NGU Rapport 93.149

Diamantførende gneiser på Fjørtoft i den vestlige gneisregion, Møre & Romsdal.

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RAPPORT

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Tittel:
Diamantførende gneiser på Fjørtoft i den vestlige gneisregion, Møre & Romsdal.

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Sammendrag:

Rapporten presenterer de foreløpige resultatene fra en detaljert kartlegging av et lite område (0,5 x 2 km) med diamantførende gneiser på den nordøstlige delen av Fjørtoft (Nordøyane i Haram komunne, Møre og Romsdal). Området er delt inn i 3 ulike tektoniske blokker: Knurrevika- og Vågholmen-blokkene lengst i nord og Hellvika-blokken som tolkes som underlaget. Knurrevika-blokken inneholder ulike granat-amfibol-biotitt-gneiser (med og uten klinopyroksen), granat-biotitt-gneiss og mange små og store eklogittlinser. Vågholmen-blokken domineres av en granat-kyanitt-biotitt-gneiss og inneholder mindre eklogittlinser (opptil 100 x 20 m). Hellvika-blokken består av varierende plagioklas-rike gneiser, migmatittiske gneiser, øyegneiser, granodiorittiske gneiser og eklogitter. Bergartene er intenst deformerte med betydelig skjærbevegelse, strekning og injeksjon av granittiske årer og linser. Knurrevika- og Vågholmen-blokkene ser ut til å være karakterisert av henholdsvis subhorisontale og subvertikale lineasjoner.

Høsten 1992 ble det ekstrahert mikrodiamanter fra en prøve av granat-kyanitt-biotitt-gneis og en prøve av granat-amfibol-pyroksen-biotitt-gneis ca. 700 m øst for Hellvika. Til nå har vi ekstrahert og bekreftet 2 diamantkorn i en prøve av granat-kyanitt-biotitt-gneis fra steinbruddet på Vågholmen.

Emneord: Eklogitt	Tektonikk	
Berggrunnsgeologi		
Kaledonsk fjellkjede		

INTRODUCTION

Since the first finding of a few grains of microdiamond from Fjørtoft was reported (Dobrzhinetskaya et al., 1993) the priorities for current research have been detailed geological investigations based on mapping, structural, petrological and geochronological study of the rocks at different scales. The significance of these microdiamonds is still uncertain and it cannot yet be established as to whether or not they confirm growth under ultra-high pressure metamorphic conditions. They could alternatively have been formed under metastable conditions during Caledonian tectono-metamorphic events and even their premetamorphic alluvial origin cannot be absolutely excluded. In any case, the presence of the microdiamonds underlines the importance of studying parts of the Western Gneiss Region to develop better understanding of the deep geological processes during Caledonian orogenic events.

GEOLOGICAL SETTING

The Western Gneiss Region (WGR) of Norway consists of Precambrian basement tectonically reactivated and metamorphosed under eclogite facies conditions during Scandian subduction of the Baltic plate beneath the Laurentian plate. Thin and discontinuous cover sequences of Precambrian and/or Early Palaeozoic rocks were isoclinally infolded in the basement. Results of U-Pb zircon, titanite and monazite dating from 29 Proterozoic gneissic rocks from the central part of the WGR (Tucker and Krogh, 1991) showed that the major period of the crustal formation was between ca. 1657 to 1686 Ma. Emplacement of mafic dykes and augen granitic gneisses into this crust occurred between 1462 and 1508 Ma. Granodiorite and pegmatite dykes have been dated at ca. 942 to 951 Ma. Subsequent high-grade metamorphism of the eclogite facies is dated at ca. 400 Ma. At the same time high-grade metamorphism of eclogite facies is dated at ca. 510-520 Ma by Sm-Nd method (Jamtveit et all., 1991, Griffin and Brueckner, 1980). Unfortunately there were no discussions between geochronologists how these uncertainties must be interpreted.

Robinson (1993) has focused upon distinguishing the basement and cover tectonostratigraphic units in the field and, thereby, will produce a new type of geological maps for WGR. His mapping was focussed on the NE-SW-trending linear belt of infolded cover sequences from Surnadal to Vigra. In this area he recognised four tectonostratigraphic units above basement: Risberget, Sætra, Støren and Blåhø-Surna nappes. Throughout the region, the structure is one of deep isoclinal synclines of cover nappes in basement that appears to have formed during sinistral ductile shearing (Robinson 1993).

The diamond-bearing gneisses from Fjørtoft belongs within a relatively narrow belt of the Blåhø-Surna nappe which includes eclogites and ultramafic rocks folded into basement: the latter contains also abundant eclogites (Robinson, per. comm.,1993).

THE ISLAND OF FJØRTOFT

The island of Fjørtoft has been mapped by Mørk (1989). On that geological map two heterogeneous units including eclogites were distinguished: metasedimentary kyanite-garnet-biotite and garnet-biotite gneisses and ortogneissic complex contained eclogites.

The northern part of the island has been remapped in detail by Dobrzhinetskaya, Larsen and Eide in 1993 to document the geological occurrence of the diamond-bearing gneisses (Fig. 1). Three groups of the country rocks (Knurrevika, Vågholmen and Hellvika) which include some eclogites and peridotites, has been interpreted as three subvertical tectonic slabs juxtaposed together. These slabs are described below:

Knurrevika slab. The large eclogite body enclosed in gneissic rocks as originally mapped by Mørk is actually much more heterogeneous and does not conform to the previous simple subdivision. Numerous lenses of eclogite were mapped which range in size from 10-15 cm to hundreds of meters and are enclosed in layered amphibole-garnet-biotite, pyroxene-amphibole-garnet-biotite and garnet-biotite gneisses. One small lens of serpentinite is situated at the shore of Helvika Grunne in the Helvikhaugen area. The rocks are strongly sheared and it has been noted that migmatitic rocks follow highly strained steep zones with WN-ES strike. Detailed mapping (Fig.2) shows fabrics and relationships between migmatitic and other quartz and pegmatite veins and small bodies indicating that they intruded eclogites and gneisses.

The rocks which host the syn-shearing products range from protomylonites to mylonites or ultramylonites. They are characterised by the presence of an S-C foliation and shear-bands. Subhorizontal stretched (extensional) lineations and asymmetric drag-like small-scale folds occur. These folds appear to be chaotic near the competent eclogitic boudins. Folds formed during the shearing movements are intimately related to the fabric of the evolving shear zones. They usually fold an early-formed (pre-migmatitic) mylonitic fabric and also banded migmatitic material, whilst the mylonitic fabric, which was forming at the time that the folds were developing, defines their axial plane. A minimum of two generations of the steeply oriented shear zones of the same WN-ES strike can be distinctly recognised: D_1 is premigmatitic and D_2 represents syn/post migmatitic ductile shearing. The sense of tectonic transport in the D_2 postmigmatitic strike-slip shear zones was dextral. The second generation of the quartz and plagio-microcline granite veins and bodies was established during semi-brittle shear movements (D_3). The D_3 shear zones are latest and cross all earliest fabrics.

Strain-induced rock products such as retrogressive minerals (micas, amphiboles) and systems of granite veins with Ksp were collected within shear zones and will be dated by the Ar/Ar method to provide a means for dating the time of movement in the shear zones. These data could also be useful to place constraints on the time of exhumation of these rocks.

Vågholmen slab. Kyanite-garnet-biotite gneisses with a few lenses and small inclusions of eclogites predominate. A small outcrop of serpentinised garnet peridotite, near the road in Nyten, is situated on the contact with Helvika slab. A Grt-Cpx association from the Nytun peridotite has been dated at 511+/-18 Ma by the Sm-Nd method (Jamtveit et al., 1991) and it was interpreted as the age of eclogite metamorphism.

The rocks were subjected to hot shearing during two generations at the minimum. The most common syn-shearing material is manifested by apparent segregations of quartz into very strongly flattened and stretched quartz-plagioclase-rich veins which are usually subparallel to the mylonitic foliation (C-fabrics) of their host gneisses. These elongated segregations of quartz, (so-called "ribbons"), have a subvertical orientation. In the ribbons, the direction of the maximum extension corresponds with the orientation of the extentional fabrics in the host mylonite. Strain-induced garnet commonly results in rotated porphyroblasts with "shadow-pressures" distinct from the postkinematic grains wich cut the mylonitic foliation and quartz ribbons. A few ductile, small-scale shear zones are characterised by abundant growth of the retrograde micas.

Hellvika slab. The most part of the slab consists of the fine-grained plagioclase-rich garnet-biotite or biotite gneiss, garnet-biotite migmatitic gneiss, augen gneiss and granodioritic gneiss which enclosed large and small boudins and lenses of eclogites. These associated rocks are usually considered as a basement assemblage. At the shore of the Helvika Grunne the Helvika slab has a clear tectonic contact with the rocks of the Knurrevika slab and toward the east, along strike, the rocks of the Vågholmen slab are juxtaposed between them.

All gneisses of the Hellvika slab possess a strong regional gneissosity that strikes generally west-east and has a steep, north or south dip. There are shear zones with subhorizontal stretched lineations on the steeply dipping S-C foliated surfaces. A subvertical extentional lineation has been found within a small-scale local shear zone in this unit. The strain-induced products are represented by retrogressive micas (subhorizontal lineation) and amphibole (subvertical lineation) and may have formed episodically during an extended period of shearing. We may also expect that the trajectory of the movements changed during that period. These observations are very important and stress-induced minerals will be used for Ar/Ar dating to document the timing of exhumation.

MICRODIAMOND OCCURRENCE

The largest number of microdiamond crystals have been recovered from kyanite-garnet-biotite gneisses of the Vågholmen slab, while only 2 grains have been identified as diamond from garnet-biotite gneisses of the Knurrevika slab. We sampled 50 kgs of both types of rocks for confirmation of the diamond occurrence. The rocks have been subjected to thermo-chemical dissolution in the chemical laboratory at NGU where diamond has never before been tested in order to exclude laboratory contamination. At the present time two crystals of microdiamond have been optically identified at NGU and also have been identified by Raman spectroscopy at the Mineralogical Department of the Museum of Natural History in Paris. These diamonds have a round and spheroidal shapes and possess high contents of nitrogen; microdiamonds derived from kimberlitic pipes are also documented to possess high (O.3%) nitrogen (Kvasnitsa, 1985), so this may be one possible origin for the Fjørtoft microdiamods.

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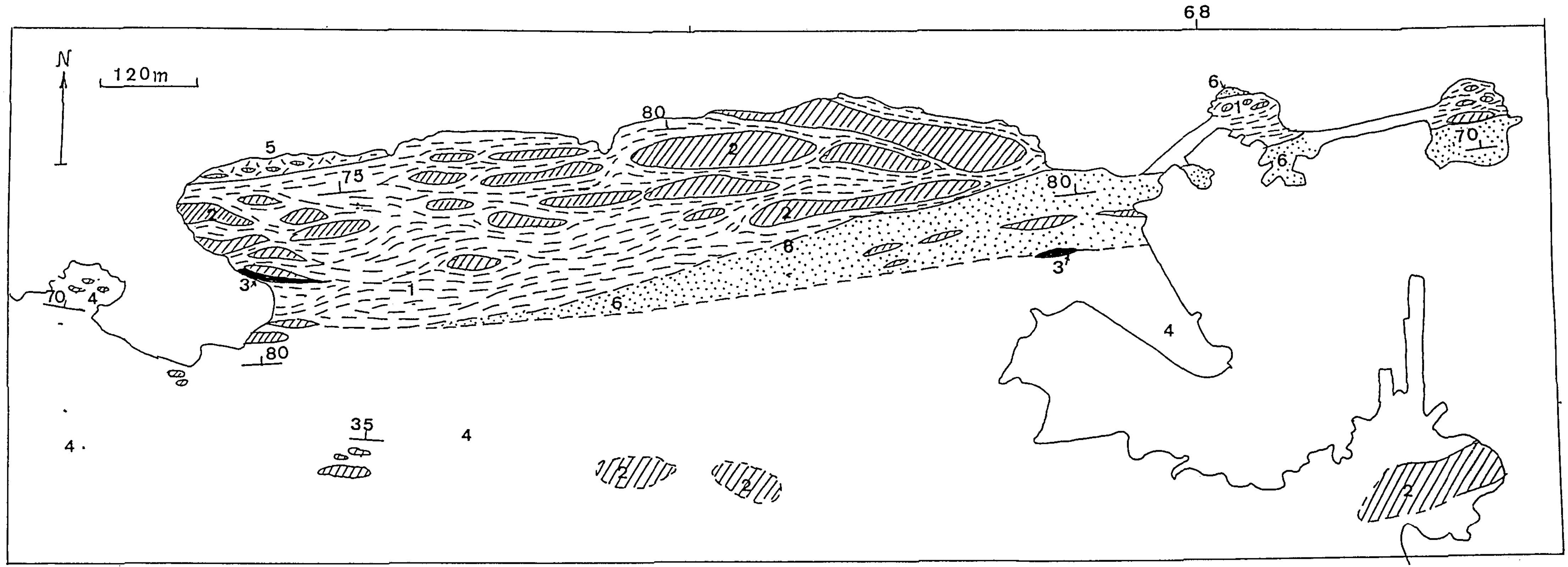

Fig.1. Geological map of the northen part of the island Fjørtoft.

1 - amphibol-garnet-biotite, pyroxen-amphibol-garnet-biotite and garnet-biotite gneiss;
2 - eclogite;
3 - serpentinised garnet-peridotite;
4 - plagioclase-rich garnet-biotite, and biotite gneiss, garnet-bioite migmatitic gneiss, augen gneiss and granodioritic gneiss;
5 - fine-grained biotite and anphibol-biotite gneiss;
6 - kyanit-garnet-biotite gneiss

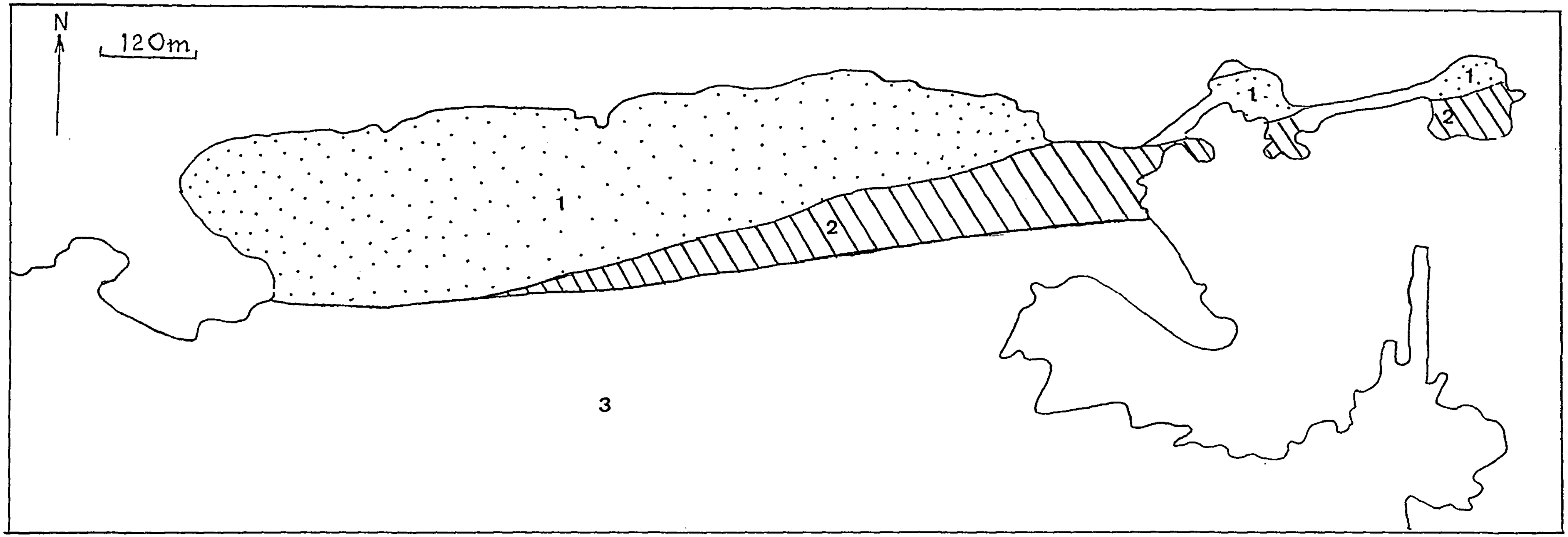

Fig.2. Tectonic map of the northern part of the island Fjørtoft.

1 - Knurrevika slab;
2 - Vågholmen slab;
3 - Hellvika slab.

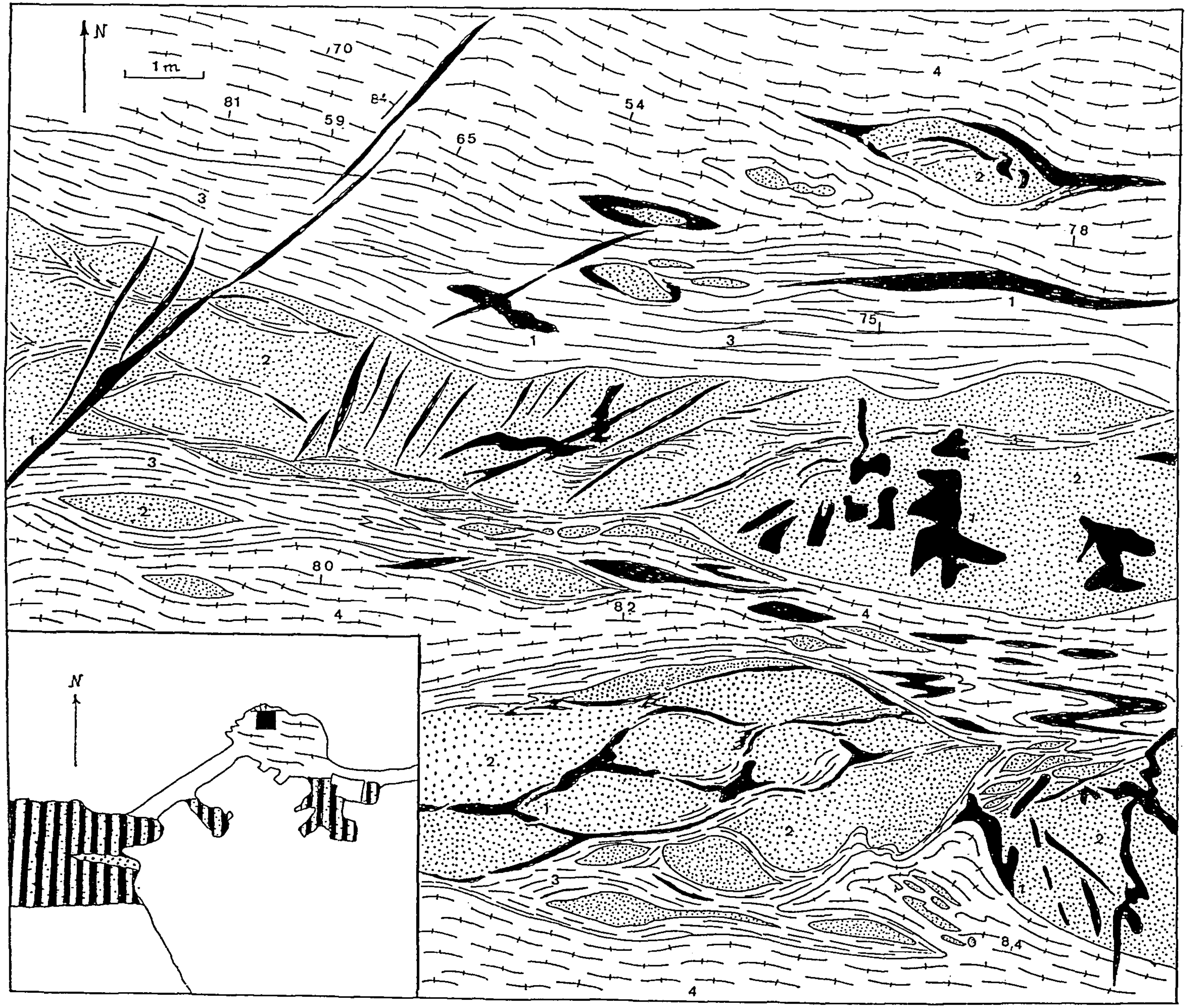

Fig.3. Geological map of the eastern part of the Knurrevika slab.

1 - granite and pegmatite;
2 - eclogite;
3 - transitional rocks (Amf-Grt-Bt gneiss and foliated eclogite);
4 - Grt-Bt gneiss, migmatised Grt.Bt and Amf-Bt gneisses;