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Lithologic and tectonic profile across the Muohtaguobla area, Rombak basement window, Northern Norway. Field report.

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# RAPPORT

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**Tittel:**
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Sammendrag:

Områdene Sjangeli og Muohtaguobla tilhører en tidlig Proterozoisk vulkanitt-sediment serie som i de nedre deler (i øst, Sjangeli) består av pelittiske sedimenter, båndede silikat-karbonat bergarter og mafiske tuffer og lavaer. De øvre deler av serien (i vest, Muohtaguobla) består av pelittiske sedimenter, mafiske tuffer og felsiske vulkanitter. Disse suprakrustalene er intrudert av Proterozoiske plutonske bergarter.

De Proterozoiske suprakrustale og plutonske bergarter er sterkt påvirket av den kaledonske orogenesen. Påvirkningen er særlig markant i N/S-gående mylonitt-soner. Deformasjonsstilen har nær sammenheng med litologien; isoklinale foldestrukturer opptrer i duktile bergarter mens åpne foldestrukturer er assosiert med mere kompetente bergarter.

Rapporten er på engelsk.

| Emneord | fagrapport | |
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| berggrunnsgeologi | | |
| strukturgeologi | | |

# Lithologic and tectonic profile across the Muohtaguobla area, Rombak basement window, Northern Norway. Field report.

Rolf L Romer and Theresa M Boundy

## Abstract

The Sjangeli area and Muohtaguobla area form a Proterozoic volcano-sedimentary sequence, which in its lower parts (to the east) consists of pelitic sediments, banded silicate-carbonate rocks, and mafic tuffs and lavas, while in its upper part (to the west) pelitic sediments, mafic tuffs, and felsic volcanics occur. This stratigraphic sequence has been intruded by Proterozoic plutonic rocks.

The Proterozoic supracrustal and plutonic rocks have been strongly affected by the Caledonian orogeny and thrusted along ~ N-S striking mylonite zones. The deformation style correlates with the lithology; isoclinal fold structures are related with ductile rocks, while open fold structures are associated with rigid (more competent) rocks.

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## Introduction

The aim of this investigation was (1) to study the contact relationships between the Muohtaguobla supracrustals and the Ruvssot-Sjangeli supracrustals to the east, and (2) to investigate the tectonics of the area and the field-relations between graphitic schists and quartz-pebbled conglomerates of possible Late Precambrian / Early Cambrian age and Early Proterozoic volcano-sedimentary rocks and intrusives.

Recent attempts to map the Muohtaguobla area, Northern Norway (location map Fig. 1), have resulted in conflicting geological interpretations (Birkeland 1976, Korneliussen and Sawyer 1986).

Birkeland (1976) recognized the Caledonian structures and that the graphitic schists and quartz-pebbled conglomerates resembled the rocks of the Dividal group which are found at the northern edge of the Rombak window. Therefore, he interpreted these rocks as downfolded into the Proterozoic basement during the Caledonian orogeny.

Korneliussen and Sawyer (1986), on the other hand, recognized the similarity and continuity of the Muohtaguobla rocks with the Proterozoic supracrustal rocks from further west in the Rombak window, and also the intrusive character of Proterozoic granites. Therefore, they assumed these supracrustal rocks to be Proterozoic, although they questioned the stratigraphic position of the quartz-pebbled conglomerates, into which no intrusive granite had been found.

From our field data we conclude that (1) the Muohtaguobla area was strongly deformed and mylonitized during the Caledonian orogeny and that (2) the rocks represent reworked Proterozoic rocks similar to the ones found in the Sjangeli area (Romer 1987) with exception of the conglomeratic layers and the acid meta-tuffs (cf. Korneliussen and Sawyer 1986). One strongly mylonitized unit (referred to as "hårdskiffer" = hardschist) may represent a highly deformed version of rocks from the Sjangeli area.

This report is based solely on our field studies (2 weeks) and personal communications with Are Korneliussen (NGU) and Gerhard Bax (Stockholms Universitet).

## Profiles across the Muohtaguobla area: The different deformational styles

The following four sections refer to those from Profile A-A' and B-B' shown on Fig. 2.

### PROFILE A-A'

*Section 1.*

The easternmost Muohtaguobla units consist of several thin thrust sheets, which are locally isoclinally folded. These sheets show Caledonian structures, which are represented by prominent 320E lineations. These lineations have been used (1) to determine tectono-stratigraphic up/down and (2) as an indicator for Caledonian thrusting (pers. comm. G. Bax, Stockholms Universitet).

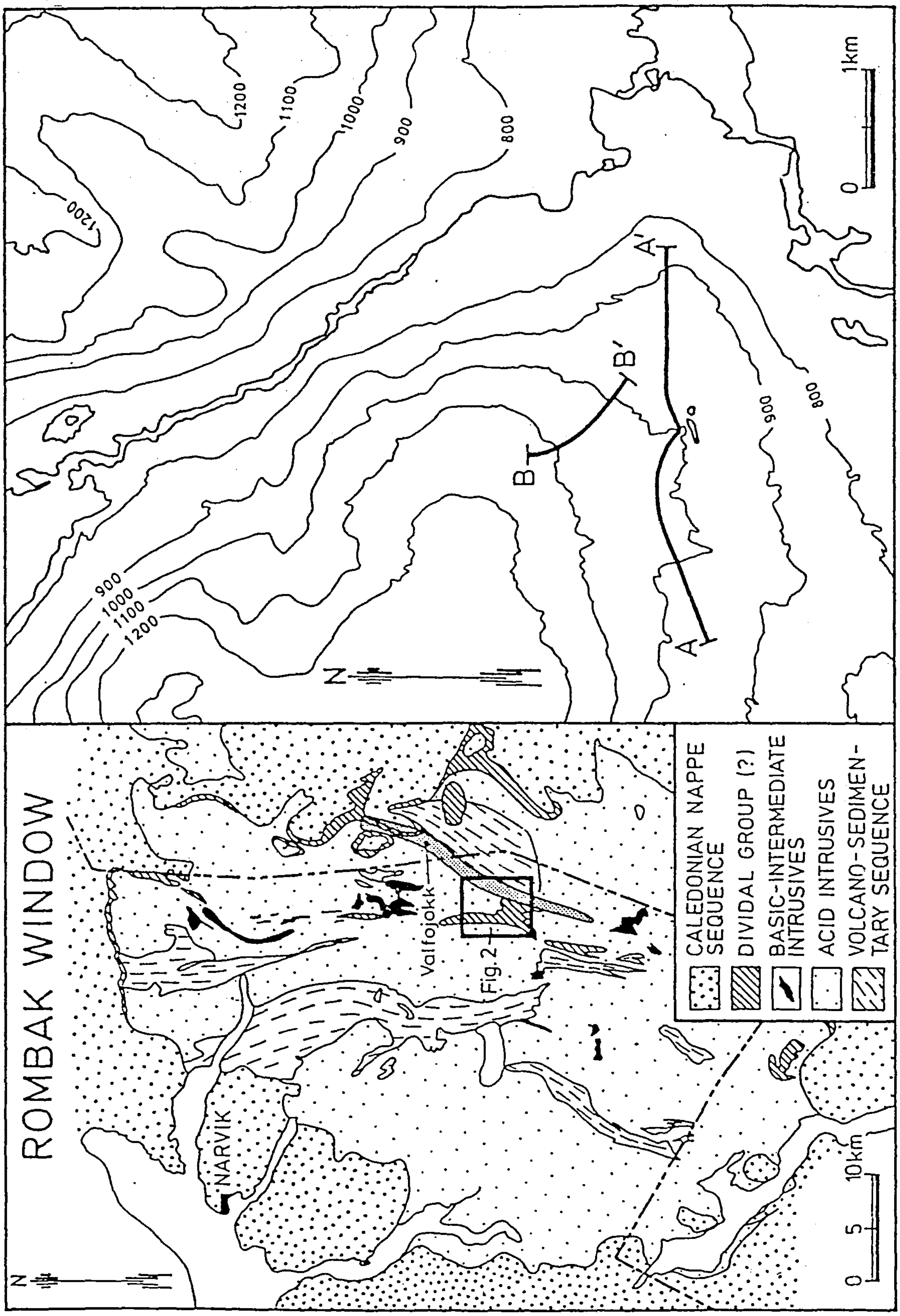


Fig. 1: a) Geological map of the eastern part of the Rombak-Sjangeli window, showing the Muohtaguobla and Sjangeli area and the major lineament (shaded) separating these two supracrustal belts. Modified from Birkeland (1976), Vogt (1950), Korneliussen and Sawyer (1986), and Romer (1987). b) Topographic map of the Muohtaguobla area indicating the position of the geological profiles (Fig. 2) and the field of the lineament map (Fig. 3).

The different gneiss "slabs" are very inhomogeneous, varying from augen gneiss to flaser gneiss to schist over distances of only a few meters. They strongly resemble the Proterozoic basement gneisses found in other parts of the Rombak-Sjangeli basement window (e.g. "Vassijaure granite"). The orientation of the lineation of these gneisses (320-340E) is generally found in the Caledonian nappes (cf. Bax 1988) and therefore indicates that the gneisses had been further deformed during the Caledonian overthrust.

These gneisses appear to represent basement slices which have been thrusted over other basement slices. No conglomerates have been found in this section.

To the west of this section, two mylonite zones converge northwards (see Fig. 3) limitting the gneisses which fill the intermediate space. These gneisses form a "roof-tile" pattern. These "tiles" are sheared off slices of basement gneisses and give tectono-stratigraphic up indications to the west. No intercalations of Proterozoic supracrustal or Caledonian cover rocks have been found.

*Section 2.*

From east to west, this section is comprised of interlayered gneisses and meta-tuffs, local meta-volcanites, carbonate-containing meta-tuffs, mica schists, and rusty mica schists (often containing graphite in strongly varying concentrations).

The whole suite (gneiss - mica schist - meta-tuff) has been isoclinally folded, with 20E striking fold axes which plunge ~ 10-$20^{0}$ N. The axial plane is upright (Wulff-net data: 24E/70W). A second generation of open, low-amplitude folds has refolded the first folding. Stereo-net data indicate an axis direction of 114E/20E for this second generation folds. The fold axis of the first generation folds plunge to the north in the northern part of the Muohtaguobla area and to the south in the southern part of the Muohtaguobla area. Therefore, in the Muohtaguobla area, the folds of the first generation became domed up. The mica schists and the meta-tuffs behaved ductily and developed a prominent Caledonian 320E lineation.

The rusty mica schists and the meta-tuffs of the Muohtaguobla area resemble the mica schists along the western edge of the Sjangeli supracrustals, and the meta-tuffs at Sjangelitjåkko, respectively. Stratigraphic and tectonic up coincide, which is consistent with the adjacent Sjangeli area.

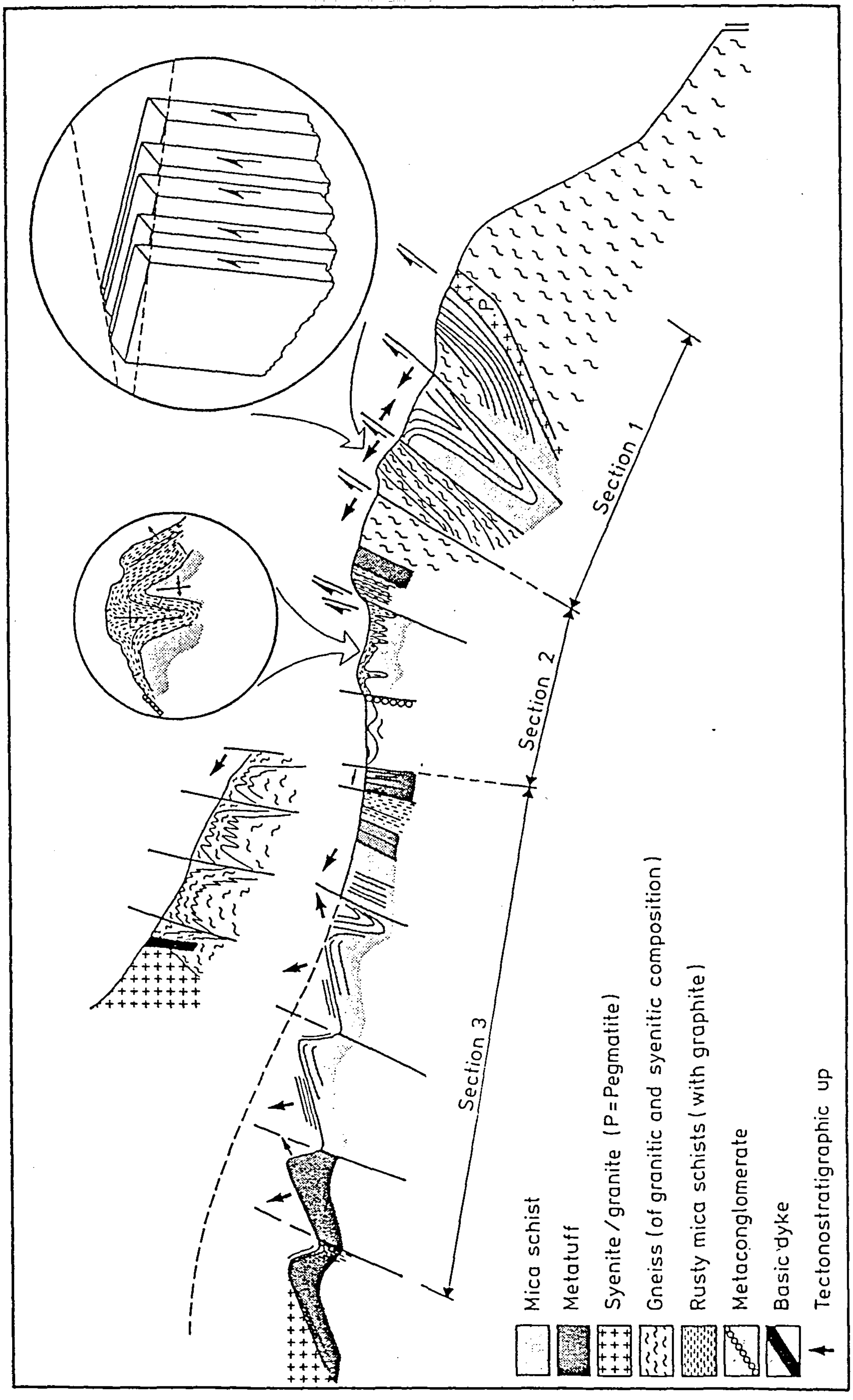


Fig. 2: Profiles A-A' and B-B' across the Muohtaguobla area illustrating the different tectonic styles of deformation. Section 1 to 4 refer to the text. Each section describes a specific style of deformation.

*Section 3.*

The westernmost part of the Muohtaguobla area is characterized by asymmetric folds (8E trending, gently N plunging fold axis) with a steep eastern and a sub-horizontal western limb. The synclines are tight and show often associated quartz veins. In contrast, the anticlines are open and have an angular hinge zone. No quartz veins were observed in the anticlinal hinge zones.. The steep limbs of the fold are characterized by isoclinal parasitic folding (N-plunging axes in upright, 8E striking fold axial planes), while the flat limbs show asymmetric parasitic folds (Z-type) with low-amplitudes and long wave-lengths. The steep lims with their isoclinal parasitic folds represent mylonites.

To the west, the supracrustal rocks are intruded by Proterozoic "granites"/gneisses. At the contact, the deformational style changes. The gneiss has zones of both weak (augen gneiss) and strong (flaser gneiss) deformation. Zones with strong deformation grade into mylonites, which form an anastomosing pattern, resembling a braided river pattern. Within the network lenses of weakly deformed gneiss (augen gneiss) occur.

**PROFILE B-B'**

*Section 4.*

This short profile extends from a arsenopyrite-pyrite-mineralized fault zone in the SE, to the gneiss (type "Vassijaure granite"), in the NW (cf. Fig. 1)

Gneisses predominate, but minor meta-tuffs also occur. The whole section is folded along 20E trending, gently N-plunging axes, which combine to a upright fold axial plane. The gneisses form broad anticlines, often with symmetric (M-type) parasitic folds in the hinge zones, while the meta-tuffs form tight synclines. In these synclines, symmetric parasitic (M-type) folds refold an older schistosity. The penetrative, younger schistosity, which is associated with this M-type folding, trends 20E, is sub-vertical and occurs in the tight hinge zone and both sub-parallel fold limbs. This penetrative vertical schistosity is parallel to the axial plane and defines mylonite zones.

At the strongly sheared intrusive contact to the gneiss/granite, the deformation style changes. To the NW of this sheared zone, the "granite/gneiss" is locally weakly deformed (coarse augen gneiss) but contains prominent fine-grained gneiss-zones (flaser gneiss) in the approximate continuation of the supracrustal mylonite zones.

## The tectonic style of the different profile sections

The tectonic style of the four different profile sections and the gneisses is due to contrasts in the ductility and competency of the various rock types.

sect. 1: Isoclinal folds (~ N-S striking sub-horizontal fold axes) and, towards the west, "tile-stacking" of slabs of gneiss. The stacking of isolated slabs predominates. No reversed tectono-stratigraphic up indications were found within the "tile-pile" (Fig. 2).

sect. 2: Isoclinal folds with ~ N-S striking sub-horizontal axes. Refolding along 114E trending, 20E punging fold axes creates low-amplitude domes. The rigid bodies form a chocolate-tablet boudinage pattern.

sect. 3: Asymmetric folds with sub-horizontal W-limbs (predominatly gneiss) and steep E-limbs (mainly mica-schists and meta-tuffs). The gneiss sheets are discontinuous and are absent in the steep limb of the fold. Asymmetric parasitic folds occur in the western limb, while a 320E lineation has been observed in both limbs. Synforms are bounded to (rusty) mica schists which show varying contents of graphite (0-20%??).

sect. 4: Open anticlines and tight sheared synclines. The anticlines consist of gneisses, where the synclines consist of meta-tuffs. The various slabs of gneiss are discontinous. The gneisses are disrupted in the steep limbs.

The isoclinal folding in sect. 2 is due to the extremely high content of ductile rocks (mica schists, meta-tuffs). This in contrast to the other sections, where gneiss/"granite" derived rocks predominate. The deformation in sect. 2 changes to a more open style of folding, as the content of "ductile material" in the "rock-package" decreases from about 80 vol% to <30 vol%. Ductile rocks are comprised of rusty and/or graphitic mica schists and meta-tuffs.

The style of sect. 2 and the occurence of SW-NE trending (Set 2, see below) lineaments (faults/mylonites), which disrupt the linear pattern of the ~ N-S trending mylonites, may be interrelated.

## The lineaments within the Muohtaguobla area

From the airphotographs mapped, five different types of lineaments can be distinguished (Fig. 3). These sets of lineaments are characterized as follows:

Set 1: N-S sub-vertical mylonite zones, often associated with hinge zones of isoclinal and tight folds; locally associated with a subset of ~340 E striking faults

Set 2: 40 E striking faults associated with the ductile rocks (mainly mica schists) in the isoclinal folded zone (sect. 2)

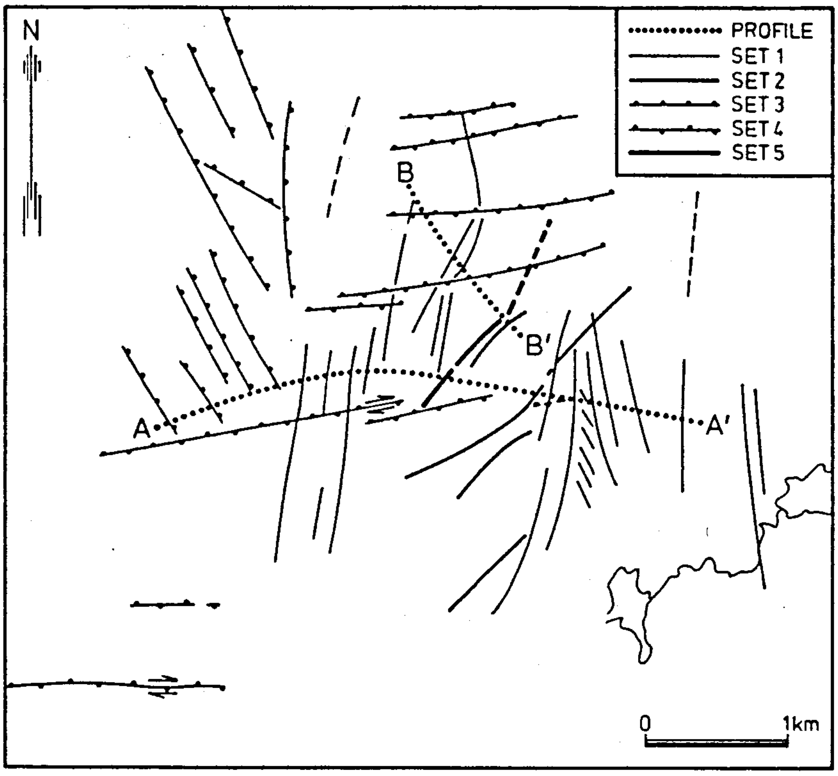


Fig. 3: Lineaments in the Muohtaguobla area, mapped from air photograph FW 7807, 31-4 (15-08-78). Five differnt types (sets) of lineaments occur. See text.

Set 3: 300-320 E stiking faults in the gneisses/granites W of Muohtaguobla

Set 4: E-W late lineaments, with local minor dextral movement (max. 100 m, observed on one fault)

Set 5: lineament (probably rock contact) with prominent change in the tectonic style from style 3 (N) to style 2 (S).

The zones of different lineaments (Fig. 3) coincide with the zones of different tectonic style. The N-S striking lineament is the dominant element, and trucates other lineaments (especially Set 3 lineaments). Further to the north, this N-S lineament bends to the east, and then (at Valfojokk) back to N-S again (Fig. 1). This dominate N-S lineament truncates the basement lineaments, from the granite to the west of Muohtaguobla. The same relationship is seen further to the north at Valfojokk. Between the Muohtaguobla area and Valfojokk, this lineament parallels the eastern contact between the Sjangeli supracrustal rocks and the granite (this contact is partially intrusive and partially tectonic; Romer 1987).

The N-S lineaments form a set of mylonites which are steeply dipping and are generally confined to hinge zones of isoclinal folds or to the narrow synclinal hinge zones, when a more open asymmetric fold style is present. In domains with an open fold style, the anticlinal hinge zones generally are not mylonite zones.

SW-NE striking lineaments (Set 2) occur between different sets of N-S striking lineaments (Fig. 3) and are confined to the zone of isoclinal folding (upright N-S striking axial planes with gently N-plunging axis). The SW-NE lineament are defined by the traces of fold axes from the subsequent open refolding (gently eastward plunging 114 E striking axis).

**The connection between the Muohtaguobla area and the Sjangeli area**

The lithologies of the Sjangeli and the Muohtaguobla area are similar, especially the rusty mica schists and the meta-tuffs. However, the conglomerates, acid meta-tuffs, and highly deformed "hårdskiffer"-like rocks have not been observed in the Sjangeli supracrustal rocks. In addition, the Proterozoic tectonic trends are similar, especially the N-S trending lineaments, and also the truncation of the 300 E lineaments (Fig. 1) which occur in the intrusive units.

These similarities and the geographical relation indicates that the Muohtaguobla area could be the SW-ward continuation of the Sjangeli area (Fig. 1). The Muohtaguobla area became strongly segmented during the Caledonian orogeny and was overthrusted onto the basement. This Caledonian impact was minor in the Sjangeli area, and there occur Proterozoic N-S lineaments, which did not become reactivated during the Caledonian orogeny (Romer 1987).

In this scenario, the Muohtaguobla area would represent the upppermost part of the (known) stratigraphic sequence of the Sjangeli area (cf. Romer 1987).

**Potential bearings of the basement reactivation for precious metal deposits**

Pb-isotopic data demonstrate the addition of lead to previously existing mineralizations in the Sjangeli area during the Caledonian orogeny (Romer in prep.) The lead addition was strongest in permeable rocks such as mylonites. The lead addition was associated with pervasive fluid flow. Similarly, the Muohtaguobla area could have been mineralized or a mineralization could have been formed in the upward continuation of the basement mylonite in the Caledonian cover (Romer in prep.). From the occurences of the mylonites it would appear that synclines are more favorable sites for mineralizations then anticlines, since anticlines do not show related mylonites. Further, it is more likely that the mylonites acted as channelways and that metals did not precipitate in larger amounts until a chemically different rock unit is encountered. This rock unit would cause the exhaustion of the chemical buffer of the fluid and trigger precipitation. Such a "trigger-unit" could be the lowermost Caledonian nappes in the upward continuation of the mylonite zones (compare Romer in prep.).

## Conclusions

The Muohtaguobla area appears to represent the upper stratigraphic level of a volcano-sedimentary sequence, of which the Sjangeli volcanics form the lower level. The Muohtaguobla area, in contrast to the Sjangeli area, has been completely tectonized during the Caledonian orogeny. The tectonic style appears to be dependent on the predominant lithology, varying from "tile-stacking" to isoclinal folding. The dominant lineaments (mylonites) stike N-S and limits the geographical distribution of the different tectonic styles.

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