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Report to accompany the geological map of the Reinfjord ultramafic complex, Reinfjord, N Troms.

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Malm/metall	Cr Ti Fe Ni Cu Olivin serpentin talk magnesitt	

Sammendrag

FOR FALCONBRIDGE NIKKELVERK A/S

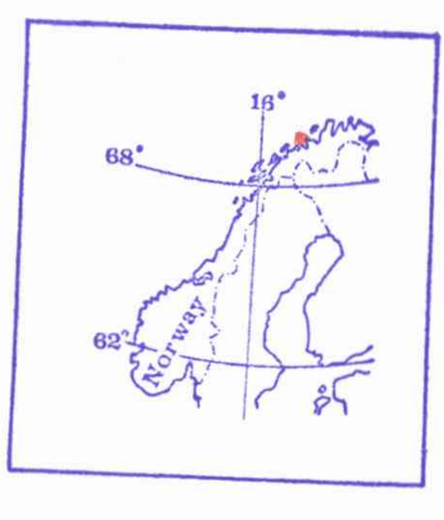
A/S SULFIDMALM

PROJECT 905-16

REPORT TO ACCOMPANY THE GEOLOGICAL MAP OF THE REINFJORD ULTRAMAFIC COMPLEX, REINFJORD, N TROMS, NORWAY.

C.M. BENNETT

B.Sc., FGS.



A/S SULFIDMALM

INTER-OFFICE MEMORANDUM

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3 SAKSBEARB. Nixon				SVARDATO

Date: 5/7-72

To: Falconbridge Nikkelverk A/S

cc: A.M.Clarke, D.R.Lochead, H.A.Rosenqvist

From: J.B.Gammon

Subject:

905-16, Reinfjord ultramafic complex

Please find attached Benretts report and map of the Reinfjord ultramatic complex in Nord-Troms.

This area is being investigated this summer as part of the "West-Finnmark Project". It will be noted that Benrett has observed sulfides, including the assemblage pyrrhotite -pentlandite-, chalcopyrite, particulary concentrated at the margin of the complex.

Prospecting will be initially consentrated in the areas.

J.B.Gammon

I Introduction

1. General

The Reinfjord ultramafic complex is situated at lat. 70°N, long. 21°E and occupies the high ground between Reinfjorden and Langfjordhamn. The exposed outcrop of the ultramafic complex measures approximately 6km (N-S) by 4km (E-W) and a minimum 1000m thickness of ultramafic rocks are exposed. The complex is inferred to extend beneath the ice of Langfjordjökelen in the manner shown on the accompanying map.

The ultramafic rocks are intrusive into the SW corner of an extensive sheet of layered two-pyroxene gabbro which covers much of the ground between Reinfjord, Sör-Tverfjord and Jökelfjord (Hooper 1971, Fig 9).

The ultramafic complex and the surrounding gabbro are extremely well exposed. The groundis rocky and unstable screes are common on steeper slopes. Access to the ultramafic complex is best achieved along the valleys running northwards and eastwards from Reinfjord village. All other valleys are negotiable but there is an ice-fall at the head of Isedalen which makes access along this route difficult. The shore along the NE side of Kvænangensund is rocky and access by small boat is advisable only at Reinfjord, Björnvik and Tverfjord. Other points are accessible only in very calm seas.

2. Explanation of the map.

The geological map is drawn on base sheets enlarged from AMS series maps and locally modified with the aid of aerial photographs. The topographical representation is not intended to be entirely accurate.

Boundaries between rock types within the ultramafic complex are gradational in many instances. The lines drawn are intended to give the general distribution of the varies ultramafic facies, and may not be strictly accurate.

II Geology

The main geological features of the area covered by the map are given by Bennett (1971).

1. Definitions

Dunite: A rock consisting of more than 90% olivine

Wehrlite: A rock with essential olivine and clinopyroxene

Lherzolite: A rock with essential olivine, clinopyroxene and orthopyroxene.

Peridotite: A general term for olivine-bearing ultramafic rock

Pyroxenite: A general term for ultramafic rock consisting of pyroxene with up to 5% olivine

Wehrlitic dunite: A peridotite with up to 20% clinopyroxene:

Abbreviations: ol=olivine, cpx= clinopyroxene, opx= orthopyroxene, plag= plagioclase feldspar, amph= amphibole (in this case hornblende).

2. Distribution of rock types

a. The ultramafic complex.

The ultramafic complex contains a crudely concentric zonation of rock types: the Upper Dunite Zone (UDZ), occupying the high ground in the vicinity of Langfjordjökelen consists of homogeneous dunite and wehrlitic dunite with poikilitic clinopyroxene. Partly surrounding the UDZ and forming the plateau S of Langfjordjökelen lies the Middle Layered Zone (MLZ), a series of regularly layered clinopyroxenites, wehrlites and dunites. This zone grades laterally into the lherzolitic Upper Marginal Zone (UMZ), a zone of hybrids containing pyroxenitic and feldspathic members. A screen of gabbro 100-150m thick lying within the SW part of the layered sequence divides the UMZ (above) from the Lower Marginal Zone(LMZ) below a sequence of massive repeatedly layered lherzolites, characterised by the appearance of poikilitic bronzite.

Both marginal zones contain concordant rafts and lenses of recrystallised gabbro in various stages of assimilation, and also contain concordant spindled masses of course-grained olivine-pyroxenite and melagabbro.

The boundary between the marginal zones and the MLZ is based on the disappearance of orthopyroxene as a conspicuous primary phase. Field eveidence for a transition between the MLZ and the UDZ is ambiguous: on the W side of the complex the boundary is truly gradational and has been mapped on the criterion of the disappearance of conspicuous clinopyroxene schlieren. On the E side however, the UDZ shows a sharp contact with the MLZ and the UMZ, the relationship being both intrusive and tectonic, in places being marked by a shallow thrust.

b. The gabbro.

It is probable that the layered gabbro sheet once formed an envelope to the ultramafic complex, broken only on the SW side where layered peridotites intrude garnet-gneiss. The contact between the lowest part of the gabbro sheet and the garnet-gneiss is generally concordant and may be interlayerd and gradational (eg. at Kjerringdalen). At Storvannet, the contact between gabbro and gneiss is affected by later tectonism which has reulted in shearing and an abrupt steepening of the foliation in the gneiss.

The gabbro screen lying within the SW part of the ultramafic complex displays concordant layered contacts with peridotite. The screen is an integral part of the layered gabbro sheet and expands southeastwards towards Kjerringdalen.

Contacts between the upper part of the gabbro and the peridotites exposed on the high ground E of Langfjordjökelen and on peak 1001 are similarly flat-lying and interbanded.

3. Faults

Two major fault zones cross the area on bearings between 040° and 080°. The fault zones are complex and involve considerable shattering, but generally produce an aggregate downthrow to the north. They also involve sub-horizontal movement. Several small faults with a similar trend have also been mapped.

This trend is offset by later fractures trending 120°. Serpentinisation of the ultramafic rocks is pronounced along the major fault zones, especially along the Storvannet- Tverfjordalenvann profile.

4. Ultramafic veins

A network of peridotitic veins cut the layered peridotites of the ultramafic complex and locally invade the marginal gabbro. The veins represent late-stage crystallisation products directly related to the emplacement of the ultramafic complex. No mineralisation has been found directly associated with these veins.

III Petrology

1. The gabbro

The petrology of the gabbro is given by Bennett (1971). In general terms the gabbro assemblage is:-

cpx+opx+plag(An_{50-65})$\pm$ol(Fo_{82-83})+magnetite+ilmenite$\pm$green spinel$\pm$amph$\pm$biotite.

Apatite, zircon and sphene are accessories Minor amounts of disseminated sulphides occur in the lower (mafic) layers at Storvannet, together with some chrome-spinel.

2. The ultramafic complex

a LMZ. cpx+opx+ol(Fo_{78-85})$\pm$plag(An_{68-83})+magnetite+ilmenite$\pm$chrome-spinel$\pm$sulphides

b.UMZ cpx+opx+ol(Fo_{76-85})$\pm$plag(An_{68-76})$\pm$chrome spinel+magnetite +ilmenite$\pm$sulphides

c.MLZ ol(Fo_{83-89})+cpx$\pm$chrome spinel +magnetite+ilmenite$\pm$sulphides

d. UDZ ol(Fo_{88-90})±cpx+chrome spinel+magnetite+ilmenite±sulphides

Amphibole, biotite and apatite are accessory minerals in all zones. Orhtopyroxene is a secondary mineral in the MLZ following the reaction

ol+liquid ⟶ cpx+minor opx

Green spinel occurs in reaction coronas between olivine and plagioclase in hybrid marginal facies.

IV Mineralisation

1 Chromite

Chrome-spinel with approximately 22% by weight Cr_2O_3 occurs as dissemination grains between silicates in all parts of the ultramafic complex, but is more abundant in the MLZ and UDZ. No stratiform accumulations have been observed. Values for Cr in analysed samples (with locations on the accompanying map) are given in Table 2 and range from 722-5963ppm. Clinopyroxenes in the ultramafic complex contain between 0.30% and 0.80% Cr_2O_3 and so a significant proportion of total Cr in the ultramafic rocks, especially those rich in clinopyfoxene is held within a silicate phase.

Chrome-spinel is not an important mineral in the gabbro, but is present in small amounts (generally less than 1% by vol.) in the lower mafic cumulate layers exposed immediately S of Storvannet (see values for NOR 4898 and NOR 4816, Table 2).

2. Sulphides

Sulphide minerals occur in minor quantities in most of the rocks of the ultramafic complex. Highest concentrations exist in the LMZ, parts of the UMZ and along the E margin of the UDZ. Areas where sulphide concentrations have been observed are marked on the accompanying map. The highest concetrations have been found in the lower part of the LMZ near Reinfjord and at Kjerringdalen and along the S margin of the UMZ eg. NOR 4841, see map). The high concentrations constitute between 1% and 5% of total volume of the specimens examined.

The sulphide minerals are usually intergrowths with magnetite (and some ilmenite) and occur as irregular segregations disseminated between silicate grain-boundaries, but may also occur as microscopic lamellar inclusions along pyroxene cleavage traces. The principal sulphide phase is pyrrhotite with subsiduary pyrite, pentlandite (with secondary alteration) and chalcopyrite. The predominance of magnetite in ore segregations is attributed to a paucity of S available in th efluid phase.

Ni values for rocks analysed are given in Table 2. Highest concentrations are approximately 2000ppm. Higher concentrations probably exist: no attempt was made to include obviously mineralised samples in the analyses. The locations of analysed samples are given on the map. It is worth remembering that a high proportion of the total Ni in many of the samples analysed is present in olivine.

3. <u>Iron-titanium oxides</u>

Some marginal facies of the gabbro contain high concentrations of Fe-Ti oxides. These rocks are easily recognisable owing to iron-staining in weathering products. The gabbro in contact with garnet-gneiss at Storvannet containsabout 10% by volume of Fe-Ti oxide. Similar concentrations occur in gabbro marginal to peridotite along the southern margin of the UMZ. Fe-Ti oxide also comprises 5%-10% by volume of some horizons in the higher levels of the gabbro (eg NOR 5007)

V. Economic Potential.

1. <u>Dunite</u>

The dunitic rocks of the UDZ show only moderate but nevertheless pervasive serpeninisation. They also contain clinopyroxene, chrome-spinel and magnetite-ilmenite as impurities. Their potential use as refractories is questionable and their location is remote from present steel-making districts.

2. Serpentine, talc etc.

Serpentinisation is well advanced along the Storvannet fault zone but no extensive high-grade deposits of serpentinite, talc, magnesite or asbestiform minerals occur within the complex.

3. Chromite.

No workable concentrations of chromite have been found.

4. Iron-Titanium ore

The concentrations reported are of low-grade compared with similar-type deposits now being exploited, and are not considered significant.

5. Sulphides (Nickel)

Potential areas for investigation into sulphide mineralisation are marked on the map . The mineralisation appears to be closely associated with coarse-grained (sometimes pegmatitic) pyroxenitic rocks along the margins of the complex The sulphides are of magmatic origin, and the surrounding garnet-gneisses are not mineralised Concentration of a late-crystallisation fluid phase along a temperature and fluid-pressure gradient at the margins of the complex seems a likely explanation for their occurrance There is no reason at present to suggest that a mineralised zone formed by gravitational settling of an immiscible sulphide phase should be present at depth.

Mineralogisk-Geologisk Museum,
Sarsgt 1,
Oslo 5.

28th May 1972.

M C Bennett

Table 2. Trace-element results for rocks from the Reinfjord ultramafic complex and its gabbro envelope.

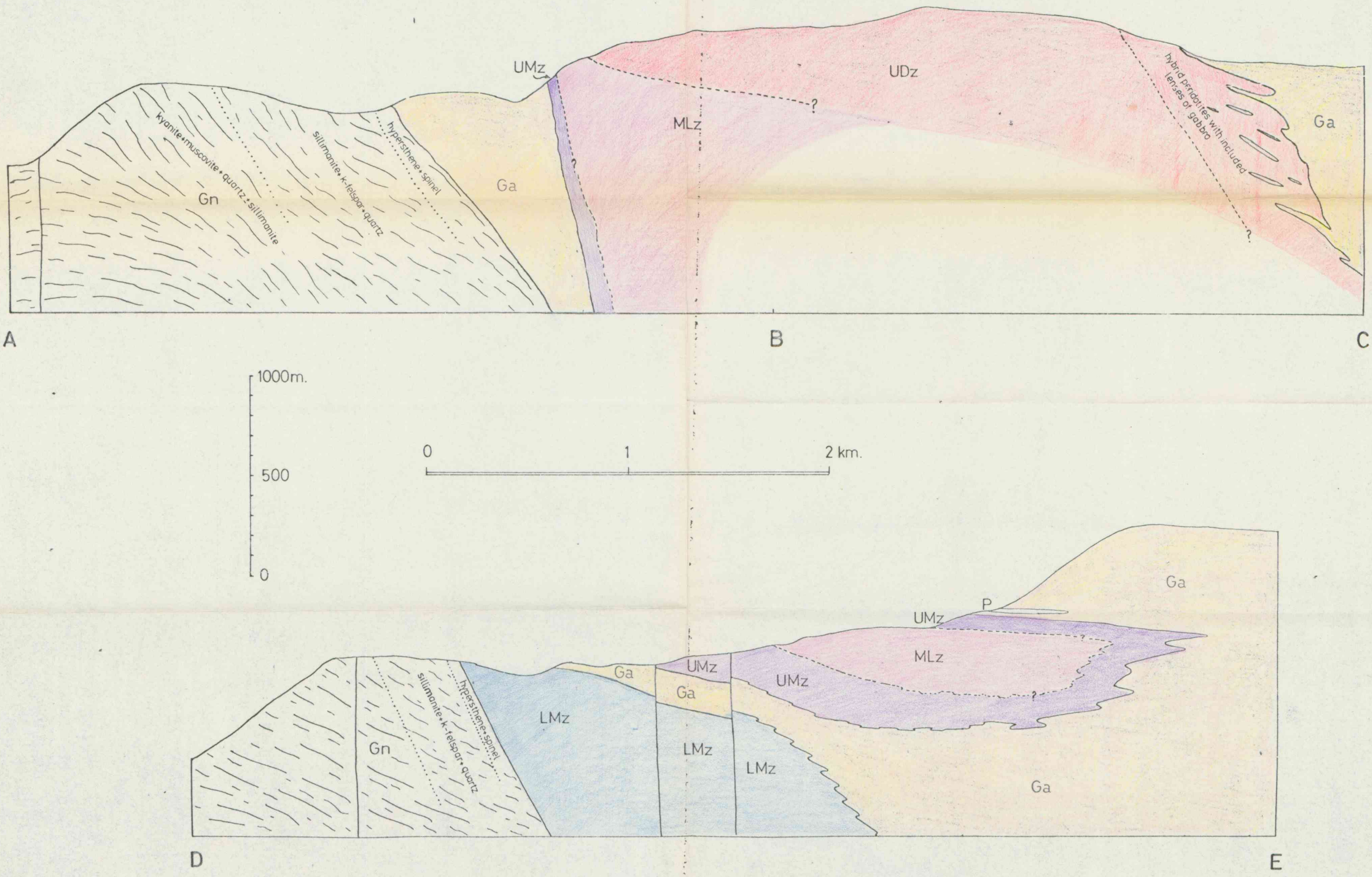
Rock no. and zone	Rock Type	Concentration in ppm			
		Cr	Ni	Na	K
Upper Dunite Zone					
NOR4899	Wehrlite	1449	1643	230	<20
NOR4950	Dunite	1837	2156		
NOR4980	Dunite	2612	2243		
Middle Layered Zone					
NOR4864	Olivine-pyroxenite	2022	639		
NOR4915	" "	3293	1085		
NOR4916	Wehrlite	1995	702		
NOR4846	Olivine-pyroxenite	5963	671		
Upper Marginal Zone					
NOR4841	Lherzolite	1664	1327		
NOR5000	Clinopyroxenite	2517	602	1224	30
NOR4906	Olivine-pyroxenite	752	591		
NOR4936	Felspathic-peridotite	2322	498		
NOR4937	Pyroxenite	1616	285		
NOR4969	Felspathic-peridotite	1956	620		
Lower Marginal Zone					
NOR4817	Olivine-pyroxenite	2850	856	1892	800
NOR4992	" "	1744	763		
NOR4873	" "	2438	852		
NOR4957	Olivine-rich peridotite	825	1193		
NOR4963	Pyroxene-rich peridotite	2856	367		
NOR4997	Lherzolite	871	1147		
NOR4877	Olivine-pyroxenite	3161	485		
'Early' coeval veins					
NOR4948	Clinopyroxenite	4870	904		
NOR4851	Wehrlite	1859	1535		
'Late' coeval veins					
NOR4952		996	903		
NOR4982		732	345		
NOR4986		1809	938	2300	220
Layered gabbro sequence					
1. NOR4898 (base)		700	294		
2. NOR4816	Gabbro	336	418	7049	830
3. NOR4856		22	106		
4. NOR5007 (top)		<10	54		
Hornfelsed gabbro					
NOR4917		226	306		
NOR4938	Gabbro	112	119		
NOR4959		765	325	5937	650
Amphibolites					
NOR4843		340	177		
NOR4883	Amphibolite	280	198		
NOR5008		174	177		

References.

Bennett, M.C., 1971. The Reinfjord Ultramafic Complex. (Extended abstract). Norges Geol. Undersök., 269, 165-171.

Hooper, P.R., 1971. The mafic and ultramafic intrusions of S.W. Finnmark and North Troms. Norges Geol. Undersök., 269, 147-158.

DIAGRAMMATIC SECTIONS THROUGH THE REINFJORD ULTRAMAFIC COMPLEX



Legend as in Fig.1

Boundaries between ultramafic zones are gradational

Geological Map of the Reinfjord Ultramafic Complex Nord Troms, Norway.

By M. C. Bennett 1971.