Makkaur and characterized as sparagmite-like rocks. The very monotonous sandstone sequence of the Makkaur Formation reaches about 3500 m in thickness. The uppermost part of this formation occurs at the head of Syltefjord where (according to the description of Holtedahl, 1918, pp. 193-194) dark arenaceous shales and yellowish dolomites rest on coarse-grained sandstone exhibiting cross-bedding. There is a concordance and continuity of sedimentation but the contact is relatively sharp. The arenaceous shales and dolomites have been included in the next formation described below.

Syltefjord Formation

A part of "Syltefjords and Persfjords dolomit-skifer-sandstensserie" of Holtedahl (1918, p. 223).

The Syltefjord Formation crops out near Syltefjord and shows lithological similarity to the Båtsfjord Formation. The Syltefjord Formation consists of ligth-grey dolomitic limestones interbedded with red and greenish sandstones and mudstones often exhibiting ripple marks and mud cracks on the top surfaces. Holtedahl (1918, pp. 193-194, Pl. XVI) observed oolitic and stromatolite-like structures in carbonate rocks of Syltefjord at Veinesodden. Along the SE side of Syltefjord the beds of the Syltefjord Formation dip steeply in a NW direction and are in contact along a thrust fault with reddish and grey sandstones (Båsnæring sandstones). The known thickness of the Syltefjord Formation may be established as ca. 1000 m.

Beds of the Barents Sea Group occur again south-east of the SE coast of Syltefjord as far as the outer part of the coast of Varangerfjord (see Fig. 2). The units present are mainly those of Kongsfjord, Båsnæring and Båtsfjord Formations. Isoclinal dip of the beds which can be observed in the section between Kongsfjord and Syltefjord does not continue east of Syltefjord; in this part of the Barents Sea region the beds are distinctly folded. Axial planes of synclines and anticlines trend in a SW-NE (Caledonian) direction; a distinct

syncline, with the Båtsfjord Formation in the core and with limbs consisting of Båsnæring Formation, occurs in Persfjord. This structure has been observed already by Keilhau (1844) and by Holtedahl (1918).

2. Raggo Group

Sedimentary sequences referred to the Raggo Group underlie the northern part of the Varanger Peninsula, which is called the Raggo Peninsula (Raggohalvøya). Beds of the Raggo Group in the coastal section between Sandfjordbukten and Berlevåg dip quite steeply toward NW and are thrusted over the Barents Sea Group. The thrust plane marks the base of the Raggo Group. The top surface of the group is not known. Total known thickness of the Raggo Group may be established as about 9000 m (?). A geological section of the Raggo Group is best exposed along the NE coast of the Varanger Peninsula between the NW side of Sandfjordbukten and Skonsviken. The Raggo Group consists of clastic rocks; similarly as in the Barents Sea Group, tillites have not been observed.

Within Raggo Group two formations may be differentiated:

1. Løkvikfjell Formation,
2. Berlevåg Formation.

Løkvikfjell Formation.

The name "Løkvikfjeldets sandstensserie" was introduced by Holtedahl (1918) for the sandstones which crop out along the sea shore west of Kongsfjord, between Styret and Sandfjordbukten's north side. Løkvikfjell mountain consists of the rocks of this formation.

The present authors divide the Løkvikfjell Formation into two members: (1) Sandfjord feldspathic grit and, (2) Kjølnes sandstone and slate.

Sandfjord feldspathic grit. This member occupies two separate areas: (a) the area extending in a NE-SW direction from the Sandfjordsaksla and Styreaksla mountains on the coast of Barents Sea to the western slopes of Skidnefjell on the north-eastern coast of Tanafjord, N of Trollfjord; (b) the area which occupies the central part of the Varanger Peninsula between Buefjellet mountain, Gednjevannet lake and Ordofjellet mountain and which extends further eastwards op to Skogåsvidden. In addition, isolated klippen of beds of the member under consideration have been observed on the peninsula which divides Båtsfjord from Syltefjord and which consists mainly of Makkaur Formation. The Sandfjord member consists of coarse-grained, pink, light-grey, yellowish or red-violet feldspathic grit with conglomerate intercalations, in layers 0.3-1 m in

thickness. Cross-bedding is common in these beds. Pebbles are usually subrounded and reach up to 10 cm in diameter, usually they are about 2-3 cm. Pebbles of white or pink quartz, of red or violet quartzite, red jasper and black siliceous rock have been observed. The psammitic material of the grit consists mainly of rounded quartz grains and quite abundant particles of pink feldspar. Generally, this sediment is reminiscent of the sparagmites.

In a well exposed section between Sandfjordbukten and Kjølnes it may be observed that conglomerate layers occur mainly in the lower part of the member. Upwards, the feldspathic sandstones become medium-grained, shale intercalations appear and then the member passes into Kjølnes sandstone and slate.

Thickness of the Sandfjord feldspathic grit in this section is ca. 2000 m.

Kjølnes sandstone and slate member. This member consists of interbedded sandstones and slates and reaches a thickness of about 2000 m. Medium-grained quartzitic sandstones and coarse-grained feldspathic sandstones, grey and grey-pink, form layers ca. 0.2-0.7 m thick. In some places quartz conglomerates appear. Sandstones are interbedded with dark-grey and black slates and phyllites. Generally the sediments of this member become more and more metamorphosed when traced from east to west. The member does not appear in the SW slopes of Skidnefjell mountain in the northern vicinity of Trollfjorden because the Berlevåg Formation thrust over it in this area and rests with a tectonic contact directly on the Sandfjord feldspathic grit.

Berlevåg Formation

This has been observed in the area near Berlevåg, between Berlevåg and Store Molvik, and N of Trollfjorden. Near Berlevåg this formation is represented by black and black-green phyllites and there is presumably a continuity between the Kjølnes sandstone and slate member and the Berlevåg Formation. Between Berlevåg and Store Molvik the black phyllites are interbedded with quartzites and north of Trollfjorden occur strongly disturbed grey quartzites and grey-green phyllites. In the latter area the phyllites and quartzites of Berlevåg Formation are thrusted directly on the Sandfjord feldspathic grit, as it was already mentioned above.

Although little work has been done on the Berlevåg Formation it may be concluded, in agreement with Holtedahl's (1918) opinion, that a SW-NE running thrust, separating autochthonous (or para-autochthonous) and allochthonous sequences, dies out in a NE-direction and that on the N coast of the Varanger Peninsula there is a continuity and transition from unmetamorphosed to metamorphosed beds.

Igneous rocks

Numerous dykes of basic rocks occur in the Barents Sea region, a feature which seems to be characteristic of this region. The dykes are especially common in the area between Kongsfjord and Syltefjord, intruding sedimentary sequences of the Barents Sea Group. They are distinctly marked in morphology as upstanding ribs within slaty, easily disintegrated beds of the Kongsfjord Formation and apparently are most numerous here. They are, however, equally common in sequences consisting mainly of sandstones or carbonate rocks (e.g. Makkaur Formation, Båtsfjord Formation). The dykes usually do not reach more than about 10 m in thickness; they occupy vertical fractures and, in general, form a set striking in an ENE direction (60-80°). Usually the dykes do not exhibit any signs of tectonic disturbance; in a few cases, however, some deformation appears. This led Holtedahl (1918) to conclude that the intrusions took place before the orogenic disturbance in this region was completely finished.

Dykes of basic rocks do not occur in the Raggo Group. However, Holtedahl (1918, p. 182) observed some thin (2-4 m) basic intrusions concordant to Berlevåg Formation rocks at Skonsvik near Berlevåg.

Origin and age of sedimentary rocks of the Barents Sea region

The thick sedimentary rock sequences in the Barents Sea region, especially those of the Barents Sea Group, would seem to be an unusual feature of the geology of Finnmark. Only the sedimentary rocks of the Raipas Group at Altafjord have been considered by Holtedahl (1918, p. 305) as "...an equivalent of the series, seen on the north coast of the Varanger Peninsula". This comparison was based on similarities between the sandstones and dolomites with stromatolitic structures, present in both these successions. The Raggo Group shows a lithological similarity to the Laksefjord Group described by Føyn (1960) from the Laksefjord district (the first suggestion concerning this similarity was made to us by Føyn, personal communication). In particular, the Løkvikfjell Formation seems to correspond to the Landersfjord quartzite and the Berlevåg Formation to the Friarfjord phyllite. Except for the above-mentioned similarities, no other lithological analogies between the Barents Sea region and other regions of Finnmark have been established up to the present time.

The sedimentary rock sequences of Finnmark, especially the unmetamorphosed ones of eastern Finnmark have many times been compared with those of Ribačij Peninsula, Sredni Peninsula and Kildin Island. Holtedahl (1960, p. 125) even correlated particular lithological units occurring in both these

regions. Other comparisons were of rather general character, especially those concerning age. In the opinion of many geologists (Wegmann, 1928, 1929; Lupander, 1934; Polkanov, 1934, 1936; Keller and Sokolov, 1960; Keller et. al., 1963, pp. 103-113) the Ribačij and Srednij Peninsulas may be divided into two geological regions: (1) a northern, allochthonous region, that of the Ribačij Peninsula and (2) a southern, autochthonous region, comprising the Sredni Peninsula an Kildin Island. The sedimentary rock sequences of the northern region are thrust over those to the south. It was only Fieandt (1912) and later Agapiev and Vronko (in Luktevič and Haritonov, 1958, p. 365), who did not observe the presence of a large thrust fault between the Ribačij and Sredni Peninsulas. This latter oponion, however, seems recently to have been repudiated by Russian geologists (Keller et. al., 1963, p. 113); although the thrust is not marked on the "Carte tectonique de l'Europe" (I ed., 1964) or the "Tectoničeskaja Karta Eurazji" (1966). On the "Carte geologique de l'Europe" (1964) a fault (not thrust) is shown.

The Trollfjord - Komagelv thrust occurring on Varanger Peninsula has the same SE-NW trend as the thrust which divides the Sredni and Ribačij Peninsulas and would appear to be a direct prolongation of the latter. A conclusion from this - and that favoured by the present authors - is that there is one large thrust fault, or set of parallel thrust faults, which separates the Sredni and Ribačij Peninsulas from each other and crosses Varanger Peninsula. Consequently, the northern, allochthonous (called "exterior" by Keller and Sokolov, 1960), Ribačij block should correspond to the Barents Sea region of Varanger Peninsula, and the southern, autochthonous ("interior" after Keller and Sokolov, 1960) block of Sredni Peninsula and Kildin Island should be the equivalent of the Tanafjord - Varangerfjord region. However, litho-stratigraphical correlation between the corresponding blocks is not at all easy. Comparison of the lithological sections of the "Older Sandstone Series" and Vestertana Group with those of the "Kildinskaja svita" and "Volokova svita", differentiated and described on Sredni and Kildin by Keller and Sokolov (1960), shows some dissimilarities. It should, however, be emphasized that: (1) in both regions shallow-water sediments are developed in which facies changes can be expected to occur, even over small distances; (2) there is a slight angular unconformity present between the "Older Sandstone Series" and the Vestertana Group (Holtedahl, 1918, Føyn, 1937) and, similarly, the "Volokova svita" on Sredni rests unconformably on a denuded surface of the "Kildinskaja svita"; (3) in the "Kildinskaja svita" dolomites occur (on Kildin with stromatolites) which may be loosely compared with dolomites occurring at the top of the "Older Sand-

stone Series"; (4) ranges of thickness of sedimentary sequences in both regions are similar.

Tillites, present in the Vestertana Group and constituting an important horizon in any correlation of Eocambrian sediments, are lacking in the "Volokova svita". Beynon et. al. (1967) suggest, however, that the tillite formations of the Vestertana Group observed in the Leirpollen area (Varanger Peninsula) thin eastwards; it is thus probable that these formations disappear in this direction and do not reach the Sredni Peninsula region.

It can also be noted that the considerably thick sedimentary sequences of the Barents Sea Group and the Raggo Group can to a certain extent be compared with the sedimentary succession of the allochthonous Ribačij Peninsula block.

A geological section across the Ribačij Peninsula has been described by many authors (e.g. Fieandt, 1912; Wegmann, 1928, 1929; Lupander, 1924; Tenner, 1936), lately by Agapiev and Vronko (in Lutkevič and Haritonov, 1958, pp. 365-366, and in Keller et. al., 1963, pp. 110-111) and the sequence divided into the following formations, number 1 being the oldest:

1) "Svita Ejna" - coarse-grained, feldspathic sandstones with conglomerates and with peculiar dolomitic concretions up to 0.3 m in diameter. Intercalations of quartzitic shale. Thickness 3600 m(!)
2) "Zubovskaja svita" - feldspathic sandstones and shales with distinct cleavage. Thickness ca. 900 m.
3) "Slates of Cyp Naboloka" - dark-grey and black slates with closely packed cleavage planes; in some places yellow concentrations of jarosite.
   Thickness not less than 500 m.
   Total thickness 5000 m.

From the description of this succession it is apparent that the great thickness of the sedimentary sequence of the Ribačij Peninsula and the predominance of clastic sediments are the features which may best be used in a general comparison of this region with the Barents Sea region; a more precise correlation is not possible. It is probable, however, that e.g. the thick clastic "Svita Ejna" corresponds to one of the thick clastic formations of the Barents Sea region (Løkvikfjell Formation? Båsnæring Formation? Makkaur Formation?).

Deposition of the thick sedimentary sequences of the Barents Sea region seems to be closely associated with the development of a geosyncline. The Barents Sea Group starts with the Kongsfjord Formation which exhibits many features typical of a geosynclinal greywacke facies. This formation passes upwards into mainly red feldspathic sandstones of the Båsnæring Formation which appears to represent a molasse (red-bed) facies. Further upwards a calcareous facies

occurs, this being the Båtsfjord Formation. Above that a repeated sucession comprising molasse facies and calcareous facies is represented by the Makkaur Formation and Syltefjord Formation. The general picture, therefore, is of a sedimentary basin, deep at the beginning but becoming gradually shallower, being infilled by sediments the accumulation of which was more rapid than the basin's rate of subsidence. Periods of restriction of clastic sediment supply are recorded by calcareous facies. In general terms this assemblage would seem to be representative of the sediments which usually characterize the cycle of development of a geosyncline (miogeosyncline). The lower part of th Raggo Group (Løkvikfjell Formation) may be interpreted as a molasse facies, also connected with an orogenic cycle. The sedimentary environment of the upper part of this group (Berlevåg Formation) is difficult to elucidate because of secondary, metamorphic changes.

Evidence indicating an Eocambrian and Latest Precambrian (i.e. Hyperborean) age for the sedimentary rocks of the Varanger Peninsula concerns only the sequences present in the Tanafjord - Varangerfjord region and cannot be used in considerations of the age of sedimenary sequences of the Barents Sea region. As mentioned previously, there is no lithostratographical correlation between these regions, separated from each other as they are by a large thrust.

No evidence for the age of any part of either the Barents Sea Group or the Raggo Group has so far been obtained. These rock sequences may indeed be placed anywhere in the vast period of time from Late Precambrian up to Silurian. The Caledonian deformation of the above mentioned group is characterized by a NE-SW trend of many structures and by a slight metamorphism of the upper part of the Raggo Group. Considerations concerning a more exact assignment of age for the rocks in question may at this stage be based only on the unsatisfactory method of comparison with rock sequences in adjacent areas.

Comparison with the Raipas Group, suggesed by Holtedahl (1918), gives unsatisfactory results because the age of the latter is not definitely established, referred either to "Esmarkian" (Rosendahl, 1945; Spjeldnæs, 1964) or to younger Precambrian (Holtedahl, 1960; Reitan, 1960, p. 92; 1963).

A comparison with the allochthonous block of the Ribačij Peninsula, even if correct, still does not solve the problem of age of the sedimentary rocks of the Barents Sea region. An age for the rocks of the former region has been given as Hyperborean by Polkanov (1934) on a basis of comparison with sedimentary rocks of Eocambrian age on Varanger Peninsula(!). However tillites have been recorded (Wegmann, 1928, 1929; Lupander, 1934) on

Ribačij Peninsula, presumably within the sedimentary succession recently termed "Svita Ejna" (description of the geological section after Agapiev and Vronko in Keller et. al., 1963, p. 111). Agapiev and Vronko (l.c.) make no mention of tillites, while Keller and Sokolov (1960) have argued against a glacial origin for conglomerates previously called tillites. Later, however, (Lungersgauzen, 1963, p. 567) the typically glacial character of tillites and tillite-like deposits of Ribačij, Sredni and Kildin has been accepted. This opinion, in all probability based on new observation, can be helpful in establishing the age of sediments from Ribačij as well as the Barents Sea region. However, it should be emphasized that the tillites of Ribačij, if they do exist, may not necessarily correspond exactly in age to those from Finnmark but could represent another, independent horizon.

Absolute age determinations of sedimentary rocks from eastern Finnmark have not yet been carried out, but Polkanov and Gerling (1960) have published data concerning absolute ages of rocks fra. Sredni, Kildin and Ribačij. The absolute age of the glauconitic sandstone of the "Kildinskaja svita" on Sredni came out at 920 mill. years, on Kildin 1030 - 1010 mill. years. An absolute age of phyllites from Ribačij has been established as 887 - 715 mill. years.

In any consideration of age of rock sequences from the Barents Sea region, some previous, broad regional comparisons should be mentioned. Ramsay (1897-99, 1911), Reusch (1920) and Tschernyschew (1902) suggested the occurrence of an old mountain chain, the remnants of which are now represented by the Timan mountains, Kanin Peninsula, Kildin Island, Ribačij (with Sredni) Peninsula and Varanger Peninsula. Holtedahl (1918), however, did not accept the idea of an Timanian chain in Finnmark. Later, Schatsky (1958) defined the Timanides as a region including Timan, Kanin, Kildin and Ribačij, which was deformed during the Baikalian disturbance - older than Caledonian - and Stille (1958) regarded the same region as probably representative of an Assyntian geosyncline extending westwards as far as Finnmark. It would, therefore, seem that the Barents Sea region, which occupies an isolated position in the geology of Finnmark, should be regarded as a part of the Timanian miogeosyncline.

Riphean rock sequences of Kanin and Timan are metamorphosed and cut by large bodies of igneous rocks, and because of this a detailed lithological similarity to the sections across the Barents Sea region cannot be expected. Only the upper, less metamorphosed division of the Riphean of Timan (Zhuravlev and Gafarov, 1959), consisting of conglomerates, quartzites, slates, dolomites and algal limestones may be loosely compared with the rocks of the Barents Sea region. The better preserved, typical sections of miogeosynclinal Riphean

are those of the western slopes of the Southern Urals (Schatsky, 1945, 1958, 1960). This ca. 10.000 m thick assemblage consisting of successions of variegated clastic sediments and dolomites is, quite possible, a distant but similarly developed lithostratigraphical equivalent of the sedimentary sequences of the Barents Sea region. It should be mentioned that the Riphean of Kanin and Timan is also regarded as miosynclinal, similar to that of the W slopes of the Southern Urals (Zhuravlev and Gafarov, 1959).

In conclusion, the above considerations concerning the rocks of the Barents Sea region point to an age rather older than Cambrian (i.e. Late Precambrian and Eocambrian, Sparagmitian, Hyperborean, Riphean etc.), although the authors have a clear understanding of the hypothetical nature of this statement.

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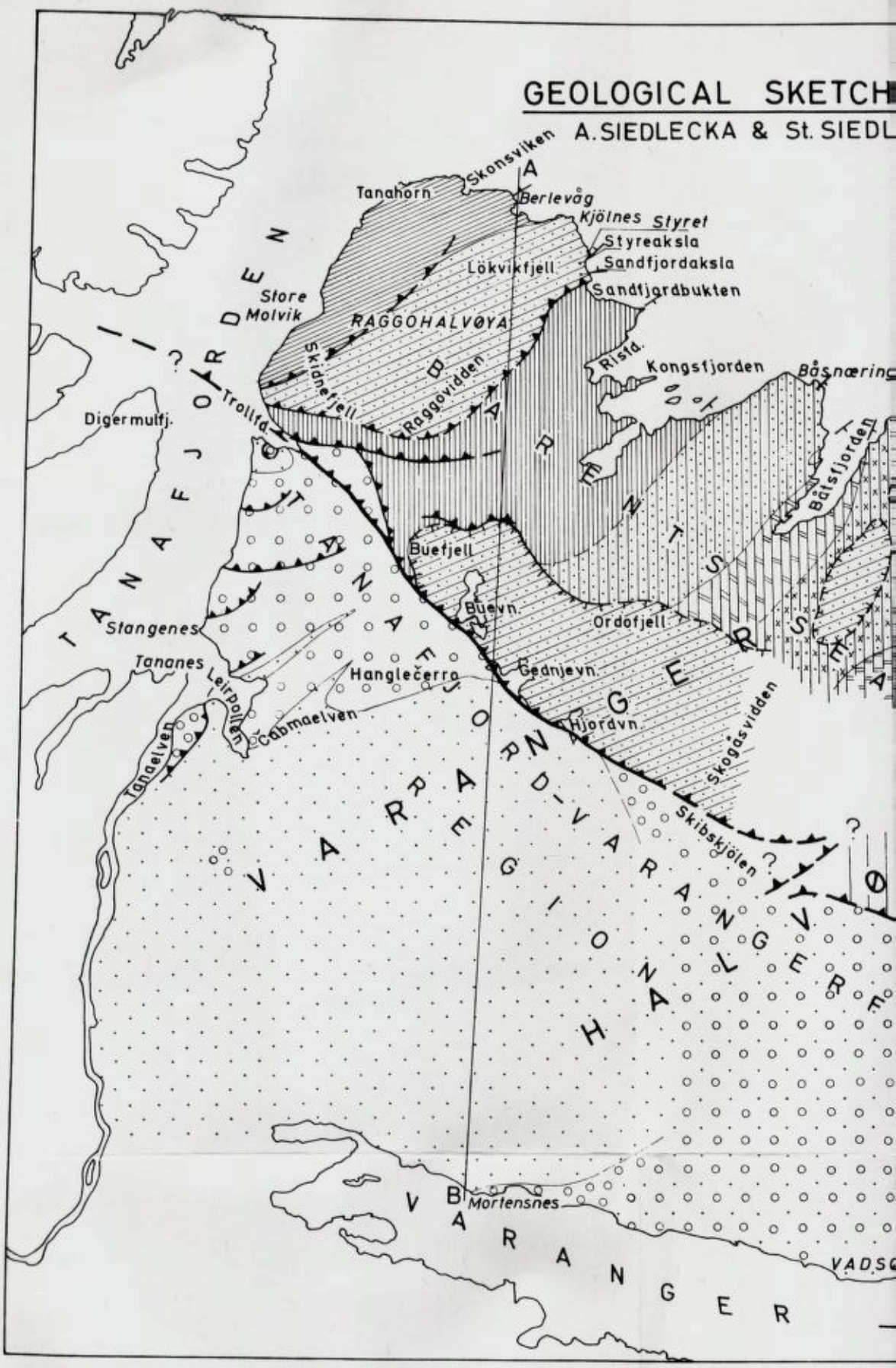
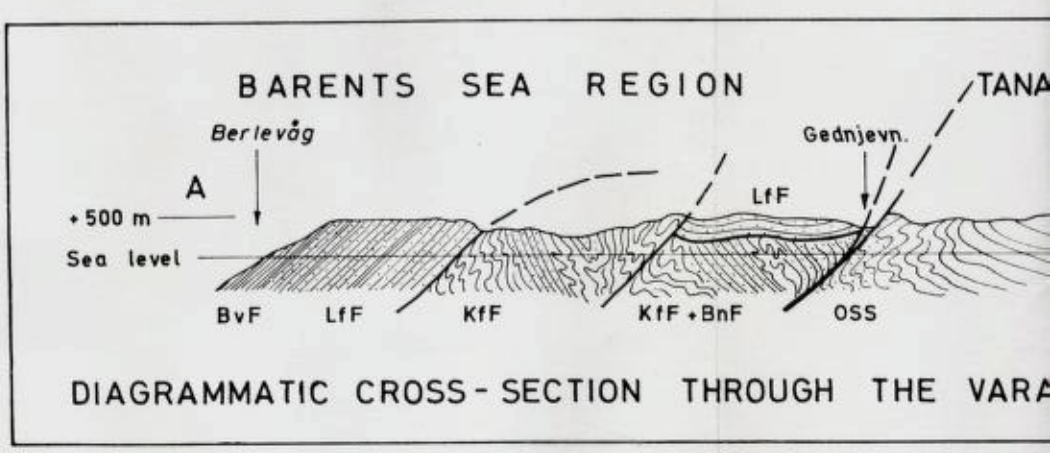
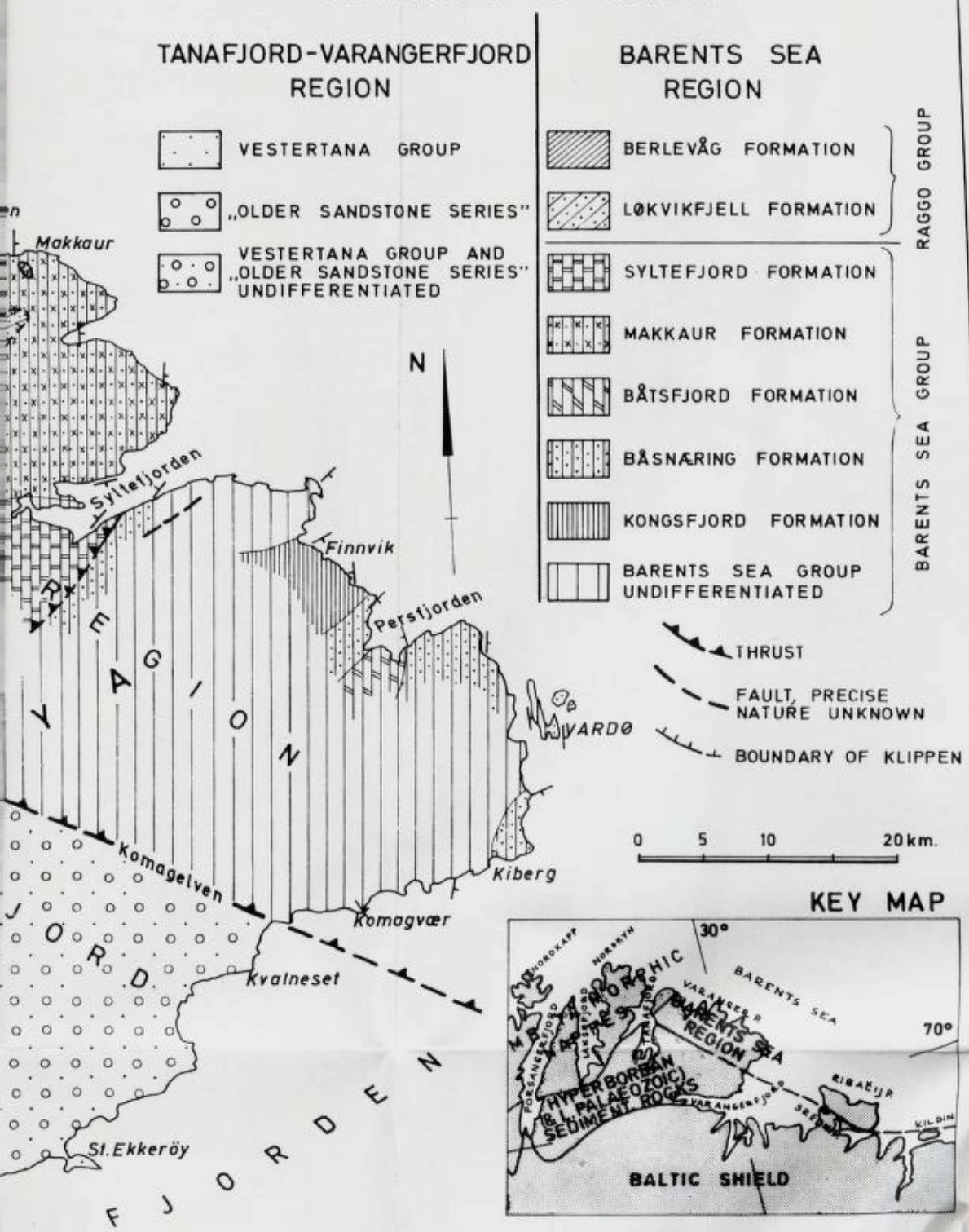




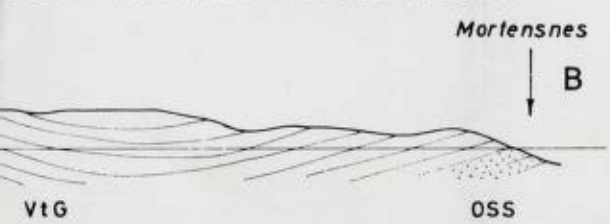
DIAGRAMMATIC CROSS-SECTION THROUGH THE VARA

MAP OF THE VARANGER PENINSULA

ECKI 1967



FJORD-VARANGERFJORD REGION



ABBREVIATIONS:

BvF = Berlevåg Formation
LfF = Løkvikfjell Formation
KfF = Kongsfjord Formation
BnF = Båsnæring Formation
OSS = Older Sandstone Series
VtG = Vestertana Group

NGER PENINSULA ALONG THE LINE A-B ON THE MAP