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Tittel Sulphide prospecting in the Reinfjord area.				
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Fagområde Geologi	Dokument type Rapport	Forekomster Reinfjord area: S of Isdalen Olderfjord area: Spitsnes		
Råstofftype Malm/metall	Emneord Ni Cu Fe S			
Sammendrag				

A/S SULFIDMALM
INTER-OFFICE MEMORANDUM

RG
Nixon

Date: 24th January, 1973

To: Falconbridge Nikkelverk A/S ✓

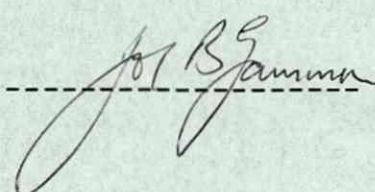
cc: A. M. Clarke, D. R. Lochhead,
H. A. Rosenqvist, R. B. Band,
B. A. Sturt

From: J. B. Gammon

Subject:

905-16, Reinfjord area, N. Troms. (Report No. 203-72-16).

Please find attached Rosenqvist's report on prospecting in the Reinfjord area, N. Troms. Sulphides are encountered along the pyroxenitic border facies of a layered ultrabasic intrusion. The best assay returned was 0.42% Ni, 0.32% Cu, 1.6% S. Sulphide enriched horizons were also found in a rhythmically layered norite intrusion from which the best assay result was 0.31% Ni, 0.30% Cu, 1.8% S. Further follow up work will be carried out during the course of "Operation Phoenix" in 1973.



FOR FALCONBRIDGE NIKKELVERK A/S

A/S SULFIDMALM

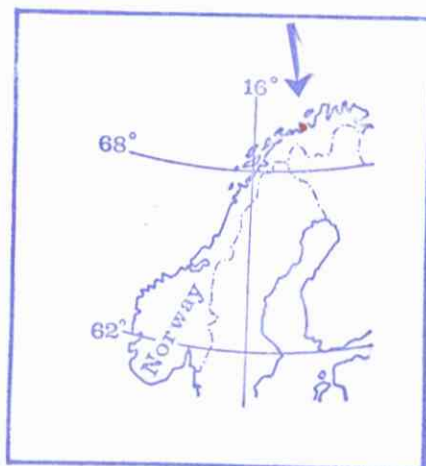
PROJECT 905-16

SULPHIDE PROSPECTING IN THE
REINFJORD AREA, N. TROMS.

DECEMBER 1972

by

H. A. ROSENQVIST



INTRODUCTION.

The report deals with sulphide prospecting, carried out in two selected target areas within the Loppa district, N. Norway. This district forms the SW part of the mafic-ultramafic province of Vest-Finnmark, the general target for project 905-16.

A. The Reinfjord ultramafic complex.

B. The Olderfjord norite.

The geology and economic potential of the first target have been treated in an earlier report by M. C. Bennett (Sulfidmalm report 202-72-16).

LOCATION AND ACCESS.

The Reinfjord area ($21^{\circ}\text{E}/70^{\circ}\text{N}$) is located N of Kvaenangen fjord, approximately midway between the towns Tromsø and Alta. (Fig. 1).

The small fishing village of Reinfjord can be reached by a (more or less) regular boat connection from Jøkelfjord, or by taxi flights. Target A occupies the high ground NE of Reinfjord, whereas target B is exposed in the mountains W of this fjord.

The area is mountaineous and both targets are well exposed. The ultramafic complex extends beneath the ice cap Langfjordjøkelen, otherwise the targets are only locally covered by snow, small lakes and talus material. More than usually rough topography, with steep walls and unstable screes, creates accessibility problems. In simple "hammer prospecting" these are however only time consuming rather than obstructive.

A. REINFJORD ULTRAMAFIC COMPLEX.

General.

The ultramafic complex consists essentially of layered peridotites intruding garnet gneiss in the S and W, but elsewhere intruding layered gabbro (Fig. 2). The complex forms a roughly saucer-shaped mass, with lateral dimensions approx. 6 x 4 km. A minimum of 1000 m thickness is exposed.

Fig. 3 is a simplified picture of the zoned rock type distribution within the ultramafic complex, as mapped by M. C. Bennett.

UDZ Upper dunite zone: Dunite and wehrlite.

MLZ Middel layered " : Layered clinopyroxenites and wehrlites.

UMZ Upper marginal " : Two-pyroxene peridotite, felsphatic peridotite and pyroxenite.

LMZ Lower marginal " : Layered olivine-pyroxenites, pyroxene peridotites and pyroxenites.

For a detailed geological map and description it is referred to Bennetts report (202-72-16).

Of particular interest is a "sulphide phase" occurring within the marginal zones. Prospecting, carried out during a 9-day trip in July 72, was mainly directed towards these zones. Also the central portions were prospected, but in a reconnaissance manner. Later in the season a limited section of the sulphide carrying SE margin (MLZ-UMZ) was mapped as an attempt to outline the magnitude and possible pattern of sulphide mineralization here. Some reconnaissance VLF-EM profiles were also run over this section.

SULPHIDE MINERALIZATION.

(1) LMZ:

This zone was prospected in upper Kjerringdal and along the steep slopes E of Reinfjord. The rock is a fine-medium grained pyroxene rich ultramafic, locally also slightly felsphatic. Small amounts of interstitial po-cp mineralization can frequently be observed.

Richest found mineralization assayed:

<u>Sample</u>	<u>Ni</u>	<u>Cu</u>	<u>Fe</u>	<u>S</u>	
16 Lo 8	0,15	0,07	8,5	0,2	%
16 Lo 9	0,18	0,16	8,2	0,3	%

(2) UMZ/MLZ:

The boundary between these zones are difficult to observe in the field, especially on the W-side as pointed out by Bennett.

- The area N of Isdalen ice-fall was prospected between Sneidalen and the peak 1001. (See Bennett's map). Only sporadic sulphide grains were found and the area seems to be without economic interest.

- The Isdalen - Storvannet section of the marginal zones frequently carries disseminated sulphides, but in accessoric amounts. The sulphides, po with minor cp, occure interstitially particularly within pyroxenitic rocks. "Concentrations" (est. 2-5% of vol.) were observed in small irregular portions, also in localities not marked by Bennett as sulphide bearing.

A promising type of mineralization was found at the head of a narrow valley S of Isdalen. Approximately 10% of sulphides (po-cp) occur interstitially disseminated in a coarse grained pyroxenite (samples 5 and 50). Being of very modest dimensions (vertical exposure 70x70 cm), this sulphide enriched portion is economically insignificant in itself. Nevertheless it gives a clear indication of what type of enrichment could be expected within the ultramafic complex.

Samples from sulphide enriched portions within the Isdalen - Storvatnet section assayed:

<u>Sample</u>	<u>Ni</u>	<u>Cu</u>	<u>Fe</u>	<u>S</u>	
16 Lo 5 b	0,42	0,32	8,7	1,6	%
" 6	0,24	0,13	10,2	1,0	%
" 19 (loc. boulder)	0,31	0,10	7,9	0,8	%
" 50	0,36	0,25	9,2	1,5	%
" 51	0,20	0,11	7,9	0,6	%

- Sulphide enriched portions of any importance were not found along the southern margins. Irregular and faint disseminations can be observed at the head of a valley running eastwards from Reinfjord (i.e. southernmost UMZ), whereas the section NW of claim point K4 seems to be almost free of sulphides.

The layered olivine pyroxenite (MLZ) in the southern part of the complex also appears to be almost sterile. Two faintly disseminated portions were observed and the richest possible mineralization sampled:

<u>Sample</u>	<u>Ni</u>	<u>Cu</u>	<u>Fe</u>	<u>S</u>	
16 Lo 16	0,15	0,07	8,5	0,2	%
16 Lo 52	0,27	0,08	15,8	0,2	%

- Reasonable amounts of sulphide disseminated pyroxenites occur along the E margin of the complex. Up to 10 vol. % of sulphides (po-cp) were found in pyroxenites adjacent to the intruded gabbro. This section contains the most wide spread sulphide mineralization exposed within the ultramafic complex. It was therefore selected for more detailed investigations. (See A-4 below).

(3) UDZ:

This is a rather homogenous dunite frequently cut by narrow coarse grained mafic dikes. Sulphides within this body are rare. The locality N of Tverrfjorddalen vann, noted by Bennett, carries a maximum of 1-2 vol. % of pyrrhotite. The mineralization is here associated with a pyroxene bearing olivine rock (wehrlite).

(4) The E margin of MLZ/UMZ:

Geology and mineralization.

A 1600 m long section (N 40 E) of the marginal zone was mapped at 1:1000 scale by F. Engberg (10-16.8.). His main task was to outline the sulphide mineralized portions. Engberg's map, also showing sample localities with assay results, is enclosed (1-203-72-16).

Three main rock types are distinguished within the area:

- (a) Gabbro (16 Lo 62) is a banded fine-medium grained anorthositic rock. No sulphides were observed.
- (b) Olivine pyroxenite (16 Lo 64) is a layered ultramafic with a characteristic yellowish scraggy weathering surface. It corresponds to Bennett's MLZ. Sulphide mineralization only occurs as scattered single grains within this unit.
- (c) Pyroxenites in general occupy the ground between (a) and (b). They show clearly intrusive sharp contacts against the gabbro whereas contacts against olivine pyroxenite are gradational. Using the grain size and abundance of sulphides as criteria, 4 types of pyroxenite were distinguished.

1. Pyroxenite (blue) comparatively free of sulphide mineralization. Type sample 16 Lo 63.
2. Mineralized coarse grained pyroxenite (red). Type sample 16 Lo 73.
3. Mineralized medium grained pyroxenite (purpur). Type sample 16 Lo 76.
4. Mineralized porphyritic pyroxenite (darked). Type sample 16 Lo 98.

Apart from the distribution of these rock types, the map (1-203-72-16) also show the visually estimated sulphide contents within them. The sulphides, mainly pyrrhotite with some chalcopyrite and pyrite, always occure interstitially between the silicates or along the cleavage face of pyroxenes.

The sulphide disseminations are of uneven and discontinuous character, but generally speaking they are more wide spread than in the rest of the margins of Reinfjord ultramafic complex. The most wide spread mineralization occure within coarse grained pyroxenite, the largest one being exposed over an 250x40 m area. (300N - 500N).

A total of 35 rock samples from the area were assayed for Ni, Cu, Fe and S by XRF (Kristiansand lab.). Keeping in mind that only sulphide carrying samples were assayed, the results are all but promising. (Table 1).

Ni/S contents are marked on the map. The field observation that sulphide enrichment slightly have favoured the coarse grained pyroxenite, is confirmed by assay results!

VLF-profiles.

VLF-electromagnetic measurements were made along 6 profiles over the mapped section. A Crone Radem instrument was used, transmitter at Bordeaux, France (15,1 kHz). Observed dip angle data and calculated "Fraser values" *) are shown on map 2-203-72-16.

*) FRASER D.C. (1969) Contouring of VLF data:
Geophysics v. 34, p. 958-967.

Table 1: Assay results, E-margin.

	NUMBER OF SAMPLES	% Ni		% Cu	% Fe	% S	
		RANGE	ARITNM. MEAN	RANGE	RANGE	RANGE	ARITNM. MEAN
TOTAL	35	0,05-0,24	0,10	< 0,05-0,09	6,3-12	0,19-1,20	0,44
Pyroxenite 2	18	0,05-0,18	0,10	< 0,05-0,09	6,7-12	0,19-1,20	0,55
Pyroxenite 3	8	0,05-0,24	0,10	< 0,05	6,3-10,4	0,19-0,70	0,40
Pyroxenite 4	5	0,06-0,10	0,08	< 0,05	6,5-8,8	0,19-0,31	0,23

Two clear anomalies on the southernmost profile D, weakly picked up on E, are not explained by present field observations. The anomaly zone in NW is most likely related to a tectonic zone, clearly visible on aerial photos.

The main experience from this VLF-reconnaissance is that the method was unable to find the observed sulphide disseminated belt. Considering the discontinuous type of mineralization, this might however be achieved by a more systematic and detailed survey.

B. THE OLDERFJORD NORITE.

General geology.

The Olderfjord norite (Fig. 2) is described by Hooper in 1971 (NGU 269 pp. 148 - 151) as a rythmically layered well preserved N-S elongated intrusion.

"Rythmic layering, due to variable proportions of the principal mineral phases, labradorite and orthopyroxene, and locally emphasized by variation in grain size and texture, can be mapped accross the intrusion.

Although disturbed by many small faults, the general assymetric synformal nature of this structure is well preserved, dipping away from the vertical eastern contact at 60° W, passing through the horizontal and lying at approximately 20° E against the relatively shallow (30° E) dip of the western contact. Density stratification is observed in many places, but is not universal. Igneous lamination and lineation occurs in the pyroxene rich layers. The more feldspathic layers are largely recrystallized, but there appears to have been no change in composition of either the feldspar or the pyroxene during this process. It must be assumed that recrystallization took place either at a temperature very similar to that of primary crystallization, in the chrystal mush stage or, if later it took place without the availability of water to form hornblende.

A very slight cryptic layering has been detected by careful optical measurement of the pyroxene and plagioclase. The higher temperature assemblages occur at the top and bottom of the exposed section (Reinfjorddalen), and the lowest temperature assemblage near the middle. The final portion to crystallize is more feldspathic than, and locally transgressive to, earlier layers and contains almost as much clinopyroxene as orthopyroxene."

Concerning the regional setting of the Olderfjord norite, Hooper presents a hypothesis based on the assumption that the adjacent Sandland - Middagsfjell gabbro (to the N) and the Andsnes peninsula gabbro (to the NW) all belong to the same original intrusion (See fig. 2). According to the idea, the Olderfjord norite represents "a north-south elongated feeder dyke, widening rapidly upwards to the west to form the conformable Andsnes sheets and with the Sandland - Middagsfjell mass forming the upper part of the intrusion, packed with sedimentary rafts."

Sulphide prospecting.

Elementary hammer prospecting for sulphide mineralization was carried out by students KL/LM during a 10-day trip in July 72. A strongly weathered rusty zone - Spitsnes rust belt - was located in the southernmost part of the area approximately 1500 m NW of cape Pilvaag (see red spot on fig. 2). The E-W trending belt (est. 300 x 50 m) is exposed 500-600 m a.s.l. on the steep and unstable southern slope of Spitsnestind. Samples, showing a fine grained sulphide dissemination in presumably a mafic layer of the norite, assayed

<u>Sample</u>	<u>Ni</u>	<u>Cu</u>	<u>Fe</u>	<u>S</u>
16 Lo 31 (loc. bould.)	0,31%	0,30%	18,0%	1,8%
" 32 (outcrop)	0,41%	0,15%	17,6%	1,2%
" 33 "	0,31%	0,11%	12,8%	0,8%

Except for the Spitsnes rust belt, no significant mineralization was found within the norite. Sulphides are rare, occurring only as small interstitial grains in accessory amounts, if not totally absent. Two samples, representing the "richest" mineralization found outside Spitsnes rust belt, were assayed:

<u>Sample</u>	<u>Ni</u>	<u>Cu</u>	<u>Fe</u>	<u>S</u>	
16 Lo 25	0,20	0,08	11,8	0,9	%
" 27	0,18	0,09	12,0	0,5	%

CONCLUSIONS.

- A. - As pointed out by Bennett (202-72-16), sulphide mineralization of the Reinfjord ultramafic complex is associated with pyroxenitic rocks along the margins.
 - Observed sulphides always occur interstitially and in an irregular and discontinuous manner.
 - Field observations and assay results indicate that the mineralization in general is without economic interest.
 - Minor follow up work seems however justified by:
 - a) The mineralization found S of Isdalen.
 - b) The unexplained VLF-anomaly at the E-margin.

This work is suggested to include:

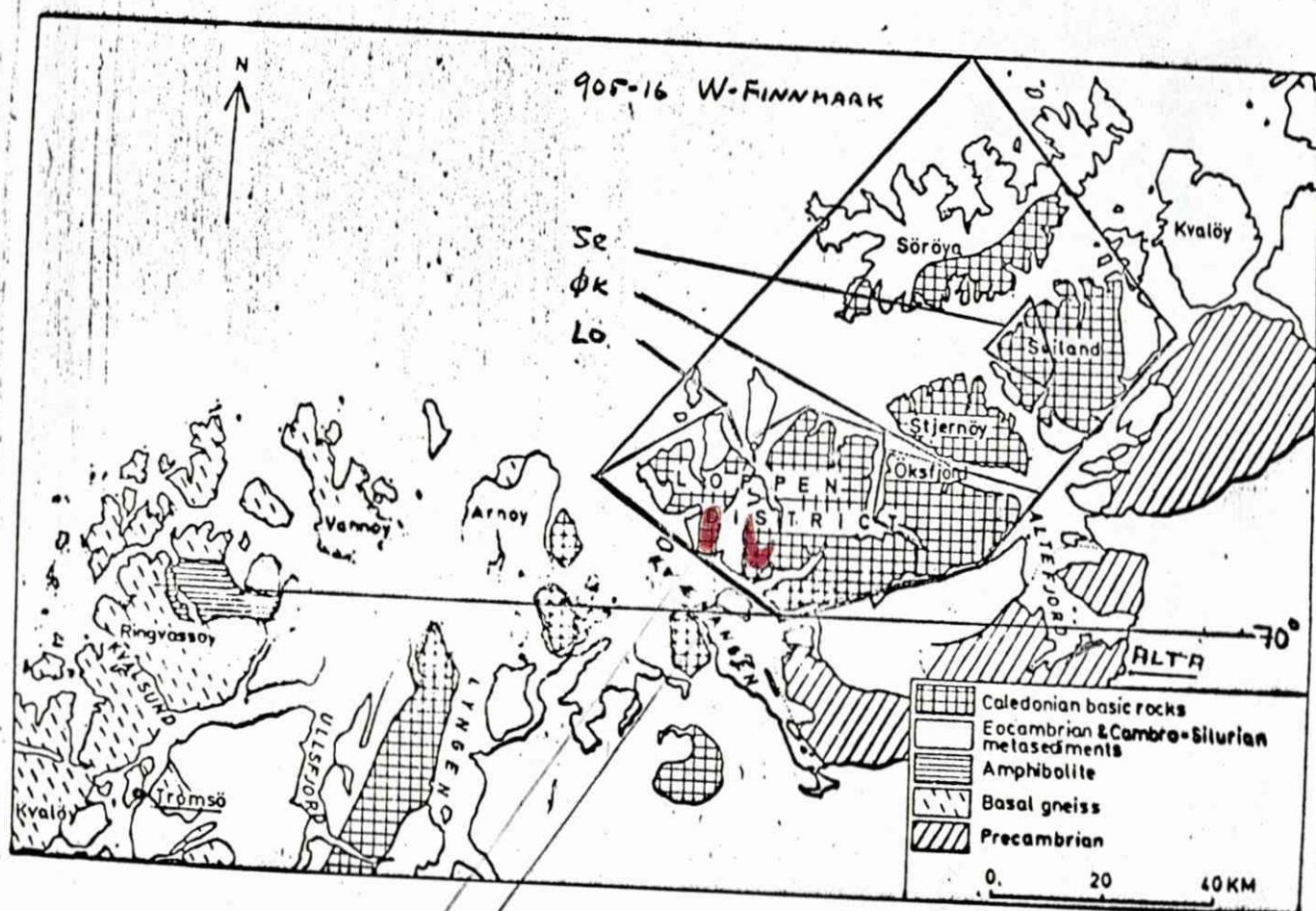
- 1) Geological investigation of the "showing" S of Isdalen. (Blasting and mapping).
- 2) Detailed VLF-EM/Mag. survey over this area S of Isdalen.
- 3) Field examination of the VLF-EM anomaly at E-margin by geological and systematic VLF-EM/Mag. work.

- B. - Reconnaissance prospecting of the Olderfjord norite showed that it in general only contains totally insignificant amounts of disseminated sulphides.
- The "Spitsnes rust belt" suggests that sulphide enrichment occurs. If present in other localities these should be detected by helicopter reconnaissance (Operation Phoenix 1972).
 - The Spitsnes locality is recommended for geological examination, i.e. tracing, sampling and mapping the sulphide enriched belt.
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Encl. Fig. 1: Genl. location map.

- " 2: Geological map of the Løppen district.
- " 3: Reinfjord ultramafic complex. Location map.

Map 1-203-72-16 Reinfjord ultramafic complex.
Geology of part of the E-margin.
" 2-203-72-16 VLF-EM profiles.
Reinfjord ultramafic, E-margin.



REINFJORD ULTRABASIC COMPLEX

OLDERFJORD NORITE

Fig 1. LOCATION MAP

GEOLOGICAL MAP of the LOPPEN DISTRICT

WEST FINNMARK

- DRIFT
- LIMESTONE
- GREENSTONE-PELITE ASSOCIATION (OLDERFJORD)
- PELITE
- SEMI-PELITE
- UNDIFFERENTIATED PELITE AND SEMI-PELITE
- FELSPATHISED AMPHIBOLITE-PSAMMITE HORIZON WITH CALCAREOUS BANDS
- SKIFER STEIN
- SEVERELY FOLDED MASSIVE TRANSITIONAL TO GARNET GNEISS (SILDA)
- UNDIFFERENTIATED PSAMMITES
- GARNET GNEISS
- GNEISS ASSOCIATED WITH BERGSFJORD THRUST ZONE
- ADAMELLITE
- PERTHOSITE
- LAYERED ULTRABASIC INTRUSION
- BANDED SYENITIC GABBRO
- TWO PYROXENE GRANULITE
- LANGSTRAND OLIVINE GABBRO
- MÅRN GABBRO
- OLDERFJORD LAYERED NORITE
- QUARTZ-FELSPATHIC BANDS IN GABBRO
- GABBRO WITH UP TO 50% METASEDIMENT INCLUDED
- UNDIFFERENTIATED GABBRO
- FOLIATION
- PRIMARY LAYERING IN GABBRO
- DIRECTION OF YOUNGING

THE MÆVER PELITE GROUP

LOPPA

THE BRYNILEN PSAMMITE GROUP

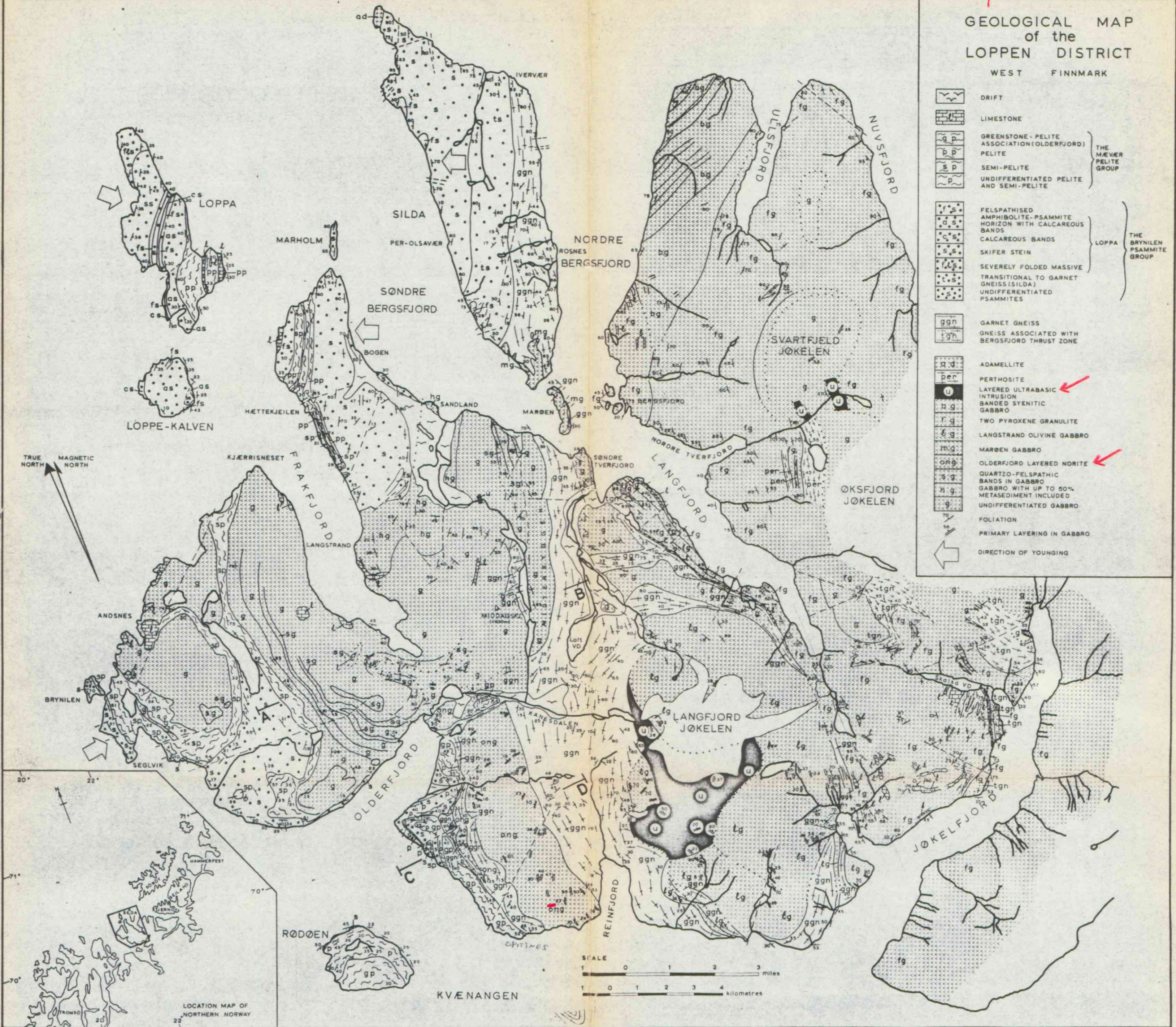
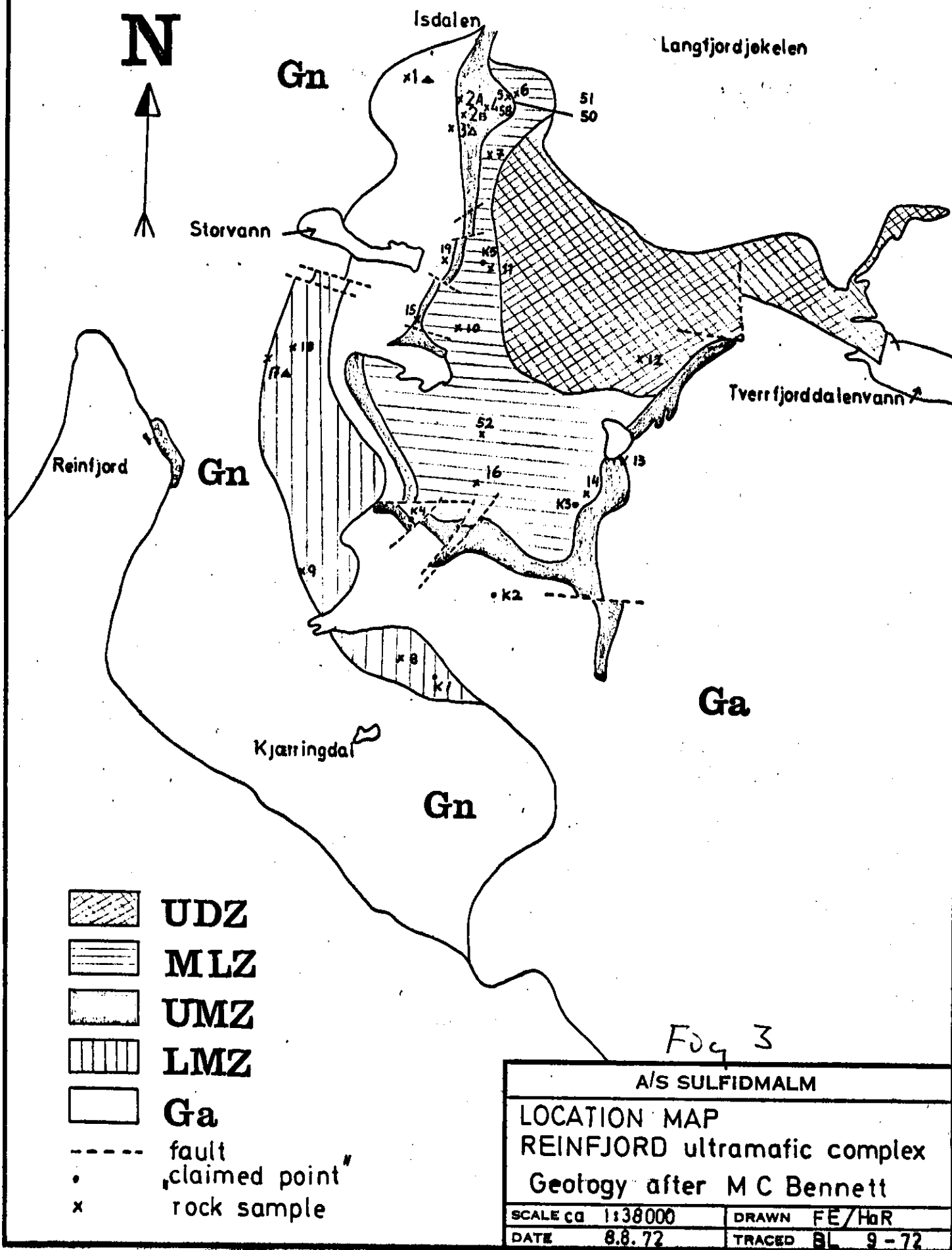
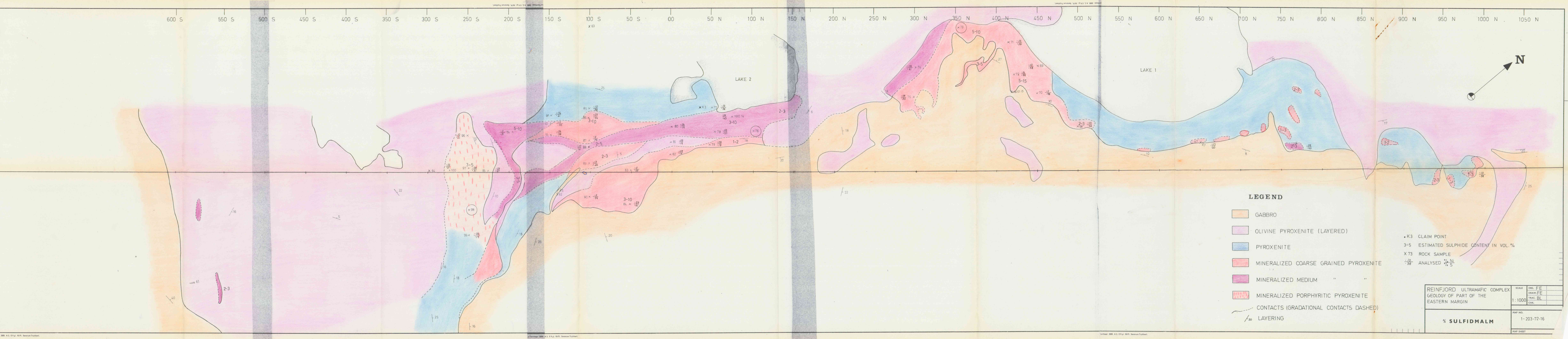


Fig. 9. Geological map of the Loppén district, West Finnmark and North Troms, Norway.

1:100,000

Mapped and compiled by P.R. Hooper 1961-1968 with additional information from D. Lewis (Andnes peninsula), C.W. Gronow (Loppa and Silda) and C. Blackburn.



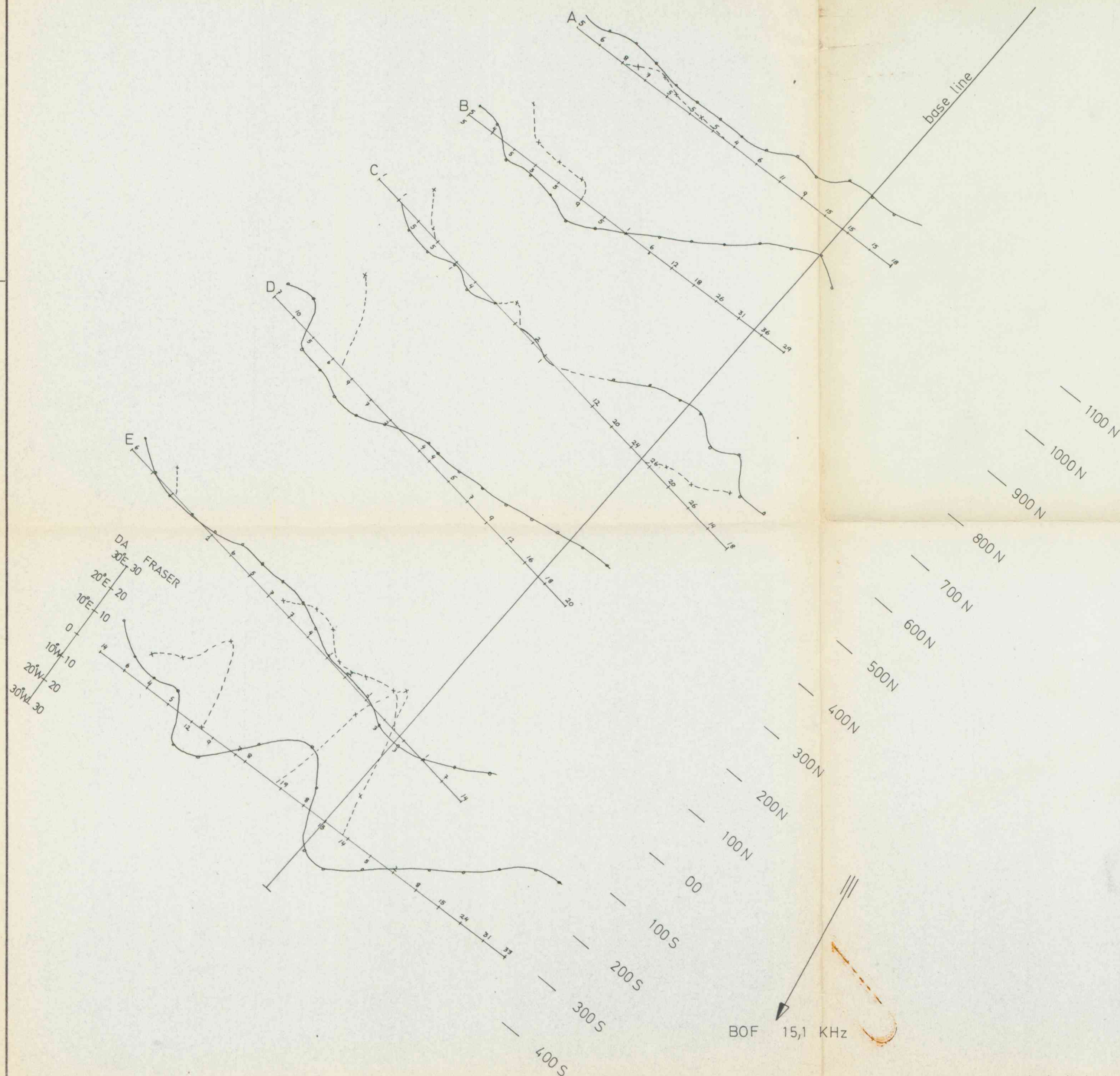


LEGEND

- GABBRO
- OLIVINE PYROXENITE (LAYERED)
- PYROXENITE
- MINERALIZED COARSE GRAINED PYROXENITE
- MINERALIZED MEDIUM
- MINERALIZED PORPHYRITIC PYROXENITE
- CONTACTS (GRADATIONAL CONTACTS DASHED)
- LAYERING

• K3 CLAIM POINT
3-5 ESTIMATED SULPHIDE CONTENT IN VOL. %
X 73 ROCK SAMPLE
-10/-38 ANALYSED % Ni / % S

REINFJORD ULTRAMAFIC COMPLEX GEOLOGY OF PART OF THE EASTERN MARGIN	SCALE	OBS. FE	
		DRAW. FE	
	1: 1000	TRAC. BL	
		CHK.	
% SULFIDMALM	MAP NO.		
	1-203-72-16		
	MAP SHEET		



Instrument : Crone Radem VLF-EM

Station : Bordeaux France (15,1 kHz)

East
West : Dip Angles of resultant field.

Fraser values only positive ones plotted

VLF-EM PROFILES
REINFJORD ULTRAMAFIC E, MARGIN
N-TROMS NORWAY

SCALE 1:5000	OBS. KS	8/72
	DRAW. HaR	9/72
	TRAC. BL	9/72
	CHK. 10.8	9/72

1/2 SULFIDMALM

MAP NO.

MAP SHEET